Awareness and Use of Mobile Phone Apps by Farmers in North West Nigeria

AA Khidir

orcid.org / 0000-0003- 2163- 6625

Thesis submitted in fulfilment of the requirements for the degree
Doctor of Philosophy in Agriculture with Agriculture Extension
at the North-West University

Promoter: Prof OI Oladele

Graduation ceremony: April 2020
Student number: 29603757

DECLARATION

I, the undersigned student, declare that this thesis titled "Awareness and Use of mobile Phone Apps by Farmers in North West Nigeria" submitted to the North-West University, Mafikeng Campus in partial fulfilment for the award of degree of Doctor of Philosophy in Agricultural Extension, Faculty of Natural and Agricultural Sciences, School of Agricultural Sciences is my own work. The work presented herein, is my original and innovative efforts with the exception of citations therein, and I attest that this research effort has not, to the best of my knowledge, been presented anywhere for award of any form of degree.

Name: Abdullah Abubakar, **KHIDIR**

Signature: 

Date: 16 – 03 – 2020

DEDICATION

This research study is sincerely consecrated to the Almighty God, the Omnipotent, for His grace, mercies, divine favour and assistance, which enabled me to complete this study successfully.

ACKNOWLEDGEMENT

My heartfelt and profound gratefulness goes to my Supervisors, Prof. O.I Oladele, Dr L.K. Mabe and Dr S. Modirwa, for their stern principles and strident guidelines which greatly improved this work. Sir and ma, it was not easy, but every single correction was worthwhile. My special thanks to all the Lecturers present during the Department and School presentations. Your various contributions have indeed improved this research work. I am indeed very appreciative to my Wife, Mrs. Fauziya Atinuke KHIDIR, and our beloved children Ahmad Abdullah Khidir, Abubakar Abdullah Khidir, Abdurrahman Abdullah Khidir, Abdullah Abdullah Khidir, Abdulbaasit Abdullah Khidir and Halima Abdullah Khidir. I really appreciate their patience and endurance all through the study period. My profound gratitude goes to Mrs Oladele for her motherly care and concern during my stay in South Africa; Dr. Akinyemi Mudashiru and Dr. Yusuph Jelili, for their relentlessness at maintaining their motivation push to ensure the successful completion of the study; Dr. Haruna Kura, Dr. Mathew Olasupo, Dr. Esther Fayemi, Dr. Latifat Kehinde Adebayo, Dr. Abdulhakeem FMC, Mr Saheed Oyeniran, Mr. Adeola Segun, Mr. Emmanuel Fawole, Mr. Thaddeus Bodaga, Mallam Junaidu Musa, Mallam Sanusi Belli, Mallam Tijani Abu Rimi, Mr Fahad Ibrahim, Mr Ahmed FUDMA, Uncle Timothy, and all well-wishers who could not be mentioned here. I will forever be indebted to all the staff of the Nigerian Agricultural Extension Research and Liaison Services (NAERLS) and Katsina and Kano States Agricultural and Rural Development Authority (KTARDA and KNARDA) for providing me with all the necessary assistance during the field work. My profound gratitude goes to my aged parents, Alhaji and Mrs. Khidir Abubakar. Finally, I also sincerely appreciate the congregation of Deeper Life Campus Fellowship (DLCF), North-West University South Africa, for the moral support which made me feel at home during my studies.

Abdullah Abubakar, KHIDIR

Department of Agricultural Economics and Extension
North-West University, Mafikeng Campus, South Africa.

Table of Contents

Table of Figures

LIST OF TABLES

ABBREVIATIONS

ADP	Agricultural Development Programme
CABI	Centre for Agriculture and Bioscience International
CTA	Centre for Agricultural and Rural Cooperation
ECX	Ethiopia Commodity Exchange
FCT	Federal Capital Territory
FAQ	Frequently Asked Questions
FAO	Food and Agricultural Organization
GAP	Good Agricultural Practice
ICT	Information and Communication Technology
ICTA	Information and Communication Technology Agency
IDS	Internet Data System
IFAD	International Fund for Agricultural Development
IFMR	India's Institute for Financial Management and Research
IIT	Institute of Information Technology
IRRI	International Rice Research Institute
ITU	Information Technologies of the United Nation
IUU	Illegal, Unreported and Unregulated Fishing
IVRS	Interactive Voice Response Services
KACE	Kenya Agricultural Commodity Exchange
KHETI	Knowledge Help Extension Technology Initiative
MACE	Malawi Agricultural Commodity Exchange
MITOWA	Market Information System and Trader's Organization of West Africa
NAERLS	National Agricultural Extension and Research Liaison Services
NCC	Nigerian Communications Commission
NDFA	National Directorate of Fisheries and Aquaculture
NMRiceMOBILE	Nutrient Manager for Rice Mobile
NPC	National Population Commission
RFLP	Regional Fishery Livelihood Programme
RML	Reuters Market Light
SDG	Sustainable Development Goal
SMS	Short Messaging Services

VERCON	Virtual Extension, Research and Communication Network
WAP	Wireless Application Protocol

ABSTRACT

This research examined the awareness and use of mobile phone applications in North-West Nigeria and specifically investigated the demographic and socio-economic characteristics of farmers, mobile phone apps available, awareness and usage levels of agricultural mobile apps, extent, intensity, purpose, knowledge, and constraints to apps use by farmers. The study adopts *ex-post facto* design with a sample size of 385 farmers from an extension block of Agricultural Development Project in the Selected States of Katsina, Kano and Kaduna. Using a multi-stage, coupled with purposive and random sampling techniques, three hundred and eighty-five (385) respondents, who provided main statistical data for this study through the application of a set of pre-tested and structured questionnaires, were selected. Data were analysed with frequency counts, percentages, standard deviations, Tobit regression model, OLS regression model and probit regression model. The results showed that the average age of farmers in the zone was 36.5years, while the average farming experience recorded was 16 years. Majority of the respondents were males, had one form of formal education, had mean household of 7 members, had access to land through ancestral heritage, did not belong to any farmer association, engaged in farming as their primary occupation and practiced Islamic religion. Furthermore, the majority (96%) of the respondents owned mobile phone, out of which 60.5% were owners of analogue phones. Most Farmers in the region were mostly aware and used voice call and SMS apps: call app (95%) and SMS (78%), however with a low intensity of usage *vis-a-vis* 1.410 and 0.932 respectively. Findings further revealed the main purposes farmers use mobile phone apps include: Use of call app for contacting family and friends (96%), purchase of farm inputs (70%) and marketing/general information (65%); while SMS is used mainly to contact family and friends (59%). The farmers generally had positive perception toward the mobile phone usage and its associated technologies. Furthermore, they were highly knowledgeable on the ability to place and receive voice calls (94%; $\bar{x}$=0.940, SD=0.237), understand when out of airtime (84.9%; $\bar{x}$=0.849, SD=0.358), store and retrieve numbers at any time (83.9%; $\bar{x}$=0.839, SD=0.368) and load airtime (81%; $\bar{x}$=0.810, SD=0.393). The constraints identified by the majority of the respondents affecting the awareness and usage of mobile phone apps include the high cost of phones (78%), poor network (77%) and complexity in operating phone (73%). However, the results of the severity of the constraints showed that the most severe constraints include high cost of phone ($\bar{x}$=1.8; SD=1.03), poor power supply ($\bar{x}$=1.7; SD=1.20) and poor network ($\bar{x}$=1.6; SD=1).

Probit regression model showed that the significant determinants of the adoption of mobile phone apps include knowledge, constraints, attitude, nature of the occupation, mobile phone as communication gadget, type of labour, ownership of farmland, religion, years of farm experience, marital status, age and location. The result of Tobit regression analysis of factors influencing use intensity of mobile apps in the study area unveiled that age ($p<0.05$), nature of education ($p<0.01$), farming experience ($p<0.01$), housing material ($p<0.05$), nature of occupation ($p<0.05$), attitude ($p<0.1$), awareness ($p<0.01$) and knowledge ($p<0.01$) significantly influence the extent / intensity of usage of mobile phone apps. Moreover, the Ordinary Least Square regression result of determinants of

intensity/extent of usage of apps in the area showed that nature of education (t=3.30), years of farm experience (t=3.21), awareness (t=11.01) and knowledge (t=6.54) were significant at 1 percent level of significance, while age (t=2.20), home material for living home (t=2.32), nature of occupation (t=2.35) and attitude (t=2.04) were significant at 5 percent level of significance, thus indicating that eight variables significantly influence and determine the intensity and extent to which mobile phone apps are utilized in the study area. It was concluded that mobile phone apps are not well utilized by farmers in the study area despite their highly favourable disposition to the technologies and as such, it is recommended that stakeholders in agricultural and rural development come up with policies and programmes that would increase the awareness and adoption level of mobile phone apps in the region through the enhancement of the enlightment levels of the farmers, establishment of training centres focused on the use of mobile phone apps and internet exploration, e-extension model that is premised on mAgric and encouraging active utilization of the apps for farm-related information accessing and dissemination in the farmers-extension-workers-researchers linkage or pathway, while taking into consideration those factors influencing the use of these apps. More so, change agents like extension workers, local and international agencies should encourage the diffusion of contemporary technologies among small scale farmers and identify the highly vulnerable farmers to barriers in the adoption/diffusion pathway for special intervention.

Keywords: Attitude, awareness, knowledge, mobile phone, purpose, use of mobile phone apps, and use intensity.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

In recent epoch, science and technological innovations have assisted farmers immensely in the industrial worlds by driving massively, agricultural productivity. However, the reverse has always been the case in the developing world, where smallholder farmers responsible for about 80 percent of the food production are still far from recording similar gains (IFAD, 2011). Many of the farmers in this part of the world are women who are short of access to lots of tools required for sustainable livelihoods like contemporary irrigation and crop management practices, fertilizers, mobile technology, postharvest loss-control mechanism, improved seeds as well as information and extension services (Kwadwo and Daniel, 2012).

The importance of technology in agriculture includes its significant role in remedying the effect of inadequate numbers of extension workers in the Asian and African continents. Farmers can contact extension officers at any time via mobile lines for information; and the poorly equipped officers in terms of latest information also take advantage of the mobile technology to access agricultural newsletters to get the most up-to date details and pass the same to the farmers (Okeke *et al*., 2015). ICT also plays a vital role in easy management of running farms and other agricultural businesses by ensuring effective record keeping, storage of information and effective communication among farmers and extension officers (Subair *et al*., 2012).

Before the advent of Information and Communication Technology (ICT), particularly the mobile phone system, growth in the agricultural sector was almost a mirage in developing countries like Nigeria, especially when attention and resources were shifted to the oil sector. The large gap in the farmer-extension-research ratio compounded the problems and as a result, farmers rarely have access to the latest information on the global trends in the agricultural sector. They were often left to be contented with their traditional or indigenous ways of farming and occasional contacts with extension agents, friends and family members. However, with the advent of ICTs, the roadmap for growth and development changed and the agricultural sector is gradually experiencing rapid positive transformation.

In the context of contemporary Nigeria, the conceptualization of ICT is perceived as a phenomenon and increase utilization of it in all sectors of our national system has been sensed basically during the introduction and exploitation of global system of mobile telephony. The uniqueness of this component is premised on the fact that it offers opportunities for everyone and communities at large to be the source and consumers of information. According to Subair *et al*. (2012), the mobile phone increasingly enhances affordable or low-cost access and sharing

of information and also encourages and facilitates interactive participation in the creative application of sourced information.

Okeke *et al.* (2015) identified various sources farmers can access information like mobile phone, radio and TV, video displays, web or net portal, rural telecasting, farm call centres, Emails, offline-related multimedia CDs, open distance learning facilities, and contact databases. These are ICT tools commonly in use in agriculture. These tools have proven to be effective and reliable in facilitating information processing, storage, retrieval and transmission. Their reliability as a source of information was further stressed by Torero and Von (2005) as cited in Okeke *et al.* (2015), as veritable tools with which a network of interactions can be stimulated among individuals such that they overcome the physical barriers of distance and social standings to become integrated in the global knowledge system.

The extent to which farmers are aware and apply the ICTs will be commensurate with the extent to which the desired growth and transformation in farming activities would be achieved. Several studies (Christine *et al.*, 2011; Siwel, 2012; Xiaolon and Shaheen, 2012) have shown that the mobile component of ICTs has the highest usage in agricultural information system worldwide. The exceptional speed of adoption and consumption of mobile technologies have raised the generally universal hope on its prospective contributions to the diffusion of innovative and modern farming technologies promptly with appreciably impressive speed (Xiaolon and Shaheen, 2012). Mobile technology is a strong tool that can support farmers to boost their yields by connecting them through text messages and helplines to agricultural market information, finest practices and consultative services designed to meet their local needs (AVCA, 2011).

According to Kwadwo and Daniel (2012), in Africa, the livelihoods of over 70% of the rural populace depend on the agricultural sector, and regrettably, remote communities have the highest cases of incidence of impoverishment and hopeless food security projections. In addition, a key factor responsible for low livelihoods in these rural African communities is the predominantly poor outputs that have, over the years, characterized the agricultural sector. The authors then submitted that any endeavour at pacifying the scourge of poverty would invariably mean focusing on the transformation of the agricultural sector. They further add that the lack of technological and market information were the foremost reasons for the low productivity. This acknowledges that the availability of relevant facts and figures as well as being well equipped with the information have become the main driving force of societal and economic revolutionary expectations in today's world. Similarly, the rural areas in Nigeria cultivate the bulk of the food that feeds the nation (Tijjani, Akpoko and Abdullahi, 2015). In fact, the main source of livelihood to the people in rural areas of Northwest zone was acknowledged by Epka, Oladele and Akinyemi (2017) to be agriculture. Furthermore, the zone is recognized as an agricultural centre for the country despite that it remained the poorest (NBC, 2013, as cited in Ekpa, 2017). A number of researchers (Kwadwo and Daniel, 2012; Tijjani, Akpoko and

Abdullahi, 2015; Ashoka and Ashoka, 2016; Okeke *et al*., 2015; Sulaiman *et al.,* 2015) have shown that information system remains key to the development of the sector. With the rapid and sharp upsurge in mobile phone technologies, and with the remote areas not left out, the extraordinary rate of acceptance of the technologies, according to Xiaolan and Akter (2012), has generally heightened the hope about its prospective contributions to the spread and diffusion of modern farming techniques within the shortest possible times. Indeed several rural communities in other parts of the world, most specifically rural communities in developing nations, are currently witnessing an unprecedented revolutionary trend in agricultural development occasioned by the evolution and widespread adoption of contemporary mobile phone technologies. For instance, Balwant Singh (2013) working paper 29, Capturing the Gain, gave practical instances where farmers affirmed to the high efficacy potential of mobile phone technologies in improving their agricultural production. In addition, remarkable success recorded by the SMS-dependent services initiated and developed by Zambian's National Farmers' Union (e-Transform AFRICA, 2012) as well as the Musoni Services— Microfinance join the cloud in Kenya, Myanmar, Tanzania, Uganda, and Zimbabwe are another few instances. Despite the fact that the zone is recognized as an agricultural centre of the nation, with majority of people from the zone engaging primarily in farming (Olapojo, 2012; in Ekpa, 2017), and the fact that farming is their primary source of earning and livelihood (Ekpa, Oadele and Akinyemi, 2017), the zone is acknowledged to be the poorest among other geopolitical zones of the nation (NBC, 2013; in Ekpa, Abayomi and Denis, 2017). The question now is, given the high potential proficiency of mobile phone technologies to positively revert the ugly face of agriculture and in turn enhanced socio-economic conditions of rural farming populace, are farmers in the North-West Nigeria aware of these opportunities? If yes: To what extent have they been applying the tools, considering their present degenerating poverty situation presumably sustained by low agricultural production?

As mobile phones diffusion rate increases rapidly in developing worlds, there is also a corresponding increase in research on the usage of mobile phone technologies, particularly by farmers resident in rural domain. For instance, in Tanzania, fishermen are exploring mobile phone technologies to promptly share vital information among themselves on critical variables like weather forecasts, locations expected to make the best catch, neighbouring market information and to organize pick-up of catches. The case of digital mandi (for the Indian Kisan) used by farmers to get information about current rates of crops at different market, sources and accessibility of seeds and additional inputs, availability of pesticides and prevailing market prices for agricultural products as well as the E-wallet programme in Nigeria aimed at curbing corrupt practices in input supplies to core rural farmers are other good examples. These and many other applications of mobile phones have proven the widespread consciousness and adoption of mobile phone technologies amongst food producers (farmers) in general, as evidenced by the report of the Nigerian Communication Commission (NCC, 2016). However, the high rate of poverty, food insecurity and hunger in North West Nigeria (Dauda *et al.,* 2017; United Nation, 2016) are believed to have been entrenched and

sustained by low agricultural output in the rural areas as well as periodic religious and ethnic problems (Kwadwo and David, 2012; Maclaulay, 2014).

1.2 Problem statement

ICT revolution has led to the development of many mobile phone applications. These include apps such as voice call app, SMS/MMS app, browser, WhatsApp, Facebook, IMO, recorder, Gmail, Google, Instagram, opera mini, chrome, YouTube and Yahoo mail, farmerConnect, Farmer HelpLine, E-Wallet, NAQAS, mFishery, iCow, Rural eMarket, Esoko, Agribiz, AgroSIM, M-Shamba, m4agriNEI, etc. Some of these applications are applied in agriculture in areas such as pre-cultivation activities like information on crop choice, selection of appropriate land for farming, calendar design, how to access credit. In addition, they are applied in best practice crop production such as best practices on land preparation, access to input and its management, information on best practices for water, pest and fertilizer management. Furthermore, they are applied for post-harvest activities as in marketing, transportation, packaging and processing; and weather updates for prompt decision to avert losses.

According to Okunoye and Ilorin (2017), Nigerian internet penetration stood at 45 percent, up from 38 percent in 2013, as the number of actual mobile phone subscribers also increased from almost zero in 2000 to over 148 million subscribers with 106 percent teledensity in March 2016. Most recently, the Nigerian Communications Commission (NCC), (2020), unveiled that active mobile internet users was over 172 million subscribers with a teledensity of 123.48 percent as of December, 2018. The latest ITU data unveiled that over 138 million mobile phone subscription and a mobile phone infiltration rate of 77.8 percent in 2014, a rise from 73 percent in 2013. Payments for mobile internet services (subscription) have also progressively improved in the past years observed. Evidence by the report of NCC showed that 95,940,792 mobile internet subscribers were recorded in January 2016, corresponding to a dispersion rate of 51 percent (Udeogu, Adibe and Ike, 2017). With more than half of the Nigerian population (51%) now acknowledged to be internet users and ranked 8th globally as the internet consuming nation, the country's telecommunication system is considered as one of the most fastest rising telecom sector in the African continent (Internet World Statistics, 2017; Adeleke and Aminu, 2012; Nwaubani and Kapoulas, 2013). Additionally, internet Live Statistics (2017) showed that Nigeria has the highest internet customers when compared to South Africa, Kenya, Mauritius, Morocco and Tunisia. Furthermore, with reference to data from the Central Intelligent Agency (CIA) World Factbook unveils that 43% of the country's populace is between the ages of 0-14 years, 19.6% are between the ages of 15-24 years, 30.74% are between the ages of 25-54 years, 3.97% are between the ages of 55-64 years while only about 3.13% of the population is over 65 years of age (CIA, 2018), implying that a higher number of smartphone and internet users in Nigeria are between 13-50 years of age. Report of increase in youth participation in agriculture empowerment programs championed by the current administration in the country aimed at capacity building on agriculture in order to reduce youth unemployment, restiveness and poor agricultural output can be overcome if agriculture can tap into smartphone, internet and social media penetration amongst the youth

which forms the bulk of the Nigerian population. This serves as a motivation for this research effort at reviewing the awareness and scope of deployment of various mobile phone applications available to farmers and to present a mobile App design that will provide day to day information about farming activities for optimum decision making and enhanced agricultural production.

Rebekka and Saravanan (2015) found that the ICT gadget most widely and conveniently used by an overwhelming majority (over 90%) of the selected farmers was mobile phones. Furthermore, the farmers affirmed using the mobile phones for social communications, contacting middlemen for marketing of their farm produce and contacting professionals instantaneously for agricultural advisory services, as well as in times of health emergencies. Also, Isaac (2016) established that mobile phones have significantly enhanced rural livelihood, specifically in the context of market-oriented farming carried out under an enabling and favourable ICT regulations, policies and adequate infrastructures. In light of this, Isaac recommended a market-driving farming for small-scale or subsistence food producers so that they can maximize the benefits of mobile phone technologies.

Similarly, Williams and Opeyemi (2015) earlier ascertained that marketing, managing of animal health, linking customers, remote managing of farms and general use like contacting stakeholders in real time during difficult situations were key areas farmers significantly explore the benefits of mobile phones. In addition, Surabhi (2016) discovered that services in the form of information delivery to farmers through mobile phone technologies contributed significantly in discouraging information biasness among farmers generally and along gender line in particular. The findings of the study, as explained by the author, unveiled that farmers that participated in the research work as respondents, affirmatively reported the positive impact of mobile phone technologies in their farming activities. According to the them, this is pronounce in areas of access to accurate and well-timed weather-centred recommended agro-related messages that have aided their prompt, timely and precise response by making informed decisions where necessary like getting the right input in the appropriate proportion in place and the proper usage of the input. These have in turn assisted in bringing down significantly the cost of production.

Jimma, 2017, also unveiled the Agriculture Hotline Service initiated to help enhance extension delivery activities in Ethiopia. According to the author, the service is well known to have significantly impacted positively on extension practices. Describing the application, the author illustrated that the Hotline is a free Interactive Voice Response (IVR) and SMS through which information gets to farmers on cereal, horticulture and pulse and oilseed crops as well as wide range of general agricultural related activities. It was further revealed that there were over 90 lines taking an average of 35,000 calls daily, available in the main local languages — Amharic, Oromiffa and Tigrinya. Remarkable indeed, as the language barrier no longer became anything to worry about as far as mobile ICTs applications are concerned.

The Nigerian agricultural economy has enormous potentials and agricultural inputs play very important function in exploiting these opportunities in all aspect of farming. It has been reported that in the past, nearly all input procurements and deliveries in the country were fraught with fraudulent activities, discrepancies and poor management (Tiri *et al.,* 2014). These unhealthy situations have cost the government at both Federal and State levels huge sums of money on agricultural inputs procurement and distribution which often did not reach the proposed beneficiaries (smallholder farmers) and thus, did not have significant impact on the nation's food security status (Adenegan *et al.,* 2018). The Federal Government shouldered virtually all procurement and distribution of fertilizers. This situation dampened the prospect and capacity of private companies to partake effectively in the sector. As with most subsidy regimes in the country, the sector was nauseatingly underdeveloped which opened various windows of opportunities for fraud and diversion. Worried by the repulsive development, the Federal Government came up with the Growth Enhancement Support Scheme (GESS) which was designed to be a substitution scheme aimed at making available subsidized farming inputs needed by farmers via an electronic wallet mechanism (e-wallet). In the programme, a certified farmer usually receives inputs provisions through the e-wallet apparatus that is furnished with unique voucher numbers relayed to him/her through his/her mobile phone via an SMS app. The farmer thereafter goes to a corresponding accredited agro-allied dealer to claim the inputs (Ezeh, 2013; Adesina, 2013; Signal Alliance, 2014). Every state designated Agricultural Development Project (ADP) provides helpline staffs, with at least 3 helpline staffs (mainly extension workers/agents) designated to every Local Government Area within its jurisdiction. The helpline staffs and supervisors are in daily contact with the farmers via apps such as call app, WhatsApp etc. with the aim of satisfying their agro-related requests. The redemption supervisor assists in the Verification of the identity of the farmer and code as contained in the SMS message acknowledged and presented by the client (farmer) also who likens it with the information on the farmers' register as received by the supervisor from the service providers. Thereafter, the inputs are delivered right away to the verified farmers via their mobile phones in the form of redemption code and directive for collection (Grace, 2014). In addition, the project provides direct connection between the farmers and major players in agro-inputs as well as the government, which enables the government to circulate valuable information and access farmers' worries for appropriate policy action, thus ensuring farmers' progress (Ezeh, 2013).

According to Yusuf, Abdullahi and Haruna (2015), most of the beneficiaries (smallholder farmers) perceived e-wallet scheme as effective in ensuring transparency and reducing sharp practices prevalent in the old system of input procurement and distribution. Other agricultural apps in existence that have shown significant potential in enhancing farming activities include Connected Farm Field App that allows farmers to take records of farm activities during farming operations (Oguntie *et al.,* 2018); RiceAdvice-Weed Manager an android-based app developed by Rice Africa to tprovide farmers with guidelines on specific field management practices for rice production operation in many parts Africa including Nigeria (AfricaRice, 2018); App developed 2017 by the

Nigerian digital agriculture platform called Farmcrowdy for Android, iOS and Windows mobile devices with the aim of creating an environment of farming that is characterized by less drudgery and stress by using a mobile phone and profit maximization in a collaborative manner between the well-to-do referred to as sponsors and the poverty-ridden rural farmers whose production bases have often been limited by lack of fund. With the aid of the app, the sponsors can identify farm choices and sponsor as many units as could be afforded by paying the required amount for the farming operations. Updates on the progress made are sent to the sponsors and at the end of the farm cycle period, the sponsors get back their sponsorship fees/costs as well as the share of the profit as returns on harvests (Oguntie et al., 2018)

With all these applications and decision support initiatives or systems within the agricultural domain, predominantly in the developing world; coupled with impressive internet penetration rate under the control of teaming youths as internet customers; as well as remarkable successes in access, and adoption utilization of ICT (particularly the mobile components), low agricultural production and food insecurity have continued to bedevil the developing countries like Nigeria, with a more serious situation in the selected states as reflected by the high incidences of poverty in the region – 76.4 percent and 82.2 percent for Kano and Katsina States respectively; with a regional average value of 80.9 percent (UN, 2016). Given this worrisome circumstance despite the healthy spread of mobile technology in the country, it becomes pertinent to ask the questions on awareness and usage status of ICTs in the area.

Given the high penetration rate of mobile phone apps and their efficacy at enhancing agricultural output through timely, prompt and accurate information flow as recorded in several other parts of the global communities which are mostly the developing countries like Malawi, Kenya, Bangladesh, DRC and Ghana (Kwadwo and Daniel, 2012; Stephane and Bianca, 2016; Raheem and Jocelyn, 2016; Charlie, Stephane and Bianca, 2014), it becomes necessary to know through an empirical finding, the awareness and usage-status of mobile phones apps in the zone. Ogbonna *et al.* (2015; 2012), Sulaiman *et al*. (2015) and Okeke *et al*. (2015) have laid emphasis on the effectiveness of ICT towards effective agricultural service delivery; and have evaluated factors related to farmers' desire and willingness to use technology in accessing farm-related information in many parts of Nigeria. None have, however, examined the awareness and exploration of mobile telephony applications by sodbusters in Nigeria, and specifically, the region under consideration. This research endeavor was designed to fill that gap, and as well come up with a mobile application model(s) that would be suitable for the information needs of the farming communities in the area.

1.3 Research questions

In an effort to find a lasting solution to the problem, the study was guided by the following research questions:

1. What are the socio-economic features of the respondents?
2. What is the farmers' awareness of mobile Apps in the area?

3. Are farmers using mobile Apps in the area?
4. To what extent do they use mobile apps?
5. What purposes are mobile Apps being used for in the area?
6. What are farmers attitude toward mobile Apps?
7. What is the knowledge level of the farmers about mobile Apps?
8. What constraints are the farmers facing with respect to mobile Apps usage?

1.4 Main objective of the study

Mainly, the study determined farmers' awareness and use of mobile apps for agricultural services in the North West region of Nigeria.

1.4.1 Specific objectives of the study

Specifically, the study investigated:

i. The socio-economic and demographic characteristics of the farmers;
ii. Farmers' awareness of mobile phone apps;
iii. The use of mobile phone apps by farmers in the area;
iv. The extent of use of mobile phone apps by farmers in the study area;
v. The purpose of the use of mobile apps by farmers in the area;
vi. Attitude of farmers towards the use of mobile apps in the area;
vii. Farmer's knowledge of mobile apps' usage in agriculture; and
viii. Constraints facing farmers in the use of mobile apps in the area.

1.5 Hypothesis of the study

Ho: There is no significant relationship between some personal characteristics, attitude, knowledge, constraints and the use of mobile phone apps for both agricultural and non-agricultural services by the farmers.

1.6 Significance of the study

Understanding the background and capacity of the farmers are a crucial impetus for a well-articulated policy that will change the state of agriculture prevailing in Nigeria in this era marking an electronic breakthrough worldwide. The result of this study will, therefore, be a potential guide for all stakeholders (governmental, non-governmental agencies, international bodies/agencies etc) involved in the efforts towards improving agricultural production and livelihood condition of farmers in the zone. The evolution of global communication technologies clasps the prospect to unambiguously influence the farmers' livelihoods because agriculture is increasingly becoming knowledge intensive. Having access to timely, accurate and precise information that is tailored to arrays of challenges facing the farmers is critical in helping the farmers make the best use of their resources in the current dynamically changing

circumstance. Therefore, the study outcomes that can potentially serve as an anchor for drawing programs and policies that will build the capacity of the farmers to be able to effectively harness agricultural information in the zone will surely be a highly welcomed initiative.

Effective transfer of farm-related information to farmers is fundamental to the attainment of optimum efficiency in agricultural advisory service delivery practices in the region. Agricultural advisory practices in the contemporary world of information epoch have gained recognition as an indispensable channel of publicizing information and counselling (advisory functions) among grangers in farming communities, an achievement premised on the breakthroughs in ICT, specifically the mobile phone. This is so because the high penetration rate of mobile phone technologies into the agricultural sector has greatly helped to curtail the serious challenge of the wide gap in the extension workers-farmers ratio in several other sections of the planetary. As such, stakeholders in extension services delivery can leverage strongly on the outcome of this finding to effectively strategize on their ongoing effort to bring about the desired changes to agricultural activities in the zone. Taking advantage of the widespread mobile applications coupled with good numbers of network service providers in the rural domain, particularly the study area, is a comparative advantage that should extensively be leverage on for the emergence of effective agricultural extension activities in the area. Research efforts that could contribute towards aligning the rural farmers and extension agents with global trend in the dynamics of information age like this are a viable opportunity to enhance extension service delivery in the zone.

The application of ICT, particularly the cellular telephone technology, in strategic as well as systematic agricultural information dissemination system and rural development is highly noteworthy, considering the fact that its adoption is currently witnessing an unparallel increase in virtually all facets of rustic life in most developing nations. Mobile phone technologies assumed the position of a viable tool in extension services globally because agricultural extension practices depend majorly on information sharing between farmers and a wide range of other key players particularly the front line extension agents that constitute a bridge connecting husbandmen with other foremost players in the agricultural noesis and information system. Having a clear picture of the challenges inhibiting the growth of the agricultural sector in the zone will offer an opportunity for the extension workers and agents to assemble the right resources and information that will help ensure successful service delivery to the farmers. Research work of this nature is a promising ground for the agent to better equip themselves to help the farmers overcome challenges peculiar to their communities. The wide gap between farmers and extension agents is no longer a constraint as this is being bridged by ICT, particularly mobile phone technologies, as the link between the farmers and the agents are tightened in many areas where these technologies are effectively utilized. This offers the agents opportunities to update themselves with circumstances surrounding the farmers, and as such seek for an appropriate answer for the farmers in real time.

In essence, the outcome of this finding can help extension service delivery workers and the husbandmen to ensure timely acquisition and delivery of information; open up doors for capacity development for farmers and extension agents to be able to access information for their respective operations; bring to the fore the challenges peculiar to the area, and hence, could be a potential guide for all stakeholders designing programs and policies for agricultural growth and development in the zone, through the exploration of the mobile phone technologies window of the information and communication technology (ICT).

1.7 Chapter Summary

This chapter introduced the study on the awareness and use of mobile phone apps for both agricultural and non-agricultural services by farmers in North Western, Nigeria amidst speedy diffusion rate of mobile phones in the country as a whole giving the strong background of the region as a key agricultural hub yet the most poverty-ridden component of the country. The statement of the problem was methodically articulated and presented stressing the call for acceptance and exploitation of mobile phone technologies by farmers in enhancing their farming activities and rural development in general in Nigeria for efficient food production and enhanced socio-economic conditions. This gave birth to the delineation of nine research questions which the study attempted to proffer answers to through eight broadened objectives and one hypothesis. The justification and relevance of the study were well expressed in the chapter and the study is projected to make available information to all stakeholders in agriculture and rural development for the evolution of relevant policies that would merge agricultural production in the area with current global trend in food production and poverty eradication.

CHAPTER TWO

LITERATURE REVIEW, THEORETICAL AND CONCEPTUAL FRAMEWORK

2.1 Introduction

This chapter lays emphasis on linking with the existing and available body of knowledge on the issue at stake as well as reflecting on contributions from past research. It reviews relevant works of literature, models on adoption and adoption decision theories that include theories of diffusion, behaviour modification, and planned behaviour and gives a detailed conceptual framework for the study.

2.2 Concept of e-Extension Services in Agriculture

The application of electronic technologies in conducting information and knowledge transfer in agriculture is referred to as e-Extension. According to Thatchinamoorthy (2018), e-extension also called cyber extension, refers to extension over cyber; and in agriculture, refers to the use of the power of online networks, computer communication and digital interactive multi-media to facilitate the dissemination of agricultural technology. And that it entails the effective utilization of ICT via national and international networks, internet, expert systems; multi-media learning systems and computer based training systems to enhance information access to key players in agricultural information transfer like the farmers, extension workers, research scientists and extension managers. Based on these, the author outlined the need for e-extension to include acceleration of agricultural growth and development, expansion of farmers' knowledge resource base, ensuring better information access, supplement shortfall in technical manpower base, ensuring stronger research-extension-Client linkage, evolution of efficient feedback mechanism, empowerment of smallholder and marginal farmers and provision of services to farm stakeholders beyond the scope of technology transfer role. With the forgoing, the author submitted that ICT, by these virtues, have helped to bridge the knowledge gap among farmers and enhance the capabilities of Extensionists as well as strengthen the research-extension-farmers linkages.

Ifejika *et al* (2019) on the other hand, submitted that E-extension is the use of internet technology or information communication technology as a platform for exchange of information and providing services to key players in the agricultural value chain. E-extension tools facilitate transfer of information through arrays of methods/techniques such as voice, image, motion, instants messages, and applications (Ifejika *et al*, 2019). The authors further unveiled citing Huber *et al* (2017) that the Report of Developing Local Extension Capacity (DLEC) stated thus; "with regard to advisory methods, Nigerian AEAS uses a wide variety of approaches. However, we see the biggest opportunities in ICT-enabled extension, which we define as extension agents (EAs) systems and programs that utilize appropriate information and communication technologies for information sharing, capacity strengthening, program and performance management, and other EAs activities. The authors then identified the Key opportunities for ICT-

enabled extension to include the use of Interactive Voice Response (IVR) to enable farmers to authenticate input quality and for the private sector to establish ICT-enabled extension that is profitable and sustainable".

According to Global Good Practices in Rural Advisory Services (sourced on net at www.https://www.g-fras.org/en/good-practice-notes/16/web-portals-for-agricultural-extension-and-advisory-services.html?showall=1), in the realm of portal e-extension services, two portals predominantly exist:

i. those providing technical and market knowledge to end users at the grassroots level; and
ii. those helping with capacity development of Extensionists.

Knowledge portals (e.g. www.knowledgebank.irr.org, www.rkmp.co.in), e-extension portals (e.g. www.eXtension.org, www.e-agriculture.gov.ng,), video-based portals (e.g. www.accessagriculture.org, www.digitalgreen.org), market information portals (e.g. www.agmarket.nic.in), information portal for rural people (e.g. www.vikaspedia.in) and institutional portals for extension and advisory services (www.nafis.go.ke, www.kilimo.go.ke) are captured under first the categorization. While portals like agricultural extension society of Nigeria or Agricultural Extension in South Asia contain volumes of resources and tools to forester the sharing of knowledge and networking among intellectuals and other stakeholders, and hence captured under category two.

Meanwhile, usage of social media platform is tilted more to the individual perception/mindset than age. A good number of studies have depicted that Extension practitioners and farmers are among the possessors and consumers of mobile phone technology believed to be the predominant communication tool in use for accessing and connecting to social media platform (LeBoeuf *et al.*, 2012; Fahy, 2013; Ifejika, 2013). Nigeria, with overwhelming 87million engaged in agricultural occupation, requires a strong e-extension delivery services delivered via Short Message (SM) platforms. While many farmers worldwide are taking advantage of SM to relate with relevant stakeholders like experts and their peers, extension agents and extension societies in the country tend to nurture a narrow mindset about rural dwellers and are thus stereotyping farmers with the assumption that they are technologically incapable (Diem *et al*., 2011; Payn-Knoper, 2013). To change this trend, there is a need for investment in communication infrastructure by public extension agencies in the 37 Agricultural Development Programmes (ADPs) as well as NGOs and agro-industries as well as Universities with extension outreach communities. Unfortunately, the situation in the country is intolerable given the low exploitation of information and communication technology tools by government agencies; and this has created a huge constraint to running agric related business in the country. To buttress this, the surveys of the United Nations from 2008 to 2012 unveils that the ranking status of the county's e-government readiness dropped in 2008 down to 2010 and 2012 but experienced an upward movement in 2014 (Oni *et al*., 2016). The study of Abdullahi *et al* (2019) specifically expresses this unfortunate situation in the North western part of the country. The findings of the authors showed poor usage of mobile phone apps by farmers in the area for access of extension delivery services.

2.2.1 Strategies of e-Extension

Extension and advisory services could be a complex process, which in most times, this complexity in simple communications model is easily underestimated. To overcome this complexity, a number of strategies have been adopted, which according to Karen (2013) include communicating to the target population i.e. learning how to adjust the message to suite the audience in terms of their needs, mental comprehension and material resource capacity in a well-designed repository of information, critical knowledge targeted at audience level, quantity and weight of information and method of communication needed for an appropriate response. Aker (2011), FARA (2009) and Woodard (2012) discussed how mobile phones can be used to connect agricultural information call centers. The provided information can be modified on the basis of the caller's detail and changes in agricultural conditions. Extension agents have for many years altered messages on the basis of the receivers' comprehension and information needs of the callers. Hence, it could be advised that the need to customize information with respect to farmers' knowledge status should be integrated into the principles guiding ICT design. For instance, the design of the Kenyan National Farmers' Information Service, www.nafis.go.ke, permits extension agents to adjust information on the foundation of local circumstances (FARA, 2009). The dissimilarities in the customization result in a multivariate set of responses. This, in some cases could lead to negative communication processes as in the case of poorly trained extension agent. These agents are known for repeating outdated information leading stagnation in farmers' output growth indices. Such ICT framework would benefit the poorly trained agent in transferring latest information to illiterate farmers and as technical documents for the literates. To ensure successful customization, senders must understand the target population. Swanson (2008) opined that the customization process and identification of target entities often entail devolution of the country-led extension delivery services. Due to the difficulties in identifying these targets, the author provided multiple population targets approach on the basis of gender, farm size, business level and diversification of crops. The message here is well-coined by Karen (2013) that "for ICT to be truly effective, it must be grounded in a thorough analysis of needs and subsequent prioritization. Communication cannot be effective unless the sender knows the receiver and customizes the message content and delivery mechanism accordingly". The author further posited that as part of the information transfer process, the sender should be able to identify the type of message to be dispersed. That is, is the message a one-time message or a series of messages that could lead to a better clarification? Therefore, ICT interventions need to be designed to meet the specific type of communication that should prevail. Toyama (2011) for instance, used Bloom's Taxonomy, characterized by six levels of education goals for cognition -- from knowledge to comprehension, application, analysis, evaluation and synthesis — to showcase that knowledge, comprehension and application are the most critical for rural farming communities.

Furthermore, another strategy is knowledge transmission (communications) via skills, training and educational procedures (Karen, 2013). The later pointed out that Information is generally perceived as data that provides critical

but short messages as in the case of market prices, weather reports or specific, short advisories (e.g., on a pest outbreak). This pave the way for transition from simple information, the communication process into providing skills, training and education. Nonetheless there is always an overlap in all these; with each level of communication expressing more complexity than the other. As receivers acquire more skills, education or training the sender can convey more complex and nuanced information via ICT.

Extension agents rely on face-to-face communication to train farmers. Toyama (2011) and Akers (2011) express that extension practice is dear need of transformation, together with new ways of offering services. Using ICTs to proffer training and education for low literate audiences is often hard to design however ICTs increase spreading which is necessary if more smallholder farmers are to be successful.

The advent of internet spelt another new dimension in communication in extension practices. Information can be harvested at any point in time in a reservoir of complex networked computers. The data in this system (networking) undergo regular updating, making access to up to date information a guarantee. The use of broadcast technologies is another strategy that depicts e-extension process. Though broadcast tools generally constraint to limited audience participation, many radio programs targeted at farmers, however, often provide questions and answers forum via voice calls using their mobile phones or land lines. Nonetheless, there is more audience participation with one-to-one mobile or even well-designed Internet training or DVD/CD training (Karen, 2013). The author further stated that combination of broadcast tools with interaction can augment the impact because broadcast is targeted at providing services to large groups of individuals via radio, television or video production. Digital video is currently in use on site for minimal trainings using television, video players and online, usually via satellite feeds using a monitor or projected on a screen.

In most recent time, mobile phone technologies impel extension strategies in many parts of the world. Several studies (Karen, 2103; Rebbeka and Saravanan, 2015; Nwabugwu *et al* 2019) have shown that in many parts of the world, mobile technology has the highest penetration of all ICTs. In the poorest of nations and Africa as a continent, and Nigeria in particular, the impact is growing, though it lags in the rural and farming communities (Khidir *et al* 2019). For instance, Roa (2011) showed that four countries identified with the largest subscriber base in Africa continent are Nigeria, South Africa, Kenya and Ghana. The expectation that the Middle East and Africa would showcase the strongest mobile data traffic growth of any region at a compound annual growth rate could be ascertained to with the current trend of upsurge in the growth rate of mobile technology in these parts of the world. The actualization of this expectation in rural areas where most farming takes place is not as healthy (Ifejika, 2013; Khidir, 2019; Abdullahi *et al* 2019), and the cost for rural families is considered very high due to the very low standard of living that depict abject poverty. However, where information can be extended to farmers in areas of market information services, weather reporting and follow-up contacts etc., mobile devices could do better. This is

because these mobile apps can improve the frequency of messages, particularly if the voice and broadcast technologies integrated into a systematized response.

The current trend shows that mobile revolution in ICT usage has compelled extension to synchronise functions and services with appropriate ICT applications. Donner (2009) shares a number of services that use mobile phones for interaction with rural farmers out of which providing market data is the most predominant. In addition, before the advent of mobile technologies, connecting to rural farms and providing information was time-consuming and entails travelling over a long distance in hours.

The World Bank ICT in Agriculture Sourcebook showcased several examples from many projects in which extension agents and farmers use mobile phones to facilitate communications processes among them. To ensure efficient communication process, most of these projects are not limited to mobile applications alone but coupled with Internet-based applications. However, the impacts of mobile apps on extension functions recently drown attention by several researchers due to the revolutionary impact on contemporary ICT usage. For instance, Sourcebook showed that the most sustainable approaches that explain these are the Kilimo Salama and M-farm because their approach involved profit-oriented companies that make money in the transaction, and lower the overall costs through economies of scale (World Bank, 2011). In Kilimo Salama, the prices are paid to the Internet service providers operating at intermediary level. Farmers are charged 5 percent increase on inputs such as seeds and fertilizers as insurance cover, and the farmers get compensated from the insurance fund in case of disaster, damage, crop failure due to poor weather condition etc. Kilimo Salama on the other hand pays automatically for data from the weather stations. M-farm, on the other hand, provide insurance cover for farmers' seeds, fertilizers and pesticides. These two projects are located in Kenya because the telecommunications policy environment is encouraging. As a result many telecommunications innovations have emanated from Kenya because it provides a friendly environment that encourage the spurring of innovation in telecommunications business. In Nigeria, the e-wallet initiative of the government is a key project that reflects the deployment of mobile technologies to ease farmers' access to input. Though, it was reported by Ifejika *et al* (2019) that about 1.69 billion people are accessing social media via mobile phones worldwide and active mobile SM accounts penetration pegged at 23 percent, of which Nigeria and India have the highest share of web traffic through mobile in the world (ITU, 2015; Kemp, 2015), the story of active deployment of this latest technology in agriculture has been very discouraging. For instance Abdullahi et al (2019) reported poor usage of the e-wallet by farmers in the study area. Similarly, the account of the success of the project in the north central zone of the country as unveiled by Ifekija et al (2019) was completely discouraging.

2.2.2 e-Extension teaching methods

Methods used in extension may be classified into three that include individual contacts, group contacts and mass contact methods. The use of electronic devices to facilitate communication between stakeholders across the class

in the farming circle is what e-extension methods entails. For instance the use of mobile phone to establish contact via voice call with a farmer is an approach domiciled in the individual classification. The formation of communication group such as whatsapp group is an example of group e-extension method as illustrated by Ifekija *et al* (2019) {WhatsApp group platform (+2348066952076) of Catfish Farmers Association of Nigeria (CAFFAN)}. In the same sense, the use of radio, television, web portals and internet facilities to reach larger audience reflects a mass e-extension method.

In the contemporary world, ICTs (particularly the mobile phones) are the dominant electronic devices engaged intensively in all aspects of human endeavour because of their dynamism and applicability in proffering solutions to wide arrays of challenges often associated with farming communities. Therefore, an attempt is made here to unveil some literature revelations of electronic extension delivery services and mode/methods of delivery.

According to Payne *et al*. (2010a), there are good numbers of ICT-based extension delivery initiatives that have been developed to help farmers enhance their farming activities, financial prudence/control, exploitation of best agricultural practices, research, weather forecasting, climate appraisal, supervision of distribution and supply pathways. Some of these initiatives identified by the authors include the Cocoalink, Esoko and radio Ada in Ghana; Kilimo Salama, KenCall Farmers Helpline, M-PESA established in Kenya and the Shambani of Mali; and the MAKWACHA domiciled in Malawi. KenCall Helpline, according to the authors, is a real-time profit-oriented call centre manned by agricultural experts saddled with the responsibilities of providing smallholder farmers with agricultural information, advice and support using mobile phone, specifically the call apps component, to facilitate voice calls and voice calls-back to farmers; the hourly radio program tagged Mali Shambani, takes place once a week featuring news on agricultural activities as well offering responses on extensive array of topics like current market prices and development, farming skills, climate and weather conditions, seasonal concerns, funding prospects, ease of inputs accessibility, and land use criteria. The interactive component of the program affords farmers the opportunity to call and ask agricultural-related questions from a team of specialists either via phone calls or SMS platform; the Kilimo Salama designed by UAP Insurance (the Syngenta Foundation for Sustainable Agriculture, and mobile operator Safaricom) with the aim of providing agricultural insurance cover for farmers via their mobile phones, through a payment order captioned ‘pay as you plant' that enables small-scale grangers to secure insurance cover for their agricultural production accessories against unfavourable weather situation like drought or undue downpour. The payment order entails that farmers remit an extra 5% for a bag of inputs like seeds, fertilizers etc to be insured, and using mobile technology, registrations of latest policies as well as claims are effected as determined by an automated weather posts were weather conditions are monitored (Martz, 2011); M-PESA, an e-banking platform that enables farmers to engage in cash transfer by sending and receiving money through the use of their handsets, a model that recorded incredible bearing on the wellbeing of farmers in Kenya

and Malawi, and to this end, SafariCom was reported to have recorded about six million one hundred and eighty certified M-Pesa subscribers far back March, 2009 (ITU, 2010b).

The smart-card-centered MAKWACHA model in Malawi, as reported by NyirendaJere, (2010), has made it possible for rural farmers to receive payments and make purchases of agro-inputs by electronic means using the card at any of the designated ATM terminals located around commercial centres in rural communities all over the country; a mobile phone-based program named Cocoalink, was established by Cocoa Board of Ghana aimed at updating cocoa growers with updated info on how to improve their farming practices, safety rules on farm, crop disease control/prevention, postharvest practices and marketing of their crops (Martiz, 2011). According to the author, through this platform, farmers are intimated with information and specific answer to inquiries free of cost via voice response and texts in the local languages or English as desired by the farmer concerned; IRRI (2011) reported that the International Rice Institute initiated a programme tagged Nutrient Manager for Rice Mobile (NMRiceMobile) aimed at enlightening producers of the grains in Philippine using advisory services via their mobile sets on the most favorable times, quantity, and brand of fertilizer to use for their rice crop so as to get the most out of their production and in turn maximize profit and prevent wastage. This is achieved by dialling a toll-free number by both farmers and extension workers at which a relayed voice instruction is heard in a preferred language (either local of English) that direct them to provide answers to at least 12 questions about their production-related issues using the keypads on their phone, and thereafter the farmer gets a customized suggestion via text; Kithuka *et. al.* (2007), in Kwadwo and Daniel (2012) explained that in Kenya, community health workers explore the mobile telephone for delivery of animal health services to animal farmers, a practice that has trimmed down transaction expenditures and enhanced efficiency of animal care prospects, a process facilitated by workers through the purchase of veterinary medicine outfit/kit and mobile handset at a reduced affordable rate, while animal health professionals under the project get mobile phones used mainly to facilitate timely and efficient updating of one another and receive tips on need to conduct referrals. In addition, Oladele (2011) posited that interestingly VSAT (Very Small Aperture Terminals) as well as related orbiter devices can be found mounted in some remote neighborhoods and prominent markets in Nigeria, thus stressing that "ICT heralds the formation of knowledge societies in rural areas of developing world, which is only realizable when knowledge and information are effectively harvested for overall agricultural and rural development". In line with this development is the recent launching of an app tagged Iska Weather Service by 9mobile in partnership with weather forecasting portal called Ignitia in the country to enable farmers to predict weather accurately before and during the planting season. It is an online service platform with the potential to guarantee farmers in Nigeria the ability to predict the weather conditions with over 80% accuracy level, thereby empowering the farmers to prepare against adverse weather conditions that can affect their crops. To achieve this goal, farmers that patronize the service provider are to be provided with localized weather forecasts via SMS and USSD, with 80 % accuracy (Bolanle, 2018).

2.3 Use of Cellphone-Base Technology in Agricultural Extension Services

With nearly one billion smallholder farmers believed to be in existence worldwide, agricultural advisory delivery services is therefore without any doubt in search of most suitable avenues to assist these vulnerable sodbusters in terms of prompt supply of relevant information, technology access and adoption, real-time advisory services, and empowerment through easy access to source of funding and good markets price for both inputs and outputs (Kwadwo and Daniel, 2012). This, according to Davis and Asenso-Okyere (2010), has led to the evolution of many mobile-based extension innovations like fee-for-services in New Zealand; all-encompassing rural community level agricultural advisory services in China; market-impelled empowerment scheme operated under farmer associations and privatization activities in Uganda; the farmer field school in Asian continent and lately in East Africa; farmers skill acquisition units and specialized extension workers in Ethiopia; farmer-friendly extension services in Latin America and the Caribbean; and ICT-centered agricultural extension in Asia and Africa. In addition, NAQAS programme of the NAERLS domiciled in ABU, Zaria, Nigeria that provides a platform for farmers to call using their mobile phone to ask questions on farming issues bordering them; the E-wallet programme of the Nigerian government aimed at ensuring efficient input distribution to farmers (Yusuf, Abdullahi and Haruna, 2015); Diversified Agricultural Support Project (DASP) together with National Agricultural Technology Project (NATPO) of the World Bank; the Agricultural Information Flow System titled 'Knowledge Help Extension Technology Initiative' (KHETI) that uses a special mobile phones for operations, as well as Danida, an IFAD-funded gender-focused projects and the private sector e-Choupal initiative all in India (Xiaolan and Shaheen, 2012; Calvin, Soroja and Chris, 2013:22); ICT-based Commodity Exchange markets in Ethiopia (ECX), Kenya (KACE) and Malawi (MACE) that pass on relevant facts and figures on latest market prices of commodities to clients instantly upon request (Mukhebi, 2011 in Calvin, Soroja and Chris, 2013:19). According to the authors, KACE has market information and linkage system (MILS) composed of market resource centres (MRCs), SMS application, interactive voice response services (IVRS), internet database system (IDS), nationwide radio service, countryside FM radio transmission service and the KACE headquarters central control hub (KCH) used for information collection, processing and delivery. Additionally, the authors submitted further that MRCs are kiosks primarily stationed in countryside markets to generate relevant information that serve as a basis of the Kenya Stock Exchange market information for clients/producers and agribusiness environment. Davis and Addom (2010) on their part gave a report that the Market Information Systems and Traders' Organizations of West Africa (MISTOWA) in collaboration with private individuals, came up with a website (www.tradenet.biz) to facilitate exchange of market-related information like market prices, available offers on buying and selling, and contact details of traders for simplicity at the instance of request (as well through mobile phone SMS apps), and creation of online vacuum for producers and trade organizations alike to develop websites for featuring business-related information; according to Martiz (2011), in Ghana, services initiated and established by an indigenous company, ESOKO, have helped tremendously in facilitating activities such as publicizing buy/sell order by farmers and traders via networks of

certified persons that gather latest prices of about 20 agro-commodities in 30 marketplace across the country and farmers access the information by subscribing for it; LINKS – Livestock Information Network and Knowledge System - is a section of the global livestock collaborative research support programme shouldered by Texas A&M University, that offer updates on monetary values of livestock at regular interval as well as data on nearly all the foremost livestock marketplaces located in east African countries – Ethiopia, Kenya and Tanzania – alongside records on state of pasturage, animal health impairments, social unrest and availability of water by way of texts messaging, email, global radio broadcast systems and the internet to facilitate taking informed decisions at multiple scales (LMIS, 2011).

Considering the CKW initiative, Jack, Ellen and Verena (2016) unveiled that it came to light that the desire of the initiators to reach farmers in country sides is achieved by the use of networks of peer advisors. The extension-service-delivery potential of this initiative is acknowledged to be so that the most isolated villages are reached via the utilization of a network of local advisors, who are farmers chosen by their peers. The local advisors are furnished with the smartphone and using the phone applications. Farmers are then fed with information on weather, market price situations and advisory services on best treatment practices for pest and diseases control and eradication (Grameen Foundation, 2016).

Furthermore, Xiaolan and Shaheen (2016) illustrated that the level, quantity and pace of extension service access and delivery have significantly improved, occasioned by the mobile phone technology-based intervention. The authors further identified other areas the farmers have benefitted from the initiative to include expansion of awareness and knowledge-base of the farmers on latest farming practices, willingness and desire to try new innovations/technologies in the future without fear and ease of obtaining credit. All these are devoid of any exceptional favour to any farmer, implying that no one is disadvantaged irrespective of his/her educational level or background. The initiative involves the use of smartphones to generate Short Dialogue Strips (SDSs) to instigate and spring up communications involving small/marginal farmers and agricultural connoisseurs. The SDSs are mainly audio-visual created on the premises of local farming practices and facts. An NGO that is cooperative-driving named Sironji Crop Producers Company Private Limited (SCPCL) directed the project. Given the success of this project as unveiled in the study, it was concluded by recommending that a system established on the foundation of good adoption of technology by locals, particularly youths that have received some sort of training, and could be the antidote for poor inclusive development.

2.4 Effects of ICT-based agricultural extension and advisory services

In India, Rizvi (2011) conducted an impact study on the use of Lifelines (a mobile-based advisory service for farmers), using a contrasted intervention and control group experiences. The data was arrived at and gathered using surveys supported by participatory rural assessment instruments like the focus group discussions. The findings, according to the author, revealed a progressive boost in the annual proceeds of the farmers that accessed the services

marked by an upward yearly average income of 37% ahead of the control group as well as an increase in savings and earnings recorded by 67% due to increased productivity and disease control occasioned by the adoption of the app; the e-AGRIKultura (ICT) project implemented in 2005 and 2006 for Philippines farmers in six provinces in southern and central parts of the country to provide farmers with real-time information on farming technologies via the net and visual media was examined by Barrios *et al.* (2011). They carried out a study on the scheme in 2010 to ascertain the relationship linking ICT and enhancement of living conditions in remote areas by surveying 450 household in the scheme and control locations. Using selection models, they calculated the contribution of ICTs and discovered indication of an irrefutable and significant link between ICT, condition of living and earnings. Illustrating, the authors explained that with the project household farm proceeds was US$2,114 while prior to the program it was about US$1,203. Also, Lokanathan *et al*. (2011) conducted a study on enhance price lucidity, leveraging on an ongoing ICT-based intervention program believed to have impacted on enhancing farmers' living conditions in Sri Lanka. According to the authors, price information was placed at the disposal of the clients via arrays of technologies that include SMS, cyberspace, WAP, Unstructured Supplementary Service Data (USSD) as well as assigned call centres (accessed by dialing '977' from any phone). The authors unveiled that for robust results with high degree reliability, the study was carried out over a time span of ten calendar months with a selected group of husbandman that were involved in growing multiple crops, largely in fruit and vegetable production in dual cropping cycles. Based on their findings, the authors posited that the evidence, from the findings, suggest that accurate information, up-to-date price information together help to advance farmer' living status, a development that facilitated behavioural transform that assisted farmers advance their capacity to harmonize the supply of their farm produce and demand for same based on price change indicators.

According to the submission of Mukhebi (2011), as quoted in Calvin, Saroja and Chris, (2013: 19), the Kenya Agricultural Commodity Exchange (KACE) launched in 1997, a venture premised on profit making initiated the evolution of the radio programme tagged *Soko Hewani* ("the supermarket on air" in Swahili) primarily to assist subscribers make purchases as well as dispose-off farm produce/commodities including acquisition, disposal and leasing of farm machinery and as a result facilitated delivery of services for 13 conventional agricultural products, six kinds of farm animals and their related products such as poultry and dairy products, inputs like fertilizer and seeds, and even others such as aquatic and honeybee produce while also involved in grading, storage, processing, quality testing, packaging, funding and transportation of commodities with the aid of the cellular telephone technologies. This is achieved through the deployment of sophisticated ICT hardware and software controlled by agents of KACE in a well located Market Call Centres, who receive, process and respond to requests from farmers 24 hours daily. Furthermore, the authors explained that each potential buyer or seller is charged an even bill of K Sh 100 (about US$1.10) for every call made— irrespective of the call duration, while also raising revenue through market payments and other services which attract additional charges in the form of fees. Explaining the role of

mobile phone in this model, the author spelled out that one of the key processes is that using a handset, a potential seller calls the Market Call Centre for the purpose of initiating an offer prospects for disposal or rent out agriculturally related commodities, property or service. Then a potential/client buyer in quest of details regarding available prospects or services calls in via a cellphone or subscribes through online designated websites, or visits the nearest KACE Market Resource Centre.

Though several studies (Olaolu *et al*, 2018; Ifejika *et al*, 2019; Abdullahi *et al*, 2019) have shown poor deployment of mobile apps in extension service delivery in Nigeria, and the study area in particular, there are instances of efforts to impact on farmers lives through the introduction of e-extension in extension service delivery in Nigeria. For instance, Ifejike et al (2019) showed that Kwara ADP Facebook (https://m.facebook.com) has 81 likes and 81 followers; YouTube video created on 5th October 2017 on aquaculture livelihood enterprise in Nigeria (https://www.youtube.com/watch?v=Oi7ZkNLzFg0) recorded 58 views; FAO YouTube on Turning points in modern aquaculture (https://www.youtube.com/watch?v=4eAXwk2orY0) had over 18,000 views, 10,000 download and 81 likes as at May 2016. Also, WhatsApp group platform (+2348066952076) of Catfish Farmers Association of Nigeria (CAFFAN), Anambra State chapter created on 25/11/2016 has 172 registered members who share information on aquaculture input supply such as fingerlings, feeds, credit mobilization from community bank, marketing, fish processing and packaging technologies, as well as generate and share farm related information/data, conduct training, alert members on meetings, build entrepreneurship knowledge, link up with CAFFAN national secretariat and fish feed companies through their distributors for price rebate among others; and Access Agriculture D-group that is using YouTube video to disseminate agricultural technologies to reach 14,637 members in agricultural value chains (www.accessagriculture.org).

2.5 Potential of ICTs in Transforming Rural Agriculture: Some Case Studies

In most recent times many ICT innovative intervention initiatives have been developed and tested worldwide, particularly in developing countries, to help farmers enhance their living status through improved agricultural outputs and earnings, and also to decrease hazardous conditions and uncertainties associated with farming activities. The main applications of the ICT in agricultural sector proposed by FAO in collaboration with ITU are shown in figure 2.6

Fig. 2.1: Fig. 2.1 Role of ICTs in Agriculture.

Source: FAO and ITU (2016: 7-10)

From the figure above, it can be seen that ICTs in the agriculture cycle offer a wide range of solutions to an array of constraints in agriculture. This is a promising field of human endeavour concentrating on improving farming activities and rural growth and development through enhanced information and communication route. The findings have proved its high efficacy potential in changing positively the fate of farming globally, particularly in the developing world.

According to Enock *et al.* (2012), the strategic applications of ICTs to the agricultural sector, recognized as the leading economic industry in nearly every African country, proffers a better alternative with respect to economic

revolution and reduction/alleviation or outright eradication of state of impoverishment endemically associated with the continent.

The role ICTs can play in ensuring this increasingly owing to the fact that personal devices such as handsets/tablets are becoming more easily accessible and adopted. Furthermore, given the high efficacy of ICT (particularly the mobile devices) when entrenched in broader stakeholder systems, it would in no small measures bridge critical information gap in the agricultural sector resulting in economic growth, development and overall transformation. This is premised on the fact that mobile technology component of ICT is progressively being adopted more for being the latest technology of preference given its versatility in the timely resolution of challenges bordering on information transfer. It also makes available other ICT oriented services easily. Based on this, the authors identified five major categories of stakeholder groups that the wide adoption of ICT in agriculture plays strategic roles for. One is farmers comprising of individuals and associations (either organized or informal). Visualizing the way ICT can help foster growth and development in the agricultural sector, the authors presented a figure on farming life cycle conceptualized as a three-stage course (see figure 2.7 below) that include Pre-cultivation stage which entails deployment of ICTs in drawing a calendar, selection of crops etc; crop cultivation and harvesting which involves the use of ICTs in land preparation and planting, input management, pest management etc; and finally deployment of ICTs in Post-harvest activities like marketing, transportation, packaging etc.

Information and service needs offer through the crop lifecycle

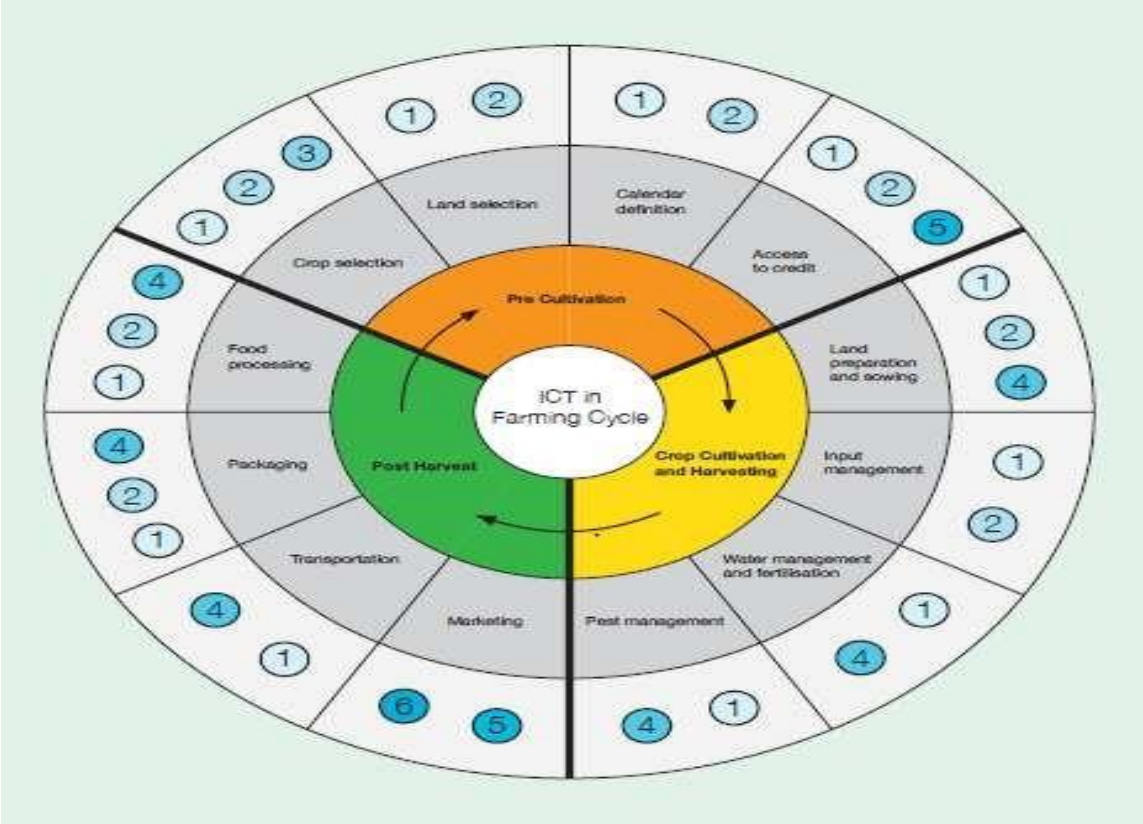

Fig. 2.2: ICT in Farming Cycle.

Source: Delottle in Enock et al., (2012:5)

Several works of literature have attempted to expose the potential of ITCs in enhancing farming practices in rural communities. Authors, like Calvin Miller and his co-authors, Gerard Sylvester, Stephans Gambier of CTA, have presented several cases of ICT usage by farmers in enhancing their productivity. Calvin, Saroja and Chris (2013) reported that farmers get technical advice on monitoring planting and harvesting crops as well as pesticide and fertilizer usage using information obtained from digital photos taken by the farmers under an intervention project called e-Segu of the International Institute of Information Technology in Hyderabad, India. To curtail the problem of possible low milk production in Sri Lanka, Web and mobile technologies were introduced to dairy farmers under a project named e-Dairy introduced by the state's Information and Communication Technology Agency (ICTA). It was aimed at enhancing the livelihood of the remote communities that accounted for about 70% of the country's inhabitants. The government, on realizing that about 53% of the country's milking-cows could not get pregnant, became worried of a sharp possible shortfall in the number of milking-cows and drop in the income level of the rural populace, decided to ascertain the cause of the problem and discovered that the problem was an aftermath of lack of well-timed artificial insemination and breeding services that also emanated from poor communication between farmers and the vet public service providers. The situation compelled ICTA to bridge the gaps through the

use of mobile-phone SMS messages and computers equipped with touchable-button installed in the milk disposal locations where farmers assemble daily in the morning to sell their milk product. Farmers that would need the insemination and general animal health service which also include inducement of pregnancy were easily reached. The Agricultural Department in Turkey put in place five weather stations to monitor and gather data that will unveil the need for pest control and prevention of frost which is thereafter relayed to the farmers via their mobile cell phones. Data gathered include information on likely pest prevalence periods. This aids farmers on pesticide use regime, implying that during possibility of low pest infestation as reported by the information farmers received, they reduce the number of pesticides used by as much as 50%, thereby lowering their cost of production and enhancing their profit and income status. Information on the possibility of high pest infestation helps farmers to prepare well by securing all the necessary pesticides to combat the pest, thereby ensuring and maintaining improved crop production. Data on temperature collected and sent to farmers through their cell phones help them take crisis management strategies like burning leaves around their farms/fields. In 2012, coffee farmers in India were provided with advisory services under CABI's Direct2Farm Service modified to offer a mobile extension delivery services called Café Movel which targeted 150,000 coffee farmers in southern India. The model of the service includes an interactive FAQ (Frequently Asked Questions) section, a private dialogue series between growers and specialists, voice broadcast section to the community, market and weather information voice feeds using SMS mobile cell app, social media and micro blogging for farmers. Furthermore, it was reported that Timor-Leste (a relatively new nation), was once engulfed in social and economic difficulties affecting the nation's source of earning (fishing) – illegal fishing activities coupled with very limited resources and poor capability to manage the county's waters. To salvage the nation from these challenges, the National Directorate of Fisheries and Aquaculture (NDFA) in collaboration with the FAO-Spain Regional Fisheries Livelihoods Programme for South and Southeast Asia (RFLP) came up with an affordable and easy to handle technological device tagged personal locator beacons (PLBs) which are a component of a community-support IUU fishing reporting scheme. The technology is a tracking devices equipped with a GPS mechanism that is capable of automatically relaying positions every 15 minutes instantaneously via satellites. The technology is furnished with two buttons — the first labelled 911 used in times of emergencies and the second one with the imprint ILEGAL designed for reporting illegal fishing activities by farmers. Therefore, with this device at the disposal of the fishers, they were able to call for assistance whenever they run into danger during fishing and in return for the safety guarantee, as well as to report any illegal fishing activities spotted to the authorities in near real-time. The case of increasing consciousness about food security and safety that elevates consumers' quest for good quality food in Thailand compelled the government to take drastic steps that led to the introduction and implementation of food quality and safety programmes for crops, livestock and fisheries, That entails Good Agricultural Practice (GAP) through the Ministry of Agriculture and Cooperatives. Saddled with responsibilities that borders on control along with inspection, the Ministry of Agriculture ensures that food producer who applied for GAP certification are evaluate based their production procedures/techniques and

those who scaled the assessment successfully are to label their farm produce with GAP logo. However, the stringent requirements put in place to guarantee the success of the programme led to serious administrative bottleneck with a resultant delay in securing the GAP certification by the farmers. This situation led to the introduction of Mobile GAP Assessment System (MGAS). The system comprises of four modules that include farmer and farm registration module, the farm management data module, the certification module and farmers' report module. The first module is an information input form accessible using mobile phone devices designed to collect farmers' data that involve the use of Google Map API to depict the boundary and determine the dimension of each farm. In the process it generates QR code that holds the farmer's details and location. The third module is operated by the inspection officers and is composed of an android tablets which is handy and easy to use and operated offline in remote areas lacking connectivity used by the inspection officers to locate the registered farm. Finally the fourth module offers feedback to farmers on the performance of their farms which they access using their mobile phones. During the registration stage, shortcomings on the farm are easily noted and corrected before another inspection (Gerard, 2015).

In addition, Connected Farm Field App is an app that allows farmers to take records of farm activities during their farming operations using a smartphone or tablet. The flexibility of the app makes it easy to handle many crops detail at a time. This implies that details on variables such as costs for every input can be recorded; thereby allowing that financial information about each farming operation is well captured. This app can function in Andriod, iPad and iPhone devices (Oguntie et al., 2018).

Additionally, RiceAdvice-Weed Manager is an android based app developed by AfricaRice to provide farmers with guidelines on specific field management practices for rice production operations in Africa. The App is made up of two components that include RiceAdvice (aimed at providing required data on yield, nutrient management and cropping calendar) and RiceAdvice-WeedManager. Both components of the app are interactively easy to use, and the guidelines and procedures provided emanated from various answers farmers provided to variety of choice queries mostly in the form of questions on the state of their farms, crop management practices and marketing procedure. The app is very relevant to stakeholders in rice production such as food producers, advisory aid workers, private rice sectors, and rural development outfit officially and unofficially recognized in Africa (both local and international agencies) who have shown kin interested in advisory services for rice cultivation. The app is functional on Android devices (mostly version 4.4 and up) and is supported using English, French as well as Kiswahili linguistic communications. The uniqueness associated with the app is that it can function in the absence of an internet connection, and collected data can thereafter be synchronized with the database server once active internet is resumed. Currently, the app is available in many African countries including Nigeria (AfricaRice, 2018).

Furthermore, a Nigerian digital agriculture platform called Farmcrowdy developed an App for Android, iOS and Windows mobile devices in 2017. The aim of coming up with this app was to create an environment of farming that is characterized by less drudgery and stress by using a mobile phone and profit maximization in a collaborative

manner between the well-to-do referred to as sponsors and the poverty-ridden rural farmers whose production bases have often been limited by lack of fund. . In addition, prospective sponsors can follow progress activities in farms when they are not yet ready to shoulder the cost, and such information assists them to make the right choices when they are ready. The Farm option allows the user to follow a farm of interests through farm updates and notifications. Apart from the following farm option for updates and notifications on available farms, the learn option is another medium which allows users (sponsors) to acquire requisite knowledge through updates, blog posts and other content that could help them get necessary information on the right steps and options available. Farms such as cassava farms, poultry farm, soya beans farm, Rice farm and Maize farm can be followed and sponsored (Oguntie et al., 2018).

2.6 ICT Applications: Awareness and use in Agriculture.

Awareness of the high potential of ICT in agricultural development is growing because privately owned ICT devices like mobile phones and PCs, are becoming more easily accessible, accepted and adopted. Mobile technology, specifically, is progressively being considered and used as a latest technological innovation preferably adopted for conveying the benefits of ICT innovativeness globally. In light of this, several studies have been done to elicit the significance of ICT, particularly mobile phones, to growth and developments in the rural-based agricultural sector. To annex ideas from the pool of these research efforts to the benefit of this study, it becomes necessary to explore the findings of these studies. This will help have a clear picture of the field of study and provide guide in coming up with tools of data collection, analysis as well as measurement of variables. In addition, it will provide a platform for comparism of study outcomes and depict new development in the field.

"Access and application of ICT among farming households of south-east Nigeria" is one such study showcasing the importance of ICT in agriculture. It was conducted by Ezeh (2013) to expose the stage of awareness and usage of ICT in the south-eastern part of Nigeria. The findings unambiguously clarified that despite a high state of consciousness and consumption of ICT in the country, there has been limited access and utilization of the technologies among farmers in the south-east part of the country. Despite low diffusion of ICTs in the region, radio, television and mobile phones remain the major ICT channels farmers explore for information. The results of the study also unveiled that available facts on physical farm dimensioning, quantification of farm output, latest variety of plant seeds as well seedlings, most appropriate planting methods as well as fertilizer usage were most important areas extension workers sort the deployment of ICTs in enhancing and improving food production practices in the zone. To facilitate improvement in the utilization of ICTs in the area, it was recommended that there is the need to strengthen the application of modern-day ICTs (phones, internet, etc) against the conventional ones like radio and television, offer satisfactory training needs on the application of ICTs for farmers and agents of advisory service providers in the region.

Findings on the assessment of ICTs application among cassava growers in Anambra State, Nigeria, by Nenna (2016), showed that mobile phones ranked the highest as channel of information access by the cassava farmers in the state. This is an indication of high penetration and diffusion rate of mobile technology irrespective of the arrays of constraints which include high cost, inadequate access occasioned by poor network, low technical-knowhow, and severe poverty situation, amongst others. These are problems confronting the farmers in usage of ICT technologies in the area. All other parameters also substantiated the success story of ICTs as revealed in the study. The inferential statistics (Pearson Product Moment Correlation analysis) unveiled a significantly positive connection between all selected explanatory variables measured and the main variable of the study, i.e., ICTs' usage level.

Yusuf *et. al*., (2015) on one hand, was able to, through empirical finding, show the efficacy of ICTs at checking corrupt practices in the agricultural sector through a study titled "Effectiveness of E-Wallet Scheme in Curbing Sharp Practices Associated with Agricultural Input Accessibility Among Small Holder Farmers in Kano State, Nigeria". The study was aimed at examining one of the government efforts through the application of ICT at checking the menace of corruption that has eaten deeply into the fabric of every sector of the Nigerian society. The emphasis was on input procurement and distribution to farms. The perceptions of the beneficiaries were sorted, and the result of the findings showed general satisfaction with the introduction of the scheme at checking sharp and corrupt practices. The authors went further, as a way of alerting the government of possible failure of the scheme in the nearest future, when they asserted thus "although beneficiaries mostly perceived e-wallet scheme as effective in ensuring transparency and reducing sharp practices prevalent in the old system, yet the 'people' component (i.e. human factor) of the e-wallet system seemed vulnerable which could undermine the success of the initiative". Premised on the outcomes of the study, it was suggested as a way of recommendation that government pay special attention to disproportion in gender inequality, while also ensuring that stipulated conditions, such as registration of beneficiaries, possession of mobile phones, and attendance of necessary training are abided with in order to curtail the possibility of failure in the future.

Kwadwo and Daniel (2012) in their study considered the significance of ICTs' development at the continental level and posited that the impacts are witnessed in Africa with a significantly progressive growth recorded in the past decennium. Their work specifically considered the relevance of evolving ICTs in the context of food production in Africa using Asia as a case study while laying emphasis on farmers' ability to easily secure relevant facts and figures and basic necessities required in the improvement of farming practices and productivities as well as farmers' livelihoods in general. Their findings suggested that countries should shun the culture of dominance and encourage competitiveness enshrined in the principle of collaborative network service providers to encourage an environment competitiveness for healthy efficiency improvement and reduction costs of service delivery to consumers. The result of that suggestion is evident in the Nigerian situation whereby multiple service providers created an atmosphere of

competition, a situation that forced service charges to drop to the barest minimum. Here are some key findings of the authors: with the aid of ICT the popular Ethiopian Commodity Exchange (ECX) is able to convey prices of commodities to farmers instantly on request and within two minutes of any deal farmers get feedback via electronic display boards, exchange's website and text messages provided in four local languages. It was estimated that an average of 20,000 requests through mobile voice call service were recorded every day facilitated via an assigned number dialed freely demanding for data on monetary worth of commodities and services. Likewise, the Kenya Agricultural Commodity Exchange (KACE) as well as that of Malawi also employs boards to display offers and bids as well as dissemination of information through SMS and internet.

General market details coupled with crucially sensitive report that centers on wide arrays of crops and domestic animals commodity products are collected, updated and analyzed by KACE ensuring their reliability and are timely provided to the public while in the process concentrating on major stakeholders in the commodity value chain that are mainly smallholder farmers and small scale agribusinesses. A typical KACE service delivery system is composed of Interactive Voice Response Service (IVRS), Market Resource Centres (MRC), mobile phone Short Messaging Service (SMS), an Internet Database System (IDS), National Radio (NR), FM radio and the headquarter i.e. KACE Central Hub (KCH). MRCs are small kiosks strategically stationed in local markets mainly to generate required market information for farmers' and agribusiness' consumption while also providing windows for commodity offers and bids. The functionality of the MRC entails dialing a unique phone number by prospective user to access needed info via specified guides in the language desired by the user. In IDS, however, most recent market details are dispatched each day to clients captured in the database in form of electronic mail messages. KCH in the country's capital Nairobi receive, process the information, controls, revises to the latest realities, circulates and coordinate all the market information needs/services from MRC through MILS. In Senegal, a mobile phone mAgric app called Manobi provides access to information on the market price on different crops from the different market across the country. With the aid of a mobile phone, Manobi officials relay the price details en route for inclusion in the Manobi database via Wireless Application Protocol (WAP). The sodbusters, in turn, employ their cellulants to gain access to the data for responses. CTA (2006) and Jenson et al. (2004) unveiled that husbandmen in rural Mozambique exposed to market facts and figures are able to secure higher farm prices. This was made possible by the activities of the country's agricultural marketing services which collect and disseminate the market prices information to farmers nation-wide through an array of media such as national and rural radios, text messages, emails, internet, television and newspapers. Premised on the potential of mobile cells as tools for recording, devices for listening, money-making apparatus and catalysts for maintaining frequent discourse, community radio houses are extensively exploring mobile phone technology in various programmes, especially programmes that have to do with advisory services in agriculture. To ensure effective service delivery, various means were adopted such as ease of access to information directly from the radio station for those resident around the vicinity of the station by simply

going there to make inquiries and report any issue related to farming, broadcast of farmers programmes for them to listen to and the use of SMS app to send and receive relevant details. The case of exploiting mobile phones by cocoa farmers in Ghana to get production and marketing facts is another good example illustrating the efficacy of mobile phone technology. The outcome of the pilot project called Cocoalink advanced by the Ghana Cocoa Board revealed the potentiality of the mobile cellular technology as farmers were provided with vital information on improving farming techniques and activities, safety measures on farms, amelioration of crop disease conditions, etc. Another most highlighted example of an ICT initiative that is mobile phone-based is the Reuter Market Light (RML) founded in India. In this initiative, every farmer subscribed to the initiative gets four SMS messages daily from RML at an annually token fee of 800 Indian Rupees. Information relayed to the farmers range from data on weather condition, crop plants and current and possible future prices of commodities at various markets.

Shawn and Nilesh (2016) examined the function of managerial processes in agricultural production line by assessing a mobile-phone-centered agricultural advisory services launched for farmers in India through an application referred to as Avaaj Otalo (AO). The application is adjudged to be a low-cost information source for farmers. The study was intended to ascertain if such cheap information source could deliver timely, important, and implementable information to farmers at such low price than the traditional sources the farmers were used to, and prove to be better in terms of yield outcome. As a result of the advisory services, cumin production increased by 28% while cotton recorded 8.6% above the conventional production for a sub-group assessed using the app. The app operates on the basis that farmers captured under the scheme are permitted to make a call using a hotline, put forth questions and entertain a response from experts in the field of agriculture and local extension agents. Callers can as well have access to answers to questions posed by others farmers. In addition, the service provided via this app is a weekly programme where very time-sensitive variables like weather forecasts and pest management strategies are delivered to farmers. The entire communication process is moderated by the Development Support Centre (DSC).

Pisuth *(*2015*)* conducted a case study on rice farmers in Thailand, an Asian country well known for rice production. The study aimed at examining the operational basis of Good Agricultural Production (GAP) among rice farmers in Thailand. It was observed that the application was designed to surmount the difficulties associated with the earlier paper-centered GAP certification in the country. The challenge led to the introduction of Mobile GAP Assessment System developed as an instrument for farmers and Certification Body (CB) officers to electronically facilitate the certification process that is possible using mobile devices such as tablets, Android OS and PCs. The success of a trial scheme launched in a small village north of the country in 2013 showcased the potential of the application. Gonnet (2011) on his part unveiled that RONGEAD, a non-profit-making outfit which supports small-scale cashew tree farmers in five regions of Côte d'Ivoire to have better access to markets through the transmission of market-related information to them via SMS. This is achieved by sending 3 000 SMS messages, e-newsletter and a remote radio broadcasts on latest market prices specifically to the five regions. At the regional level, the price data is

analyzed by two sector specialists and then summarized to guide producers make well-informed decisions on when and where to dispose of their produce. In order to ensure better utilization of the summarized data, a training opportunity for producers was introduced basically to equip the producers with skills of interpreting the data and understand market trends as well as how to make better decisions out of the data.

2.7 Significance of mobile applications in Agriculture

Mobile phone technologies have been confirmed to be the commonly owned ICT device amongst sodbusters (Hassan *et al.,* 2008; Okello *et al.,* 2010). According to Ansari and Pandey (2011), about 83 percent of the farmers in Uttarakhand community in India were recorded to be in possession of mobile phones for over two years. In the same vein, Sharma *et al.* (2012) also pointed out that over 98 percent of the farmers in Punjab neighbourhood in India owned mobile cell phones. This indicates that there is a significant upsurge in the penetration rate of latest ICT devices within rural populace, and thus if well applied in farming, they could make a huge impact in the development process in rural areas.

The impressive penetration rate of mobile technology has made accessibility to information easy, as substantiated by Colle (2010) in Saravanan and Suschiradipta (2013:141), when he maintained that "among ICTs, impressive penetration and adoption of mobile Apps in many of the developing countries, changing the agricultural communication process mobile phones have made personal communications readily accessible to women and men, poor and prosperous, rural and urban dwellers in developing as well as industrial countries". This emphasizes that shooting up agricultural productivity in African nations and encouraging youth engagement in economic spheres and entrepreneurship development are among the main agenda of the contemporary Sustainable Development Goal (SDG) adopted by the United Nations in 2015. Focusing on mechanisms (like ICTs) that would foster a sustainable and significant increase in agricultural productivity has become a crucial matter, particularly in the rural settlements of emerging countries. This is because the largest proportions of farmers in the developing countries are found in rural domain and over 75 percent of people in these countries are poor living in rural communities.

Different sorts of ICT devices and applications teem in the country (Nigeria) in recent times and are being exploited by extension agents to boost agricultural extension service delivery. This has gone a long way in offering solutions to resource and capacity challenges that characterized extension practices as there could be extremely least need to amplify the number of extension workers to meet the huge deficit challenges associated with extension worker/farmers ratio if cellulants are well deployed (Okeke *et al.,* 2015).

Communication/dissemination of information on agricultural extension practices and food production activities is playing a fundamental role in sustaining efficient agricultural extension services. Therefore, the application of ICTs in enhancing information transfer and facilitating the connection of people in rural environment (together with the global agricultural communities) has proved that low literacy level associated with farmers in rural areas may no

longer be considered a reason to elude farming communities the benefits of appreciable levels of extension arrangements (Okeke et al., 2015). According to Rebekka and Saravanan (2015), the employment of cellular phone is setting an unparalleled pace, notwithstanding the inadequately developed electrification system of rural communities in most developing countries. The reason for this may not be farfetched as mobile technology is providing multiple benefits to the residents of remote communities. Its grandness in usage is vividly clear in terms of promptness in situations of exigencies and necessity (Sife *et al.,* 2010). For example, it is acknowledged that farmers were also using ICTs to ascertain days markets are attended in different localities for proper marketing of their produce as well buy other basic needs at good market prices (Oyeyinka and Bello, 2013). In addition, traditionally available ICTs such as radio and television have also been proven to be instrumental to farmers in securing updates on agricultural practices (Batte *et al.,* 1990; Nazari and Hasbullah, 2008; Shetto, 2008; Emmanuel, 2010; Nakweya, 2013). Moreover, cellular telephone apps such as voice call and Short Messaging Services have been discovered to enjoy wide and regular usage by local food producers generally (Mtega and Msungu, 2013).

2.8 Challenges to the Effective Utilization of ICT in Agricultural Extension

The main limiting factors to ICT utilization by farming communities and workers in the field of extension based on the findings of Chadwick (2000), Mukesh, Deepati and Kanini (2010) in Okeke, *et al.,* (2015) include poor ICT infrastructural development as well as erratic and fluctuating power supplies; soaring cost of ICT gadgets and access/interconnectivity; poor knowledge of ICTs as most extension workers and farmers do not have the competency and self-efficacy to operate ICT facilities because they lack training in this respect; high level of illiteracy among farmers and extension workers as most of them have poor educational background and as such lack awareness on the latest agricultural technologies and methods that make farming much more easier, attractive and profitable; inadequate capital which has often constrained small scale farmers to acquire ICT facilities; and not being in the picture of existing loan opportunities due to severe state of penury and low level of education. With the proper application of ICT, these vulnerable farmers can be assisted through the provision of information on existing loan facilities and how to access them.

Slavoljub (2014) observed that farmers are faced with shrinking profit margins caused by an increase in prices of inputs without a corresponding increase in the prices of outputs, and coupled with this is the continuous effects of increased globalization and market deregulation which have continued to mount pressure on the farmers. In the same vein, Enock *et al*. (2012) posited that in as much as it is no doubt that food security is crucial to the continued existence of individual persons, families and nations in general; the agricultural sector in the African continent has been in a declined state for more than 40 years in the past. Therefore, underprivileged farmers have mainly remained deprived with an estimated 73% of these farmers found in rural areas living below the poverty line. Recasting the possible reasons for this abnormally in the face of huge material and human resources that abound in most developing world, the following challenges were identified to be the major causative factors: Poor culture of

investing in rural areas; lack of access to modern market and iniquitous local market environment; poor access to highly developed technologies; very poor and weak infrastructural development; skyrocketed production and transport expenses; gender unevenness in access to production inputs, assets, opportunities and services; widespread diseases, especially HIV/AIDS; natural tragedies; deforestation, environmental degradation and loss of biodiversity; and finally, unwarranted dependency on foreign support. Other challenges include war, tribal and religious crisis like the Boko Haram insurgency presently going on in north-eastern Nigeria; low or complete absence of profit on investment; and wrong or inappropriate government policies on agriculture; policy summersault usually occasioned by a change in government etc.

According to Gerald (2013), two levels of challenges are identified to be bedevilling mobile agriculture vis-à-vis constraints at the design level and at developmental level. The author summarized these challenges at the design stage as DNA— the Device, Network and Architecture. As a way of illustration, the author pointed out that, in 2012, 50% of the 1.9 billion mobile phones disposed off were simple basic and feature phones, implying that such phones can only support simple mAgric services. For instance, in developing countries like Nigeria, most farmers could only afford and operate simple analogue phones that cannot support internet-dependent mobile services. Explaining further, the author illustrated that the second most important factor to be considered in designing mAgric app is the network dependency. This illustrates that though over ninety percent of humanity worldwide is served by a 2G network as forty-five percent are supported by 3G network, which is however mainly tilted in favour of developed worlds. In third world, the coverage is generally non-homogenous, with reported cases of many pockets of very poor or absence of coverage, particularly in remote or inaccessible areas as farmers resident in such places are not in position to avail themselves of the benefit of cellphone technologies. This, no doubt will influence the nature and success of mAgric apps in developing countries, as according to the author, data-weighty apps are most likely not going to function in such sparingly serviced areas. On the architectural challenges, the author explained that while designing mAgric apps, the architectural make should be carved out in a manner that guarantees utmost benefits to the prospective consumers/users as well as the Mobile Network Operators (MNO). Citing SIM-based apps as serious challenge, the author pointed out that, majority prominent MNOs are reluctant to partner with emerging technology companies except there is an evidence of obvious future benefits in favour of the MNOs. In addition, considering the status of most technology builders as young and new, it is often difficult to secure the partnership cooperation of MNOs. Challenges at the developmental level identified by the author include availability of information to farmers as most times they are not certain of who to consult for way out of their predicaments. This is coupled with characteristic incapability to annex information from sources outside their immediate locality, while also not confident of the reliability of the information as per their situations; and therefore, securing the trust of the farmers matters a lot. The second challenge identified by the author is the status of interaction with the farmers. He pointed to the fact that the pronounced shortage in the numbers of Extensionists

and researchers has limited the level of contacts with farmers and as such lamented that in most of the developing countries an extension agent has more than 1000 farmers to attend to. He further claims that it is basically impracticable for Extensionists to carter for the farmers at the start stage of adoption of new technologies. Nevertheless, the mobile phone, especially mobile social media, according to the author, can to a large extent, help to solve this problem, given the fact that with cell phones usage, local food producers can intermingle easily with Extensionists and agricultural experts in real time, as well as share their knowledge among themselves thereby making the adoption process more rapidly and more successful. Other challenges to agricultural growth and development are the draining of youths via migration from rural to urban centres where they hoped to find anything they lay their hands on to earn a living. This has resulted in a shortage of active manpower in the farming communities in most African countries like Nigeria.

2.9 Theoretical Background

The theories above were carefully selected based on their relevance to the study. The need to understand what it takes to accept and use mobile phone technologies by the farmers informed the selection of adoption theories. The theories outlined and explain the interplay between the farmers' inner reactions in the response to their immediate environment; especially when new innovations such as the mobile technology suddenly appear. Because human nature differ from person to person, the extent and nature of the reaction to the presence of this mobile technology, which will unveil extent of acceptance and usage, called for adoption of diffusion of innovation theory. The theory depicts the strata in the adoption process as farmers could be identified with their level of adoption. Farming communities could also be categorized based on level of acceptance and usage (diffusion) of the technology. This is very crucial to the success and outcome of this study.

Owing to influence of societal values, norms and religious beliefs, farmers' view point about themselves and the environment tend to be defined. It therefore becomes necessary to understand this with respect to usage of mobile phone by the farmers. The theory of reasoned action was screened to be the best theory to help understand this situation. Other external influences that have effects on farmers, use of mobile apps were understood with the help of technology adoption model, an upshoot of the latter theory. Finally, the theory of planned behaviour was used to understand behavioural disposition to acceptance and usage of mobile apps by farmers because certain category of farmers identified as innovators by the adoption and diffusion theories tend to be less influenced by societal beliefs and are known to exhibit dynamism in relating with new innovation in their environment. This theory explained that behaviour at times are planned ie under the will of the exhibitors. To understand this dynamism as is relates to apps' usage, this theory was considered.

2.9.1 Theories of Adoption

In English, the term theory is used as a concept of a scheme (Hycenth *et al.*, 2010). In social sciences it is considered as an analytical framework or paradigm that is used to study and interpret social phenomena (Seidman, 2016). Collinisco (1999) on the hand considered the term to mean the tool used by social scientists to make variation and general statements on diverse social orders and to evaluate contemporaneousness as noticed in few centuries ago. Adoption, however, according to Rogers (2003), is considered as the initial or least level of behavioural exploration. It follows, therefore, that theory of adoption is an analytical framework of study that describes the initial and minimum level of behavioural disposition in the utilization of what appears new in ones' immediate environment.

2.9.2 Adoption decision theories

According to Hycenth (2010), the decision to adopt an innovation (new ideas, technologies etc) in agriculture is explained by two theories: Cognitive and Behavioural theories. According to cognitive theories, an action is prompted by the uncomfortable state of tension which emanated from holding two thoughts that are at variance or ideas in the mind simultaneously. The theories focus on internal state such as motivation, problem-solving through decision making and thinking coupled with attentiveness. What this implies is that the farmers' resolve to adopt an innovation such as the mobile phone apps is triggered by certain factors that constitute external driving force which results in internal reactions or "tension" in the farmers. This results in them being uncomfortable, which in turn results in a feeling of deep urge to ease the tension by responding through sorting for solution to the cause of the tension. As a result, the farmers become motivated to be conditioned in a manner that permits them to solve the problem through understanding the nature and concept of the cause of the tension. In order words, the desire to learn how to use mobile phone apps is triggered. This leads us to the Behavioural theories. The behavioural theories, according to the author, are based on the idea that behaviour is acquired through conditioning. Hence, the farmers adjust their ways in conformity with what it takes to understand the solution to the cause of the tension. In the process of acquiring the necessary knowledge, the changes follow in the general attitude of the farmers. These changes reflect on the pattern of actions of the farmers toward having a tension-free and comfortable state. In order words, they have gained new knowledge that has made them better than what they used to be before. The implication of these theories to this study is that identifying and understanding the dominant forces influencing the decision of farmers to either use mobile phone apps or not will provide insight as to the best policy action to deploy in fostering the awareness and deployment of apps in the area under consideration. Such information would also assist change agents in making an appropriate decision in implementing intervention programmes that would enhance the adoption rate of the apps. Once efforts towards directing the decision making on adoption are successful, the farmers will now go through stages in the adoption process.

2.9.3 Theory of diffusion of innovation

Because humans generally differ in their nature and level of response due to natural variation, the farmers also exhibit this tendency. As a result, Ekong (2003) posited that individuals adopt at different rates. This idea gave birth to another theory of adoption coined theory of diffusion. This was initially conceptualized in 1957 by Roger in one of his most influential work that has continued to define the limit of this theory, titled "Diffusion of Innovation". Using his Bell Curve, referred to as Rogers' Bell Curve (figure 2.1), he was able to describe a stratification concept that helps to categorize the farmers based on their various nature and level of responses to the external driving force. The curve shows that farmers are categorized into five based on their nature and level of response to the new phenomenon. The categorization include Innovators, early adopters, early majority, late majority and Laggards/ Phobits.

Given the variation in our environmental circumstances that depicts variation in our society and the developed world where these theories emanated, Ekong (2003) drew our attention to the posture of some critics to these theories base on applicability in an indigenous African context. The author, therefore cautioned that the few adoption studies done in a developing country like Nigeria have pointed out that there may be marked differences between findings in the advanced nations and those of developing nations. He continued that in the application of foreign research findings on adoption, it is important to recognize some of the assumptions underlying them and the problems which such assumptions may pose. The position of this author has clearly proved this study right for considering the need to re-examine these theories in the light of realities peculiar to our rural settings. In light of these, the author identified factors influencing adoption of innovation in the context of developing nations like Nigeria. These include comparative edge of the new innovation, defined as the level of superiority of the latest invention to the one it is meant to supercede. If the innovation commands high relative advantage, an average rural farmer will consider its cost. This implies that the higher the cost the less likely the innovation will be adopted no matter its level of efficacy. In contrast should the innovation scale these huddles, a typical rural African will examine its complexity, which, the author defined as the degree to which an innovation is difficult to comprehend and utilized. He posited that an innovation that is characterized by simplicity and ease of usage seems more likely to be adopted than complex one (owing to the general low educational level in most typical African rural communities). If such innovation is within the knowledge capacity of the farmer, he becomes interested in visibility of the results of its usage. Thereafter the farmer would want to know the various areas such innovation can be applied in his day to day activities. If they are minimal, such innovation may not be adopted by majority. If such innovation commands high divisibility, then the issue of compatibility with existing norms and values determines the farmer' next decision action. If in line with the cultural norms and beliefs, then he adopts it otherwise not. The roles of the change agents participate significantly in ensuring the success of adoption process, importantly in creating the necessary awareness as well as good demonstration of how to put the innovation into use. Community characteristics also influence adoption

rate in African societies, as innovation tends to thrive in a heterogeneous society than a homogenous one. The nonchalant attitude (termed inertia) occasioned by low exposure tends to work against adoption of innovation in many African communities. The age of the farmer is a crucial factor, as older farmers tend to have developed a habit that is strictly guided by customary values and norms. Some farmers tend to have intrinsically developed fear and anxiety for change, because of the uncertainty of the outcome which may pluck them into a difficult corner of life. Vested interests at times depress adoption process, especially if such innovation is against the vested interest of some influential persons within and outside the community. Finally, the status of a stranger before a typical rural farmer is another factor, as most rural dwellers have that tendency to suspect an outsider. These were observations made by the author about innovation adoption in rural communities in Nigeria. Other contemporary factors peculiar to Nigerian rural communities are the influence of a peer member returnee from the urban centres. This is common among adolescents and youths. These groups of rural community member tend to influence their peers with innovations adopted in the cities. Locations of the farming communities also tend to influence the adoption process. Rural farming communities close to the urban centres are usually being influenced by the modernization that characterizes the city, as such farmers in such communities tend to be more versatile in adopting new ideas compare to farmers in communities far located from the urban cities. However, with the understanding of the decision adoption theories earlier explained, a change agent can foster changes in midst of these challenges by promoting the positive forces above the negative forces inhibiting the change (i.e. application of Kurt Lewin' theory). As in the case of mobile phone applications, the change agents can promote those forces like adequate awareness campaign about the apps, illustrating the benefit of the apps, inviting financial institution to come up with a sustainable credit policies that will guarantee empowerment of the farmers to be able to sustain the usage of the apps, encouraging the government to intervene with friendly policies and establishment of training centers for acquisition of knowledge on the usage of the various apps and so on.

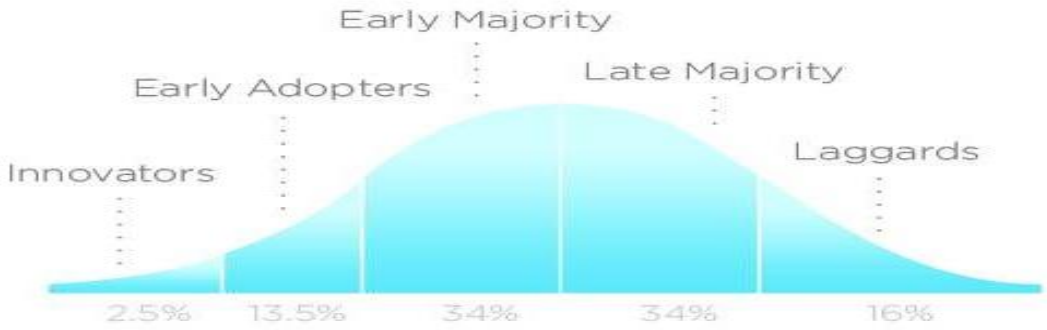

Fig. 2.3: Innovation Adoption Lifecycle

Source: Roger' Bell Curve (Rogers, 2003)

All these theories were in response to the changes brought about by technological developments in the 20 century. With the aid of his curve, Rogers was able to explain clearly the pattern of technology acceptance among certain group of people (in this case, the farmers). This is referred to as the technology adoption cycle. Wikipedia defines this cycle as the sociological model that illustrates the adoption or espousal of latest invention or innovation base on the demographic (in this case agrarian environment) and psychological characteristics of defined groups (i.e. the farmers). The Bell curve, being a standard normal distribution graph, suggests the division of technological adoption lifecycle in any community is five as shown in figure 2.1 above. The author and originator of the curve posited that the categorization is ideal maintaining that there is no pronounced break in the innovativeness continuum of the five categories (Rogers, 1962: 168-171). This categorization enjoyed the ratification of the North Central Rural Sociological Committee and the Subcommittee for the Study of the Diffusion of Farm Practices as well as some notable agricultural researchers like Beal and Bohlen in 1957. They were all on the same term as to the psychographic profiles of each adoption category, which was developed into a report. The report, according to Bohlen and Beal (1957), summarized the categories as innovators who are known to own large farms, educationally advantaged, more successfully wealthy and risk oriented in nature. Early adopters are known to be younger, educationally versatile with the tendency to exhibit community leadership traits which influence neighbours and commanding less wealth and influence. Early majority are considered to be more conservative in nature but with exhibition of attitude of openness to accommodate new ideas and actively involved in community activities. Late majority are recognized as older, educationally deprived, fairly conservative and unpopular in socially settings. Lastly, Laggards also referred to as Phobits known to be extremely traditional, own and manage small farmlands and capital base, usually among the eldest and least educational exposure.

Innovation is also considered to be an idea, ways of doing things or entity that is perceived as uncommon by the subject/adopter. Many factors are presumed to be acting upon the adoption of innovation– like characteristics of adopters, the route of choices of adoption and diffusion of innovation (Premkumar, 1998). Rogers (1995) proffered some generalizations about typical adoption/diffusion that innovations characterized by certain features adopters often see as determining the pace and speed of adoption process which may include comparative edge, user-friendly, complexity status, perceived ease of usage and easily noticeable; certain personal disposition (e.g. level of educational attainment) of likely adopters that placed them above others in other innovativeness; the resolution to adopt an innovation takes place in stages (i.e. stages of diffusion of innovation) that include stage of awareness of the innovation that usually entails information sourcing and gathering about the innovation, stage of being influence and development of perceived thought about adopting the innovation, decision stage as to whether to adopt the innovation or not, stage of implementing the outcome of the decision taken and finally confirmation stage which entails evaluation of the actual outcomes with respect to desired expectations if the adoption decision was positive;

behavioural disposition of some persons referred to as champion or change agents can accelerate (or retard) adoption of an innovation; and finally, the diffusion process often takes off slowly at the initial stage, and then progresses rapidly after the initial take-off stage and eventually levels off.

The most important motivational force for the adoption of new technologies by farmers, according to Premkumar (1998), is the predictable benefits these technologies would bring into providing ease in their general day to day activities. The findings of Zmud (1985) and Saleh (2015) cautioned that, before farmers can look forward to the benefits of any innovation, they must have gained awareness of the innovation and the need for it in their usual daily activities (termed demand pull) as well as usage prospect of the innovation. The decisions to adopt an innovation can either be optional (i.e. the wish to accept or decline an innovation are vested in the wish of the adopters), collective (i.e. the preference to adopt or reject the innovation is not determined by an individual, rather by general consensus of the concerned members) or authoritative, i.e., the choices to accept or reject an innovation are vested in the will of few individuals in position of authority, in this case local, traditional and religious leaders (Rogers, 1995). Hence, the decision to adopt or reject information technologies like the mobile phone apps within a rural community would normally fall into one of these three categories of decision route. In addition, most adoption/diffusion investigations in the field of information system fall within one of adopter studies and macro diffusion studies (Attewell, 1992). According to Branchaeu (1990), adoption studies focus on variations that exist within the adopters in terms of innovativeness, while macro diffusion studies deal mainly with the categorization of the adopters base on the rate, pace and pattern of the adoption process of a technology (e.g. mobile phone apps) across the various group of adopters. Considering the availability and high penetration rate of cellular telephone technologies in Nigeria, and the study area in particular, this study would, therefore, fit in the latter category.

The relevance of the above theory is that farmers, in the adoption of mobile phone apps, exist in strata with each stratum reflecting a level of adoption of the apps in the study area. Every stratum has peculiar characteristics that should guide stakeholders when designing policies and programmes aimed at facilitating the adoption of mobile phone apps in the region. The idea is that steps towards ensuring utilization of apps in the region will be meaningful and successful only when the various categories of farmers in the adoption process are identified and treated based on their specific characteristics and also be given a sense of belonging as a major stakeholders in any policy and programme aimed at enhancing the awareness and use of mobile phone apps in enhancing their socio-economic condition.

2.9.4 Theory of Behaviour Modification

This theory postulates that two forces are acting simultaneously and they both define the attitudinal disposition of an adopter in the presence of an innovation. These forces are the inhibiting forces which are main constraints barring adopters from using an innovation and tend to direct the attitudinal disposition of the adopter away from using the

innovation (Albrecht *et al.,* 1987), and the driving force that tend to enhance, support and facilitate attitudinal change in favour of the innovation (Hycenth *et al*., 2010). These forces hold true for all innovations including the mobile phone apps. Negative vices such as high level of illiteracy, abject poverty, poor government policies, civil disorder (crises), insurgency, lack encouragement tend to limit the ability of farmers to have adequate exposure to information about current mobile cell phone apps which invariably bars them from using the apps. In the same vein, positive tendencies such as high literacy level high standard of living, access to credit, sound government policies that encouraged farmers tend to facilitate awareness of current innovations such as mobile phone technology and encourage its adoption.

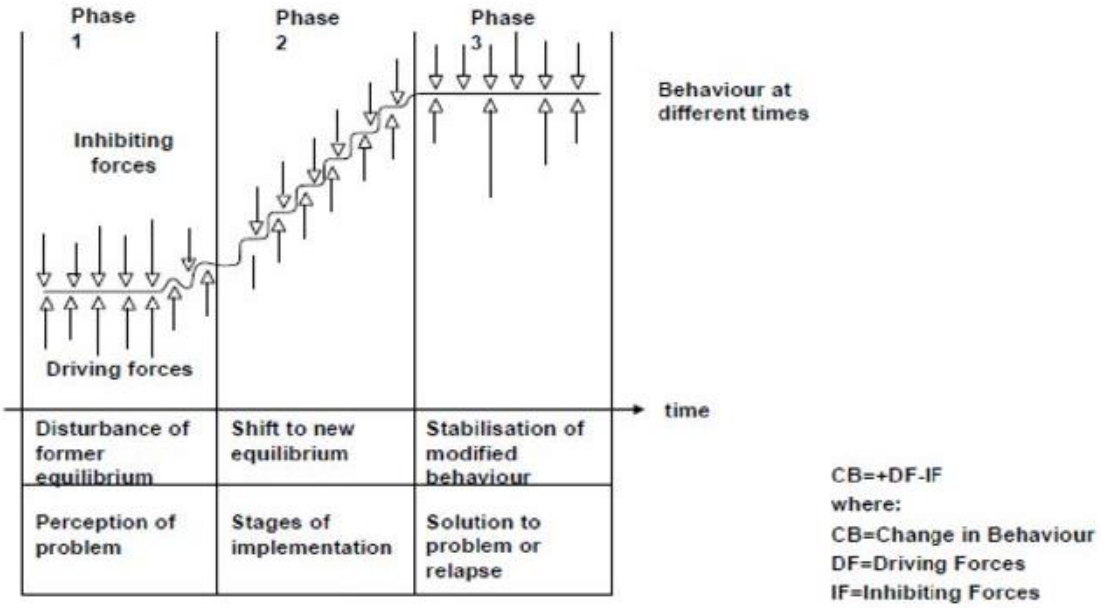

Fig. 2.4: Theory of Behaviour Modification.

Source: Albrecht *et al.*, 1987, in; Hycinth, 2010.

These forces tend to maintain position of equilibrium or disequilibrium with anecdotal degrees of tension between these forces, both striving for dominance in controlling the attitudinal disposition of the adopter (i.e. the farmers). Based on this, Kriesemer and Grotz (2008) posited that if these forces are acknowledged at the decision-making stage, the likelihood of diffusion can be projected and the impact for policies and programmes can be suggested, and hence could be drawn and concluded to support the dominance of the facilitating forces. Understanding the nature and magnitude of the force will, therefore, assist stakeholders in deciding on the line of actions that will foster the utilization of mobile phone apps in the study area.

2.9.5 Theory of Psychological field

Kurt Lewin put forth a theory referred to as the theory of the psychological field to help have a better understanding of human behaviour as it relates to the adoption of innovation. According to the theory, the interface between the situational forces and the perceived environment is best illustrated as a meadow of forces that creates a state of tension termed a psychological field (Hycenth, 2010). This leads to setting a goal that reflects either a positive or negative attitude towards the source or reason for the tension. (See figure 2.2 below).

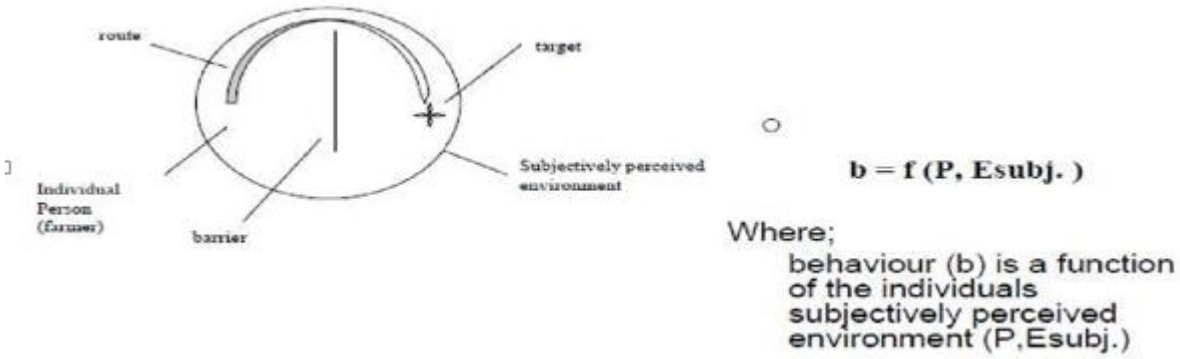

Fig. 2. 5: Theory of Psychological Field (Kurt LEWIN)

Source: Albrecht et al. 1987 in; Hoffmann, 2005; Ndah, 2008; and Hycinth, 2010

Another theory of adoption decision worth mentioning is Hohenheim Concept of diffusion by Hoffmann (2005) as presented by Hycenth (2010). By using Rogers' version of curve Bell, he came up with a categorization of adopters in four phases as against that in Rogers' version. According to the author, while Rogers described the innovators as venturesome and educated, Hoffmann described them as disruptive elements perhaps because of their over-ambition and less risk concern. However, the two versions are strongly related in that, while the Rogers version describes the various categories of adopters in any given social setting, Hoffmann version describes the phases of adoption transition each category of adopter would have to go through to attain full adoption process. The transition phase, according to the Hoffmann version if the innovator component is excluded include: the critical phase when adopters are newly engaged in the use of the innovation and is often characterized by challenges that have to do with understanding the technicalities of usage, the complexity and cost of the innovation; transition to self-sustaining phase that explain the level of commitment of the adopters to the use of the innovation as well as how far they have been able to counter the barriers to the adoption of the innovation; and finally, the last phase of the adoption wave that shows those that have successfully mastered the use of the innovation and have also countered all major barriers to the use of the innovation thereby reflecting the level of diffusion of the innovation in the community.

Moreover, Hohenheim's concept was able to show that not all the recipients (farmers) in the adoption circle were captured under the categorization of Rogers. This is because, in the course of considering an innovation, the farmers may be barred by circumstances beyond their control from onset even before adopting the innovation. Furthermore, those that are not barred by any barrier beyond their control go for the innovation. At this stage some may face challenges beyond their control which may bar them from forging ahead with the innovation, and therefore will have to give up the adoption process (i.e. endpoint, as Hoffmann puts it), implying discontinuation in the adoption pathway which further calls for a need to modify the Rogers' theory. Those that were able to overcome their barriers forge ahead and that lands them in the next phase of striving to attain full control of the use of the innovation (i.e.

turning point). As it is said to practice makes perfection, they gradually attain perfection, which in Hoffmann's version is the final phase of adoption (see figure 2.4 below).

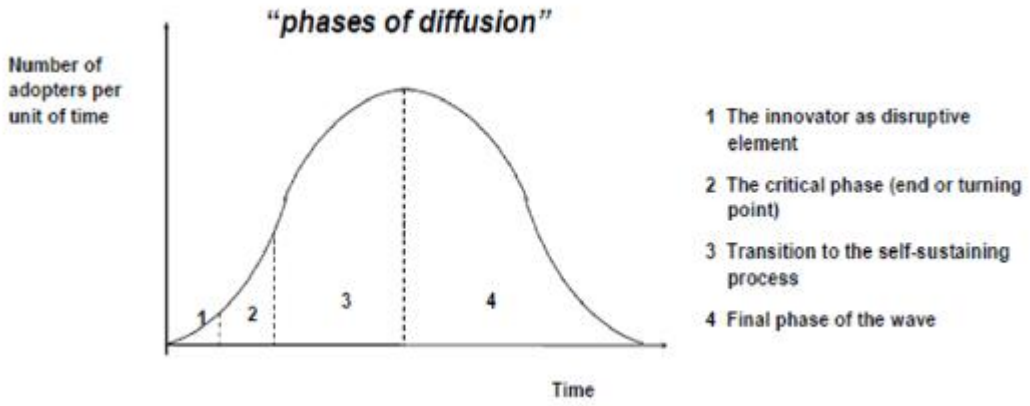

Fig. 2.6: The Diffusion Theory (Hohenheim Concept).

Source: Hoffmann, 2005 in Hycinth, 2010.

From the illustration above, it can be perceived that a category is not captured in the categorization of Rogers. This category consists of farmers who are convinced of the innovation, have set a goat to acquire it but were incapacitated by barriers beyond their control from the unset of the adoption process as well as those that could not go beyond the critical phase. This, therefore, calls for a need to review Roger's theory to capture this set of farmers/potential adopters. On this note, the categorization of Roger's version of diffusion theory should consist of Innovators, the incapacitated as positive minded but highly vulnerable elements to barriers, Early adopters, Early Majority, Late Majority and Laggards.

2.9.6 Theory of reasoned action

Another very relevant theory here is the theory of reasoned action postulated by Ajzen and Fishbein (1980) widely used in innovation adoption, particularly by researchers in research work that is also related to attitude and perception. The theory states that individual behavioural intentions are a determinant of their attitudes and subjective norms. Individual's viewpoints about themselves and their environment form the basis for their attitude and subjective norms which in the long run influence their intentions (Otieno *et al.*, 2016). Farmers' dispositions (attitudes) towards the adoption and utilization of an innovation are affected by the perception of the farmers on the usefulness of the innovation (in this case mobile phone apps) and its impact on the system (the agrarian environment), while subjective norm is based on the individuals perception about how others want to act and their willingness to comply with what the people and environment want them to do (Otieno *et al.*, 2015). Therefore, the intention to adopt and continue to use an innovation such as mobile phone apps by the farmers is determined by

their dispositions (attitude, beliefs and perception) on the effects of the usage of the apps on their day-to-day activities.

2.9.7 Technology Acceptance Model (TAM)

Another foremost model related to technology adoption and adoption often considered as an upshot of the Theory of Reasoned Action is the Technology Acceptance Model (TAM) proposed by Davis (1986). This theory offers explanations on how external variables such as knowledge influence individuals' belief, attitude and intention to utilize an innovation such as mobile phone technologies. TAM illustrates that an individual's belief on any innovation like mobile phone apps is based on perceived usefulness and perceived ease of use of such innovation. As posited by Fathema, Shannon and Ross (2015), these two variables, based on TAM, are major determinants of users' acceptance and utilization of an innovation. With respect to this model (TAM), this study focuses on farmers' knowledge (as influenced by other variables) of mobile phone apps and its effects/usefulness on creating awareness and fostering usage of the mobile phone apps which is expected to expose areas requiring relevant policy recommendations that will be a potential guide to stakeholders in rural development such as the government, extension administrators, international agencies and others which, in the long run would lead to the evolution of viable policies that could result in effective utilization of mobile phone technologies for an efficient and dynamic e-extension activities and enhanced agricultural production and worthy standard of living among farming households in the study area.

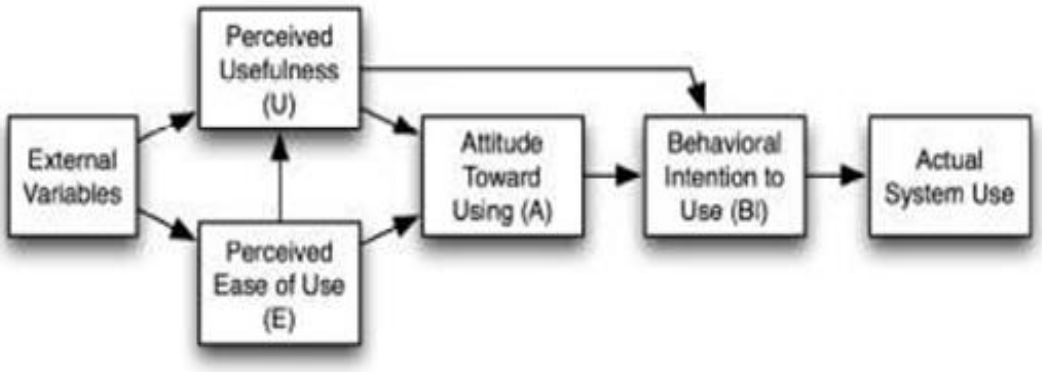

Fig. 2.7: Technology Acceptance Model.

Source: Maina (2015).

2.9.8 Theory of planned behaviour

The last theory to be considered under adoption is the theory of planned behaviour put forth by Ajzen (1991) as presented by Hycenth (2010). This theory helps to comprehend how people's (adoption decision) behaviour can be manipulated based on the fact that behaviour can be deliberate and planned, i.e., deliberate behaviour (figure 2.8) (Hycenth, 2010). According to the theory, human actions are assumed to be guided by three kinds of beliefs: Behavioural beliefs (which is based on the assumption of the likely outcomes of adoption of the innovation),

normative beliefs (which is premised on the influence of cultural norms and values which tend to direct action and expectation of others) and control beliefs which are based on the understanding that existence of certain factors may facilitate or impede the prospect of the adoption process. This implies that farmers tend to adopt mobile phone apps that they believe would serve their basic information transfer needs within the limit of their technical capability. Apps that farmers feel do not have direct bearing to their information needs are not considered worthy of adoption. In addition, apps that encourage vices considered odd by the norms and values of the community may call for caution in the adoption of such apps as farmers would want to avoid negative comments from fellow farmers. Furthermore, external factors such as cost implication, nature of educational development in the community, availability of network services among others could be significant determinants of acceptance of cell phone apps by farmers in the community. Figure 2.8 illustrates the relationship between these beliefs and the adoption process

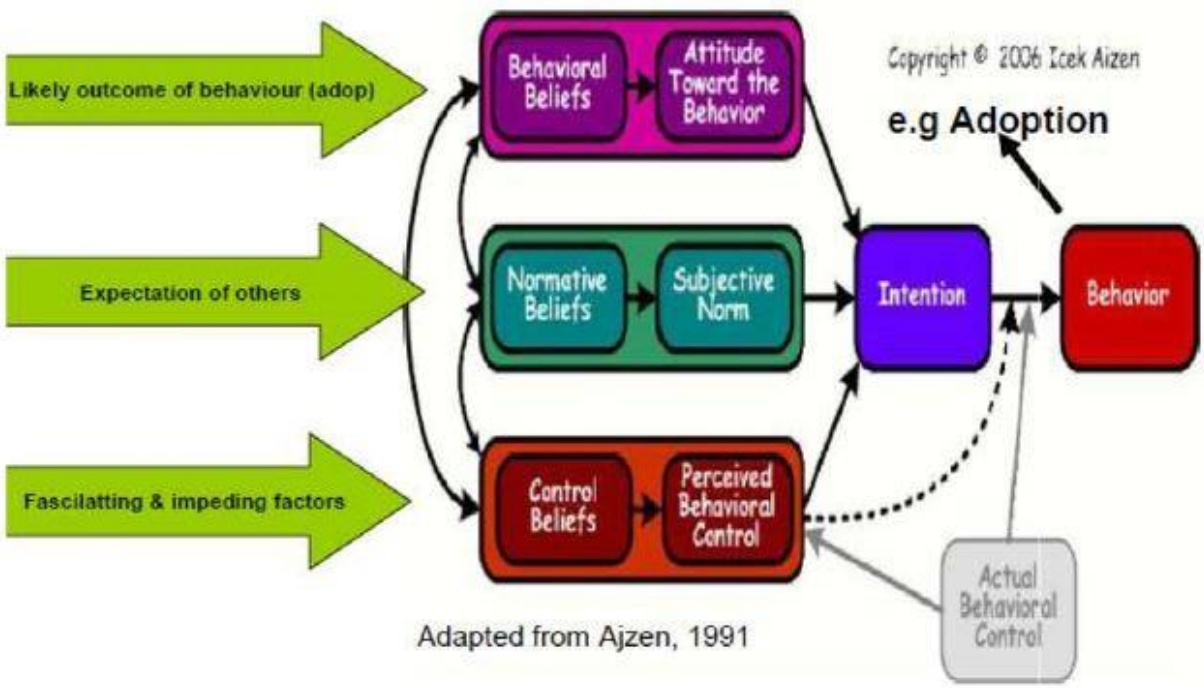

Fig. 2.8: Theory of Planned Behaviour.

Source: Ajzen, 1988, 1991 in: Hycinth, 2010

These considerations are very crucial in ICT adoption in rural communities, and borrowing from the author, it can be illustrated that if the farmers nurture a negative mindset toward the innovation (in this case the mobile phone apps), the chances that such innovation will see the light of the day in such an environment is very narrow. On the contrary, a positive disposition towards an innovation from the initial stage is a great impetus for that innovation, and an indication that it will successfully diffuse in that environment. More so, if the expected adopters have the feeling that certain elements that are very influential to them are not comfortable with the innovation, the chance that such innovation will gain acceptance is completely not promising. Likewise, if the expected adopters are of the

opinion that those influential elements (local leaders, religious heads, norms and socio-religious values) are in tendon agreement with the innovation, they will work hard against barriers to ensure that such innovation gained wide acceptability and adoption. Finally, if the expected adopters fear the workability of the innovation due to anticipated obstacles, they may have a rethink about wasting their time on what they feel may not materialize. All these factors influence the adoption as well as the extent of use of innovation like cellphone apps, among farmers. Hence, the theory of planned behaviour is thus related to this study in the sense that the eventual acceptance and deployment of the innovation of cellphone apps is premised on the knowledge and attitude of the farmers vis-à-vis the perceived usefulness of the apps evident by their perceived effects (behavioural beliefs).

2.10 Conceptual Framework

Based on Cognitive theories, Behavioural theories, innovation/diffusion theories and theory of reason action in synergy with adoption decision models like the theory of psychological field technology acceptance and theory of planned behaviour, a diagrammatically synthesized framework was informed and conceived. The conceptualized structure is divided into three essential sections which include independent, intervening and dependent variables. The explanatory variables are made up of farmers' personal and demographic characteristics such as location, age, gender, marital status, educational level, household size, income, farming occupation and years of experience in farming. These individual and demographic features can impact significantly on the perception of the farmers toward awareness and usage of cellular phone apps in the study area. The positive or negative disposition of the farmers with respect to their awareness and use of mobile phone apps is capable of being influenced by their attitude towards mobile phone apps which can be inferred from their knowledge on the existence of the app and ability to use the apps. Also, the constraints that the farmers come across in the cause of familiarization with the apps may affect their usage of the apps which include the extent and intensity of usage. All these variables are considered in this study and the way they interface with each other are all based on the personal characteristics of the farmers.

The dependent variable for this research finding is the general usage of mobile phone apps (more importantly for extension services) by farmers. This elucidates the dispositions of the farmers towards their awareness and use of mobile phone apps in the area. Farmers' view with regard to deployment of handset for agricultural/non-agricultural purposes, the extent of usage, intensity of usage, impact of usage on crop and animal production and usage in accessing extension services for improved farming activities and enhanced socio-economic conditions will influence their attitude toward the apps.

It was observed that there are some intervening variables that have an indirect impact on the awareness and use of cellphone apps by farmers in the study area. These, among others, community factor that has to do with acceptability of the apps, training opportunities, relative educational advantage of members of the farmers' households, activities of change agents such as extension workers, agencies, NGOs and other stakeholders that have significant

contribution to make in fostering the success of mAgric services in the study area; and the prevailing government policies and programmes that are impacting on rural mobile telephony process in rural domain. All these intervening variables considered act in synergy with each other as they pose a significant impact on the existing interface involving the dependent and independent variables (Oluwasogo, 2018).

Farmers, through various sources of information, become acquainted with mobile phone apps (awareness of the apps, associated benefits/perceived usefulness). The position of the apps before the farmers is based on the information that they got is determined by the cultural norms and values (normative beliefs) of the farmers in synergy with the control beliefs. In a situation where there is no conflict between the information about the apps and the cultural norms of the people, then such apps would scale through to the next determinant stage. The behavioural disposition of the farmers towards the apps would now be based on perceived ease of use of the apps reflected by a modified and defined attitudinal disposition towards the apps. The farmers then develop the intention to either adopt the apps or not; all of which is influenced by the farmers' socio-economic features such level of educational exposure, income level and size of household, as well as constraints to the use of the apps such as poor network and power supply, low income level, poor access to education, among others. In the course of the adoption process, the farmers are identified in strata base on their different levels of responses in the adoption pathway (i.e. Rogers' Bell curve in figure 2.3).

The adoption pathway is best described by Hohenheim's concept of diffusion theory. All the identified categories of adopters pass through technology induction process starting with a stage described as the critical phase, which is a stage of testing the perceived ease of use. At this stage, some of the farmers who could not scale the hurdle dropped the ambition to adopt the innovations (mobile phone apps) i.e. endpoint. These categories, in addition to those who were barred from the onset due to circumstances beyond them, referred to as "positive minded incapacitated" are considered friendly to the mobile phone apps and only needed external support for the inhibiting factors to be dominated by the driving force (action of the intervening variables). Adopters that crossed this phase in the adoption pathway land in the transitory phase characterized by striving to attain perfection in the use of the apps in their day to day activities. Subsequently, they attain perfection described as the final phase, a phase characterized by farmers who have attained full diffusion in the adoption of the mobile phone apps. At this stage, farmers can easily use the apps with little or no difficulties without any support to access information.

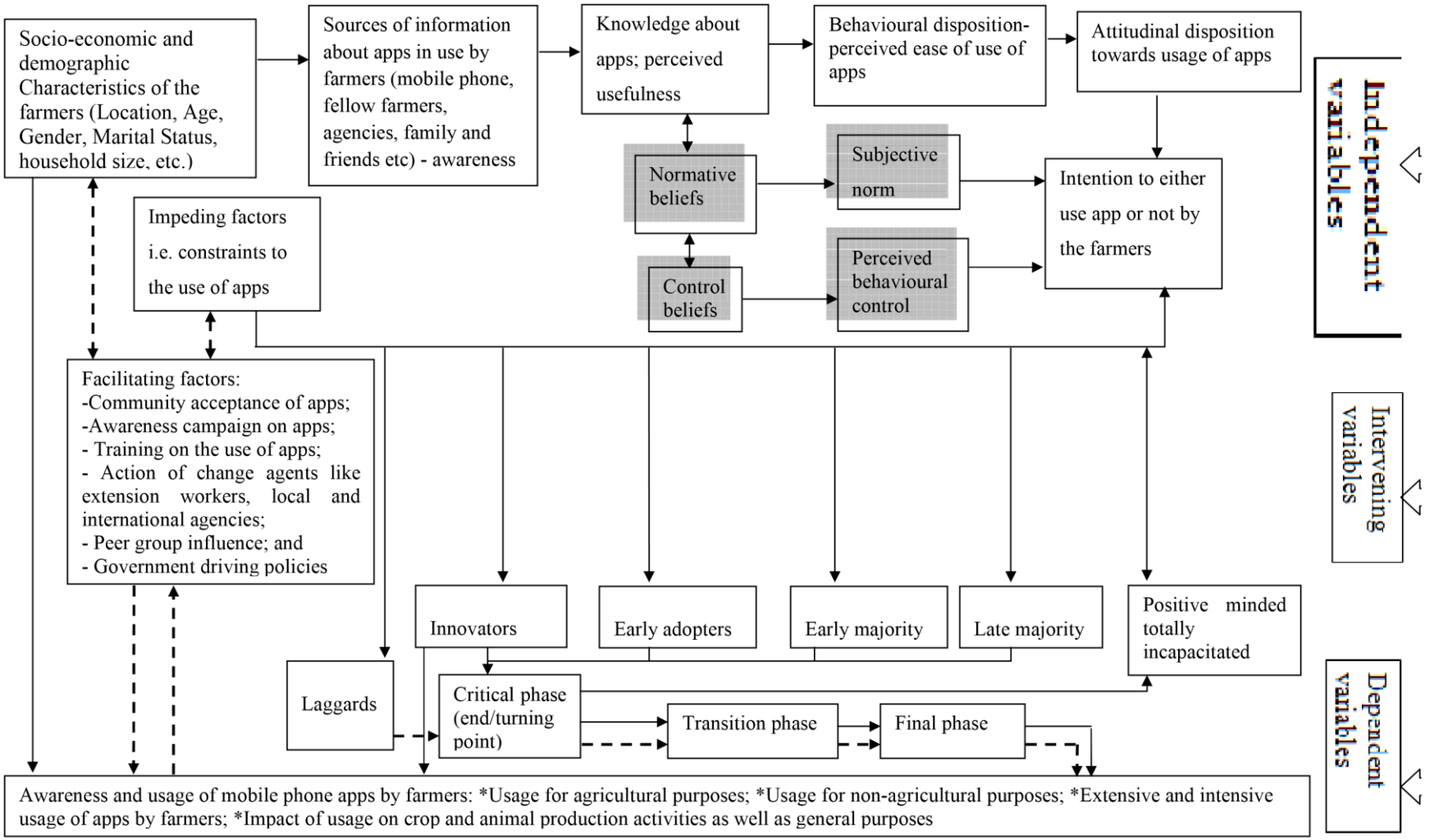

Fig. 2.9: Conceptual Framework on awareness and use of mobile phone apps by farmers in North-West Nigeria.

Source: Author's concept, 2018.

2.11 Chapter Summary

The chapter focused on reviewing the literature on the concepts of adoption with respect to awareness and usage of cellular telephone technologies, its development in Nigeria, the extent of spread in rural communities and usage in farming activities. The study further explored some theoretical models on adoption and its relation to awareness and use of cellular phone apps in rural areas of Nigeria. In line with this, the chapter revealed theories that are related to the study which include theories of adoption, psychological field (Kurt LAWIN), behaviour modification, planned behaviour and the technology acceptance model. The chapter was concluded by giving a detailed hypothesized conceptual framework for the study conceived from the reviewed models and theories.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the details of the methodology that was used in the research work as well as procedures employed for data collection processes. It also gives an in-depth description of the research tools/instrument used, the validity and reliability of instrument employed as well as the various relevant models employed during the process of data analysis.

3.2 The study area

This study was conducted in North-Western part of Nigeria. The location of the zone is between latitude $9^0 10^1$ and $13^0 50^1$ to the North; and longitude $3^0 35^1$ and $9^0 00^1$, covering a land area of about 168.719km^2 equivalent to about 18% of the country's land mass. It is bounded in the North by the Niger Republic; in the East by Bauchi, Yobe and Taraba States; in the south by FCT, Niger and Nassarawa States; and in the West by Benin Republic. The region has an equatorial climate characterized by distinct wet (rainy) and dry seasons with relatively low humidity. The mean annual rainfall ranges from less than 500mm in the northern part to 1800mm in the southern part and a minimum temperature range of 15-17 C during the harmattan (cold) season and 35-40 C during the dry season. The vegetation is typically northern guinea savannah. The total estimated population is 49,564,917 and they are mainly farmers. The climate of the zone is favourable to crops like maize, sorghum, millet, rice, groundnut, cotton, beniseed, potato, cowpea, watermelon, tomatoes, pepper etc. (NPC, 2017). It is the most populous zone in the country. The zone comprises seven States namely: Kano, Kaduna, Katsina, Sokoto, Zamfara, Jigawa and Kebbi State; out of which three states were selected using simple random sampling technique. The zone is blessed with renown centres of learning that include Universities, research institutes, polytechnics, and colleges of education which spread across the zone. In addition, major internet and mobile service providers like the popular MTN, global com, Etisalat, Airtel etc operate in the zone. These, indeed are indications of an E-ready environment.

Table 3.1: Geographical and demographic description of the three selected states

State	Land size (Km^2)	Population (millions) 2006 census	Projected Population (millions) 2019 using 3.2% annual growth rate	Latitude	Longitude	No of LGA	Annual Rainfall Range(mm^2)	Annual Tempt Range(^0C)
Katsina	24,192	5,801,584	8,215,043	(10^050^1-13^038^1)N	(4^016^1-7^013^1)E	34	550-900	25-42
Kaduna	46,053	6,116,503	8,660,968	(9^010^1-11^030^1)N	(6^010^1-9^000^1)E	23	700-1100	21-35
Kano	20,680	9,383,682	13,287,294	(11^045^1 – 12^005^1)N	(8^045^1-09^005^1)E		625-980	15 – 33.5

Source: NPC, 2006

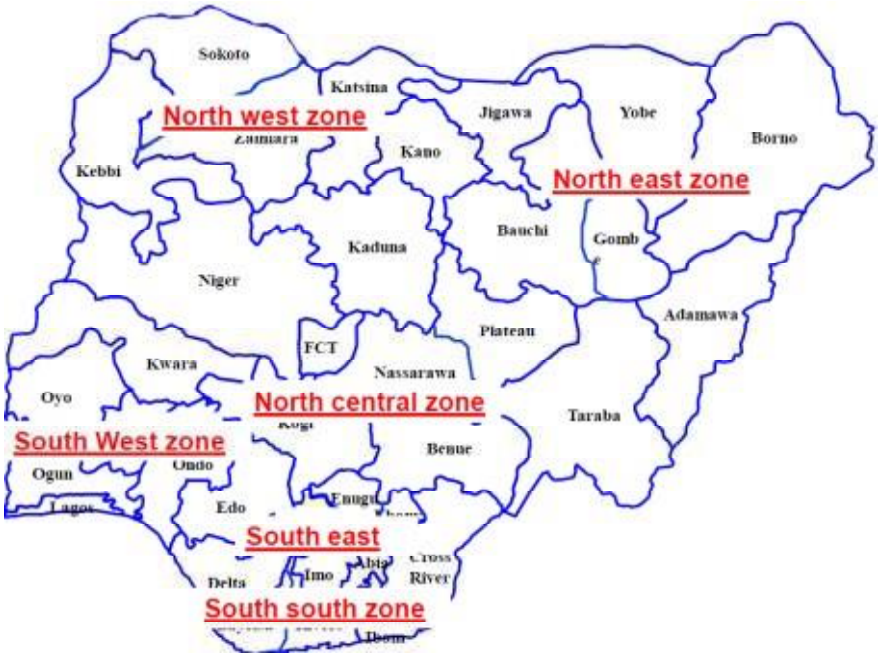

Fig. 3.1: The different geographical zones of Nigeria

Source: Obayelu and Awoyemi, 2010.

3.3 The Research Design

The research design adopted for this study was the *ex-post-facto* in an effort to explain the current adoption decisions with the previous factors experienced by the farmers. According to Cohen, Marion and Morison (2000), an *ex-post-facto* experiment reflects a collection of people that are known to be different with some unique features and then tries to establish the reasons behind these variations. This study, therefore, focused on awareness and use of cellular

phone apps by farmers in North-West Nigeria. The design is suitable for this study because it ensures that the study is conducted on a well-organized system (a group of farmers under extension block categorization of the ADP extension programme) that ensures easy access to the target individuals, i.e., from what is already in existence (Marilyn and Jim, 2013). The research seeks to understand the relationship between contemporary ICT device (specifically mobile phone technology) and farming prospects of farmers; which would lead to making a recommendation that would foster this relationship for a better farming outcome. This is substantiated by Kerlinger and Rint (1986), that in the realm of social science research, an ex post facto exploration seeks to reveal likely relationships by making observations on the existing order or state of affairs and searching previous outcomes and circumstances for plausible contributing factors. The subjects of the research were farmers, who engaged in different fields of agriculture. The farmers were recognized based on their locations, as a carved-out entity for technology transfer and induction process (e.g. extension model villages and ADP extension Blocks) by officially recognized agencies mainly NAERLS, ADPs and Universities. An ex-post-facto research design is most suitable for such a system that is organized on the basis of proper identification and distinction of the target as pointed out by Cohen, Manion and Morison (2000).

3.4 The Population of the Study

According to McMillan and Schumacher (2006:119), a population can simply be considered as a group of persons that march into definite measures which can form basis for generalization of research outcomes. Similarly, David (2017) described population as a broader group of people to whom generalization of study findings/results is intended. Hence, the population of the study consists of all farmers in the North Western part of Nigeria. The population size of farming households in the region was estimated to be above 9,000,000 as that of the selected states was 6,895,014; with 1,361,094 for Katsina State, 4,316,100 for Kano State and 1,217,821 for Kaduna State (NAERLS and DAE, 2013 and 2015).

3.5 Sampling Procedure and Sample Size

Farmers in adopted villages in the selected States ADPs and some Universities within the zone were used for the study. The universities randomly selected include Bayero University Kano; ABU, Zaria (host university of NAERLS) in Kaduna state; and Federal University, Dutsinma in Katsina state.

The multi-stage sampling procedure was used in selecting farmers for data collection. In the first stage, three ADP states (namely Katsina, Kano and Kaduna) were purposively selected owing to the soaring incidence rate of poverty (NBS, 2013) in these states. These states are predominantly agrarian in nature with farming as the main source of livelihood of most rural dwellers found there. Secondly, an agricultural ADP zone was randomly selected in each State. Thirdly, an extension block was also randomly selected from the selected zone. Fourthly, three Local Government Areas (L.G.A) were then randomly selected from each extension block, giving a total of 9 L.G.As in

all. The fifth stage also entailed random selection, in this case five (5) communities from each L.G.A in Katsina and Kaduna States while ten (10) from Kano State were selected to bring the total to sixty (60) Communities. This was done by considering extension outlets of the selected universities to ensure that farmers in the respective model villages of the universities were captured. Additionally, the reason for the variation in the number of communities is to ensure that state with more population of farmers gets more coverage to ensure that more farmers are captured in the study. The sixth stage was the proportionate distribution of the sample size across the three states; therefore, 76, 241 and 68 respondents for Katsina, Kano and Kaduna respectively. Finally, the respondents for each State were equally distributed across the selected communities in the States, i.e. approximately five respondents per community in Katsina State; eight respondents per community in Kano State and six respondents per community in Kaduna State. The sample size (385) was generated through the use of ROASOFT sample size calculator at 50 percent response distribution, which was achieved when the total number of farmers in the three states was fed into the sample size calculator; and then proportionately distributed across the three states.

3.6 Data Collection

3.6.1 Instruments for Data Collection

Data for the study were collected using a well-structured pre-tested questionnaire that is composed of seven sections that are centered on the specific objectives of the study. Hence, questionnaires were arrived at based on the objectives of the study together with a thorough review of works of literature. The first section was to collect data on the socio-economic characteristics of the respondents; the second section was to identify mobile phone apps available in the study area; the third section of the questionnaire was to determine farmer' awareness of the mobile phone apps; the fourth section was to examine the use of the apps by the farmers; fifth section was to investigate the extent of usage of the apps by the farmers; the sixth section was to ascertain the purpose of use of the apps; the seventh section of the survey instrument was to ascertain the attitude of the farmers towards the use of the apps; the eighth section of the questionnaire was to elicit information on farmers' knowledge of the use of mobile phone apps in the area; and the ninth section was to identify constraints inhibiting farmers in the use of mobile cell phone apps in the study area.

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. The secondary data were collected from NAERLS, network service providers (MTN and Airtel Katsina) 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.

The variables contained in the data instrument were measured as follows:

Section A

Respondents were asked to specify the category they belong to on their personal and demographic characteristics as contained in the questionnaire. The variables presented to the farmers were measured as follows:

Age: The actual age of the respective respondent as at the last birthday was obtained and measured in years.

Gender: This was measured as a dummy variable coded 1 for male and 0 for female. Marital Status: Respondents' marital status was ascertained and measured as 1 if married, 0 if otherwise.

Household size: Respondents were asked to state the number of individuals with whom they live under the same shelter, share foods and other basic utilities with in their homes.

Nature of educational attainment: Respondents literacy level was measured as 1 for possession of Arabic education and 0 if otherwise.

Years of farming experience: Respondents were asked to indicate how long in years they have been engaging in farming activities.

Membership of farmer groups: Respondents were asked to indicate if they belong to any farmer association or group, measured as 1 if yes and 0 otherwise.

Means of mobility: This was measured as 1 for motorcycle and 0 if otherwise (Human (Trekking), Motor vehicle, vehicle, bicycle and farm animal).

Access to extension agents: Respondents were asked to indicate if they have access to extension agent or not, measured as 1 if yes and 0 otherwise.

The religion of respondents: Respondents were asked to indicate which religion do they practice (Islam, Christianity and Traditional religion).

Access to credit: Respondents' access to credit was ascertained and measured as 1 if yes and 0 otherwise.

Sources of credit: Respondents were asked to indicate their various sources of credit (bank, microfinance, NGOs, family and friends and others).

Source of income: Respondents were asked to specify their source(s) of income.

Nature of occupation: Respondents were asked to indicate if farming is their primary occupation or not. This was measured as 1 if farming is primary and 0 if otherwise. Ownership of land: Respondents were asked to indicate if the own land which is measured as 1 if yes and 0 otherwise.

Size of farmer land: Respondents were requested to specify the expanse of their farmland and this is measured in a hectare.

Land acquisition method: Respondents were asked to indicate the method used in acquiring their land and this is measured as 1 if through inheritance and 0 otherwise.

Housing material: Respondents were asked to specify the type of material used in building their living homes and this is measured as 1 if mud and 0 otherwise.

Seasonal income: Respondents were asked to specify how much they realize seasonally as income, which is measured in naira (₦).

Seasonal expenditure: Respondents were asked to indicate how much they expend seasonally, also measured in naira (₦).

Source of information: Respondents were asked to indicate their source(s) of information (radio, phone extension agents, agencies, associations and family and friends) on a Yes (1) and No (0) basis.

Section B

Ownership of mobile phone: This was measured as 1 if yes and 0 otherwise.

Ability to use a mobile phone: Respondents were asked to indicate if they can use their mobile phone which is measured as 1 if yes and 0 otherwise.

Type of phone respondent can operate very well: Respondents were asked to indicate which phone they have good operational mastery of among analogue (a), android/digital (b) and both types of phones (c). Percentage of respondents in each category was obtained.

The number of mobile phones possessed: Respondents were asked to indicate the number of mobile phones they owned measured as analogue (a), android/digital (b) or both (c). Percentage of respondents in a, b and c were obtained.

The number of apps in respondents' mobile phone: Respondents were asked to specify the number of apps in their phones which was categorized as a. 1-5, b. 6-10, c. 11-15, d. 16-20 and e. >20. The percentage of respondents that indicated each category was obtained.

Use of apps for farming or non-farming activities: Respondents were asked to indicate if the apps were used for farming or non-farming or for both activities. Percentage of farmers in each category was obtained.

Categories of apps respondents like to see the most: Respondents were asked to indicate the category of apps (Agric-related, dairy, social media, metrological) they would always appreciate on the basis of Yes as 1 and 0 otherwise for each category.

Amount respondents are willing to pay for an app: Respondents were asked to indicate how much they will be willing to pay for apps from a list of categories of prices and percentage of respondents per category was obtained.

Respondents' sources of apps: Respondents were asked to indicate as Yes (1) or No (0) their source of apps from a list of sources presented to them. The percentages of their responses were obtained.

Instructions on how to use mobile phone: Respondents were asked to indicate on the basis of Yes (1) and No (0) if they had training on the use of mobile phone. The percentage score for each category of response was calculated.

Type of phone trained on its use: Respondents were asked to indicate the type of phone they were trained on how to use. The percentage of respondents per type of phone was obtained.

Apps respondents can operate well: Respondents were asked to indicate on the basis of Yes (1) and No (0) from a list of apps, the one they command good operational ability. The percentage of response per app was calculated.

Communication with extension agent through apps: Respondents were asked to indicate if they communicated with extension agents through the use of apps which are measured as 1 if yes and 0 if no. A list of 14 apps was presented to the respondents and Percentage of each category of response was obtained for an app.

Apps used in communicating with extension agents: Respondents were asked to indicate from a list of apps (14 apps) on the basis of yes (1) and no (0), the one they use in communicating with extension agents. Percentage score for each category of response per app was obtained. Extension support for crops through apps: Respondents were asked to indicate on the basis of yes (1) and no (0), crops they got extension support for through app. A list of crops (13 crops) and apps (14 apps) were presented to the farmers and they were to respond for each app crops they get extension support on through the app under consideration. Percentages of responses per app for all the crops were obtained.

Influence of apps on animal production: Respondents were asked to indicate the number of animals added to their animals brought about by the use of apps. The possible increases were categorized and percentages respondents' responses for each category of possible increase were obtained.

Section C

Awareness and use of apps: Lists of 23 apps were presented before the respondents and they were asked to indicate as either yes (1) or no (0) for every app if they were aware of the apps and put them to use or not. Percentages of responses for each app were obtained.

Date of awareness of apps: Respondents were asked to indicate the year they came to know about the app they were aware of. The corresponding duration of awareness in years was estimated for each app. The years were categorized and the percentage of respondents per category was obtained.

Date of first use of app: Respondents were asked to indicate the year they first started using the apps they were aware of. The number of years a respondent has been using the app under consideration is estimated. This was done for all the apps and the usage years were categorized and the percentage of farmers under each category obtained.

The intensity of use of apps: Respondents were asked to indicate the rate at which the apps were put to use and were rated on a 3-point Likert scale of "All activities (3), Most activities (2) and Few activities (1)". Using 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 really 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.

Section D

Purpose of use of mobile apps: Lists of 9 possible purposes was presented before the farmers and were asked to indicate on the basis of Yes (1) and No (0) with respect to every app. The percentages for every app against each purpose were obtained. The first four topmost purposes and the fourth least ones were identified.

Section E

Attitude towards the use of mobile phone apps: The attitude of the farmers on the usage of mobile phone apps was measured taking into consideration farming activities that they were likely to engage apps. Respondents were presented with a list of 30 attitudinal statements on the general applicability of apps in the farming environment, rated on a 5-point Likert scale of strongly agree (5), agree (4), undecided (3), disagree (2), strongly disagree (1). Using an interval limit of 0.05, any statement with mean below 2.95 was considered unfavourable; mean values above 3.05 was considered very favourable; and mean value that falls within
2.95 and 3.05 was considered favourable.

Section F

Knowledge Level of farmers on the use of mobile phone apps: The farmers' knowledge level on app usage was measured taking into consideration their farming profession and as such were presented with a list of 34 statements on the general usage of mobile phone apps in a farming community. They were asked to indicate whether these statements were true (1) or otherwise (0) and the percentage value for each statement was obtained; and further using a 2 point scale of true (1) and false (0), the statements were rated. Using an interval limit of 0.05, mean values below 0.45 were considered low as for mean above 0.55 were considered a very high level of knowledge. Mean value in the range of 0.45 and 0.55 was considered a minimal level of knowledge. Hence, the minimum acceptable score from a respondent for an app is 0.45; while the maximum attainable score for the app is 1.

Section G

Constraints to the use of mobile phone apps: A thirty two (32) items in form of statements were presented to the respondents and they were asked to state whether these items are constraints to the use of mobile phone apps on a Yes (1) and No (0) basis. Those items identified as constraints to the use of mobile phone apps were then rated on a 4-point Likert-type severity scale of Very serious (3), Serious (2), Neutral (0) and not serious (1). Using an interval limit of 0.05, any item with mean below 1.45 is considered not serious constraints, mean score of value above 1.55 is considered very serious and mean value in the range of 1.45 and 1.55 were considered serious.

3.7 Validity and Reliability

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 regarding awareness and use of mobile phone apps, 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. A high-reliability coefficient 0.88 was obtained which showed good and desirable consistency of the instrument. 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.

3.8 Data Analysis

This study employed a number of analytical tools, that include descriptive statistics that were used for all measurements, i.e., all the objectives. The Likert scale techniques were further used to measure the intensity of use of apps by farmers, attitude of the farmers towards the use of apps and constraints on the use of cell phone apps by farmers (i.e. the third, sixth and eighth objectives respectively). To ascertain factors influencing the intensity of app usage by farmers, Tobit regression model was used while probit regression model was used to ascertain the factors influencing the usage status of five most commonly used apps by farmers in the area. The ability of the tools to model variables known to have either a right or left censoring in the dependent variable, in the case of Tobit (Tobin, 1958); and dependent variables that are dichotomous in nature as in probit (Omotayo, 2017) make these models most appropriate.

3.9 Model Specification

3.9.1 Descriptive statistics

Descriptive tools used include tables, percentages, mean, frequencies distribution, and standard deviation for all measurements i.e. all the objectives. The analysis, in this case, was done using SPSS.

3.9.2 Probit Regression Model.

The effects of explanatory variables on the adoption of mobile applications by farmers in North-West Nigeria were assessed using probit regression model. The model was used because it is a standard method for carrying out an estimation of multi-category dependent variables. The model is specified as follows:

$$Yj = \alpha + \beta j \sum_{i=1}^{n} Ij + \mu j \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where;

Y_j is the binary dependent variable indicating farmers' adoption status Dummy variable 1 if a farmer adopts app and 0 if otherwise.

Five top Apps most prominent in the area was considered during analysis. The APPs were voice call app, SMS app, Facebook app, WhatsApp and Bluetooth app. Therefore,

Y_1 = Adoption status for voice call app; Y_2 = Adoption status for SMS; Y_3 = Adoption status for Facebook; Y_4 = Adoption status for WhatsApp; and Y_5 = Adoption status for Bluetooth.

α and β_j are parameters of the estimates

n = number of variables

μ_j = Error term

I_j = the explanatory/independent variables specified below; where j = 1, 2, 3 ……n

Therefore, I_1= Location i.e. 1, 2 and 3 if Katsina, Kano or Kaduna respectively; I_2= Age (continuous); I_3= Gender, where 1 for male and zero otherwise; I_4= Nature of Education which is 1 if Koranic and zero if not; I_5= Marital status which could be either 1 if married and zero otherwise; I_6= Religion captured as 1if Islam and 0 if not; I_7= Household size (continuous); I_8= Farm size (continuous); I_9= Experience (continuous), I_{10}= Ownership of farm land represented as 1 if yes and zero otherwise; I_{11}= Land acquisition method i.e. 1 if inheritance and zero otherwise; I_{12}= Type of labour measured as 1 if family labour and zero otherwise; I_{13}= Nature of occupation measured as 1 if farming and zero otherwise; I_{14}= Access to credit measured as 1 if yes and zero otherwise; I_{15}= Housing material measured as 1 if mud and zero if not; I_{16}= Phone as source of information measured as 1 if yes and zero otherwise; I_{17}= Knowledge of apps which is 1 if farmer's response is *true* and 0 if *false*; I_{18}= Farmers' attitude represented as 1 if favourable and zero if not; I_{19}= Constraint measured as 1 if yes and zero if not; and I_{20}= Awareness represented as 1 if farmer's response is in the affirmative and 0 if not.

The analysis was done using STATA 13. The influencing variables considered were as shown in Table 3.2.

Table 3.2: Factors Influencing the Use of Mobile Phone Applications in the Study Area.

Variables	Coding System	Category	Expected Sign
Location	1 Katsina, 2, Kano, 3 Kaduna	scale	-/+
Age of farmer	Number in years	continuous	-/+
Gender of respondent	1 if male, 0 if not	dummy	-/+
Nature of Education	1 educated in Arabic, 0 if not	dummy	-
Marital Status	1 if married, 0 if not	dummy	+
Religious belief	1 if Islam, 0 if not	dummy	+
Household size	Number of siblings	continuous	+
Farm size	Number in hectares	continuous	-
Experience	Number in years	continuous	+
Ownership of farm land	1 if yes, 0 if not	dummy	+
Land acquisition Method	I if inherit, 0 if not	dummy	-/+

3.9.3 Tobit Regression Model.

Respondents' intensity of usage of apps were ranked on a 3-point Likert scale of all activities (3), that entail use

Type of labour	1 if family, 0 if not	dummy	-/+
Nature of Occupation	1 if farming, 0 if not	dummy	+
Access to Credit	1 if yes, 0 if not	dummy	-/+
Housing material	1 if mud, 0 if not	Dummy	-/+
Communication kit	1 if GSM and 0 if others	dummy	-/+
Knowledge of apps	Aggregate value	Continuous	-/+
Farmer' attitude	Aggregate value	Continuous	-/+
Constraints	Aggregate value	Continuous	-/+
Awareness	Aggregate value	Continuous	-/+

of apps for farming activities like accessing information on weather, fertilizer procurement, labour accessing and coordination, sharing of farm related information with fellow farmers, monitoring farm operation, accessing advisory services as well as nonfarm related activities like contacting family and friends etc; most activities (2), which entail a situation where the farmer use the apps for majority of the activities enumerated above; few activities that entail use of apps on occasional basis (1).These were then used to generate their use intensity index as follows:

$\bar{x}_W$ (Weighted Mean Score) for each app…….. (5)

$\overline{\{S_{max} + S_i + \cdots + S_{min}\}}$

Where $\{S_{max} + S_i + \cdots + S_{min}\}$ is the sum of the scale points.

Using the generated index as the dependent variable, a Tobit regression model was fitted to assess the factors influencing the intensity of the usage of apps by the farmers (null hypothesis). The model was chosen because of its ability to model variables that have either a left or right censoring in the dependent variable (Tobin, 1958). Tobit regression model, according to Wooldridge (2002) and Greene (2003) and Aliyu, Elegwa and Wario (2015), takes the form:

$Y^* = \bar{x}_i\beta + \varepsilon$ …… (6)

Where Y* is the dependent variable, i.e. the generated use intensity index of the apps, β is a vector of unknown coefficients; $\bar{x}_i$ is a vector of independent variables (stated in table 3.2), in line with Adewumi *et. al.* (2011), the independent variables used include the socioeconomic variables of the farmers as well as perceptional status of the farmers on usage rate of the apps in the area; and ε is an error term that is assumed to be independently and normally distributed with mean zero and a constant variance of S^2.

Y* is a latent variable that is unobservable, however, it can only be observed as a continuous variable when the data of the dependent variable is above the limiting factor, in this case, zero, implying that if Y is at the restraining factor, it is considered as zero. This relationship is mathematically presented as:

$Y = Y$ if $Y^* > Y_o$ …… (7)

$Y = 0$ if $Y^* \leq Y_o$ ……..… (8)

Where Y_o is the limiting factor. These two equations represent a censored distribution of the data.

The expected value E_y of the intensity of use of mobile phone apps is given as

$Ey = \bar{x}_i\beta\ F(z) + \sigma\ f(z)$ …… (9)

Where $\bar{x}_i$ is the vector of explanatory variables; F(z) is the cumulative normal distribution of z; f(z) is the value of the derivative of the normal curve at a given point (the unit normal distribution); z is given as $\bar{x}\beta / \sigma$

B is the vector of Tobit maximum likelihood estimates whose coefficient sign will indicate the direction of influence or effect, and σ is the standard error of the model

3.9.4 Ordinary Least Square Regression Model

The generated use intensity index was also used as the dependent variable to fit an ordinary least squares regression model to further assess the determinants of the intensity of usage of mobile phone apps by the farmers (null hypothesis).

The equational form of the model is specified as

$Y= \beta_0 + \beta_1\ \bar{x}_1 + \beta_2\ \bar{x}_2$ ..... $\beta_n\bar{x}_n + e$..... (10)

Implying that Y is the generated use intensity index, the independent variables were stated in Table 3.2 and e in the error term.

3.10 Measurement and Scaling of Variables

Objectives (iv), (vi), (vii) and (viii) were analyzed using Likert type techniques to measure the level of adoption/usage of mobile applications by farmers, their attitudes toward applications, their knowledge of the use of the apps and constraints facing farmers in the use of apps respectively. Likert type scale of three (3) points scoring scale of 3, 2 and 1 was adopted for objectives (iv) to ascertain intensity of use of the apps, corresponding to all activities, most activities and few activities; in the case of objective (vi) which provided information on attitude of farmers towards apps, a five-point Likert scale (5, 4, 3, 2 and 1) was used which corresponded to strongly agree, agree, undecided, disagree and strongly disagree; while a two-point scale was adopted for objective (vii), using a scale of 1 for true and 0 for false; and finally, for objective (viii), a four-point scoring scale of 3, 2, 0 and 1 were used corresponding to very serious, serious, neutral and not serious respectively. In all cases, a mean interval of 0.05 was adopted. According to Osala (1986), the researcher would want to report a mean score on the scaling of the Likert type technique. Based on this grading, the intensity/extent of usage of apps, attitude towards apps, knowledge of apps usage techniques and constraints to the use of apps by farmers were considered.

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

where;

$\bar{x}_W$ = Weighted Mean Score

n = No. of farmers/respondents

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

where:

$\bar{x}_S$ = 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 = $\bar{x}_S - 0.05$……(3)

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

Decision rule:

If $\bar{x}_W$ < Minimum cut point, the result is low/unfavourable/really in use/not severe;

If $\bar{x}_W$ > Maximum cut point, the result is very high/highly favourable/frequently in use/very severe;

If $\bar{x}_W \geq$ minimum cut point < maximum cut point, the result is moderate/occasionally in use

3.11 Ethical Considerations

The researcher observed the highest possible ethical and professional codes of conduct throughout the study. A deliberate effort was made to ensure the removal of prejudices, biases and sentiments that could hamper with basic elements of good research ethic, objectivity and neutrality. To have a quality and reliable research outcome, the following ethical issues were strictly taken into consideration in the course of this study:

Anonymity and Confidentiality: Respondents were given the right to choose to remain anonymous and as such, they were not asked to indicate their names or give anything that could constitute a means of identification on the questionnaire. Information collected from the respondents was treated with absolute confidentiality.

Voluntary Participation: Respondents were given full right to choose to take part in the study or decline.

Informed Consent: The objective of the research was clearly spelt out to the respondents and their permission requested to participate in the study and their positive assent to participate in the research was passed across through verbally.

Beneficence and Non-malfeasance: Throughout the study, the welfare of the respondents was always being considered to be very important and as such, the study did not in any way involve in anything that could cause harm or injury to the health and interest of the respondents.

Observations and face-to-face interviews: This method was used for data collection for the study. This was done to assist the respondents where they needed clarification considering their low level of education. By so doing, any form of difficulty in the process of providing required information was eliminated.

3.12 Limitation of the Study

1. A serious deficit and total absence of appropriate documentation by the farmers were observed and consequently constituted a serious barrier in the course of carrying out research work as most of the farmers depend exclusively on memory recalls. Therefore, to reduce error impact, information on key variables was strictly utilized here;
2. The case of generalisation of the research findings, considering the sample frame was dispersed over a wide expanse of the study area, calls for a need to randomly sampled size, hence making the data a representation and adequately robust enough at three estimate levels, i.e., villages, district heads and local government level, which portrays an impressively overwhelming results. However, the assembled sample was satisfactory to come to a generalized conclusion about the whole population of the research work.
3. Financial constraints, ethical issues and short time frame were the main challenges in the course of research. However, with moral and financial support from NWU in the form of motivation, bursaries and research grants, my personal sponsor and ultimately God almighty, the challenges where cushioned. More effort and time were committed to data collection, analysis and result discussion, which must have facilitated the speediness of the research work.
4. Finally, despite all the mentioned difficulties and shortcomings above, the outcome of the findings is valuable and significantly dependable.

3.13 Chapter Summary

This chapter gave a highlight on the description of the study area and the research methodology adopted for the study. The descriptive and quantitative research design was used to profile the perceived effects of awareness and use of mobile phone apps as it relates to farmers in the study area. It gave an account of the sampling technique, instrument used for data collection, validity and reliability of the instrument and the data collection procedure. A multi-stage sampling procedure was employed in the selection of 385 farmers and a structured questionnaire was adopted to extract information from them. Descriptive and inferential statistics were employed in the analysis of the data. Models fitted for inferential statistics which include probit regression model, Tobit regression and Ordinary least square regression were all well explained in the chapter.

CHAPTER FOUR

EMPIRICAL RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the results of the descriptive analysis results of data from the field. It covers information on personal socio-economic features, including farmers' level of awareness of mobile apps, use of the mobile apps in the area, extent to which the farmers use the apps, the attitude of the farmers towards the apps, purpose to which the apps are put to use and constraints facing farmers in the use of mobile apps in the area.

4.2 Socio-economic and Demographic Characteristics of Respondents

Table 4.1 below shows the demographic and socio-economic characteristics of the respondents in the study area.

The findings show that males were more involved in farming than females. This was evident from the results in table 4.1 which revealed that majority (97.9%) of the respondents were male. This indicates an uneven gender distribution of farmers in the area. This might not be unconnected with the condition prevalent within the socio-cultural setting guided by the dominant religious values (Islamic religious values) of the people. This corroborates the finding of Yusuf, Abdullahi and Haruna (2015) in the their study of the efficacy of E-wallet mobile phone app at curbing sharp and corrupt practices in input distribution to farmers in Kano State, as they also discovered majority (89.9%) of the farmers were males; Caroline (2015) in her study of use of cellphone technologies in agricultural extension delivery in Ghana also discovered that more males (76.8%) were farmers. In a similar vein, Williams and Opeyemi (2015) in their research efforts on use of ICT in livestock farming in Ibadan, unveiled that majority (70.2%) of the farmers engaged in the study were males. Though, Oduwole and Fadeyi, (2013) opined that illiteracy and remoteness were the main reasons women were indifferent to farming activities, the dominant religious values that tend to treasure women excessively is another major factor. More so, Oyesola (2000) as cited by Oyewole (2015) posited that the easy access of male farmers to land as against the women folk and male farmers having more energy to do farm operations were responsible for male dominance in farming activities. This suggests that the involvement of women in agriculture in the region is not encouraging (Mtsor and Idisi, 2014), a situation that can be checked if effective sensitization and education are encouraged (Ekpa, 2017). The implication of these findings is that poor engagement of women in farming could limit the number of active apps users in agriculture in the area, thereby resulting in a wide margin between the use of apps for agriculture and non-agricultural purposes.

The outcomes as in Table 4.1 further confirm that majority (95.6%) of the farmers practice Islam as their religion, implying that majority are Muslims while only a few (4.2% and 0.2%) were Christians and Traditional worshippers respectively. This finding is substantiated by the finding of Ekpa (2017) who unveiled that 91% of the respondents in the area were Muslims; and Hassan *et al*., (2015) who also recorded high percentage (69%) of farmers in the

zone practice Islam as their religion. The high percentage of followers of Islamic faith in the study area could be because the area is positioned in the core Northern part of the country abhorring largely Muslim communities; and considering the fact that Islam was first introduced in this region when it was brought into the country.

In the same vein, the table also shows majority (71.7%) of the interviewed farmers were married out of which a larger proportion (39%) were into a monogamous marriage. This is in consonance with the findings of Yusuf, Abdullahi and Haruna (2015) that also showed that 81.1% of farmers registered for e-wallet mobile phone app in Kano State were married. A similar result was reported by Daniel (2015) who showed that 80% of farmers in Uganda were married; Maina (2015) reported similar result (60%) in a study in Limuru Sub-county. This signifies that the bulk of small-scale farmers in rural communities are married which might not be unconnected with their religious and cultural beliefs attached to marriage institution often considered as a symbol of responsibility and respect. Hence, such responsible farmers represent a symbol of honour and dignity, a virtue crucial to the adoption and spread of innovation and technologies (like mobile phone apps) in the area.

In addition, table 4.1 further unveils that nearly all (99.2%) of the farmers had a form of education; specifically, 29% and 19% of the respondents completed secondary and tertiary education, respectively, 26% had Arabic and primary education in each case, implying that farmers with secondary education are more in numbers than others. These findings are in agreement with that of Daniel (2015) who reported a similar trend in Uganda. This also corroborates the findings of Yusuf, Abdullahi and Haruna (2015) and Akinbile, Akiwu and Alade (2014). This might likely have positive impact on respondents' awareness and use of mobile phone apps, as educational status is expected to enable them to have wider exposure to developmental trend and make better and well-informed decisions in the adoption and exploration of technological advancement like the mobile phone technologies in their immediate environment to enhance their productivity (Obinne, 1991).

Furthermore, the table exposes that almost all (98%) the respondents personally owned farmland for their farming activities in the zone or region the study was carried out. This is in concurrence with findings of Ekpa (2017) that majority (94%) of farmers in North-West Nigeria owned land. To substantiate his finding, the author cited Enujeke and Ofuoke (2012), who equally discovered that 62% of farming households were generally landowners. This indicates that agriculture is considered the foremost occupation as a basis of livelihood for majority of rural dwellers in the study area (Tijjani, Akpoko and Abdullahi, 2015; Aremu, 2008). This implies that securing land for farming activities is not an obstacle the farmers have to contend with in the area, which also suggests why the bulk of the food that sustain the Nigerian population comes from the Northern parts of the country.

The results in table 4.1 show that a good number of the respondents (65.7%) cultivated between less or 2 hectares, while very few (13%) were cultivating more than four hectares. The average farm area in the region was 2.05 hectare. This corroborates the finding of Yusuf, Abdullahi and Haruna (2015), that majority (93.9%) of farmers

surveyed in Kano State cultivated between 1 and 5 hectares of land. Similarly, Williams and Opeyemi (2015) showed that 78.6% of livestock farmers in Ibadan had between one and six plots of farmland (acre equivalent for a plot). In a similar vein, Eze's (2013) findings unveiled that 56.25% of the farmers that access and apply ICTs in South East Nigeria cultivated between 0.1 and 5 hectares of land; indicating that most farmers in the farming communities were small scale farmers This agreed with the submission of Olayide (1992), Orisakwe and Agumuo (2004) and Akinbile *et al*. (2014) that most farmers in Nigeria are small-scale in nature, known to be cultivating small area of land, explaining why most farmers in the region produce at subsistence level. It is expected that farmers who cultivated large areas are most likely going to wholeheartedly accept cell phone technologies compared to those having small farms because those with large farms must have invested more and would be more careful in ensuring the success of the investment by being sensitive to relevant information, a motivational factor that drives the desire to use mobile phone technologies as source of information on market situations and others for enhanced productivity and profit maximization (Caroline, 2015). Hence, farmers controlling large farm size are more prone to utilize ICTs in agricultural technology delivery (Williams and Agbo, 2013), because larger-scale farmers are able to command higher benefits from the consumption of mobile phone technologies as they are able to access resources concerned with input availability and disease control as well as get technical or professional help immediately in case of plant disease. Information on market prices assist them to prevail over any possible constraint on production or market access with better capability than small farmers (Falola, Adewumi and Olaniyi, 2013).

The different land acquisition methods in the zone is also captured in table 4.1. The results show that greater part of the farmers (63.9%) acquire their land by inheritance while some (39%) got theirs by rent; 26.2% of the respondents got theirs via purchase; 8.1% got parts of their productive land through a gift from well-wishers. This indicates that smallholder farmers dominate the region, as land tenureship by inheritance limit farming activities to small farm holdings due to continue fragmentation of farmlands over time. This might be one of the major factors inhibiting commercialization of agriculture in the area and subsequent empowerment of farmers to be able to effectively get necessary awareness information on new technology for onward adoption in their production and day-to-day activities. As such, Ekpa (2017), having discovered that 68% of farmers in the study area got farmland through inheritance, asserted that "land tenureship by inheritance is generally characterized by land fragmentation which could invariably lead to low output due to widespread small farm holdings and diseconomies of scale which in the long run affect farmers' income generating capacity". These will consequently affecting the earning potential of the farmers to be able to acquire and adopt ICT gadgets like smartphones to enhance their farming enterprise.

Table 4.1 further shows that slight majority (59.5%) of farmers in the North West region fell between 21 and 40 years age bracket. Few (7.5%) were below 20 years while only 2.9% were over 60 years of age. Mean value of respondents' age was 36.5 years with standard deviation of 11.9. This signals that most farmers here were in the youthful age bracket, which is the age group that is considered to be devoted and more open to innovative ideas as

several studies have reported a negative relationship between older age and both consumption of agricultural information and adoption of enhanced technologies (Tijjan, Akpoko and Abdullahi, 2015). Again, the mean age of respondents, which suggests that farmers in the region were of middle age, is supported by the findings of Yusuf, Abdullahi and Haruna (2015) that majority (83.3%) of the e-wallet mobile app scheme beneficiaries in Kano State were mainly of middle-age. Similarly, Jaji, Abanigbe and Abass (2017) also revealed that majority (54.6%) of female farmers in Lagos State were of middle age (i.e. youthful), as a result, posited that over half of the population of farmers are in their active age, indicating functional capacity to use mobile phones for improved farming activities. Confirming this position is the report by Omoregbee and Ighoro (2012) that the directional tendency of farming trade is changing as youths and the younger generations are beginning to take part in the venture, and is confirmed to significantly influence their choice to adopt mobile phone technologies. This implies that there is a brighter prospect for farming in the future as the youth with their energetic and innovative nature, are gradually dominating the agricultural domain in developing countries which presents a virile and agile average farming age group with the consequent capability of doing a lot of farm work if well supported (Ojeleye, 2015).

Table 4.1 shows that the category of household size with the highest frequency is 2-7 and corresponds to 32% of the respondents. This is followed by 8-13 categories corresponding to 29% of the respondents. Others were respondents with a single household size which amounted to 26% of the respondents and those with household size exceeding 13 persons corresponded to 13% of the farmers. Average family size was 7.11 with a standard deviation of 6.40. This substantiates the findings reported by Ojeleye, Ayanlere (2015), who showed that farmers in Kaduna State had above 7 members in the household. In a similar vein, Asa and Uwem (2017) in a related study conducted in Itu area of Nigeria, observed that majority (52%) of the farmers had a family unit size of between 6 and 10 persons. This indicates that the farmers keep large members of household which may suggest that they are burdened by high dependency ratio which is likely going to limit the financial ability of the farmers to bear cost implication of securing information about mobile phone technologies as well as the cost implication of owning and maintaining such technologies. However, in a situation where such farmers' children are grown up enough to shoulder some of their needs, large household size could be an advantage to technology adoption; this is because family labour might be readily available, thereby reducing significantly production cost and challenges associated with securing labour which could boost their financial ability to bear the cost of owning and maintaining mobile phone technologies. More so, farmers with children are more likely to secure assistance from their wards (irrespective of educational level) on how to use their mobile phones in simple operations such as making and receiving calls, sending and receiving a text message as well as storing and retrieving messages (Ogbeide and Ele, 2015).

Result of the findings as shown in table 4.1 further show that the primary occupation of majority (78.2%) of the respondents was farming, while it was secondary to few (21.8%). This indicates that the study area is an agrarian environment. This corroborates the findings of Yusuf, Abdullahi and Haruna (2015) which unveiled that 88.3% of

the respondents in the e-wallet mobile app scheme in Kano state live primarily on farming. Similarly, Jaji, Abanibge and Abass (2017) in Lagos, Nigeria showed that majority (67.7%) of the farmers hinge on farming as their primary basis of income. There is, therefore, the need to facilitate dynamism in production through efficient information flow which should drive widespread awareness and usage of mobile phone technologies among farmers whose livelihood is primarily farming. Table 4.1 further reveals the income-expenditure pattern of the respondents. The outcomes reveal that the income of majority (57%) of the respondents exceeded their expenditure, thus implying that 43% of the respondents live above their earnings which automatically mean that these categories of the respondents were already wallowing in the pit of poverty. Considering the income-expenditure pattern of farmers in the region generally, it is expected that an average farmer should not wallow in abject poverty which currently dominates the area. Empirical findings, however, adduced other factors like poor educational level, high dependency ratio, very bad economic environments (high inflationary level), persistent land fragmentation and over-burdened poor government socio-economic policies, as some of the factors that have continued to erode the efforts of the rural populace to build a world of socio-economic security for themselves (Yusuf, Abdullahi and Haruna, 2015). Based on these challenges, farmers tend to resort to borrowing and adjustment in consumption as a means of coping with consequent insecurity in households' basic needs. This mirrors a state of poverty as farmers have very limited amount to save during off season while others resort to adaptation measures such as disposal of assets, decrease in production level, remittances, scavenging (destitution) etc (Olusola, 2016). All these hold true for farmers in North West Nigeria, where scavenging (begging, popularly referred to as Almajiri) characterized the social setting of the people. This virtue indeed signals poor mental and financial abilities to take advantage of the availability of mobile phone apps to enhance their living conditions. Table 4.1 unveils the distribution of the respondents according to membership of association or group. According to Ekpa (2017), an association is "a group aimed at cooperating and helping one another in terms of agricultural and financial needs of individuals in the association". The results reveal that majority of the farmers (73.2%) were not members of any association, implying that only 27% belonged to an association. This is contrary to the findings of Carolyne (2015), who unveiled that majority (58.7%) of farmers in Ghana belong to at least a farmers' association. The reason for this variation may be due to the respondents' low level of educational attainment which limits their understanding of the benefit of association. In addition, this may be due to envisaged fear of being wrongly exploited by local leaders as opined by Epka (2017), that farmers failed to associate themselves with farmer groups probably because of anticipated fear of mismanagement of resources and corruption of the leadership in most association. This entails that most husbandmen in this part of the country are deprived of the benefits of forming a common front to tackle challenges collectively, a virtue suggested by Obayelu (2010), to create a medium for information transfer/sharing and networking amongst members of farming communities. This will expectedly positively impact on farmers' awareness and use of ICT gadgets like mobile phone. Pascua (2009) in Caroline (2015) maintained a similar view

when he posited that farmers' participation in farming associations can stimulate information exchange which is expected to foster adoption and diffusion of new technologies like mobile phone apps.

Table 4.1 unveils the various farmers' association available in the region. The results depict that virtually all the associations command low patronage by the farmers, an indication that the associations in the region were ineffective in enhancing the living conditions of grangers in this part of the country. The implication of this is that, the spread of vital information amongst farmers engaging in the same type of farming enterprise is likely to be very low, thereby limiting their access to information and income-generating ability. This may consequently affect prospects that could enhance awareness of mobile phone apps, and in turn reduce their ability to own, use and maintain mobile phone technologies.

Figures in table 4.1 further reveal that slightly higher percentage (55.6%) of the respondents had access to extension agents. This result also support the findings of Asa and Uwem (2017) who unveiled that less than 60% of the farmers in Itu LGA in Akwa Ibom State had advantage of extension services. This is also evident by the findings of Tijjani, Akpoko and Abdullahi (2015) in Rimi area of Katsina state where they showed that the 3rd-ranked source of information in the study is the advice and education received from extension agents. This implies that extension delivery services in the area are not encouraging with nearly half of the population of farmers not getting extension advisory services, implying that a large proportion of the farmers are left uncared for in terms of training and technology induction activities. Given the poor educational background of the farmers, they may not be able to access information about contemporary technologies and acquiring the technical skill in operating such technologies like the numerous mobile phone apps and models on their own. It is expected that a well-organized extension delivery system that prioritized mAgric component of e-Extension, would foster speedy consciousness rate and wide acceptance of mobile phone in the region studied.

Table 4.1 further depicts that, of those that had access to extension services, the majority (27.8%) usually had monthly contact with their respective extension agents, followed by those that meet with their extension agent occasionally (10.6%); others i.e. for daily, weekly and fortnightly constituted 5.7% in each case. According to Saleh (2015), the frequency of extension contact is an important factor in the promotion of innovation targeted at smallholder farmers, hence low frequency results in a low rate of adoption of innovation implying that for a crop of 90-120 days (of the life cycle), contacts less than fortnightly are virtually poor. This might have accounted for the poor performance of extension services delivery in the area as pointed out by Tijjani, Akpoko and Abdullahi (2015), who posited that the Katsina State government needs to address the issue of availability of extension services in the State given that only one out of ten of farmers admitted getting farming information from the agents. As further unveil in the table, the results show that majority of the respondents (28.1%) that had access to extension agents meet only one extension agent per contact, while 15.1% of the farmers meet with two extension agents. Very

few (9.4% and 3.1%) of the respondents had contact with three and four extension agents in every meeting respectively. This finding further corroborates the assertion and findings of the authors cited earlier. A dynamic extension delivery system is expected to facilitate awareness and adoption of mobile phone technologies in the area given its versatility and dynamism in fostering technology adoption and information flow among users.

Table 4.1 reveals labour types employed by respondents in the region. The results show that hired labour is most engaged by the respondents (46%); this is followed by a combination of family and hired (38.4%). Others include family, rotated group and combination of family and rotated group with percentages value of 11.2%, 3.4% and 1% respectively. This suggests that farmers in the zone engaged more of hired labour to carry out work activities on their farms despite having a large family size that would have constitute free labour for the farmers. The inference is that many parents, having understood the significance of education coupled with effort of government and non-governmental agencies towards ensuring education of the poor through various programmes (most recently is the free feeding programme under the social enhancement scheme of the current administration), have encouraged school enrolment among farming households thereby limiting their access to free family labour, a situation that encouraged use of hired labour. This source of labour has serious impairing implication on farmers' net income which in turn will affect the ability of the farmers to cope with the cost implications of accessing information about available mobile phone apps, own and use mobile phone technologies in the area.

Table 4.1 presents findings on years of experience in farming. The results show that the majority (67.8%) of the respondents had between 6 and 25 years of farm experience. The results further depict that, while 16.1% of the respondents had over 25 years of experience, only a few (14.7%) had less than 5 years of farm experience. Mean value of years of experience in farming obtained for the study area was 16.37. Williams and Opeyemi (2015) reported related results in their study of ICT usage by dairy farmers in Ibadan where they showed that 89.6% of the farmers had between 1 and 15 years of experience in livestock production. Jaji, Abanigbe and Abass's (2017) findings showed that 80.8% of female farmers in Lagos had farming experience that is in the range of 5-15 years. More so, Salau *et al*. (2017), in a related study, revealed that 70.3% of the farmers in Nasarawa State' had years of farming experience in the range of 6 and 25 years. This implies that farmers in the North-West region had many years of farm experience which is expected to put them in a better position to have a better idea of the farming seasons, appropriate crops to plant and mastery of farming techniques and good income generating ability which is expected to place them in a good financial position to meet up with the cost of acquiring and maintaining ICT gadgets like mobile phone technologies. This corroborates the assertion of Sulaiman *et al*. (2015) that a fairly good time of farming experience could lead to a clearer perceptive of new agricultural programmes put in place. In line with this, Ibrahim, Adejoh and Edoka (2009) in Caroline (2015), had argued that the more experienced farmers are, the more they are exposed to sources and channels of information which placed them in a better position to gain

awareness of new and emerging technology like mobile phone apps. This is because experience is necessary to be able to garble and use new technology such as mobile phone faster in accessing extension delivery services.

Table 4.1: Distribution of Respondents According to Socio-Economic Characteristics (n=385)

Variables	Frequency (%)	Mean
Gender Male	377(97.9)	
Female	8(2.1)	
Religion Islam	368 (95.6)	
Christianity	16 (4.1)	
Traditional	1 (0.3)	
Marital status Single	106 (28)	
Married monogamy	150 (39)	
Married polygamy	126 (33)	
Divorced	3 (1)	
Nature of education		
Arabic	100(26)	
Primary	99 (26)	
Secondary	110 (29)	
High school	73 (18)	
Non-formal education	3 (1)	
Ownership of Farmland		
Yes	379 (98)	
No	6 (2)	
Land tenure status*		
Inherited	246 (64)	
Rent	150 (39)	
Purchase	101 (26)	
Gift	31 (8)	
Age		
≤20	29 (7.5)	
21-40	229 (59.5)	36.5 years
41-60	116 (30.1)	
Above 60 years	11 (2.9)	
Household Size		
1	103 (26)	
2 – 7	124 (32)	7 persons
8 – 13	112 (29)	
> 13	52 (13)	
Farm size (ha)		
≥2	253 (66)	
>2-4	81 (21)	
Above 4	51 (13)	

Nature of agriculture as occupation		
Primary	302 (78)	
Secondary	83 (22)	
Income level		
≤ 100,000	142 (37)	
100,001 – 300,000	28 (7)	
300,001 – 500,000	139 (36)	
Above 500,000	76 (20)	
Expenditure		
≤ 100,000	68 (18)	
100,001 – 300,000	83 (22)	
300,001 – 500,000	169 (42)	
Above 500,000	71 (18)	
Members of farmers' group/association		
Yes	100 (26)	
No	285 (74)	
Membership of specific farmers' group/association		
All farmers' association of Nigeria	43 (10.7)	
Rice farmers' association of Nigeria	28 (7)	
Maize farmers' association of Nigeria	20 (5)	
Wheat farmers' association of Nigeria	3 (0.7)	
Millet farmers' association of Nigeria	2 (0.5)	
Sorghum farmers' association of Nigeria	2 (0.5)	
Soybean farmers' association of Nigeria	1 (0.3)	
Apiculture farmers' association of Nigeria	2 (0.5)	
Tomato farmers' association of Nigeria	1 (0.3)	
Pepper farmers' association of Nigeria	1 (0.3)	
Vegetable farmers' association of Nigeria	3 (0.7)	
Water users farmers' association of Nigeria	1 (0.3)	
Fadama farmers' association of Nigeria	9 (2.2)	
Rice millers farmers' association of Nigeria	1 (0.3)	
Contact with Extension Agent		
Yes	214 (55.6)	
No	171 (44.4)	
Frequency of extension visits		
None	171 (44.4)	
Daily	22 (5.7)	
Weekly	22 (5.7)	
Fortnightly	22 (5.7)	
Monthly	107 (27.8)	
Occasionally	41 (10.6)	
Number of extension agents per contact		
None	171 (44.4)	
1	108 (28.1)	
2	58 (15.1)	
3	36 (9.4)	

4	12 (3.1)	
Sources of labour		
Family (F)	43 (11.2)	
Hired (H)	177 (46)	
Both F & H	148 (38.4)	
Rotated group (Rg)	13 (3.4)	
Both Rg & F	4 (1)	
Farming experience		
≤ 5	56 (14.5)	
6 – 25	261 (67.8)	
26 – 45	62 (16.1)	
Above 45	6 (1.6)	

Source: Field Survey (2017). *Figures in parentheses are percentages.

Table 4.2 shows that the foremost sources of information to the respondents were radio (81.3%), family and associates (59.0%), GSM mobile phone (41.8%) and extension agents (39.7). Other sources identified include internet (9.9%), TV (9.6%), Association (8.1%), Agencies (3.1%) and educational institution (0.8%). This indicates that radio is the dominant source of information for the farmers. The reason for this could be that since getting information by listing to radio does not require any direct cost implication, farmers seemed to rely more on it now for new information on farming activities in the area. This is expected as some findings showed a similar trend (Ezeh, 2013; Umunna, 2008; Anselm, *et al.*, 2012).

However, this is contrary to the finding of Epka (2017) who stated that the majority of farmers in Northwest Nigeria source for information using their mobile phones. The reason for this variation could be as a result of the severe economic hardship bedevilling the nation, worsened by the economic recession the country is just recovering from which might have incapacitated many farmers from being able to maintain the cost of using their phones for information sourcing and transfer. In addition, most of the farmers use simple analogue phones that are characterized by limited information sourcing capacity, thereby limiting the extent to which they could use their phones to gain access to relevant information. However, it could be argued that in many instances, farmers source for information from radio using their phones as most phones are fitted with radio devices as app (Ekpa, 2017). This is in accordance with the findings of Ogunniyi and Ojebuyi (2013) that showed that 79.5% of farmers in southwest Nigeria use their mobile phones to listen to radio. This suggests that in recent times, sourcing information via radio could directly be related to the mobile phone technology.

Distribution of respondents on credit accessibility is presented in table 4.2. The results show that good a number of the respondents (51.2%) in the region could not access credit facilities to enhance their general well-being, particularly their farming occupation. This suggests that more than half of the farming population were without access to credit or are still being credit constrained. This will invariably affect their ability to own and maintain

information accessing gadgets like smart mobile phones. Furthermore, considering the various sources of credit facilities available in the region, the finding further unveils the main source of credit to the respondents, which include: family members and friends (36.9%), Banks (6.5%), NGOs (4.4%), Cooperative societies (1%) and Microfinance institutions (0.5%) with an average amount of ₦50,588.65, ₦192,600.00, ₦101,944.44, ₦150,000.00 and ₦45,000.00 in a cropping season respectively. These findings are supported by the assertion of Ozor, Ozioko and Acheampong (2015) that credit opportunities for agricultural production were mostly from acquaintances, relations and individual savings, because farming households in rural areas have limited access to credit; and as such most households could not easily access inputs like hired labour, pesticides, mechanization and information sourcing devices such as mobile phones. The authors then opined that a review of the officially recognized credit system has become imperative and very vital, and should make up fundamental part of any sustainable rural wellbeing development strategies. In addition, Ekpa (2017) showed that the average amount (₦40,518.00) most of the farmers in the region got as credit was from family and friends; and as such posited that "the difficulty associated with securing credit from the formal sector made farmers in the region to resort to self- help within themselves to raise fund to enable them to sustain their agricultural operations". Also, the meagre amount they could assist themselves with was quite low to sustain large scale production; hence, the reason for general low output in production and widespread endemic poverty amongst the rural populace in the region. This may seriously affect the ability of the farmers to own and manage sophisticated ICT gadget like smartphones and its accessories.

Table 4.2: Distribution of Respondents According to Sources of Information (n=385)

Variables	Frequency (%)	Mean
Farmers' source(s) of information		
Radio		
Yes	313 (81.3)	
No	72 (18.7)	
Extension agent(s)		
Yes	153 (39.7)	
No	232 (60.3)	
Phone		
Yes	185 (47.8)	
No	200 (52.2)	
CDROM		
Yes	6 (1.6)	
No	379 (98.4)	
Internet		
Yes	38 (9.9)	
No	347 (90.1)	
TV		
Yes	37 (9.6)	
No	348 (90.4)	

Family and friends Yes	227 (59)	
No	158 (41)	
Association Yes	31 (8.1)	
No	354 (91.9)	
Agencies Yes	12 (3.1)	
No	375 (96.9)	
Access to credit Yes	190 (49.4)	
No	195 (50.6)	
Sources of credit **Commercial banks** Yes	25 (6.5)	
No	360 (93.5)	₦192,600.00
Microfinance bank Yes	2 (0.6)	
No	383 (95.6)	₦45,000.00
Non-Governmental Organizations		
Yes	17 (4.4)	
No	368 (95.6)	₦101,944.44
Cooperative societies		
Yes	4 (1)	
No	381 (99)	₦150,000.00
Family and friends		
Yes No	142 (36.9) 243 (63.1)	 ₦50,588.65

Source: Field Survey Data (2017). ***Figures in parentheses are percentages. Dollar equivalent of credit using ₦306.9 to a USSD CBN rate accessed at https://www.cbn.gov.ng/rates/ExchRateByCurrency.asp: ₦192,600.00 = $627.57; ₦45,000.00 = $146.63; ₦101,944.44 = $332.18; ₦50,000.00 = $488.76; ₦50,588.65 = $164.84**

Table 4.3 reveals the various means of transportation local sodbusters commonly employed in the zone. The results show that the various means of transportation identified included bicycle, motorcycle, vehicle/truck, farm animals and humans. The goods generally transported by farmers in the region include farm workers, farm inputs, farm produce and farm waste. Of all the identified means of transportation in the region, the results show that motorcycle is mostly used by the farmers for the transit of the identified goods with the exception of farm waste. This is in alignment with the finding of Epka (2017), who unveiled that most of the farmers in Northwest Nigeria use a motorcycle as their main means of transportation of persons and goods. This infers that most of the farms cannot afford higher means of transport due to their low standard of living and possibly because rural environments are characterized by narrow rough path suitable for motorcycle and other simple means of transportation. Moreover, it is assumed that the apparent dominance in the use of a motorcycle for transportation in the area is due to its simpleness and ease of manoeuvre in narrow and rugged terrains that characterized most of the communities,

thereby supporting an equivalent report by Epka (2017) and Adedeji *et al*. (2013). They also ascertained that most farmers in rural confines are living in abject poverty because of the subsistent nature of their farming activities usually characterised by low income and hence restricted to poor means of transportation. This is a virtue that gives a negative reflection of farmers' ability to own and operate mobile phones, considering the associated cost implications.

Table 4.3: Distribution of respondents according to means of transportation (n=385).

Means of Transport	Materials Transported			
	Farm Workers	**Farm Inputs**	**Farm Produce**	**Farm Waste**
Bicycle	57 (14.2%)	19 (4.9%)	4 (1%)	13 (3.4%)
Motorcycle	224 (58.2%)	265 (68.8%)	196 (50.9%)	71 (18.4%)
Vehicle	45 (11.7%)	20 (5.2%)	112 (29.1%)	63 (16.4%)
Animals	9 (2.3%)	46 (11.9%)	56 (14.5%)	81(21%)
Human	104 (27%)	18 (4.7%)	5 (1.3)	87 (22.6)

Source: Field Survey Data (2017).

Findings on the field unveiled that respondents used different materials for their structural buildings. Table 4.4 depicts that majority (73% and 71.2%) of the respondents used pure mud to build their storage and living rooms respectively, while 1% of the farmers used a combination of mud-zinc as 0.3% used zinc only as housing materials for their living room. More so, whilst 27.5% used a combination of bricks/roofing sheets to make their living rooms, 23.4% of the farmers used brick/roofing sheet to build their storage house. The result further showed that 82.3% of the farmers did not have any special structure as farm shade. In all, more than 50% of the respondents used purely muddy housing material which supports the assertion of Egwemi and Odo (2013) that rural farmers are in a state of poverty which reflects in the nature of their dwelling places mainly because of their inadequate resources, and as such majority of them are restricted to poor dwellings as they could not pay for a decent building. Facts from a background re-evaluation of livelihood of those living in poverty in Ghana by Korsi and David (2001), as cited by Epka (2017), expressed a parallel scenario as they observed that nearly all the farmers in their study area inhabited thatched structures because of their very meagre financial resource-base. The above situation mirrored the primitively poor state of livelihood in the agrarian North-West zone of the country. This outcome is not a good record that would give an impression of a rooted adoption of mobile phone apps in the nearest future to come in the region.

Table 4.4: Distribution of respondents according to housing materials in use (n=385).

Housing/shade	Type of Materials Used			
	Mud only	**Mud & zinc**	**Brick & Zinc**	**Zinc only**
Living room	274(71.2%)	4 (1%)	106(27.5%)	1(0.3%)
Storage house	281(73%)	2(0.5%)	90(23.4%)	3(0.8%)
Farm Shade	44(11.4%)	0 (0)	6(1.6%)	2(0.5)

Source: Field Survey Data (2017).

Table 4.5 shows the findings on the different crops cropped by local husbandmen in the zone. The major crops were rice (71.4%), maize (70.1%), sorghum (58.2%), tomato (51.9%) and cowpea (50.9%). Furthermore, the findings depict that average yields and income realised from the cultivation of these crops annually include: rice (4.08tons; ₦351,046.97), maize (2.6tons; ₦225,091.42), sorghum (1.17ton; ₦122,036.28), tomato (129 baskets; ₦207,820.00) and cowpea (0.6ton; ₦156,697.44). In addition, the results reveal that the least cultivated crops and their details as follows: sugar cane (2%; average yield= 199 bundles; average income = ₦103,058.33), wheat (9.4%; average yield= 1.76ton; average income= ₦256,051.72) and spinach (25.5%; average yield= 25.63 bundles; average income= ₦12,928.57). This is in consonance with the findings of Yusuf, Abdullahi and Haruna (2015) who showed that majority (over 50%) of e-wallet mobile phone app scheme farmers in Kano state cultivate mainly rice and maize. It further corroborates the findings of Abdullahi (2015) who showed that majority of farmers in the e-wallet mobile phone app' scheme in Nasarawa state earned an annual income of between ₦10,000 and ₦500,000 with an annual average of ₦383,091.70 from their farm enterprise. Similarly, Evelyn and Eliamiring (2017) showed that most of the farmers (56%) in Ilala District in Tanzania earned above USD 476.19 (equivalent to about ₦171,428.40). The inference from these findings is that the majority of the farmers cultivate mainly food crops as against cash crop that would have earned them huge income to enable them to live a better life. These crops are cultivated based on rain-fed farming, indicating that the cropping season is annually as rainy season is just once per annum. This implies that earnings from these crops accrue to farmers annually. Such low average income earnings on annual basis cannot support an average household size of seven people, thus implying that majority of the farmers were left with no alternative than to look elsewhere for additional earning to support their family. This precedence indicates that depending on farming as the main occupation for living means survival in abject poverty. This would invariably affect the capability of the grangers to acquire the prerequisite skills for self-development and exposure necessary to gain awareness of contemporary technologies like the mobile phone apps and the technical ability to use the apps as well as the financial capability to shoulder the cost implications of sustaining the usage of the mobile phone technologies.

Table 4. 5: Distribution of respondents according to crops cultivated by farmers in the study area per growing season (90 days in a yearly rainy growing season)

Crops	Frequency*	(%)*	Average Yields(kg)	Average Income(₦)
Rice	275	71.4	4077.12	351,046.97
Wheat	36	9.4	1755.97	256,051.72
Maize	270	70.1	2593.66	225,091.42
Tomato	200	51.9	128.80	207,820.00
Cowpea	196	50.9	590.22	156,697.44
Potato	120	31.2	28.86	140,428.57
Sorghum	224	58.29	1165.41	122,036.28
Sugarcane	7	2	199.33	103,058.33
Onion	163	42.3	29.48	77,275.00
Millet	168	43.6	348.09	71,755.74
Soybean	100	26	422.50	68,284.21
Spinach	98	25.5	25.63	12,928.57

Source: Field Survey Data (2017). *Denote multiple responses applicable. Dollar equivalent of credit using ₦306.9 to a USSD CBN rate accessed at https://www.cbn.gov.ng/rates/ExchRateByCurrency.asp: ₦351,046.97 = $1,143.85; ₦256,051.72 = $834.32; ₦225,091.42 = $733.44; ₦207,820.00 = $677.16; ₦156,697.44 = $510.58; ₦140,428.57 = $457.57; ₦122, 036.28 = $397.64; ₦103,058.33 = $335.80; ₦77,275.00 = $251.79; ₦71,755.74 = $233.81; ₦68,284.21 = $222.50; and ₦12,928.57 = $42.13.

4.3 Extent of use of mobile phone apps by farmers in North- West Nigeria.

Table 4.6 presents the results of the study on the determination of the extent of use of mobile phone by farmers in the study area. The results reveal that majority (96.1%) of the farmers possess mobile phones out of which 95.8% use theirs. This concurs with the finding of Ekpa (2017) who unveiled that 55% of sodbusters in northwest zone of the country use GSM. He as such posited that cellular telephone was the commonly adopted avenue of information transfer in the zone because of its multi-faceted nature combining other attributes of message sharing mechanism like the radio, TV and video system in a single device called a cell telephone. This is further supported by Adeyemi, Alonye and Owolade (2013), who reported that 98% of the respondents in their study used GSM as their channels of communication. This indicates that mobile phone technologies have highly diffused into most rural communities, implying that smallholder farmers that dominate the rural farming communities are in tune with the global trend in awareness of the existence of mobile telephony. This virtue is a good prospect for the use of cellular phone apps by farmers in the area considered.

Table 4.6 further shows that while the majority of the respondents (60.8%) could operate analogue phones, only very few (2.9%) could not operate any phone; 36.3% of the respondents could operate digital/Android phones; 9.9%, on the other hand, could operate both analogue and android/digital phones. This indicates that at least 97% of the respondents could operate one type of phone or the other, implying a high penetration rate of the mobile

phone as a means of information transfer in the area. This holds true based on the report of the Nigerian Communication Commission (2016) that facts and figures from ITU, United Nations Population and World Bank showed that the number of active mobile phone subscribers in the country as a whole was over 148 million (94%) subscribers. This signals good prospects for the awareness and use of mobile phone apps among food growers or producers in the zone.

The results in table 4.6 further depict that most of the respondents (60.5%) possess the analogue type of phone; 28.8% Android/digital; 7% both analogue and android/digital; and only 3.6% not owning any. This corresponds to the findings of Caroline (2015) in a much related study in the Eastern Region of Ghana, where it was discovered that majority of the farmers (91.1%) use ordinary analogue or feature phones. This indicates that, though the mobile phone is widely accepted as garget of communication in the study area, farmers adopted the simpler phones, perhaps because of their limited knowledge of the technology. This is a reflection of most adoption theories that suggest that smallholder farmers tend to adopt simple technologies in the initial stage due to perceived ease of use before extending to complex ones (Khalba *et al.*, 2000; Qiang, Kuek, Dymond and Esselaar, 2011; Carolline, 2015). These findings imply that because of the existence of simpler forms of mobile telephony, the technologies have gained wide acceptance among farmers in the region. This is supported by the positions of Ogbonna *et al.* (2015), Tyabo *et al* (2015), Hassan *et al.* (2015) and Omodara (2012) that ICT (mobile phone in particular) has become a very significant feature not only in the Nigerian agricultural sector in contemporary times but all over the third world or fast developing economies. This is most likely going to encourage widespread awareness and utilization of mobile set apps by husbandmen in the zone.

Table 4.6 further shows that farmers with phones not having more than five apps are more in number (36.1%); followed by those whose phone apps are in the category of 6-10 apps (23.6%). This suggests that majority of the farmers are using very simple analogue phones (Caroline, 2015) that may not be able to go on the net for information sourcing and smart and cheap information sharing via platforms like WhatsApp, e-mail and facebook. This is most likely to be a maiden finding on mobile telephone technology amongst farmers in the country as a whole and the study area in particular. This implies that farmers may not be able to maximally explore the technology of mobile ICT in enhancing their farming and day to day activities.

Distribution of respondents according to the purpose for which they put their phones to is revealed in table 4.6. The results reveal that most of the farmers (78.4%) used their phones for both farming and non-farming purposes with a tilt more to the non-farming purposes (9.9%) as against the farming purposes (7.8%) only. The benefits farming enjoyed from the use of apps are majorly marketing and input sourcing and not information sourcing via the net on global trend in agricultural development. A low case of use of mobile phone apps purely for agricultural purposes was recorded by Osadebamwem and Idabe (2015) in which they reported that only 38% of monthly recharge card

expenses by farmers in sub-Saharan Africa represented agricultural uses. This explains why increase in agricultural production in the area is not picking up at the same rate with the rate of mobile phone penetration, and as a result, the widespread availability of mobile phone technologies is not making expected impact on agricultural production in the area. The reason for this may be that the farmers were not aware of the great prospects of mobile apps to greatly impact on their production as expressed by Calvin, Saroja and Chris (2013) that "very few communities in the developing world understand the full potential that ICT can offer in the short and medium terms".

Again, the results in table 4.6 are in addition to the stream of knowledge as far as the study area is a concern. The table depicts mobile phone apps that are most likely to pull the attention of primary food producers in the region. The findings depict a larger percentage (66.2%) of the respondents were fascinated more by social media apps. This upholds the findings in table 2 that established the fact that youths, who are often attracted by social media activities, dominate farming activities in the region. This trend makes the region a fertile ground for actualizing the Sustainable Development Goals (SDGs) adopted by the United Nations in September 2015. Premised on this, Michael Hailu (CTA Director), as cited by Ashoka (2016), urged key players in agriculture and rural development to advance effective action plans that can halt state of starvation (Goal 1), double the production of local farmers by 2030 (Goal 2) and champion policies that support and foster entrepreneurship establishment, growth and development (Goal 8). This is because the youths remain a sine qua non in ensuring increased productivity and sustainable agriculture giving their immense energy and high innovative tendencies. To substantiate this, the author, in collaboration with CTA's Agricultural, Rural Development and Youth in the Information Society (ARDYIS) project, presented twenty ICT-oriented entrepreneurial ventures developed by youthful innovators from Africa and Caribbean countries that featured the application of mobile phones, social media and websites among others. Similarly, the wide acceptance of social network apps in Africa mainly by the youth has been widely reported in many studies (Adler and Know, 2002; Bargh, 2004: Banmeke and Oose, 2012). Impressively, it was also reported by Sokoya *et al.* (2012) that there is also a rising engagement of social media amongst agricultural researchers, peers, colleagues, professionals and the youth; implying that these tools/apps could be strong bridge between key players in agricultural sphere of life, particularly in the rural communities where most small-scale farmers live.

Results in table 4.6 further unveil amount farmers were disposed to pay for mobile apps in the region. The results show that while 41.3% of the respondents were willing to part away with between 50-100 naira for a mobile phone app, 32.5%, on the other hand, were willing to pay between 151-200 naira; and very few (13.2% and 13%) were willing to acquire an app at the cost of between 101-150 and over 200 naira respectively. This information is a potential guide for stakeholders nursing a prospect for a mobile application with cost implication on users in the region. Borrowing a leaf from India through the work of Shawn and Nilesh (2016), where they evaluated a cellphone-based agricultural advisory service presented to farmers via a mobile-based application called Avaaj Otalo (AO), which was aimed at ascertaining if the launching of an inexpensive information and communications

technology could deliver timely and relevant information and advice to farmers, they showed that the willingness to pay was generally low. This implies that any apps that would involve cost implication on the part of the farmers must be well thought of, or pegged at value generally assumed low by the majority. In addition, such an app must be suitable to the mental capability and socio-economic status of the farmers and as well address significantly the most pressing challenges facing the farmers. In line with this, and understanding the vulnerable financial positions of most farmers, Okeke *et al.* (2015) maintained that government at all levels should endeavour to make ICT facilities readily reachable and affordable to all categories of food producers and advisory agents, which will hopefully make it possible for farmers to promptly have updates on temperature, humidity, rainfall, solar radiation, soil moisture and wind speed.

Results in Table 4.6 further show that most farmers (83.6%) in the region depend on default apps on the phone as against 7% and 19% of respondents that source for apps from app store and social media websites respectively (features/apps peculiar to smartphones or android/digital phones). This study, therefore, unveils areas of training needs (operation and utilization of smartphones for information access and consumption by small-scale farmers) for policymakers aiming at digitalizing agricultural practices amongst small-scale farmers in the region.

Result in Table 4.6 shows that larger percentage of the respondents (60%) used their phone apps to source for labour. The results further reveal that 12% of the farmers used their mobile phone apps to source for fertilizer while 8.1% of the farmers sourced for implements using their phone apps. It was further unveiled that not a single respondents access capital, pesticides and seeds using their mobile phones. This further indicates the underutilization of the cell phone technology by farmers in the region. Though the fast evolution and acceptance of digital innovations, according to Schwab (2016), is celebrated as the fourth in the series of industrial revolutions, bridging the technological gap in human life (Annan *et al*. 2016; Gates, 2016; Warshauer, 2016), many are convinced that the new order holds great prospects for developing agriculture in Africa (Yonazi *et al*., 2012). The systematic use of ICT in agricultural productivity provides the most excellent prospects for development and good standard of living on the continent. However, to date, agricultural mobile phone services are not close to assuming their full potentiality on the continent (Baumöller, 2018), with the worst scenario manifesting here in the North-west region of Nigeria, where mobile apps are less deployed in farming activities. This suggests that farmers in the area are still adopting crude means to source for inputs, thereby making farming activities very difficult in the region.

Respondents' distribution according to information on training received on the use of cellular telephone, as shown in table 4.6, shows that majority (58.7%) of the farmers got some sort of training, either official or unofficial, on how to operate and explore cell phone in the area studied. The table further unveils that, of those trained, the majority (30.1%) were trained on the use of analogue phone only as 21.6% got training purely on android/digital. This implies

that the most popular mobile phone in the study area is the analogue cell phone, perhaps due to its relatively low price and simplicity of operation. It also portrays the low knowledge level of the farmers as far as the digital world is concerned. This is in line with the opinion of AED (2003), as cited by Tyabo *et al.* (2015), that low literacy rates in a number of rural areas in the emergent third world constitute bottleneck to the effective use of ICTs. This is because low level of literacy may have negative consequences on the level of awareness and appreciation of the technicalities of ICT usage to boost efficiency and effectiveness of utilization in agricultural production.

Table 4.6: Distribution of respondents according to possession and use of mobile phone (n=385)

Variables	Frequency	(%)
Possession of mobile phone		
Yes	370	96.1
No	15	3.9
Use mobile phone		
Yes	369	95.8
No	16	4.2
Phone farmers can operate well		
Analogue	234	60.8
Android/digital	102	26.5
Both	33	8.5
None	16	4.2
Type of phone farmers possessed		
Analogue	233	60.5
Android/digital	111	28.8
Both	25	6.5
None	16	4.2
Apps in farmers' phone		
1 – 5	139	36.1
6 – 10	91	23.6
11 – 15	68	17.7
16 – 20	41	10.6
Above 20	31	8.1
Purpose of using apps		
Farming	30	7.8
Non-farming	37	9.6
Both	302	78.4
Not applicable	16	4.2
Category of apps farmers like to see		
Agric related		
Yes	176	45.7
No	209	54.3
Diary related apps		
Yes	22	5.7
No	263	94.3
Social media apps		
Yes	255	66.2
No	130	33.8

Metrological apps		
Yes	29	7.5
No	356	92.5
Amount farmers are willing to pay for apps (₦)		
50 – 100	159	41.3
101 – 150	51	13.2
151 – 200	125	32.5
> 200	50	13
Farmers' sources of apps		
Ones on phone		
Yes	322	83.6
No	63	16.4
App store		
Yes	27	7
No	328	93

Source: Field Survey Data (2017). *Denotes multiple responses

The results in table 4.7 also show apps farmers can use very well in the study area. Percentage and mean values for each app was computed. The mean score was arrived at using a 2-point scale point. The findings disclose that majority of the respondents (93.5%; $\bar{x}$=0.935, SD=0.247) use voice call apps, followed by SMS (70.6%; $\bar{x}$=0.706, SD=0.456); while net-related applications like Facebook, WhatsApp, YouTube, E-mail, etc recorded low usage status i.e. 30% ($\bar{x}$=0.299, SD=0.458), 23% ($\bar{x}$=0.229, SD=0.421), 5.2% ($\bar{x}$=0.052, SD=0.222), 9.9% (0.099, SD=0.299) respectively. The findings conform to that of Caroline (2015) in a related study conducted in Ghana, which showed competency of farmers in the use of various mobile phone apps. The findings unveiled that voice call and SMS apps were the leading apps, as voice call app had a mean score of 4.52 and SMS had 2.30, while other apps had mean scores of less than 2. These findings substantiate the position of Heike (2018) that farmers in developing worlds are restrained, perhaps due to lack of requisite operational skills, to use of mobile phones call app for information such as contacting market agents for current prices of input and output, rather than subscribing to mobile phone services that often require some level of technicalities. SMS app is presumed to be gaining recognition among the farmer because of its applicability using their indigenous language.

Table 4.7: Distribution of respondents according to Apps farmers can use very well

Variables	Frequency	(%)	WMS (SD)
Call app	360	93.5	0.935(0.247)
SMS	272	70.6	0.706(0.456)
Facebook app	115	30	0.299(0.458)
WhatsApp	88	23	0.229(0.421)
E-mail	38	9.9	0.099(0.299)
YouTube	20	5.2	0.052(0.222)

Mobile Banking app	16	4.2	0.042(0.200)
Bank Transfer Code	16	4.2	0.042(0.200)
Tweeter	10	2.6	0.026(0.159)
Instagram	10	2.6	0.026(0.159)
Bill payment code	9	2.3	0.023(0.151)
E-wallet	7	1.8	0.018(0.134)
IMO	4	1	0.010(0.102)

Source: Field Survey Data (2017). *Denotes multiple response

4.4 Use of mobile phone apps by respondents for extension purposes

Table 4.8 shows that a large percentage of the farmers (59%) communicate with their respective extension agent through a mobile phone. This might be because large numbers of farmers have access to extension workers and services. It is has been established that ICTs, particularly mobile phones, play significant roles in facilitating speedy, proficient and less expensive information dissemination among smallholder farmers (UNDP, 2012; Cȧceres and Fernȧndez-Ardèvol, 2012). However, results here indicate that most farmers do not take advantage of the mobile phone technology to maintain close contact with their extension service providers. The findings of Saleh (2015) with respect to Niger state (a state also in northern Nigeria) also portrayed the findings here, as the author showed that contacting extension agents via calls ranked 5th out of the 7th ranking. This also suggests under-utilization of this very viable technology by farmers generally in accessing advisory support in the Northern part of the country. The table further unveils the level of utilization of the various mobile phone apps common in the study area, which shows that, of those that contact their extension agent via mobile phone, 39.5% (majority) did that through the call app; 24.4% via SMS; 9.1% using WhatsApp; 6.8% by means of Facebook; and 1% via IMO. This suggests that largest number of the farmers do not utilize mobile phone technologies in accessing extension support due to poor extension delivery services in the area.

Table 4.8: Distribution of respondents according to apps used in accessing extension services (n=385).

Variables	Frequency (%)	Mean(SD)
Communicate with Agent using mobile phone		
Yes	227(59)	
No	158(41)	0.41(0.493)
Apps farmers used in contacting extension agents		
Call app		
Yes	152(39.5)	0.935(0.247)
No	233(60.5)	
Facebook app		
Yes	26(6.8)	0.299(0.458)
No	359(93.2)	
WhatsApp		
Yes	35(9.1)	0.229(0.421)
No	350(90.1)	
IMO		
Yes	1(0.3)	0.010(0.102)
No	384(99.7)	
E-mail		
Yes	7(1.8)	0.099(0.299)
No	377(98.2)	
SMS		
Yes	94(24.4)	0.706(0.456)
No	291(75.6)	
Radio for all farmers		
Yes	4(1)	0.060(0.237)
No	381(99)	
TV for all farmers		
Yes	2(0.5)	0.021(0.143)
No	383(99.5)	
Instagram		
Yes	2(0.5)	0.026(0.159)
No	383(99.5)	
FarmerHelpLine		
Yes	2(0.5)	0.018(0.134)
No	383(99.5)	

Source: Field Survey Data (2017)

The results in Table 4.9 reveal that in all the apps considered as a means of getting extension support for millet via the mobile phone, none recorded up to 8% of the total respondents. The app with the highest number of respondents, in this case, is the call app with merely 6.8% of the total respondents getting extension support through it. The results further revealed that only 3.4% of the respondents got extension support through the use of the SMS app, with other apps in the range of 0-1.3% of the respondents. This mirrored similar results for sorghum crop, as the results unveil that the app with the highest patronage for extension support in the study area is the call app with

7.5% of the respondents getting extension support for the crop using the app. Furthermore, the table shows that the next to call app is SMS with 4.4% of the respondents using the app to access extension support for sorghum. These findings further corroborate the earlier results about the poor status of mobile phone utilization by farmers in their farming occupation in the study area. These findings are further support by the assertion of Kiplangot (2003) in Sulaiman *et al.* (2015) that the impingements of ITC deployment in extension service delivery in Africa remain negligible.

The results in table 4.9 further reveal usage status of mobile phone apps in getting extension support for maize by farmers in the zone. The results showed that the largest percentages (19%) of farmers that got extension support through their phone achieved that by means of call app, which is followed by SMS app (8%), while others vary from 0-3.6%. Similarly, the table also unveils data on extension support for cowpea, however, with a more serious scenario as the app that enjoys the highest patronage, in this case, is SMS with only 3% of the respondents getting extension support for cowpea through it. Revealing further, the table unveils that other apps being engaged for the services by respondents were in the range of 00.8%. These findings, as in the case of millet and sorghum above, exposed the very low level of engagement of mobile apps by farmers for farming purposes in the zone.

Furthermore, the results in table 4.9 show the extent of the use of mobile phone apps in getting extension support for rice crop by farmers in the region. The results depict that the largest percentages (22%) of the farmers that got extension support through their phone accomplish that by way of call app. This is followed by an SMS app with 14.5% of the farmers, while others vary from 0 to 4%. In the same way, the table also unveils data on extension support for wheat, however, with a more serious situation as the app that enjoys the highest patronage, in this case, was call app with only 1.6% of the respondents getting extension support for wheat via it, while the other apps are in the range of 0-1%. Just as in the previous revelation, these results are also singing the same song of low usage of apps by farmers in the region. This outcome mirrors the implications of findings of Caroline (2015) who also reported a similar trend in Ghana. The inference here is that m-extension component of e-extension delivery services in the study area is still in the infancy and as such many farmers are yet to realize the potential of mobile phone apps in this regard.

The results in Table 4.9 further show that in all the apps considered as a channel of getting extension support for spinach via the mobile phone, none recorded up to 3% of the total respondents patronizing them by farmers for spinach production in the zone. The apps with the highest number of respondents, in this case, were the call and SMS apps with merely 2% of the respondents in each case getting extension support through them, while others were in the range of 0-1% of the respondents. More so, the table further depicts that no different scenario was recorded for tomato as it unveils even a worse situation as it depicts that the app with the highest users for extension

service delivery for tomato is call app at 4.7% patronage, and next to it was SMS with 2.3% users. Other apps also enjoyed insignificant patronage level in the range of 0-0.3% of the total respondents.

The story, in this case, is not different from the findings above as table 4.6 unveils virtually similar, if not worse situation or scenario compared with that of the crops earlier discussed. It shows that farmers that got extension support for Onion and red pepper were in the range of 0-1.3% of the total respondents, with onion recording the highest percentage of 1.3% extension services delivery via call app. The inference here is that the poor access to extension delivery services is playing out here and it gives the impression that the few instances of extension services did not prioritize e-extension platforms for service delivery to farmers and therefore mirrors a poor state of mAgric platforms in the study area. The poor utilization of mobile phone technology to access extension delivery services by farmers is a general problem in Sub-Saharan countries (Caroline, 2015; Osadebamwem and Ideba, 2015).

Table 4.9: Distribution of respondents according to crops they get extension support on via apps (n=385)

Apps Freq. (%)*	Millet	Sorghum	Maize	Cowpea	Rice	Wheat	Spinach	Tomato	Onion	Red Pepper
WhatsApp Yes	5(1.3)	9(2)	14(4)	3(0.8)	17(4.4)	1(0.3)	1(0.3)	1(0.3)	-	-
No	380(98.7)	379(98)	371(96)	382(99.2)	368(95.6)	384(99.7)	384(99.7)	384(99.7)	-	-
E-mail										
Yes	3(0.8)	3(0.8)	4(1)	3(0.8)	2(0.5)	-	-	-	-	-
No	382(99.2)	382(99.2)	381(99)	382(99.2)	383(99.5)	-	-	-	-	-
Call									5(1.3)	
Yes	26(7)	29(7.5)	73(19)	17(4.4)	84(22)	6(2)	6(2)	18(4.7)		3(0.8)
No	359(93)	356(92.5)	312(81)	368(95.6)	301(78)	379(98)	379(98)	367(95.3)	380(98.7)	382(99.2)
SMS										
Yes	13(3)	17(4.4)	31(8)	11(3)	56(15)	4(1)	4(1)	9(2.3)	1(0.3)	2(0.5)
No	372(97)	368(95.6)	354(92)	374(97)	329(85)	381(99)	384(99)	376(97.7)	385(99.7)	383(99.5)
Facebook										
Yes	4(1)	5(1.3)	8(2)	2(0.5)	13(3)	-	-	-	-	-
No	381(99)	380(98.7)	377(98)	383(99.5)	372(97)	-	-	-	-	-

Source: Field Survey Data (2017). *Figures in parentheses are percentages

Table 4.10 shows that, while only 3.6% of the respondents had an increase of between 1 and 5 cattle in their herds, 1.3% recorded an increase above five cattle. Majority of the respondents (about 95.1%), on the other hand, did not record any influence on their cattle production occasioned by the presence of mobile phone apps in the area. The table further shows that only 16.1% of the respondents recorded between 1 and 5 sheep, as 2.9% of the respondents recorded an increase greater than 5 sheep. Similarly, the results unveil that while 18.5% of the respondents recorded between 1-5 goat(s) in their flock size, only 0.5% recorded above 5 goats. Furthermore, while only 0.3% of the respondents recorded an increase in the category of the 1-5 donkey(s), 14.6% of the respondents recorded additional 15 chicken(s) with 1% recorded increase above 5 chickens owing to deployment of mobile phone apps in their chicken production activities. This coincides with the findings of Williams and Opeyemi (2015) in Ibadan, which unveiled that the relevance of ICT to cattle farmers had a mean score of 2.01 out of 5; indicating usage level below average. This suggests low usage and portrays very poor utilization of mobile phone technologies by farmers in animal production generally in the study area. These findings completely contradicted several studies (Gelb *et al*., 2009; Kithuka, *et. al.*, 2007; Kwadwo and Daniel, 2012; Matotay and Furutholt, 2012). However, it could be inferred that certain factors were responsible for these poor outcomes among which are poor extension work (Caroline, 2015; Tijjani, Akpoko and Abdullahi, 2015), low level of education in rural communities, poor government policies (Ismail and Tenuche, 2012). Other factors may include disparity in diffusion of ICTs between rural and urban area with ICT facilities concentrated in urban centres living some rural areas totally out of the development trend (Gillwald et al., 2010). This implies that there are no formidable policies on the ground to foster the growth and development of e-extension in the study area, and as such farmers are not in tune with global trend in the adoption of mAgric in their farming activities. It also suggests that the extension workers in the area may be ill-equipped with necessary requisite knowledge and skill in the use of mobile phone technologies in animal husbandry, thereby making it impossible to nurture their clients on the use of such technologies in their animal enterprise. However, the few cases of application of mobile technologies as reported by the farmers concerned were in the area of animal health management. These farmers associated the increases recorded in the numbers of their animals to use of mobile phones to advance and enhance management of animal health issues by connecting with their vet consultants and other well informed persons from the ADP extension department. As part of their narratives, they call their extension agents via mobile phones for clarification on application of drug administration procedures (particularly poultry drug administration and deworming in ruminants) taught to them during the monthly training activities of the ADP extension outreach. With easy access to vet consultants in real time courtesy of usage of mobile phone technologies, it is no doubt that such farmers are bound to record increase in their stock. This coincided with the findings of Williams and Opeyemi (2015) in Ibadan, Nigeria. According to the authors, vet consultants are often open-minded in responding positively to relevant request of their clients, particularly drug prescription requests without delay.

Table 4.10: Distribution of respondents according to the increase in numbers of farm animals as influenced by mobile phone apps.

Livestock	0	> 5	1 – 5
Cattle	366(95.1)	14(3.6)	5(1.3)
Sheep	312(81)	62(16.1)	11(2.9)
Goat	312(81)	71(18.5)	2(0.5)
Donkey	384(99.7)	1(0.3)	0(0)
Chicken	352(84.4)	56(14.6)	4(1)

Source: Field Survey Data (2017). *Figures in parentheses are percentages

4.5 Inventory of Mobile Phone Applications in the Area: Awareness and Usage Status.

This section presents the inventory of mobile phone apps available in the region as well as the result of the respondents' awareness and usage status of the available apps identified, considering also the duration of adoption of the apps as well as the extent to which the apps were put to use. The respondents were presented with a list of twenty apps and were asked to indicate as yes or no if they are aware of the apps and also use them, and the duration in years for which they have been aware of the apps. The prominently adopted apps with percentage score above 50% and the least adopted ones were identified from the percentage score of each app. The intensity of use of the apps was determined using a three-point scale as either that the apps were used for all activities (3), most activities (2) and few activities (1). Apps with a mean score below 1.95 are considered to have low use intensity; mean values above 1.95 but below 2.05 are considered to be occasionally used, and apps with a value above 2.05 are considered to be frequently used apps.

The findings in Table 4.11 show adoption details of cellular phone apps among farmers in North western Nigeria. It was revealed that the adoption of cell phone apps among farmers in the area was still very low as only two apps (voice call and SMS apps) out of the 20 apps considered were prominently put to use by husbandmen in the zone. The results depict also that all the sodbusters were aware of the call app, out of which 95% adopted it with the majority of the users (65.7%) having usage experience that spanned between 7-12 years. In addition, the results unveil that majority (97%) of the respondents were conscious of SMS app, 78% of the respondents are using the app and majority (61.8%) having usage experience in the range of 7-12 years. These findings are supported by some related studies (Sirajul and Ake, 2011; Caroline (2015; Asa and Uwem, 2017). For instance, Caroline (2015)

empirically established that majority of the farmers (89.5%) in Ghana have had awareness knowledge of mobile phone apps that spanned between 6-10 years. The findings further reveal that the least adopted apps were NAQAS (0.5%), WhatsApp Youth and Educated Adult (0.8%) and Facebook Youth and Educated Adult (1%). This suggests that the low usage of the latter apps might have stemmed from the fact that some of the apps have recently gone obsolete due to poor performance (e.g. NAQAS) and the need for internet connectivity which often requires android/digital phones, considerable level of technical know-how and additional cost implications which most farmers could cope with, as most of them could only afford and operate simple analogue phone.

Table 4.11: Distribution of respondents according to awareness and use of mobile phone apps

Apps	Aware Freq. (%)*		Use Freq. (%)		Years of awareness Freq. (%)			
	Yes	No	Yes	No	0 - <1	1-6	7-12	>12
Call	385(100)	0(0)	367(95)	18(5)	2(0.2)	41(10.6)	253(65.7)	89(23.1)
SMS	374(97)	11(3)	301(78)	84(22)	14(3.6)	53(13.8)	238(61.8)	80(20.8)
Facebook	158(41)	227(59)	122(32)	263(68)	228(59.2)	101(26.2)	55(14.3)	1(0.3)
WhatsApp	119(30.9)	266(69.1)	90(23.1)	295(77)	266(69.1)	88(22.9)	31(8.1)	0(0)
Opera	86(22.3)	299(77.7)	63(16)	322(84)	299(77.7)	43(11.2)	40(10.4)	3(0.8)
Flashare	56(14.5)	329(85.5)	41(11)	344(89)	329(85.5)	39(10.1)	17(4.4)	0(0)
Bluetooth	103(26.8)	282(73.2)	84(22)	301(78)	282(73.2)	35(4.1)	57(14.8)	11(2.9)
IMO	5(1.3)	380(98.7)	2(0.5)	383(99.5)	383(99.5)	2(0.5)	0(0)	0(0)
E-mail	43(11.2)	342(88.8)	33(9)	352(91)	342(88.8)	33()8.6	9(2.3)	1(0.3)
Instagram	9(2.3)	376(97.7)	5(1.3)	380(98.7)	376(97.7)	9(2.3)	0(0)	0(0)
E-wallet	14(3.6)	371(96.4)	12(3)	372(97)	371(96.4)	13(3.4)	1(0.3)	0(0)
NAQAS	2(0.5)	383(99.5)	2(0.5)	383(99.5)	383(99.5)	1(0.3)	1(0.3)	0(0)
RFAF**	8(2.1)	377(97.9)	7(2)	378(98)	377(97.9)	7(1.8)	1(0.3)	0(0)
TVFAF**	5(1.3)	380(98.7)	5(1.3)	380(98.7)	380(98.7)	4(1)	0(0)	1(0.3)
F. YEA**	4(1)	381(99)	2(0.5)	383(99.5)	381(99)	4(1)	0(0)	0(0)
W. YEA**	3(0.8)	382(99.2)	1(0.3)	384(99.7)	382(99.2)	3(0.8)	0(0)	0(0)
MBA**	9(2.3)	376(97.7)	5(1.3)	380(98.7)	376(97.7)	9(2.3)	0(0)	0(0)
BPC**	11(2.9)	374(97.1)	9(2)	376(98)	374(97.1)	10(2.6)	1(0.3)	0(0)
BTC**	5(1.3)	380(98.7)	3(0.8)	382(99.2)	380(98.7)	5(1.3)	0(0)	0(0)
FHL**	5(1.3)	380(98.7)	5(1.3)	380(98.7)	380(98.7)	5(1.3)	0(0)	0(0)

*Source: Field Survey Data (2017). RFAF: Radio for all Farmers; TVFF: TV for all Farmers; F.YEA: Facebook Youth and Educated Adult; W.YEA: WhatsApp Youth and Educated Adult; YEA: YouTube Youth and Educated Adult; Tubenet Youth and Educated Adult; MBA: Mobile Banking App; BPC: Bank Payment Code; BTC: Bank Transfer Code; FHL: FarmerHelpLine. *Figures in parentheses are percentag*

4.5.1 Intensity of use of mobile phone apps by farmers in North-West Nigeria

Table 4.12 presents results showing the intensity of use of all the apps by the respondents in the selected area. The results show that the slight majority (51.7%) of the selected farmers used the call app for a few activities and the app recorded a weighted mean score of 1.410 out of possible 3. This means that though the majority of the respondents use this app, it is underutilized (below 1.95), and hence may not make expected impact at improving the general well-being of the target population in the area of study. The results further reveal that majority (61.9%) of the respondents use SMS app for few activities with a weighted mean score of 0.932 out of possible 3 points, indicating use intensity 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. They also observed that though many farmers had phones, few used it chiefly because they are convinced mobile phones are devices that make verbal messaging easy among their friends and folks, rather than a tool for agricultural information. This illustrates that a few farmers consider calling "brokers" or middlemen once in a while whenever they recorded excess crops to be disposed off. Farmers who were members of same association seldom contact brokers via call; as an alternative, a co-operative member makes the call and pass on the information to other members on weekly meeting days. In the case of the SMS app, the authors harangued that this had been a reflection of many studies citing Medhi *et al*. (2011) to explain that illiteracy has limited the use of the SMS app, and that the use of SMS by farmers was also restricted by factors associated with the design of the cellular phones. Other limiting factors identified by the authors include the sophistication of the phones owned by the farmers, and the distance of the location of the farmers where the devices are used to main cities, as most farmers were found with worn-out phones supported by rubber band and partly damaged screen and keyboard. Sirajul and Ake (2011) in Bangladesh also discovered that majority (57%) of the farmers disagree that it behoove them to access the SMS as all the respondents agreed that features of mobile phone discouraged the use of the app. This notwithstanding, farmers still consider the app friendly, a reason for this aberration is explained in the argument of the author that individuals who have attained lofty height in self-efficacy correspondingly develop self-esteemed nature towards adopting new technologies over time because they tend to exerting the required efforts in that wise. This may suggest why farmers still adopt SMS app despite it 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 alert, they often resort to assistance from kin group, neighbours or friends to interpret it. In line with the above observations, Susan and Charles (2016) also reported that the practices of sending and receiving text messages are not prevalent in the circle of rural Kenyan farmers due to the general assumption that inputting text is burdensome, the complexity of handsets farmers possess, and the rural nature of the environments where the devices are used. The table further shows that the apps least adopted by the farmers in the area include Tubenet and NAQAS (with a mean value of 0.003 in each case) IMO, WhatsApp Youth and Educated Adult and Farmerline (0.005 in each case); 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 low adoption level of WhatsApp Youth and Educated Adult is as a result of the fact that the app requires smartphones that can go on-net which most of the farmers could not afford and operate. Given the years of awareness and usage status of most of the respondents, it is expected that at least the prominent apps like call and SMS should exceed, by far the average limit. However, this finding has proved otherwise. These findings agree with earlier submissions buttressing the failure of app usage in enhancing socio-economic conditions of farmers in the region. This outcome mirrors a general situation in most part of Africa. Munyua (2008) in Kwadwo and Daniel (2012) in their study of agricultural practices among small-scale farmers in Africa discovered poor usage and unreliable or sketchy adoption patterns. This has led to the argument that ICT schemes were strewn and poorly organized. In addition, Sulaiman *et al*. (2011) in an attempt to review ICT initiatives in India, considered the role of ICTs in elevating the status of rural women. The authors came to a conclusion that, despite the viability of most ICT ingenuity in the realm of information dissemination and sharing of vital knowledge among rural women, many could not take advantage of it, owing to being short of access to corresponding support facilities and services.

Table 4.12: Use Intensity of Mobile Phone Apps by Respondents in the Study Area (n=385)*

Mobile Apps	All Activities	Most Activities	Few Activities	Mean(SD)	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
NAQAS	0(0)	0(0)	1(0.3)	0.003	Rarely used
Radio for all Farmers	0(0)	0(0)	7(1.8)	0.018	Rarely used
TV for all Farmers	0(0)	0(0)	5(1.3)	0.013	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
Farmerline	0(0)	0(0)	2(0.5)	0.005	Rarely used
FarmerHelpLine	0(0)	0(0)	4(1)	0.010	Rarely used

Source: Field Survey Data (2017). *Figures in parentheses are percentages

4.6 Purpose of mobile phone apps usage by farmers in North-West Nigerian

This section presents the results of findings on the purposes to which mobile phones apps were being put to use by farmers in the study area. Nine possible purposes were considered and the farmers were asked to respond as either yes or no for each purpose with respect to each app. A total of nineteen apps were tested on the purposes that include "contacting family and friends, extension advisory services, marketing and general information, reading weather condition, bill payment, getting an update on Agric newsletter and coordination of farm activities." The prominent purposes and the corresponding apps used to achieve that were identified.

Table 4.13 presents results on the purpose to which mobile phone apps are put to use for by farmers in the northwest zone. The findings reveal the prominent apps in use by the farmers to include voice call app and SMS app. The findings unveil that the greater part (96%) of the respondents use the call app to maintain close ties with family members and associates. The results further unveil that next to maintaining mutual coexistence as a purpose of call app usage by the respondents, is the purchase of farm inputs. The table further reveals that 70% of the respondents use call app to facilitate the process of farm input procurement. Illustrating further, the results depict that while marketing/general information and spreading of vital information were being exploited using call app by over 50% of the respondents, other purpose of call app use were below average, with a more serious situation on parameters like bill payments (2%), reading weather situation (3.6%) and getting update on Agric newsletter (8.6%). These findings are in consonance with a number of studies. Osadbamwen and Ideba (2015) in a related study showed that more of phone bill (62%) went on keeping contact with family and associates as they also unveiled that application of cellphone phone in accessing market information and getting weather update by the farmers were discouraging. The authors also discovered that the majority (54.5%) used this app to source for inputs. Premised on these findings, the authors posited that prompt access to up-to-date market details enrich and encourage smallholder farmers, input suppliers and consumers in general. As farmers secure the latest market information, they will be in better position to negotiate better terms with other stakeholders. The findings of Isaac (2016) on the subject matter in Kenya indicated that majority (86%) of the key informants consented that cellular phone was mainly used to institute and maintain social coexistence. Jaji, Abanigbe and Abass (2017) also reported that the largest deployment of cellphone by female farmers in Lagos State is the accessibility of profitable markets. Furthermore, the reason for the dominance of voice call app was best explained by the findings of Anselme, Romeo and Desire (2012) which also reported that majority (97.1%) of the farmers affirmed that information via voice call app is timely, as 94% affirmed to the reliability of the information received through the app. The author further unveiled that 85.3% of the respondents affirmed to the ease of use of information accessed through the app as 56% considered the cost of using the call app lower to what they are used to prior to the adoption of the app. Based on these findings, the authors posited that these reasons might have advanced the success of mobile phone call app above other apps. Similarly, Siwel and Malongo (2012) also affirmed that this app guarantees agricultural information in real time. The authors

investigated factors acting upon the adoption level of cellular telephone in Tanzania and found that 52.6% of the respondents agree that they use the app to access agricultural information like latest monetary values of goods and services in the market and information on market situation, weather and input supplies. The findings here suggest that, though mobile phone apps were mostly used to maintain social circles/relationships; however, the use of the apps in agriculture is more centered on input purchase, marketing/general information and spread of vital information to fellow farmers.

Furthermore, the table reveals that apart from contacting family and friends which were the purpose 59% of the respondents use SMS app, all other parameters considered enjoyed patronage by less than 50% of the farmers. The records show that with the exception of parameters like purchase of farm inputs (27%), extension advisory services (24.4%) and marketing/general information (32%), other parameters had a disturbing level of patronage via SMS, the least being "read weather condition (3%), bill payment (4%) and getting update on Agric newsletter (6%). This corresponds with the finding of Jaji, Abanigbe and Abass (2017) which unveiled that only 15.2% of the farmers use SMS app for accessing market information, as 13.2% use the app for input sourcing. In a similar trend, Anselme, Romeo, Faustin and Desire (2012) also made a similar observation with rice farmers in Benin which revealed that only 10% of the farmers use the SMS app. On the aspect of the update on weather conditions, the finding of Osadebamwan and Ideda (2015) also supported these findings as it also revealed that one of the areas of farming farmers in Sub-Saharan Africa least take advantage of mobile phone technologies is getting weather updates (mean value of 2.088 out of 7). The inference here is that, as in the case of call app, SMS is also used by majority of the farmers for none agricultural purpose in the region. This stresses the importance attached to mutual coexistence by farmers in the region, a characteristic that is enshrined in the cultural milieu of the people in the region and could be concluded to be a key factor responsible for the acceptability and widespread deployment of cellulants by the grangers. The failure of the app in other areas, particularly ineffective extension activities, could be as a result of the perceived difficulty in the use of the app as well as perceived unreliability of information via the app as observed by Anselme, Romeo, Faustin and Desire (2012) in Benin. The authors also observed that farmers were not comfortable with the cost of accessing information through the app which invariably affected the frequency and scope of its usage.

The results further show that other apps that include Facebook, WhatsApp, Instagram, Opera, Bluetooth, e-mail, e-wallet, NAQAS, Flashare, Radio for all farmers, TV for all farmers, Facebook Youth and Educated Adults, WhatsApp Youth and Educated Adult, FarmerHelpLine, mobile phone banking app, bank transfer codes and bill payment code are not popular among the farmers as the findings reveal that all the apps were used by less than 50% of the farmers for all the parameters assessed. These findings are supported by a number of related studies, such as Anselme, Romeo, Faustin and Desire (2012) which showed that only 3.2% of the rice farmers interviewed in Benin use the e-mail app. Anselme, Romeo, Faustin and Desire (2012) also reported poor (3.2%) usage of mobile apps

related to radio programmes by rice cultivators and producers in Benin. The inference from the generally poor usage of most apps could be that the majority of these apps require internet facilities and function only in android/digital phones. With results in previous section showing that majority of the farmers use simple analogue phones and on which they mainly got training on how to use, it becomes obvious that apps that are net-related would not gain popularity among the farmers. These findings also imply that, though very few use these apps, however, they are used to foster the success of farming in the region. As such, the need to encourage and expand their usage potential becomes imperative given the fact that the usage is domicile in the agricultural domain among the farmers.

Table 4.13: Distribution of respondents according to purpose of using mobile phone apps (n=385)*

Apps	CFF**	PFI**	EAS**	MGI**	RWC**	BP**	SVI**	GNL**	CFA**
Call	370(96)	269(70)	152(39)	249(65)	14(4)	8(2)	203(53)	33(9)	158(41)
SMS	227(59)	104(27)	94(24)	123(32)	10(3)	16(4)	115(30)	24(6)	71(18)
Facebook	101(26)	9(2.3)	26(7)	23(6)	7(2)	0	29(7.5)	24(6)	5(1.3)
WhatsApp	84(22)	13(3.4)	35(8)	18(5)	3(0.8)	0	25(6.5)	16(4)	14(4)
Instagram	3(0.8)	0	2(0.5)	0	0	0	3(0.8)	2(0.5)	0
Opera	0	0	0	0	0	0	0	57(15)	0
Bluetooth	0	0	0	0	0	0	84(22)	1(0.3)	0
E-mail	2(0.5)	0	7(2)	1(0.3)	0	0	13(3.4)	17(4.4)	2(0.5)
E-wallet	0	11(3)	0	0	0	0	0	0	0
NAQAS	0	0	0	0	0	0	2(0.5)	0	0
Flashare	0	0	0	0	0	0	40(10.4)	0	0
RFAF	0	0	4(1)	0	0	0	0	5(1.3)	0
TVFAF	0	0	2(0.5)	0	0	0	1(0.3)	2(0.5)	0
F.YEA	1(0.3)	0	1(0.3)	1(0.3)	0	0	0	1(0.3)	1(0.3)
W.YEA	1(0.3)	0	1(0.3)	1(0.3)	0	0	0	1(0.3)	1(0.3)
FHL	0	0	2(0.5)	1(0.3)	0	0	0	3(1)	0
MBA	0	1(0.3)	0	0	0	4(1)	0	0	0
BTC	0	1(0.3)	0	0	0	9(2.3)	0	0	0
BPC	0	1(0.3)	0	0	0	3(0.8)	0	0	0

Source: Field Survey Data (2017) *Figures in parentheses are percentages. ***CFF= Contacting family and friends; PFI= Purchase of farm inputs; EAS= Extension advisory services; MGI= Marketing and general information; RWC= Read weather condition; PB= Payment of bills; SVI= Spread vital information; GNL= Get update on agricultural news letter; and CFA= Coordination of farm activities*.

4.7 Attitude of farmers toward the use of mobile phone apps by farmers in North-West Nigeria.

This section presents the result of the general attitude of farmers towards mobile phone apps in the study area.

The results in table 4.14 show a list of 30 statements used to test the attitude of the husbandmen toward the employment of cellular telephone technologies in the zone. Respondents rated these statements on a 5 point scale of strongly agree (5), agree (4), undecided (3), disagree (2) and strongly disagree (1). A mean score of < 2.95 implies poor disposition toward apps, ≥ 2.95 and ≥ 3.05 implies favourable disposition toward the apps. The findings revealed that the farmers across the study area predominantly express a favourable disposition towards mobile phone apps as the mean scores of 17 out of the 30 attitudinal statements on the use of the apps were above the definite mean value of 2.95. The most prominent statements were "Apps have helped to facilitate information transfer within farm families" ($\bar{x}$=3.89), "Apps help in speedy spread of information amongst farmers" ($\bar{x}$=3.85), "With App we have access to current information on improved farming activities" and "Apps help us to monitor market situations effectively" ($\bar{x}$=3.79) and "With Apps, our farm produce is improving in quantity" ($\bar{x}$=3.75). In addition, statements such as "apps are causing complexity in farming operations generally" (2.06), and "apps are detrimental to our local ways of farming handed over to us" (2.09) recorded mean value far below the lower cut point of 2.95, implying that the farmers were generally in support of mobile phone technologies. This suggests that most of the farmers were convinced of the efficacy of the mobile phone technologies at enhancing their farming activities (Baumöller, 2012) through effective information disseminating potential of mobile apps (Gelb *et al*., 2009; Siwel and Malongo, 2012; Williams and Opeyemi, 2015). It also implies that the farming community in the region is e-ready to take part extensively in the deployment of ICT, particularly cellular telephone apps, to change the fortune of agriculture from its present poor state to globally acceptable standard if well motivated and encouraged. The generally favourable attitude of farmers towards mobile phone was also established by Tyabo *et al.* (2015) in Niger state of Nigeria where they also revealed that 7 out of the 10 parameters used in assessing the perception of the farmers on relevance of mobile phone technologies got mean score above 3. Williams and Opeyemi (2015) also expressed the favourable perception of farmers in Ibadan towards mobile apps noting that they perceived such apps as having the capacity to help them market their goods, manage their farms, monitor the performance and activities of their farm workers.

On the contrary, statements such as "apps help to monitor weather condition" ($\bar{x}$=2.39), "apps have greatly enhanced extension services in our area" ($\bar{x}$=2.41) were far below the lower cut limit of 2.95. This reveals that the farmers though generally acknowledging the efficacy of mobile phone apps at enhancing farming activities, they also felt that it is not replicating same in providing weather updates and facilitating extension support services in their area. This corroborated the findings of Osadebamwen and Ideba (2015), which showed that using apps to get advance warning of weather risks scored 2.08 out of possible 7 and Sulaiman (2015) reported a mean score of 2.78 for use of ICT in extension delivery services. This implies that the use of cellphone apps for extension activities is minimal

(Kiplangot, 2003), probably because the extension workers are not living up to expectation (Obiora and Emordi, 2013) and most of the farmers lack extension delivery services. The reason for the poor utilization of apps for this purpose might have stemmed from the fact that the meteorology services to farmers are not well articulated, as the farmers could not access such services due to the inability of metrological stations to gather, harmonize and deplore weather information specific to farmers' location and needs (Osadebamwen and Ideba, 2015). Moreover, a weather-related app is net-dependent which requires that farmers possess android/digital phones, a situation that is found to be contrary as most of the farmers make use of analogue phones. This implies that most farmers in the region are not in a position to use their phones to access weather updates. It also implies that if policies and programmes that will foster the extensive use of mobile apps for extension delivery services are initiated and put in place in the region, huge success is likely going to be recorded. This is an exposit for stakeholders in extension delivery services in the region.

Table 4. 14: Attitude of respondents towards mobile applications in the study area (n=385)

tatement on Apps	Strongly* Agree	Agree	Undecided	Disagree	Strongly Disagree	Mean	Status
pps have enhanced contact with extension workers.	99 (25.7)	64 (16.6)	54 (15)	161(41.8)	3(0.8)	3.23	Favourable
Vith App we have access to current information on improved farming ctivities	112 (29.1)	161 (41.8)	44 (11.5)	60 (15.6)	8(2.1)	3.80	Favourable
Vith Apps, our farm produce is improving in quantity	110 (28.6)	149 (38.7)	58 (15.1)	56 (14.5)	12 (3.1)	3.75	Favourable
pps have greatly help us improve the quality of our produce	104 (27)	137 (35.6)	68 (17.7)	65 (16.9)	11 (2.9)	3.66	Favourable
vailability of Apps has no impact on our production	25 (6.5)	48 (12.5)	90 (23.4)	178(46.2)	44 (11.4)	2.54	Unfavourable
pps help us to monitor market situations effectively	119 (30.9)	137 (35.6)	66 (17.2)	58 (15.1)	5(1.3)	3.79	Favourable
pps help in speedy spread of information amongst farmers	132 (34.3)	133 (34.5)	65 (16.9)	40(10.4)	15(3.9)	3.85	Favourable
pps have helped to facilitate information transfer within farm families	130 (33.8)	148 (38.4)	57 (14.8)	38 (9.9)	12 (3.1)	3.89	Favourable
pps aid significantly in input sourcing at good price.	94 (24.4)	162 (42.1)	60 (15.6)	49 (12.7)	20 (5.2)	3.66	Favourable
pps help to monitor weather conditions	22 (5.7)	78(30)	89 (23.2)	181 (47)	63 (16.4)	2.39	Unfavourable
ppropriate and timely weather forecast is aiding good response by armers in terms of timely and appropriate decision making	37 (9.6)	148 (38.4)	77 (20)	75 (19.5)	48 (12.5)	3.13	Favourable
pps help to get update on global trend on agric development	41 (10.6)	99 (25.7)	85 (22.1)	96 (24.9)	64 (16.6)	2.88	Unfavourable
Vith apps payments of bills are made easy	19 (4.9)	43 (11.2)	92 (23.9)	160(41.6)	71 (18.4)	2.43	Unfavourable
pps help to easily access government initiatives on agriculture	43 (11.2)	108 (28.1)	79 (20.5)	88 (22.9)	67 (17.4)	2.90	Unfavourable
pps help to ensure togetherness of association members	50 (13)	130 (33.8)	77 (20)	98 (25.5)	30 (7.8)	3.18	Favourable
Vith apps members of the farmer group are effectively carried along	68 (17.7)	137 (35.6)	73 (19)	77 (20)	30 (7.8)	3.35	Favourable
nternational organizations can easily reach to farmers with the aid of apps	58 (15.1)	121 (31.4)	87 (22.6)	90 (23.4)	29 (7.5)	3.23	Favourable
pps help to monitor trend of growth in the farm	63 (16.4)	97 (25.2)	96 (24.9)	99 (25.7)	30 (7.8)	3.17	Favourable
pps help to timely detect production problem for prompt response	43 (12.2)	112 (29.1)	90 (23.4)	99 (25.7)	41 (10.6)	3.04	Favourable
Vith apps it is easy to access insurance cover for our farming process	23 (6)	33 (8.6)	83 (21.5)	185(48.1)	61 (15.8)	2.39	Unfavourable
pps aid timely delivery of farm inputs	65 (16.9)	105 (27.3)	86 (22.4)	98 (25.5)	31 (8.1)	3.19	Favourable

Apps not necessary in farming	25 (6.5)	39 (10.1)	45 (11.7)	205(53.2)	71 (18.4)	2.32	Favourable
App are detrimental to our local ways of farming handed over to us	9 (2.3)	14 (3.6)	59 (15.4)	225(58.4)	78 (20.3)	2.09	Favourable
Apps are causing complexity in farming operations generally	11 (2.9)	10 (2.6)	52 (13.5)	235 (61)	77 (20)	2.06	Favourable
I do not need apps to be able to enhance my production in quantity	32 (8.3)	36 (9.4)	47 (12.2)	206(53.5)	64 (16.6)	2.35	Favourable
Apps not significant in improving quality of production	24 (6.2)	37 (9.6)	48 (12.5)	208 (54)	68 (17.7)	2.32	Favourable
Apps have greatly enhance extension activities in our area	40 (10.4)	86 (22.3)	56 (14.6)	159(41.3)	44 (11.4)	2.78	Unfavourable
With apps, it is now easy to get information on any new problem in farming	58 (15.1)	150 (39)	63 (16.4)	93 (24.2)	21 (5.5)	3.33	Favourable
Apps have aided speedy transfer of fund for timely input delivery	30 (7.8)	54 (14)	184(47.8)	87 (22.6)	30 (7.8)	2.89	Unfavourable
Apps have aided speedy disposal of farm produce at desirable price	49 (12.7)	89 (23.1)	140(36.4)	84 (21.8)	22 (5.7)	3.14	Favourable

Source: Field Survey Data (2017). *Figures in parentheses are percentages.

4.8 Farmers' knowledge of mobile phone apps in Northwest Nigeria

This section presents the result of the knowledge of farmers on the employment of cell phone apps in the zone. The farmers were assessed using test statements. The statements were arrived at after a preliminary survey of the study area and thorough review of works of literature on the exploitation of cellular phones apps, particularly in farming neighbourhoods. It is therefore expected that these statements would help in unveiling the true knowledge status of local husbandmen in the zone.

The results in Table 4.15 reveal the knowledge of the sodbusters on the awareness and use of mobile phone apps in the North-West region of Nigeria. From a list of 34 knowledge test items rated on True (1) and False (0) scale, a 2-point scale was used to determine the mean value of each statement. The results revealed that the farmers exhibited varying degrees of knowledge on awareness and ability to use mobile phone apps. Using an interval of 0.05, a mean value below 0.45 is considered low knowledge; >0.045<0.55 is considered moderate and ≥0.55 is considered very high. Major items where they were highly knowledgeable were "I can place and receive calls with my phone" (94%; $\bar{x}$=0.940, SD=0.237), "I understand when I am out of airtime and data" (84.9%; $\bar{x}$=0.849, SD=0.358), "I can store and retrieve numbers at any time using my phone" (83.9%; $\bar{x}$=0.839, SD=0.368) and "I can load airtime and data" (81%; $\bar{x}$=0.810, SD=0.393), suggesting that farmers are conversant with simple phone operation techniques peculiar to feature/analogue phones, as calling requires mere pressing green button and ending calls with just pressing the red button. In line with these findings, Daniel (2015) showed that farmers under an SMS-based system project termed Buuza Onuliimisa in Uganda reported that all the participants in the project affirmed their sound ability to receive, make and end calls. This might be because it simply requires dialling by merely clicking the green call button to start and the red button to terminate a call, a feature that is a basic and key operation of simple analogue phones possessed by the majority of the respondents.

The results further unveiled that the farmers exhibit low level of knowledge on "use of apps to pay bills" and "ability to use phone to access insurance services" (93.2%; $\bar{x}$=0.104, SD=0.306), "ability to contact extension agents via e-mail" (93.2%; $\bar{x}$=0.068, SD=0.251); "ability to open the e-mail page using phones" (89.4%; $\bar{x}$=0.106, SD=0.309); "ability to transfer documents from desk/laptop to phone and vice versa" (87.5%; $\bar{x}$=0.221. SD=0.415) and "ability to attach document to be e-mailed" (87.5%; $\bar{x}$=0.125, SD=0.331). The reason for the low knowledge could be due to the type of phones the majority owned and can operate (analogue phone). E-mail interface uses the internet facility which analogue phones cannot explore coupled with their low technical know-how on the use of the smartphone (android/digital). The findings of Caroline (2015) in a study conducted in Ghana to ascertain level of application of mobile phone technologies in extension delivery activities support these results as the author found that farmers' competency in the use of internet, e-mail, Facebook and WhatsApp was very low (with mean value of 1.29 for each of the app out of 5). Inferentially, it could be deduced that the widespread high illiteracy level which

has prone the farmers to very poor exposure, as well as the nature of phone (analogue) that is predominant among them, could be responsible for their very limited knowledge in this case.

Table 4. 15: Distribution of respondents according to knowledge of mobile apps (n=385)

Knowledge statement	True (%)	False (%)	Mean (SD)
Internet is a source of information on all agricultural related issues	149(38.7)	236(61.3)	0.387(0.488)
You can us your phone to access information from the internet	162(42.1)	223(57.9)	0.421(0.494)
It is now easy to contact the extension agents via call	160(41.6)	225(58.4)	0.416(0.494)
It is now easy to contact the extension agents via SMS	118(30.6)	267(69.4)	0.306(0.462)
It is now easy to contact the extension agents via WhatsApp	65(16.9)	320(83.1)	0.169(0.375)
It is now easy to contact the extension agents via email	26(6.8)	359(93.2)	0.068(0.251)
I can open the e-mail page using my phone	41(10.6)	344(89.4)	0.106(0.309)
I can write and attach materials to be e-mailed	48(12.5)	337(87.5)	0.125(0.331)
I can store and retrieve numbers at any time using my phone	323(83.9)	62(16.1)	0.839(0.368)
I can place and receive calls with my phone	362(94)	23(6)	0.940(0.237)
I can use my phone to write and read text messages	288(74.8)	97(25.2)	0.748(0.435)
I can form WhatsApp group to facilitate flow of information	96(24.9)	289(75.1)	0.249(0.433)
I can access and read WhatsApp messages	108(28.1)	277(71.9)	0.280(0.450)
With mobile phone, information easily transferred from one farmer to another and extension agents to farmers	229(59.5)	156(40.5)	0.595(0.492)
Framers can use all Apps at their disposal to enhance their farming	153(39.7)	232(60.3)	0.397(0.490)
Farmers can use their phone to access inputs and farm credit	218(56.6)	167(43.4)	0.566(0.496)
With the mobile phone farmers can plan properly before and after cultivation of their farms	208(54)	177(46)	0.540(0.499)
I understand when I am out of air time or data	327(84.9)	58(15.1)	0.849(0.358)
I can load air time and data	312(81)	73(19)	0.810(0.393)
I can download apps from Google stores	129(33.5)	256(66.5)	0.335(0.473)
I can search and fix minor network issues	129(33.5)	256(66.5)	0.335(0.473)
I can update apps when the need arises	267(69.4)	118(30.6)	0.694(0.462)
I can use apps to transfer documents from desk/laptop to my phone and vice versa	48(12.5)	337(87.5)	0.124(0.331)
I can use service providers' codes to load airtime and data	267(69.4)	118(30.6)	0.694(0.462)
I can use codes to pay for bills	111(28.8)	274(71.2)	0.221(0.415)
I can use apps to pay bills	40(10.4)	345(89.6)	0.104(0.306)
I can use my phone to access insurance services	26(6.8)	359(93.2)	0.068(0.251)
I can use apps to monitor weather conditions	92(23.9)	293(76.1)	0.239(0.427)
I can use apps to measure growth trends in my yearly production process	115(29.9)	270(70.1)	0.299(0.458)

I can use apps to follow trends of prices of produce in markets around me	209(54.3)	176(45.7)	0.543(0.499)
I can update apps when the need arises	111(28.8)	274(71.2)	0.288(0.354)
With apps I can monitor trends in prices at the international market	111(28.8)	274(71.2)	0.288(0.354)
With apps I can source for good market, locally and internationally, for input purchase	222(57.7)	163(42.3)	0.577(0.495)
Using apps, I can easily source for market for my produce, home and abroad	230(59.7)	155(40.3)	0.597(0.491)
Mobile Apps have made it easy for farmers to get good price for their farm produce, home and abroad	213(55.3)	172(44.7)	0.553(0.498)

Source: Field Survey Data (2017)

4.9 Constraints to awareness and use of mobile apps by farmers in North-West Nigeria

This section considers constraints inhibiting the ease of use of cell phone apps by farmers in the region. Respondents were asked to identify constraints affecting the use of mobile phone apps from a list of 32 constraints by responding as either yes (1) or no (0), and then indicate the extent of severity of the constraints on a 4 point likert scale of very severe (3), severe (2), undecided (0) and not severe (1). Because of the rating scale used, a mean of ≤ 1.45 implies not a serious constraint, > 1.45<1.55 implies serious constraint and >1.55 implies very serious constraint.

Table 4.16 presents the results of constraints confronted by farmers in the course of using cellular telephone apps in the region. The table also unveils the severity of the constraints as perceived by the farmers. The most common constraints identified were: "High cost of phone" (77.9%; $\bar{x}$=1.8, SD=1.03), "lack of encouragement" (77.9%; $\bar{x}$=1.5, SD=0.82), "lack of awareness" (77.7%; $\bar{x}$=1.6, SD=0.93) and "poor network" (77.4%; $\bar{x}$=1.6, SD=0.95). Others include poor power supply (69.1%; $\bar{x}$=1.7, SD=1.20), high cost of airtime (68%; $\bar{x}$=1.5, SD=1.11) and complexity in operating mobile phones (72.5%; $\bar{x}$=1.5, SD=1.02). The least considered as constraints by the farmers include: no power supply (94.5%; $\bar{x}$=0.2, SD=0.63), lack of access to network (89.6%; $\bar{x}$=0.1, SD=0.43), action of association/farmer groups (85.2%; $\bar{x}$=0.2, SD=0.53) and problem of updating apps (75.1%; $\bar{x}$=0.5, SD=0.84). This is supported by Munyua (2008) in Kwadwo and Daniel (2012), who also identified high cost of available technologies, inadequate infrastructure (which is responsible for poor network), poor and very costly internet connectivity, incongruous ICT policies and low ICT skills, scarce and/or inapt credit facilities as some of the constraints inhibiting the exploitation of cellphone apps by farmers in Sub-Saharan countries. The author further acknowledged low level of participation of women and other underprivileged persons, not designed with local needs at heart, fragile society and poor teamwork as well as understanding how to access ICT services, bad information-sharing attitude and very limited understanding of the function of ICTs in growth and development in the entire facet of human endeavor. In a similar vein, Osadebamwan and Ideba (2015) also unveiled that poor network was one of the major constraints (with the highest mean value of 4.98) affecting smallholder farmers in sub-Saharan countries. The report of Okeke, Hycinth and Uzuegbunam (2015), drawn from reviews of existing literatures on the role of ICT in extension delivery services, also supported these findings as they also established that poor ICT infrastructure associated with shortage or absence of interconnectivity facilities in most rural areas with a resultant exorbitant cost of access as challenges facing rural dwellers in deploying ICTs, particularly cellphone technologies. With respect to lack of encouragement, Yusuf, Abdullahi and Haruna (2015) showed that majority (53.9%) of the farmers under the e-wallet program in Kano state, Nigeria declined getting help from redemption supervisors as the statement that "Helpline personnel and redemption supervisors discharge their responsibilities diligently without demand for 'tip-off'" had mean score of 1.39 out of 4 points. Other statements unveiled by the findings of the authors that reflects discouragement is that most (72.3%) of the farmers assented to the statement that "cumbersomeness of procedure in getting approval from 'cellulants' encourage corrupt practices" and the statement

had a high mean score of 2.78. This is supported by the findings of Rebekka and Sarvanan (2015) in Meghalaya State of North-East India who unfolded that the major constraints inhibiting farmers in accessing and using ICTs in the area were lack of awareness of the technologies and their benefits as well as poor and erratic power supply that has been hindering farmers from charging their mobile phones. Similarly, Susan and Charles (2016) reported that using SMS app also entails that the phone battery is charged – which has remained a bottle-neck in rural Kenya, due to poor electricity supply. The inference here is that most farmers could not afford and operate android/digital phone which are often characterized by many net-related apps, most of which can only operate via the internet and as such, most of the farmers were not aware of these apps none the less use the apps. This is substantiated by the report of FAO (2017) which acknowledged that high cost of smartphones (android/digital) is a major challenge affecting farmers in getting to know and use mobile phone apps with internet interface in rural farming communities where bulk of food are produced.

Table 4. 16: Severity of constraints to the use of apps by respondents

Constraints	Frequency (%) Yes	Frequency (%) No	Very severe	Severe	Undecided	Not severe	Mean(SD)	Remark
Poor network	298(77.4)	87(22.4)	61(15.8)	196(50.9	87(22.6)	41(10.7)	1.6(1.00)	Very serious
Poor power supply	226(69.1)	159(30.1)	115(29.9)	103(26.8)	159(41.3)	3(0.8)	1.7(1.20)	Very serious
No power supply	21(5.5)	364(94.5)	6(1.6)	11(2.9)	364(94.6)	4(1)	0.2(0.63)	Not serious
High cost of charging battery	132(34.3)	253(65.7)	23(6)	51(13.3)	253(65.7)	58(15.1)	0.5(0.94)	Not serious
Apps are too complex	237(61.6)	148(38.4)	38(9.9)	175(45.5)	148(38.4)	0(0)	1.3(1.08)	Not serious
Inability to operate apps	216(56.1)	169(43.9)	21(5.5)	195(50.7)	169(43.9)	24(6.2)	1.2(1.06)	Not serious
No access to apps	126(32.7)	259(67.3)	15(3.9)	90(23.4)	259(67.3)	21(5.5)	0.7(0.97)	Not serious
Lack of access to credit	230(60)	155(40)	56(14.6)	155(40.3)	155(40.3)	19(4.9)	1.3(1.14)	Not serious
Lack of access to education	249(65)	136(35)	52(13.5)	180(46.8)	136(35.3)	17(4.4)	1.4(1.11)	Not serious
Lack of access to extension	194(50.4)	191(49.6)	60(15.6)	127(33)	191(49.6)	7(1.8)	1.2(1.19)	Not serious
Lack of access to network	40(10.4)	345(89.6)	1(0.3)	16(4.2)	345(89.6)	23(6)	0.1(0.43)	Not serious
Lack of access to functional apps	190(49.4)	195(50.6)	34(8.8)	81(21)	195(50.7)	75(19.5)	0.7(1.07)	Not serious
Lack of time to practice app use	171(44.4)	214(55.6)	45(11.7)	107(27.8)	214(55.6)	19(4.9)	0.9(1.13)	Not serious
Lack of technical knowhow	280(73)	105(27)	56(14.6)	205(53.2)	105(27.3)	19(4.9)	1.6(1.04)	Not serious

Lack of information from radio	174(45)	211(55)	23(6)	72(18.7)	211(54.8)	79(20.5)	0.6(0.98)	Not serious
Lack of awareness of apps	299(77.7)	86(22.3)	42(10.9)	228(59.2)	86(22.3)	29(7.5)	1.6(0.95)	Very serious
Cost of training is high	169(43.9)	216(56.1)	25(6.5)	53(13.8)	216(56.1)	91(23.6)	0.7(0.88)	Not serious
Cost of airtime is high	261(68)	124(32)	68(17.7)	188(48.8)	124(32.2)	5(1.3)	0.5(1.11)	Serious
Lack of social interaction	215(55.8)	170(44.2)	29(7.5)	102(26.5)	170(44.2)	84(21.8)	1.2(1.09)	Not serious
Lack of willingness to learn	170(44)	215(56)	21(5.5)	100(26)	215(55.8)	49(12.7)	0.8(1.02)	Not serious
Lack of demonstration of app use	244(63.4)	141(36.6)	44(11.4)	178(46.2)	141(36.6)	22(5.7)	1.3(1.09)	Not serious
Lack of app update technology	111(28.8)	274(71.2)	13(3.4)	53(13.8)	274(71.2)	45(11.7)	0.5(0.81)	Not serious
Lack of encouragement	300(77.9)	85(22.1)	0(0)	275(71.4)	85(22.1)	25(6.5)	1.5(0.82)	Serious
Problem of updating apps	96(24.9)	289(75.1)	14(3.6)	43(11.2)	289(75.1)	39(10.1)	0.5(0.84)	Not serious
High cost of apps	185(48.1)	200(51.9)	27(7)	57(14.8)	200(52)	101(26.2)	0.7(0.84)	Not serious
High cost of phones	300(77.9)	85(22.1)	84(21.8)	204(53)	85(22.1)	12(3.1)	1.8(1.03)	Very serious
Complexity in operating phones	279(72.5)	106(27.5)	60(15.6)	192(49.9)	106(27.5)	27(7)	1.5(1.06)	Serious
Socio-religious values	171(44.4)	214(55.6)	14(3.6)	29(7.5)	214(55.6)	128(33.2)	0.5(0.70)	Not serious
Customary values	184(47.8)	201(52.2)	18(4.7)	25(6.5)	201(52.2)	141(36.6)	0.6(0.68)	Not serious

Political influence	174(45.2)	211(54.8)	8(2.1)	29(7.5)	211(54.8)	137(35.6)	0.4(0.71)	Not serious
Actions of association/grp	57(14.8)	328(85.2)	2(0.5)	20(5.2)	328(85.2)	35(9.1)	0.2(0.53)	Not serious
Problem of acceptance by local leadership	224(58.2)	161(41.8)	12(3.1)	128(33.2)	161(41.8)	84(21.8)	0.6(0.83)	Not serious

Source: Field Survey (2017)

4.10 Factors influencing the use of mobile phone apps by farmers in North-West Nigeria

This section presents the results on the factors influencing the usage status of mobile phone apps by farmers in Northwest Nigeria using two approaches. Each approach constitutes a section. The first represents the results of factors influencing the usage of five most prominently used apps by farmers in the study area using probit regression model. The five apps where arrived at after the results of descriptive statistics showed that they were the most adopted apps in the area. These apps, in order of their prominence are call app, SMS app, Facebook, WhatsApp and Bluetooth. The dependent variable is in dummy form where if a farmer uses the app, such app scores 1 and otherwise 0. The second section represents the results on factors influencing the intensity of use of mobile phone apps by farmers in the study area using Tobit regression model. The use intensity index for the apps were generated and used as the dependent variable.

4.10.1 Factors influencing the apps mostly in use by farmers in North-West Nigeria

Table 4.17 shows the results of factors influencing the adoption of mobile phone apps in the study area. The most adopted apps were: call apps; SMS app; Facebook; WhatsApp and Bluetooth apps. Each of these apps was subjected to Probit regression analysis.

The results for the Probit analysis for call app revealed that the model is well fitted at 1% with a Chi-Square value of 92.92, $p < 0.01$. Six variables were significant determinants for the use of call app. These variables include: location ($Z= 3.42$, $p < 0.01$); years of farming experience ($Z= -1.67$, $p < 0.1$); religion ($Z= 2.50$, $p < 0.05$), labour ($Z= -1.66$, $p< 0.1$), phone as source of information ($Z= 1.78$, $p< 0.1$) and constraint ($Z= 3.18$, $p < 0.01$), signifying that that the use of call app has a direct relationship with location of the farmers, their religion, phone as information source and constraints inhibiting use of apps, i.e., a raise in these variables will increase the probability of the farmers adopting mobile phone call app. In other words, the results of the findings indicate that six out of the twenty variables were found to be significantly influencing farmers' use of call app in the study area. The null (H_O) is therefore rejected.

The parameter of farmers' location was statistically significant at 1% ($p<0.01$) of level of probability with a positive coefficient (0.729) indicating a direct relationship between respondents' location and the use of call app. This suggests that the closer the farmers were to major centers or cities where most of the network service providers are located, the higher the probability that they will use the call app. Probably this is because of the fact that higher competition within the service providers tends to lower their charges and also curtail the possibility of extra charges by vendors dealing in airtime vouchers and other accessories (Sirajul and Ake, (2011). This is in addition to the high diffusion rate of the call app in such cities which tend to pose strong influence on socio-cultural practices of people in neighbouring environments.

Parameters of farmers' years of experience in farming was found to be statistically significant at 10% ($p<0.1$) with a negative coefficient (-0.051) to respondents' call app use status. It indicates that farmers' use status of call app declines as they advance in years in production/farming, thus implying that farmers' years of experience in husbandry decreases the probability of farmers being in category of call app users in the study area with the passage of time. This is a situation that is contrary to the *apriori* expectation, as it is expected that the more the years in production the high the financial ability of the farmers to be able to meet up with cost implication of call, coupled with more experience on how to deal with other challenges affecting the use of call app. This suggests that as the farmer advances in years of farming operation, he or she would have developed models for input delivery and output disposal in such a way that fewer calls via app would be required to effect all the transactions.

The coefficient of farmers' religion was found to be positive (3.010) and significant at 5% ($p<0.05$) level of probability (captured as 1 if Islam and 0 otherwise). This indicates that the religion of the respondents directly influence their use of call app in the study area, thus implying that the use of call app has a direct relation with the status of the farmers as Muslims, which is in tune with the *apriori* expectation, which suggests that the more Islamically religious the farmers were, the higher the probability that they would use the call app as most often the farmers use the call app to contact their religious leaders for clarification on issues and advice on whatever they want to embark upon to be sure it does not contravene with their religious teachings. Furthermore, religiously inclined farmers tend to call each other often to relay information from lectures attended or messages from any religious authority.

The parameter of labour type adopted by the farmers (captures as 1 if family labour and 0 otherwise) was negative (-0.911) and significant at 10% ($p<0.1$) level of significance indicating that the use of labour (captured as 1 if family labour and 0 otherwise) lowers the probability of farmers' use of cellular phone call app in the zone. This implies that as more farmers use family labour, the less is the use of mobile phone voice call app in the study area. This may suggest that since the labour force is right at the domain and disposal of the farmers negate the need to make contacts to secure hired labour, as efforts in making such contacts would often entail making calls via phones.

The parameter of respondents' use of phone as source of information (captured as 1 if yes, and 0 otherwise) was positive (0.869) and significant at 10% ($p<0.1$) level of significance. This indicates that use of mobile form by farmer enhances the probability the farmer using call app. This implies that farmers' possession of mobile phone as means of getting information directly influence their probability of using mobile phone call app in the study area. It suggests that farmers that affirmatively responded that phones were their source of information had significantly high probability of using call app when juxtaposed with those that responded negatively because

of the ease with which they could be contacted coupled with the fact that most phones are fitted with radio functions which assist them to access daily news broadcast easily. This finding is in consonance with that of Anselme *et al*. (2012), who reported a positive and significant relationship between possession of mobile phone as information source garget and the use of call app.

Finally, the coefficient of constraints affecting respondents' use of call app was positive (0.061) and significant at 1% ($p<0.01$) level of significance, indicating a direct relationship between challenges to use of call app and the respondents' use of the app; and that a unit increases in the constraints increases farmers' use of call app by 0.061. This implies that challenges tend to push the respondents to strive harder to overcome odds, and in the process their usage status of call app gets more enhanced which suggests that the call app is considered very important that no amount of difficulty would deter the farmers from using it. This is in consonance to the assertion of Sirajul and Ake (2011) that constraints such as high level of illiteracy and poor electricity supply do not deter an individual from the use of mobile phone technologies because farmers tend to exert required effort as long as the acceptance of the technology has instill in them high self-efficacy towards the use the innovation.

In the Probit model using the adoption of SMS app as a dependent variable, the results reveal that the model is well fitted at 1% with Chi-Square value of 197.44, $p< 0.000$. Eight variables were established to be significant factors influencing the adoption of SMS app by farmers in the study area. These significant variables were: age ($Z= -3.96$, $p < 0.000$); marital status ($Z= 1.83$, $p < 0.086$), years of farming experience ($Z=2.41$; $p<0.016$), land acquisition method ($Z= -1.64$; $p< 0.100$), phone as information source ($Z= 3.19$; 0.001), nature of occupation ($Z= 2.55$; $p< 0.001$) and knowledge ($Z= 5.24$, $p < 0.000$). That is, the findings show that eight out of the twenty variables were found to be significantly influencing farmers' use of SMS app in the study area, implying that the null (H_O) is invalidated. This denotes that the adoption of SMS app by farmers in the study area has a direct relationship with marital status, years of farming experience, and phone as source of information, nature of occupation and knowledge implying further that increase in these parameters will likely increase the farmers' adoption level of SMS app in the area due to their positive coefficient. The results reveal that the parameter of farmers' age was statistically significant at 1% ($p<0.01$) with a negative coefficient (-0.048) to respondents use of mobile phone SMS app. This significance means that as the age of the farmers' increases by a unit, there is a marginal decrease in the use of SMS app by 0.048, suggesting that youthful and emerging farmers are more likely to use SMS app than the older farmers.

The coefficient of respondents' marital status was found to be positive (0.598) and significant at 10% ($p<0.10$) level of significance, suggesting that married farmers were more likely to use SMS app and implying that the more the numbers of married farmers in the region, the high the probability that the SMS app would be engaged by large number of farmers for information transfer in the region. The coefficient of farmers' years of farming

experience was as well found to be positive (0.035) and significant at 5% ($p<0.05$). This suggests that farmers' years of farming experience directly influence their probability of using SMS app in the study area. It implies that the more the farmers' years of farming experience, the higher the probability that they will use the SMS app the more with a marginal value of 0.035.

The parameters of farmers' wide adoption of inheritance as mode of acquiring land– captured as 1 if yes and 0, otherwise– was negative (-0.386) and significant at 10% ($p<0.10$) level of probability. This indicates that acquiring land through inheritance by the farmers is counterproductive to the use of SMS app. It suggests that farmers who could not afford to purchase land and depend solely on free land from ancestral heritage must be living in a state of poverty which must have been barring them from being able to meet cost demand of using SMS app.

The parameter of respondents use of mobile phone as source of information (captured as 1 if yes and 0, otherwise) was positive (0.7612) and statistically significant at 1% ($p<0.01$). This implies that farmers' use of mobile phone for sourcing information directly influence their probability of using the SMS mobile phone app. It also suggests that farmers that affirmatively responded to the use of phone as their source of information have significantly higher probability of using the SMS app when compared with those that answered no. This is related to the findings of Salau *et al*. (2017) who reported a positive and significant relationship between ownership of mobile phone and use of mobile phone technologies. The coefficient of respondents' nature of occupation, which was centred on their primary occupation (farming), was found to be positive (0.703) and significant at 5% ($p<0.05$) level of significance, thus implying that respondents that answered yes to the question of whether farming is their main occupation had significantly higher probability of using SMS app compared with those that declined their affirmation. This implies that farmers for which farming constitute their main occupation are more likely to use SMS app in the region, suggesting that the briefness of the nature of SMS messaging process which is often less time consuming could be responsible for the direct relation of the use of the app and farming as an occupation well known for laborious and time demanding which often does not tolerate excessive diversion of useful daily man hour

The results further show that farmers' knowledge of mobile app was significant at 1% ($p<0.01$) with a positive (0.097) relationship, signifying higher probability of using SMS app by farmers who are versed in the knowledge of apps in the study area. This indicates that a unit increase in farmers' knowledge status of mobile phone apps in the region, increases the probability of the respondents' SMS usage status by 0.097 which suggests that if the farmers are opportuned to have trainings that will enhance their knowledge of mobile phone apps, they are most likely going to be frequent in the use of SMS app

Finally, the coefficient of respondents' awareness status of mobile phone apps was positive (0.389) and significant at 1% ($p<0.01$) level of significance. This implies a direct relationship between respondents' awareness status of mobile phone apps and the use of SMS app, indicating that a unit increase in the awareness status of the farmers about mobile phone apps increases the probability of SMS usage status by 0.389. This suggests that as the farmers get to know about mobile phone apps, the chances that they will increase their use of SMS app because SMS app is one of the most prominent app that farmers get to know easily as soon as they interact with mobile phone technology. These results conform to the findings of Siwel and Mangogo (2012) in a study in Kilolo District, Tanzania. They reported indirect relationship with age and a direct relationship with marital status.

Furthermore, Table 4.17 shows that the Probit model using the adoption of facebook app as the dependent variable was well fitted at 1% with a Chi-Square value of 280.70, $p < 0.000$. Four variables were established to be factors that significantly influence the adoption of facebook app. These variables were: religion ($Z= -3.00$, $p<0.003$); access to credit ($Z= - 2.38$, $p < 0.017$); awareness ($Z= 7.26$, $p < 0.000$); and knowledge ($Z= 6.00$, $p < 0.000$), i.e., the results indicate that for this app, religion, access to credit, awareness and knowledge were significant determinants usage factors of facebook app in the region, considering that they were all significant at 1% significant level, with the exception of access to credit that was found to be significant at 5% level of probability. This again renders the null hypothesis rejected.

The results show that religion was significant at 1% ($p<0.01$) and marked a negative (-1.652) correlation with the usage status of facebook app for farmers in the study area. This result indicates a negative relationship and suggests that the more the number of farmers that are Muslims, the less Facebook app would be used by farmers in the zone. The coefficients of awareness and knowledge were positive, implying a direct relationship with the dependent variable. This indicates that the more the farmers get to know about mobile phone apps and acquire the requisite knowledge of the operation of the apps, the higher the likelihood of them adopting the use of Facebook app. This result is expected considering the youthful age bracket of majority of the farmers as youths are generally enticed by social media and since Facebook is a social media app, the more the youths get to know about it, the more the tendency of its adoption. This is a fact pointed out by Muktar, Mukhtar and Ahungwa (2015), that the youth are so captivated by the frenzy of ICT. They opined that this is a pull that can be capitalized on by stakeholders in extension service delivery. Other reports have established that social network tools are gaining very wide acceptability in Africa, predominantly by the youths (Adler and Know, 2002; Bargh, 2004; Sokoya *et al*., 2012; Banmeke and Oose, 2012; Muktar *et al.,* 2015). In addition, youths, by nature, would always want to put to practice what they have learnt or know. Patently, it is evident that knowledgeable farmers tend to respond to projected changes quickly, are in a better position to predict future expectations and overall, have very good exposure to information and prospects than illiterate farmers, which is very likely to encourage

adoption of technical innovations like the Facebook app. Hence, the more they understand the operational in tricks of the app, the more they tend to use it. Moreover, several studies found that education (by virtue of knowledge it instil in individuals) also positively and significantly impinges on agricultural productivity and the acceptance of new technological innovations (Quayum and Ali, 2012).

In addition, by considering the use of WhatsApp as the dependent variable, Table 4.17 further revealed that the Probit model is well fit at 1% with a Chi-Square value of 301.75, $p < 0.000$. Five variables were found to be significant determinants for the use of WhatsApp application by farmers in the study area. These significant variables include: location ($Z= 3.14$, $p< 0.01$); land acquisition method ($Z= 2.22$, $p < 0.05$); access to credit ($Z= -2.28$, $p< 0.05$); awareness ($Z= 6.51$; $p<0.01$); and knowledge ($Z= 6.32$, $p < 0.01$). That is, the parameter of respondents' location was statistically significant at 1% ($p<0.01$) with a positive coefficient (0.364), implying that the location of the farmers positively influence their use of WhatsApp mobile phone app.

Method of land acquisition (captured as 1 if through inheritance, and 0 otherwise) was also found to be positive (0.779) and significant at 5% ($p<0.05$) level of significance. This indicates that there is a direct relationship between acquisition of land via inheritance and use of WhatsApp; implying that land acquisition through inheritance enhances the prospect of using WhatsApp. This suggests that farmers that mainly rely on inheritance to secure land may be poor and unable to secure land through other channels with cost implication. As such these farmers would want to adopt the cheapest means of communication through their mobile phone which can be guaranteed by using WhatsApp mobile phone app.

On the contrary, the coefficient (-0.723) of respondents' access to credit (captured as 1 if yes and 0, otherwise) was found to be negative and significant at 5% ($p<0.05$) level of significance. This is an indication of negative relationship between access to credit facilities and the use of WhatsApp. This implies that access to credit indirectly influence farmers' use of WhatsApp mobile phone app in the study area, suggesting that the more the number of farmers that have access to credit in the area, the less would be the prevalence of WhatsApp usage among the farmers in the zone. The parameter of respondents' awareness status of mobile phone app was found to be positive (0.478) and significant at 1% ($p<0.01$) level of probability, indicating that a unit increase in farmers' awareness of mobile apps increases the probability of them using the WhatsApp app by 0.478. This simply means that farmers' awareness status of mobile phone apps directly influences their use of WhatsApp mobile phone application in the study area, as the more apps the farmers are aware of, the higher the chances that the number of apps they use will increase.

The coefficient of respondents' knowledge of mobile phone apps was found to be positive (0.215) and significant at 1% ($p<0.01$) level of significance. This indicates that a unit increase in farmers' knowledge of mobile phone apps increases the probability of them using the WhatsApp app by 0.215. By implication, this means that the

respondents' knowledge of mobile phone apps has direct relationship with their use of WhatsApp mobile phone app. The implications of the findings are that use of WhatsApp has a direct relationship with location, land acquisition method, awareness and knowledge of mobile apps. This indicates that as these parameters increase, the higher the probability of the farmers using WhatsApp application.

On the other hand, access to credit has the probability to likely reduce the use of WhatsApp by the farmers as the variable had negative coefficient with the dependent variable. This implies that respondents' acquisition of land through inheritance directly influences their use of WhatsApp mobile phone app in the study area. Communication via WhatsApp could be classed as the cheapest in the deployment of mobile phone for information exchange; hence, considering the assumed poor status of the farmers who could only acquire land via inheritance, WhatsApp app provides an accessible medium to remain relevant in information flow cycle via the mobile phone apps in the study area. This finding suggests that farmers are cautious in using the credit obtained in what it was meant for to avert possible consequence of failure to pay back the credit. The larger the volume of the credit, the more stringent the condition surrounding it is likely going to be and the less likely farmers divert it to use of mobile phone apps (such as WhatsApp) (Caroline, 2015).

Finally, Table 4.17 shows that the Probit model considering the use of Bluetooth as the dependent variable was well fitted at 1% with a Chi-Square value of 176.02, $p < 0.000$. Six variables were established to be factors that considerably influence the use of Bluetooth app by farmers in the study area. These variables were: marital status ($Z= 1.87$, $p<0.1$); ownership of farm land ($Z= - 1.82$, $p < 0.1$); housing material ($Z= -1.97$, $p < 0.05$); phone as source of information ($Z= - 2.54$, $p < 0.01$); awareness ($Z= 8.46$, $p < 0.01$); and knowledge ($Z= - 3.17$, $p < 0.01$). In other word, the parameter of marital status of respondents (captured as 1 if married and 0 otherwise) was, according to the findings, found to be positive (0.500) and significant at 10% ($p<0.10$) level of probability. This indicates that a unit increase in the marital status of farmers increases the probability of them using the bluetooth app by 0.500, implying that married farmers are more likely to adopt the SMS app; while coefficient of respondents' ownership of farm land was negative (-1.206) and significant at 10% ($p<0.1$) level of significance, indicating that a unit increase in farmers' ownership of land status in the region decrease the farmers' use of bluetooth by 1.206.

The coefficients of marital status and ownership of farm land were positive, implying a direct relationship with the dependent variable. This further indicates that as the number of married farmers increases coupled with increase in the level of awareness of mobile phone apps, the higher the likelihood of them adopting the use of bluetooth app for information transfers. This suggests that as number of married farmers increase in the area, the tendency to facilitate information transfer within a short distance range, which is one of the main characteristics of bluetooth app, is likely going to increase. On the other hand, the coefficients of ownership of farm land, housing materials,

phone as source of information, and knowledge were negative implying an inverse relationship with the dependent variable. This indicates that an increase in the parameters of these variables decreases the likelihood of the farmers adopting the use of Bluetooth app, which suggests that as the land ownership status of farmers in the region is enhanced, the farmers are likely going to be more engaged with their farming activities that they may lack time to use or adopt this app, coupled with the fact that engaged farmers will often need long range information transfer mechanism which this app cannot do.

Table 4.17: Determinants of adoption of mobile phone apps by farmers (n=385)

Location	.729(.213)*	-.062(.059)	-.067(.075)	.364(.116)*	-.087(.061)
Age	-.033(.032)	-.067(.017)*	.010(.017)	-.031(.027)	-.026(.017)
Gender	-2.57(674)	.356(.702)	-.371(.767)	-1.26(.899)	3.53(248)
Education	-.556(.534)	-.319(.232)	-.356(.303)	-.458(.435)	-.369(.276)
Marital status	1.26(.766)	.598(.327)***	-.311(.273)	.244(.373)	.500(.267)***
Households size	.013(.046)	.024(.025)	-.018(.025)	-.057(.053)	.172(.029)
Farm size	.242(.156)	-.046(.058)	-.038(.073)	.107(.110)	4.35(197)
Experience	-.051(.031)***	.035(.014)**	-.012(.017)	-.018(.026)	-.005(.063)
Religion	3.01(1.21)**	-1.66(133)	.401(.778)	-.529(.899)	.002(.016)
Ownership farmland	-4.17(541)	-.386(.235)***	.161(.234)	.779(.352)**	-1.21(.663)***
Land Acquisition Method	.051(.491)	-.188(.213)	-.260(.211)	.112(.294)	-.088(.206)
	-.911(.550)***	.712(.565)	-1.65(.551)*	-.118(.348)	-.042(.202)
Housing materials	-.574(.610)	-.046(.238)	-.048(.260)	.601(.375)	.283(.274)
Communication kit(phone)	.869(.489)***	.761(.238)*	.196(.259)	.144(.349)	-.444(.225)**
Access to credit	.043(.482)	-.025(.236)	-.529(.222)**	-.723(.317)**	-.604(.238)**
Nature of Occupation	.605(.645)	.703(.276)**	-.103(.280)	-.018(.026)	-.067(.209)
Attitude	-.022(.021)	.389(.113)*	-.014(.010)	-.947(.652)	.416(.049)*
Constraint	.061(.019)*	-.014(.009)	-.015(.010)	.478(.073)*	.008(.008)
Awareness	.250(.192)	-.007(.008)	.386(.053)*	.018(.015)	.007(.008)
Knowledge	.049(.033)	.097(.018)*	.122(.020)*	.009(.013)	-.059(.019)*
Constant	3.30(865)	1.68(133)	.147(1.60)	.215(.034)*	-7.64(317)
Pseudo R^2	0.639	0.489	0.584	0.721	0.436
LR $Chi^2(20)$	93	197	280	301	176
Prob > Chi^2	.000	.000	.000	.000	.000
Log likelihood	-26.2	-103	-100	-58.5	-114

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

4.10.2 Factors Influencing the Intensity of Use of Mobile Phone Apps by Farmers in Northwest Nigeria.

The Tobit regression results from Table 4.18 reveal that the likelihood ratio statistics as revealed by the chi-square value, are highly significant (P < 0.000) indicating that the model has a strong inferential influence.

Variance Inflation Factors (VIF) was used to test for multicollinearity among the variables and they were all below 10 with a mean value of 1.64. The result shows that age, educational attainment, years of farming experience, housing materials, nature of occupation, knowledge, and attitude significantly influence use of cell phone apps in the region hence the null hypothesis of the study (Ho2) was rejected.

From the findings as unveiled in table 4.18, the coefficient of age (-0.002; $p<0.05$) had negative effect on use intensity of apps. This is in line with a priori expectation, implying that the respondents' age will lower the use intensity of apps marginally by 0.002 as it increases with time in the zone or region, meaning that as the age of the farmers decreases, the extent to which they use mobile phone apps increases. This result correlates with the findings of Abu Salem *et al.* (2017) on a study to ascertain factors affecting the use of mobile phone by vegetable farmers in Bangladesh. The outcome of their findings unveiled that age of the farmers had a negative significant relationship with their use of cellular phones. Similarly, Xiaolian and Shaheen (2012) established that one of the factors influencing farmers' adoption of the KHITTI project in India is the age of the farmers. This implies that as farmers in rural areas become aged, the use intensity of apps in the area will reduce. The reason could be perhaps due to increase in household size (i.e. increasingly higher dependency ratio), needs for expansion in housing needs and increased in farm production requiring additional expenditure etc, all of which would expectedly usurp the financial capability of these poverty ridden farmers to maintain their use intensity rate of mobile phone apps.

Similarly, the coefficient of nature of education (-0.039; $p<0.01$), coincides with the a priori expectation as it has a significant negative influence on the extent of use of mobile phone apps by farmers in the area. What this translates into is that as more of the farmers in the study area adopt pure Arabic education, the use intensity of mobile phone apps in the region will continue to drop. The reason for this outcome could be adduced from the fact that Arabic language is not the widely spoken language in the area; in fact only handful numbers of the farmers understand and can communicate in Arabic language. This automatically will limit extent of use of apps for communication by farmers in the region. Surabha and MMamta (2016) equally reported negative and significant relationship between education and use of cellular telephone technologies, implying that educational status is a factor influencing the use of mobile phone technologies by husbandmen (Osadebamwem and Ideba, 2015). Furthermore, the parameter of respondents' years of farming experience (0.002) was found to have positive coefficient and significant at 1% ($p<0.01$) level of probability, thus indicating also that a unit increase in years of farming experience of the respondents results in about 0.002 increases in use intensity of cellular telephone apps by the farmers. This also coincided with the apriori expectation. This corroborates the findings of Abdul-Aziz, Haruna and Jamilu (2015), who showed that among the factors influencing the use of ICT (of which phone ranked 2nd after radio) by female poultry farmers in Kaduna State was years of experience in poultry farming which was significant at 1% level. Similarly, Anselme, Romeo, Faustin and Desire (2012) also recorded

significant and positive relationship between years of farmers' experience in farming and intensity of use of mobile phone in Benin. This suggests that as the farmers' years of farming increase, their scope of operation would have also increased meaning more demand for inputs and more outreach for output disposal. All these would require frequent contacts, and since phone in the current world order is the fastest and easiest means of ensuring frequent contacts, it is therefore expected that as farmers progress in years of production their use intensity of mobile phone apps would also follow suit.

The coefficient of respondents' housing material (-0.023) was negative and significant at 5% ($p<0.05$) level of significance. The marginal outcome shows that a unit increase in use of mud for housing by the respondents results in about 0.023 decreases in use intensity of cellphone apps by the farmers. The outcome of this finding is in line with the a priori expectation. By implication, this means as more farmers adopt muddy dwellings, there will be decrease in the use intensity of mobile phone apps in the study area. This could be because farmers who are entangled by the menace of abject poverty find it difficult or even impossible to afford homes made of modern housing material, and therefore, often resort to the use of mud to build their dwellings. Hence, farmers who affirmed that their dwellings are muddy are generally associated with poverty; it is obvious that poverty will severely affect use intensity of apps. Therefore, since majority of the farmers live in dwellings made of mud, this is an indication of wide spread poverty among the respondents which must have been responsible for the generally low use intensity of apps in the region.

Additionally, the parameter of respondents' nature of occupation is positive (0.028) and significant at 5% ($p<0.05$) level of significant. This indicate a direct relationship between the farming as occupation and the intensity of use of cell phone apps in the study area, implying that as the more the number farmers that adopt farming as a major occupation, the high the intensity of mobile phone apps usage will be in the area. This may be because as more respondents take farming as their occupation the need to communicate for inputs and marketing will obviously increase, translating to increase in use intensity of the apps engaged for such communication or contacts.

In the same vein, the parameter of respondents' attitude (0.001; $p<0.1$) was found to be positive and significant at 10% level of significance. This indicates that there is a direct relationship between the farmers' attitude and the extent to which they use mobile phone applications. Marginally, the more favourable the attitude of the farmers is toward mobile app, the more they will engage the apps for their day to day activities by 0.001; implying a diminishing increment, until further attitudinal change will result in negative relationship. This leaves a research vacuum as to the limit of attitudinal change that will guarantee maximum use intensity.

The coefficient of respondents' awareness status of mobile phone apps was positive (0.021) and significant at 1% ($p<0.01$) level of significance. The results also illustrate that for unit increase in awareness status of the

farmers of mobile phone apps increases their use intensity by 0.021. This implies that farmers' awareness of mobile phone apps is directly related to their use intensity of the apps in the study area. What this outcome informed is that as the farmers, being majorly youths, become aware of an app and how it is being operated as well as its benefits, they tend to exhibit their youthful nature of always wanting to explore and try new things. By so doing, the use intensity of such app will gain positive momentum or increase.

The coefficient of respondents' knowledge of mobile phone apps was positive (0.001) and significant at 1% ($p<0.01$) level of significance with a marginal parameter indicating that a unit increase in the farmers' knowledge of mobile phone apps increases their use intensity by 0.0040, keeping other factors constant. This is in line with the findings of Osadebamwen and Ideba (2015), who discovered that one of the factors influencing the use of mobile phone technologies by farmers in Sub-Saharan Africa is their knowledge of mobile phone usage. They posited that attainment of knowledge of cellphone functionalities is imperative as it could open doors to more opportunities in agriculture through easy access to assistance and services online using cellular phones. This stands to say that farmers' knowledge of mobile phone apps directly influences the use intensity of these apps in the study area. Hence, the more they acquire the technical knowhow on the operation of mobile phone around them, the more they will engage mobile phone apps in communication and other purposes. This means that one of the ways to enhance the poor use intensity of apps among farmers in the region is to come up with comprehensive training programmes aimed at impacting technical skill on how to use phones, particularly smart phones that are known to be well furnished with many apps.

Table 4.18: Tobit Results of Factors Influencing the Use Intensity of Mobile Phone Apps by Farmers in North-West Nigeria.

Tobit regression				
Description	**B(SE)**	**t-stat**	**P>/t/**	**VIF**
Location	-0.002(0.00263)	-0.73	0.467	1.25
Age	-0.002(0.001)	-2.32	0.021**	3.86
Gender	0.002(0.0338)	0.05	0.961	1.30
Education	-0.039(0.0111)	-3.51	0.001*	1.32
Marital status	-0.003(0.0124)	-0.25	0.799	1.72
Households size	0.001(0.0011)	0.45	0.655	2.52
Farm size	-0.001(0.0025)	-0.40	0.687	1.74
Experience	0.002(0.001)	3.32	0.001*	2.29
Religion	0.001(0.0250)	0.05	0.961	1.39
Ownership of farmland	-0.014(0.0356)	-0.38	0.705	1.09
Land Acquisition Method	-0.010(0.0097)	-1.00	0.320	1.18
Labour	-0.008(0.0091)	-0.93	0.355	1.15
Housing materials	-0.023(0.0103)	-2.27	0.024**	1.17

Communication kit (phone)	-0.008(0.0102)	-0.82	0.413	1.43
Access to credit	.0125(0.0094)	1.33	0.184	1.21
Nature of Occupation	.0279(0.0114)	2.46	0.014**	1.21
Attitude	0.001(0.0004)	1.77	0.077***	1.62
Constraint	0.001(0.0004)	1.50	0.134	1.26
Awareness	0.021(0.0019)	11.12	0.000*	1.57
Knowledge	0.006(0.0008)	7.06	0.000*	2.14
(Constant)	0.042(0.0642)	0.65	0.514	
Sigma	0.083(0.0031)		Mean VIF	164
Number of Observation	385			
Pseudo R^2	-0.7953			
LR $chi^2(20)$	342.87			
Prob > chi^2	0.0000			
Log likelihood	386.99172			

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

4.11 Determinants of Use Intensity of Mobile Phone Apps by Farmers

Table 4.19 reveals the Ordinary Least Square regression results of determinants of use intensity of mobile phone apps by farmers in the study area. This is to further substantiate the results from Tobit analysis. The model fit indicators reveal that an F statistics value of 26.34 showed that there was a strong connection between the independent variables and the use intensity of mobile phone apps by farmers in the study area. The model predicted about 56.89 percent of effects of the explanatory variables on usage intensity and the F-value was statistically significant ($p<0.01$) showing that the model has a good fit. The prediction is also reliable as the standard errors of estimates are small and exactly the same with that of Tobit model. It was noted that the nature of education (t = 0.0367), years of farm experience (t = 0.0020), Knowledge (0.0051) and awareness (t = 0.0207) of the farmers were significant at 1 percent level of significance while their age (t = 0.0016), home material (0.0239), nature of occupation (0.0267) and attitude (t = 0.0008) were significant at 5 percent level of significance. This implies that these eight variables, as earlier shown by the Tobit model, significantly determine the use intensity of mobile phone apps in the study area, hence the rejection of the research hypothesis (Ho2) stands. The positive coefficients in Tobit model remain the same as in the OLS model, just as the negative coefficients also tallied implying that the explanatory variables had both positive and negative relationship on the rate at which farmers use available mobile phone apps at their disposal in the region.

The coefficient of nature of education (-0.0367) of the farmers had a significant ($p<0.01$) and negative influence on the use of mobile phone apps by the farmers in the study area. This indicates that farmers who are more

knowledgeable in Koranic education are not likely to use mobile phone apps frequently. This implies that an increase in the number of farmers with Arabic education in the area will lead to decrease in the rate at which farmers use mobile phone apps for their farming and other day-to-day activities. However, the finding here is parallel to that of Rebekka and Saravanan (2015) and Osadedebamwem and Idaba (2015) who reported positive and significant relationship between farmers educational status and use of mobile phone technologies in India and Sub-Saharan Africa respectively. The variation may have arisen due to variation in the nature of education considered here (Arabic education) and the western education reported by the authors, suggesting that while Arabic education negatively influences the usage status of mobile phone technologies, western education positively does that.

The parameters of the farmers' years of farming experience (0.0020) had a positive and significant ($p<0.01$) influence on their use intensity of mobile phone apps for farming and other activities in the region. This indicates that as farmers advance in years of experience in production, the extent and rate at which they use mobile phone apps also increases in enhancing information accessing for their farming activities. This implies that as the farmers advance in their farming activities, the need for more information could evolve prompting an up-shoot in the frequency of cellphone apps' usage to access the information. Similarly, information sharing process among farmers will increase thereby encouraging increase in the use intensity of mobile phone apps. This is substantiated by the findings of Caroline (2015), who equally reported positive and significant relationship between farmers' years of farming experience and frequency of mobile phone apps' usage in Ghana.

The coefficient of the knowledge level (0.0051) of the farmers had a significant ($p<0.01$) and positive influence on the frequency of use of mobile phone apps by farmers in their daily activities in the study area. This indicates that a unit increase in the knowledge level of the farmers on the use of mobile phone apps will lead to an increase in the rate at which the use mobile phone apps by 0.0051. This implies that an increase in the knowledge level of the farmers on the use of mobile phone apps will lead to an increase in the frequency and extent to which they use the apps in their daily activities. This is in consonance with the findings of Osabemwem and Ideba (2015) who reported positive and significant relationship between farmers' knowledge level of mobile phone technologies and the usage status of mobile phones in Sub-Saharan Africa.

Furthermore, as specified in the model, the awareness level (0.0207) of mobile phone apps by the farmers had a significant ($p<0.01$) and positive influence on the intensity of use of the apps in the area. This indicates that a unit increase in the level of awareness of available mobile phone apps by the farmers leads to an increase in the intensity of usage of the apps by the farmers in the area by 0.0207. This implies that the more the farmers get to know about the mobile phone apps available in their environment, the more they equally use the apps in their farming and other activities. This is supported by the findings of Evelyn and Eliamringi (2017) and Jonathan *et*

al. (2018) who reported positive and significant relationship between farmers' awareness level of mobile phone apps and usage status in Tanzania and Kenya. The parameter of age (-0.0016) of the farmers had a negative and significant ($p<0.05$) relationship on the frequency of usage of mobile phone apps by the famers in the study area. This indicates that a unit increase in the age of the farmers leads to a decrease in the frequency of use of the mobile phone apps by 0.0016. This corroborates the findings of Falola and Adewumi (2011) and Siwel and Malongo (2012), who also reported a negative and significant relationship between age of farmers and use of mobile phone technologies. This implies that young farmers will use mobile phone apps the more compared to the elderly farmers in the area; and as the young farmers advance in age, the frequency of apps usage declines gradually simultaneously.

The estimated coefficient of the housing materials commonly in use by farmers in the area (-0.0239), captured as 1 if mud and zero otherwise, negatively and significantly ($p<0.05$) influenced the intensity with which they use mobile phone apps in the area. This indicates that the more the number of farmers that live in muddy dwellings, the less the likelihood that they will use mobile phone apps regularly. What this implies is communities where farmers generally live in muddy houses may be characterize by less frequent cellphone apps' usage as such dwellings is an indication of abject state of poverty , which is a limiting factor to cell phone apps' usage that generally require cost implications.

The coefficient of nature of occupation (0.0267) of the farmers captured as 1 if farming and 0 otherwise had a significant ($p<0.05$) and positive influence on the rate at which farmers use mobile phone apps in the study area. This indicates that a unit increase in the number of farmers whose primary occupation is farming in the area will lead to an increase in the rate at which farmers use mobile phone apps by 0.0267 in the area. This implies that as the number of farmers whose livelihood is based mainly on farming increases in the area, the rate at which the farmers will deploy the use of mobile phone apps will also increase because there will be frequent needs for input sourcing, market related information for effective disposal of farm produce as well as spread of vital information to fellow farmers among others.

The parameter of farmers' attitude (0.0008) had a positive and significant ($p<0.05$) relationship on their intensity of use of mobile phone apps in the area. This indicates that a unit increase in the attitude of the farmers towards mobile phone apps results in increase in the inclination of the farmers to use the apps by 0.0008. Rebekka and Saravanan (2015) showed a similar relationship between farmers' attitude and the usage of ICTs. This implies that the exhibition of a positive attitude by the farmers towards mobile phone apps will also likely result in them having a highly favourable prospects in the extent and rate at which they use the apps.

Finally, the coefficient of farmers' knowledge (0.0051) had a positive and significant ($p<0.01$) relationship with the farmers mobile apps' use intensity in the area. This indicates that a unit increase in the knowledge of farmers

on the use of mobile phone apps results in increase in the desire of the farmers to use the apps by 0.0051. This suggests that the more the farmers acquire the knowledge on the use of mobile phone apps, the higher the tendency that they would use the apps more frequently.

Table 4.19: Ordinary Least Square estimates of Determinants of Use Intensity of Apps

OLS estimate			
Description	**B(SE)**	**T**	**P**
Location	-0.002(0.0026)	1.14	0.253
Age	-0.0016(0.0007)**	2.20	0.028
Gender	-0.0010(0.0339)	0.03	0.977
Education	-0.0367(0.0111)*	3.30	0.001
Marital status	-0.0013(0.0124)	0.11	0.914
Households size	0.0003(0.0011)	0.33	0.742
Farm size	-0.0005(0.0025)	0.20	0.843
Experience	0.0020(0.0006)*	3.21	0.001
Religion	0.0023(0.0251)	0.09	0.928
Ownership of farmland	-0.0165(0.0358)	0.46	0.645
Land Acquisition Method	-0.0084(0.0097)	0.87	0.386
Labour	-0.0071(0.0091)	0.78	0.438
Housing materials	-0.0239(0.0103)**	2.32	0.021
Communication kit(phone)	-0.0105(0.0102)	1.03	0.305
Access to credit	0.0115(0.0094)	1.23	0.220
Nature of Occupation	0.0267(0.0114)**	2.35	0.019
Attitude	0.0008(0.0004)**	2.04	0.043
Constraint	0.0003(0.0004)	0.77	0.440
Awareness	0.0207(0.0019)*	11.01	0.000
Knowledge	0.0051(0.0008)*	6.57	0.000
(Constant)	0.0550(0.0643)	0.86	0.393
Number of Observation	385		
F	26.34		
R square	0.5914		
Adjusted R sq	0.5689		
P	0.0000		
Root MSE	0.08335		

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

4.12 Chapter Summary

This chapter provided a detailed summary of the results of the data analysis carried out in the study. It also discussed the findings of the research and their implications for policy guide. A detailed description of the socio-economic features of the farmers was given with the aid of descriptive statistics. Findings revealed that the majority of the farmers were in their economically active age, males, married, experienced in farming, with an averagely large household size, possessing secondary educational qualification, with minimal access to advisory services and credit facilities that is mainly from family and associates, poorly involved in association or farmer societies, involved in the production of mainly staple food crops such as maize and rice, with the highest average seasonal income of ₦351,046.97 obtained from rice production and used hired labour for their farming.

The chapter further revealed that majority of the farmers possessed and used simple analogue mobile phones with mainly five apps, depend on default apps on their phones, used mainly voice call and SMS apps for few activities that is majorly contacting family and associates as well as purchase of farm input with mean usage intensity value of 1.410 and 0.932 (indicating low usage generally). It further revealed that they were trained mainly on use of simple analogue phone, used their phones for both farming and non-farming purposes tilted more to non-farming (mainly contacting family and friends), were fascinated by social media apps, were willing to pay ₦(50-100) for an app, used their phone to source for input mainly labour as well as did not use their phone for accessing extension services and used voice call and SMS apps to get advisory services for maize and rice crops and got information mainly through radio programmes. The farmers' attitude towards the mobile phone and its apps across the study area was favourable as they exhibited a high level of knowledge on processes of making and receiving calls as well as the ability to ascertain when airtime is exhausted and reloading of airtime. The results on the limitations to the use of mobile phone apps by farmers showed that the farmers, in the course of using their mobile phones and the associated apps, were often constraint by challenges that mainly include high cost of phones, poor network and power supply, lack of technical know-how and lack of awareness of most of the apps as the very serious constraints; while cost of airtime, lack of encouragement and complexity in operating phones as the serious challenges.

The chapter further presented the inferential statistics approaches (Probit regression analysis, Tobit regression and Ordinary Least Square regression) of the factors influencing the use of mobile phone apps by the farmers in the area. Probit regression model for five most prominent apps (voice call, SMS, Facebook, WhatsApp and Bluetooth apps) showed that for call app it include: location, years of farming experience, religion, labour, phone as garget of communication, and constraint; for SMS: age, marital status, years of farming experience, ownership

of farmland, attitude and knowledge; for Facebook: labour, access to credit, awareness and knowledge; for Whatsapp: location, ownership of farmland, access to credit and constraints; and finally for Bluetooth: marital status, ownership of farmland, phone as source of information, access to credit, attitude and knowledge were the factors influencing the use of the apps respectively. Tobit regression model for factors influencing the intensity of usage of the apps showed that age, nature educational, years of farming experience, housing materials, nature of occupation, knowledge, and attitude significantly influence farmers' use intensity of mobile phone apps in the study area. Also, the Ordinary Least Square regression result of determinants of use intensity of mobile phone apps revealed that nature of education, years of farm experience, Knowledge and awareness were significant at 1 percent level of significance while their age, home material, nature of occupation and attitude were significant at 5 percent level of significance. The significance of the variables of age, nature of educational, years of farming experience, housing materials, nature of occupation, knowledge, and attitude in both models is an indication that these variables are relevant and key influencers of the farmers' frequency of usage of mobile phone apps and will, therefore, have policy implications for a successful implementation of an e-extension delivery services that is premised on mAgric applications and services in the study area.

CHAPTER FIVE

SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Introduction

This chapter concludes the study and it presents a comprehensive review of the objectives examined and the observations made. The chapter is made up of five sections: the summary of the findings, conclusion, as well as policy implications (of the outcomes of the research efforts) and recommendations and suggested areas for further studies.

5.2 Summary of Major Findings

This research effort was encouraged, motivated and stirred by the escalating consequences of low agricultural production and its serious impact on the inability of the agricultural sector to eradicate the abject poverty situation that seems more pronounced amongst the local farmers in the study area even at the prevalence of continued technological advancement especially in the area of Information and Communication Technology (ICT). The present poverty condition in Nigeria as a whole is disturbing, and it is worsened by food insecurity occasioned by low agricultural production, an upshot of poor farming practices. Given the wide penetration rate of mobile phones in the country and the success story recorded in many other parts of the world on the impact of mobile phone apps at enhancing agricultural production of farmers in rural communities, this necessitated the examination of the level of awareness and usage status of mobile phone apps by farmers in North West Nigeria. The particular research questions considered were: What are the demographic and socio-economic characteristics of farmers in the area? What are the mobile phone apps available in the study area? To what extent do farmers use these mobile phone Apps available in the study area? What are farmers' awareness and usage status of these phone mobile Apps in the area? What is the intensity level of usage of the mobile phone apps by farmers in the area? What purposes are the mobile Apps using for in the area? What is the farmers' attitude toward mobile Apps? What is the knowledge level of the farmers about mobile Apps? What constraints are the farmers facing with respect to mobile Apps usage? The study employed descriptive statistical tools, Likert scale type technique, Tobit and probit regression models to take care of these research questions.

The results show that most of the local husbandmen in the three States (Katsina, Kano and Kaduna) use a mobile phone, with all the respondents in Kaduna state using a mobile phone, 85.5% of respondents from Katsina using mobile and 98% from Kano using a mobile phone.

Majority of the respondents (71.7%) were married, out of which most of them (39%) were into a monogamous marriage. Additionally, 95.6% of the respondents were Muslims. Furthermore, the study evinced that the majority (78%) considered farming as their primary occupation. More so, 98.2% owned farmland which is acquired mainly

by the respondents through inheritance (63.9%) and the majority of the farmers employed both families and hired labour. The findings further illustrated that local sodbusters in the region are involved in the husbandry of the following crops: Maize, Sorghum, Millet, Rice, Cowpea, Soya Beans, Sugar Cane, Leafy Vegetables, Tomato, Onion, Potato and wheat. However, maize and rice were more cultivated. In terms of means of transportation, it was discovered that the most common one adopted by the farmers is the motorcycle. Moreover, 71.2% and 73% used mud only to build their living rooms and storage stores respectively. As 81.3% of the farmers used radio as a means of enriching themselves with current information, mobile phone, on the other hand, came second with 41.8%, considering it as their main source of information. Additionally, the results revealed that 51% of the respondents' lack access to credit, as 36.9% of those that had access got it from family and friends, and the average amount accessed was 50,588.65 naira. The findings also revealed that 96% of the farmers owned a phone, out of which 60.5% owned simple analogue phones and 78.4% of the farmers use their phones for both farming and no-farming purposes with the non-farming purposes gaining dominance. Most of the farmers (66.2%, being youths), like to see more of social media apps, as 41.3% of them would not mind part away with 50-100 naira for an app. Moreover, 83.6% of the farmers depend on default apps on their phone, out of which 58.7% of the farmers got one form of training or the other on how to use mobile phones and the associated apps, as 93.5% could use call app, 70.6% could use SMS app successfully.

The findings show that 55.6% had access to extension agents. However, extension support for the farmers using apps is generally low with respondents, ranging between 0.2%-22%, affirming having received such support through mobile phone apps. Correspondingly, poor outcome was recorded in animal husbandry as the majority (over 80%) did not feel the influence of mobile phone apps on their flocks.

The findings also illustrated that all the farmers had at least seven years of awareness of call app with 65% having had 7-12 years awareness and usage status; other apps enjoyed less than 50% respondents' awareness status and as such commanded very low usage status. The results of the findings further demonstrated that the app with the highest use intensity is the call app with a weighted mean score of 1.410. This implies that no app crossed the set threshold for low usage (1.95), and hence generally low app usage status was recorded in the study area, meaning farmers really use all the apps available to them in the study area, particularly for agricultural purposes.

With respect to the various purposes the farmers used apps for, call and SMS apps were put to use by over 50% of the respondents, mainly to contact family and friends, negotiate for inputs, get an update on the market situation and spread vital information to fellow farmers. Consequently, farmers' knowledge of mobile phone apps were centred on the above identified purposes of apps usage. Consequently, findings revealed that farmers were highly knowledgeable in the following areas: placing and receiving calls (94%), understand when out of airtime (84.9%), ability to store and retrieve number (83.9%); as they displayed very poor knowledge on ability

to use apps to pay bills (93.2%), use codes to load airtime and data (89.6%) and to open e-mail page using phones (89.4%). Moreover, the findings revealed that the farmers had a generally favourable attitude towards mobile apps as most (17) of the 30 statements examined recorded above 3.00 mean score out of 5.

In terms of constraints, the results showed the main constraints that are very seriously affecting farmers in the use of mobile phone apps in the area include poor electricity supply, poor network, short of awareness of the apps and lack of technical know-how; others that are serious include cost of airtime, lack of encouragement and complexity in the use of apps. The constraints that least affect farmers in the use of mobile phone apps were identified as lack of access to a network, no power supply, action of association/groups and socio-economic values.

The study further applied the Tobit regression model to determine factors influencing farmers' app usage intensity in the study area. The outcome of the regression analysis showed that eight out of the twenty explanatory variables were established to be statistically significant and these include age ($p<0.05$), marital status ($p<0.01$), housing material ($p<0.05$), years of farm experience ($p<0.01$), nature of occupation ($p<0.05$), attitude ($p<0.1$), awareness ($p<0.01$) and knowledge (0.01). A confirmatory analysis using OLS regression model ascertained the outcome of the Tobit regression, as it showed that nature of education ($t= 0.0367$), years of farming experience (0.0020), knowledge ($t= 0.0051$) and awareness (0.0207) were significant at 1% level of significance while age ($t= -0.0016$), housing material ($t= -0.0289$), nature of occupation ($t= 0.0267$) and attitude (0.0008) were significant at 5% level of significance implying that these eight variables significantly determine the usage extent of cellular telephone apps in the zone. The study further fitted probit model analyses to ascertain the effects of the independent variable on the usage status of the five (call app, SMS app, Facebook app, Whatsapp and Bluetooth app) most prominent apps in the area. The findings indicated that age, years of farm experience, labour, marital status, land acquisition method, phone as source of information, constraints, awareness and knowledge were found to be statistically significant at 1% ($p<0.01$); while religion ($p<0.05$), nature of occupation ($p<0.05$) and access to credit ($p<0.05$) were statistically significant at 5% all of which were found to be statistically significant determinants of the five apps.

5.3 Conclusion of the Study

The study showed that, the farmers were not aware of the majority of the mobile phone apps available in the area. Despite the challenges bedevilling the farmers in the deployment of cell phone apps, the grangers were not deterred from using the few apps they are aware of as the usage was, however, channelled more to non-farming activities because of their limited understanding of the extent mobile phone apps could go in bettering their production. Hence, constraints like lack of encouragement, high cost of phone, lack of social interaction through farmers' association, lack of awareness and technical know-how as well as lack of credit facilities and education

identified by majority of the farmers as challenges need to be urgently tackled with appropriate policy actions on the part of all stakeholders in rural development.

In addition, the study showed that age, marital status, awareness, attitude, knowledge and nature of materials used for housing were the significant determinants of the usage status of the mobile phone apps considered. More so, the study showed that the farmers were only scantly involving apps in their farming activities, which is more prominent in the area of accessing marketing information and input purchase using mainly call and SMS apps. Most of the apps were mainly deployed by the majority of the farmers to contact family and friends. As a result, all the crop and animal farmers accessed during the study showed very poor input of apps by the respective farmers, despite the fact that majority owned mobile phones. The study, however, further showed that a key limiting factor to the use of apps by the farmers is the type of phone the majority possessed. Most of the farmers use analogue phones that could only perform limited functions and as such most farmers could not go on the net to access information, nor explore the net for information transfer. This is a serious limitation that needs to be critically considered. Given the fact that most of the farmers fell within the youthful age bracket, age category known globally to be very active and innovative, it is hopeful that if encouraged with easy access to android/digital phone coupled with proper training, the poor usage status of apps in the region would become a thing of the past and the rural poor farm families are more likely to have access to global knowledge system in farming.

5.4 Policy Recommendations

The outcome of study provides insight to the government, policymakers and agricultural extension administrators on the developmental approach to setting policies and procedures that will enhance awareness and adoption of mobile phone apps in the region through efficient use of mobile phone apps for farming and extension access purposes. Premised on this, the following policy recommendations were therefore proffered based on the findings as relayed from the study:

i. This study proposes that huge campaigns be made by both government and non-governmental organization, civil societies and the media outfits in the region to create and foster awareness about available cell phone apps and their efficacy in farming; as well as evolve a solution-driven e-extension delivery models that is built on the foundation of m-Agric models, as well proffer indigenous solutions that address the constraints identified by majority of the farmers in the use of apps in the area to be monumental and devastating. There is equally a need to re-orientate financial institutions on the critical position they should occupy in rural development issues, particularly the volume and frequency of credits provided to the farmers and to trim down or remove interest charges for the core and small-holder farmers. Such credits could be in form of assets (like mobile phones)

and associated training with the mandate of channelling it to enhancing farming operations (i.e. implying the use of advocacy).

ii. The findings showed that majority of the farmers were of a youthful and active age. Considering the fact that young people tend to be savvy with technology irrespective of their location, there is, therefore, the need for stakeholders to come up with policy that facilitates subsidy on smartphones and associated training for core smallholder farmers. This will speed up the transition from analogue to digital mobile telephony which is key to successful e-extension via mAgric services. The success of mAgric services in the area will surely boost the awareness and usage of apps related to mAgric services.

iii. There is a need for close collaborations among stakeholders relevant to the successful implementation of e-extension that adopts mAgric models. In this wise, the government should collaborate with main network service providers to come up with tariff plans favourable to the financial disposition of the poor farmers in areas very relevant to the farmers' needs that is smart-phone apps dependent (this can also be a way telecom service providers subsidize agriculture). This would hopefully speed up awareness of those apps and their relevance to farming activities and in turn, enhance the speedy adoption of such apps.

iv. Due to poor awareness status of most apps that are crucial to the successful application of mobile apps in extension activities in the area, the acceptability of such apps by farmers in the area has correspondingly been very poor. As such, major farm enterprises such as crop and animal farmers could not feel the impact of the presence of these apps. Therefore, there is a need to create an encouraging environment that creates awareness of the apps in rural communities in the area through regular radio programmes that provide details about these apps and their usefulness in solving problems peculiar to farming activities in the area. This, without doubt will foster the adoption of the apps by the youthful farmers who have adopted radio as their number one source of information. This, in turn, will encourage and boost the application of these apps in crop and animal production.

v. There is the need to come up with educational policies that will facilitate an increase in the numbers of those with tertiary level of learning in the zone. The government has done extensive work in this aspect at the lower level, the most prominent being the universal basic education. Nevertheless, it is very necessary and urgent to replicate same at the post-primary educational levels in rural communities so as to get those who in the end, become farmers more informed about the business which is becoming more profitable and systematic with the adoption of ICTs like mobile phone apps in many parts of the world. Awareness and adoption of most mobile phone apps were successful in communities that harbour highly educated people; as this study also confirmed, the few that were aware and use more apps, particularly net-related, were the highly educated members of the farming

communities in the study area. Hence, putting in place policies that will foster an increase in the numbers of graduates of tertiary institutions will in no small measure enhance the rate of awareness and employment of cellphone apps in the study area.

vi. The Agricultural Development Programme (ADP) and Universities with extension outreach approaches in the area should come up with e-extension programmes that are premised on creating awareness of apps very relevant to e-extension in the area; and also advancing trainings on the use of the apps and subsequent application in extension delivery services. Such apps like whatsapp, Email, Instagram/telegram and payment codes should be prioritised as farmers generally show low knowledge of their usage and as such exhibit poor attitude towards their applications in information sourcing and consumption.

vii. Finally, there is an urgent need for an ICT resource centre that would ensure uninterrupted training and re-retraining of both farmers and extension agents on the use of up-to-the-minute ICTs, particularly use of higher phones and their associated apps, for dynamic information flow in the study area. This centre can be a kind of multi-purpose community centre with a mandate of educating farmers on new developments in ICTs and providing the remote population with information and communication options. This will broaden their knowledge and exposure in the use of ICTs, more importantly, the adoption of more sensitive mobile phone apps in the area. Borrowing a leaf from Bhutan community where Community Information Centres (CIC) were established to make available services to a dispersed locals who live in mountainous, forested environment that has made it very difficult to have wired internet and telephone connectivity. While the government makes available the equipment needed, an individual deemed appropriate from the community is engaged to cover support and maintenance of the services. The centres provide services that consist of basic and advance computer training, internet accessing, provision of telephone facilities etc.

viii. Based on assessment of the socio-economic and demographic features of the farmers in the study area, the study was able to come up with a mobile application model that would fit into the society and help enhance the dynamism of information flow for an enhanced extension services delivery. The very poor usage of cellphone apps for extension delivery services, with respect to all the farm enterprise assessed, informed the formulation of this initiative. The model consists of a network of early adopters that are presumed to be the very few of the farmers that use WhatsApp application. The network will comprise this category of farmers and the extension agents controlling extension delivery services in the area. The extension agents will be the group administrator for the community he or she oversees. The next will be a subgroup, comprising the early majorities and the early adopters. The early adopters will be the subgroup administrator for the community he or she is living in. The idea here is that the interaction between the early adopters and the early majority would

facilitate the speedy development of the early majority to fully adopt the WhatsApp application. For those who do not have phones that can accommodate WhatsApp, they are to be serviced on the interim with bulk SMS by the respective group admin on occasional basis so as to motivate the farmers to speedily transform into WhatsApp users. The next is the involvement of the agencies catering for the extension agents. The agencies will be involved in the collation of the questions and comments of the farmers in all the WhatsApp conversations on community bases into data banks. These data banks will assist policymakers when there is a need for need assessment of a community under consideration for policy intervention. As such, government policies will be grass root or people-oriented and this will foster the success of the policy in the area. This is a solution to the popular policy failure that characterizes most African countries like Nigeria. The importance of the active involvement of government agencies and all major players in ICT for rural development is very cogent to the success of this proposed model. The latter position stemmed from observation documented by Charlie (2014) that there are many examples of ICTs that seemed promising on paper, but failed to strengthen the skills and knowledge of the farming communities where they were deployed. The author then opined that farmers and farmer's organisations will only benefit from more sophisticated ICTs, such as the internet and SMS messaging services, if they receive adequate training. This, therefore, points to the fact that the success of this model will be enhanced by the presence of the Community Information Centre earlier proposed.

5.5 Suggestions for Further Studies

i. This study was conducted in North-West Nigeria. There is a need to replicate the same in other regions of the country.
ii. There is also the need to carry out a comparative analysis of the performance of mobile phone apps in all the agricultural zones of Nigeria. This will help in ensuring equitable resource distribution and designing of appropriate policies for every region.
iii. Within the region, the study could be narrowed to State and Local Government Areas which would be of immense assistance in providing guidance for appropriate rural development policies at both state and local government level.

This study can be replicated with focus on extensions agents' awareness and use of mobile phone apps in the region. This will help to ascertain the technical skill level of those handling rural farmers with a view to understanding their level of competence in apps usage. This is very important because any government initiative towards enhancing farmers' use of apps will be implemented mostly by the extension agents. It is believed that institutional inefficiencies in the generation and dispersal of relevant information support from extension systems are often the top most reasons why most farmers do not adopt new farming innovations.

REFERENCES

Abdullahi, A.Y., Akinola, M.O., Akpoko, J.G., Jamilu, A.A. and Sambo, I.J., 2015. Determinants of Adoption of Recommended Sorghum (Samsorg 17) Production Practices by Farmers in Two Selected States of Nigeria. Proceedings, 20th Annual National Conference of the Agricultural Extension Society of Nigeria held at the National Agricultural Extension & Research Liaison Services (NAERLS), Ahmadu Bello University, Zaria (15th-17th May, 2015).

Abdul-Aziz, H., Haruna, S.K and Jamilu, A.A., 2015. Contributions of Information Communication Technology Use to Female Farmers in Kaduna State. Proceedings of the 20th Annual National Conference of AESON. Proceedings, 20th Annual National Conference of the Agricultural Extension Society of Nigeria held at the National Agricultural Extension & Research Liaison Services (NAERLS), Ahmadu Bello University, Zaria (15th-17th May, 2015).

Abu Salem, A., Muhammaed Nasir, U., Debashish S. D. and Md. Abdul Momen, M., 2017. Factors Affecting Mobile Phone Usage by Farmers in Receiving Information on Vegetable Cultivation in Bangladesh. *Journal of Agricultural Informatics,* 8(2), 33-43.

Adebo, G. M., 2014. Effectiveness of E-wallet Practice in Grassroots Agricultural Services Delivery in Nigeria. *Journal of Experimental Biology and Agricultural Sciences,* 2(4), 410-418.

Adedeji, O.S., Du, H. and Opoku A., 2013. "Inclusive Growth: An Application of the Social Opportunity Function to selected African Countries IMF-Working Paper (139). Washington, DC.

Adeyemi, A. A., 2017. Influence of Socio-Economic Factors on Farmers' use of Mobile Phones for Agricultural Information in Nigeria. *Library Philosophy and Practice (e-journal).1688.* https//digitalcommonsunl.edu/libphilpract/1688

Fawole, O.P. and Olajide, B.R. 2012. Awareness and Use of Information and Communication Technologies by Farmers in Oyo State, Nigeria. *Journal of Agricultural and food Information, 13(4), 326-337, DOI: 10.1080/1049505.2012.717003.*

Adler, P.S. and Know, S.-W., 2002. Social Capital: Prospects for a new Concept. *Academy of Management Review*, 27 (1), 17-40.

Akinbile, L. A., Akwiwu, U, N. and Alade, O.O., 2014. Determinants of farmers willingness to utilize e-wallet for accessing agricultural information in Osun State, Nigeria. *Nigerian Journal of Rural Sociology* 15 (1): 105 – 113

Aliyu, I.G., Elegwe, M. and Wario, G., 2015. Effects of Adoption and Use on ICT by Small and Medium Enterprises (SMEs) in Nigeria: A case study of Kaduna State, Nigeria. International Brief Series. *Education and Science Journal of Policy Review and Curriculum Development, Vol. 5 No 2, May 2015*

Anselme, B. A., Romeo, M., Faustin, V. and Desire, A., 2012. Determinants of ICT use by rice farmers in Benin: from the perception of ICT characteristics to the adoption of the technology. *Journal of Research in International Business and Management, 2(11), 273-284.*

Anton, M., 2008. Emerging Issues, Priorities and Commitments in e-Agriculture. *Agricultural Information Worldwide, 1(1), 5-6.*

Aremu, A.G., 2008. Rural Dweller' Perception on the Nigerian Agricultural Cooperative and Rural Development Bank Performance on Poverty Alleviation in Kaduna State, Nigeria. MSc Thesis Submitted to the Department of Agricultural Extension and Rural Development University of Ilorin.

Asa, U. A. and Uwem, C. A., 2017. Utilization of Mobile Phones for Agricultural purposes by Farmers in Itu Area, Nigeria. *European Science Journal, 13(19),395-402* .

Asadu, A. N., Ifejika, P. I., Chah, J. M., and Igbokwe, E.M., 2015 Gender Roles in Livestock Production Among Urban Farming Households in Southeast Nigeria. 20th Conference Proceedings of AESON. Pp. 239

Ashoka, R.R. and Ashoka, J.F., 2016. Innovation for Agriculture young ICT entrepreneurs overcoming challenges and transforming agriculture. Success Stories. CTA 2016. http://bit.ly/innovate-agriculture.

Attewell P., 1992. Technology Diffusion and Organizational Learning: the cases of business computing. *Organizational Science* 1992; 3:1-14

Banmeke, O.T. and Oose, M.O., 2012. Assessment of the Use of Social Network Tools (SNTs) by Agricultural Researchers in South West Nigeria. Communication of the IIMA 2012 Volume 12 Issue 3.

Bargh, J. A. and Mckenna, K.Y., 2004. The internet and Social Life. *Annual Review of Psychology*. 55.090902.141922.

Barrios, E. B., J. Ryan, G. Lansangan, and. Daquis, J.C.P., 2011. Impact Assessment of the eAGRIKultura project: Philippines. In D. J. Grimshaw and S. Kala (Eds.), *Strengthening Rural Livelihoods The impact of information and communication technologies in Asia* (pp. 89-108). Practical Action Publishing Ltd.

Baumuller, H., 2012. Facilitating Agricultural Technology Adoption among the poor: The Role of Service Delivery through Mobile Phones. ZEF Working Paper Series, ISSN 1865-6638 Department of Political and Cultural Change, Centre for Development Research, University of Bonn.

Baumuller, H., 2018. The Little We Know: An Exploratory Literature Review on the Utility of Mobile Phone-Enabled Services for Smallholder Farmers. *J. Int. Dev.*, 30: 134-154. Doi: 10.1002/jid.3314 Wiley Online Library.

Bohlen, J. M. and Beal, G. M., 1957. The Diffusion Process Special Report No. 18. Agricultural Extension Services, Iowa State College. 1: 56-57

Bolanle, A., 2018. 9mobile empowers farmers. Online Vanguard, 24th October, 2018.

Branchaeu, J. and Wetterbe, J. C., 1990. The adoption of spreadsheet software: testing innovation diffusion theory in the context of end-user computing. *Information Systems Research* 1990; (2): 115-43

Bronwyn, H. Hall and Beathika, K. 2003. Adoption of New Technology. NBER Working Paper Series, WP 9730. http://www.nber.org/papers/w9730.

Callinisco, A., 1999. *Social Theory: A Historical Introduction*. New York University Press

Calvin, M., V.N. Saroja and Chris, L., 2013. ICT Uses for Inclusive Agricultural Value Chains

Caroline, N., 2015. The use of mobile phones in Agricultural Extension Delivery in Eastern Region, Ghana. Thesis submitted to the Department of agriculture and natural sciences, University of Cape Coast.

Catherine, R. and John, M., 2018. The Impact of Agricultural Extension Services in the Context of a Heavily Subsidized Input System: The Case of Malawi. *World Development, Elsevier*, 105(C), 25-47. DOI: 10.1016/j.worlddev.2017.12.004

Chadwick, B.P., 2003. Knowledge Technologies for Sustainable Development. Future Direction in Agriculture and ICTs at USAID, Winrock International, USA.

Charlie Pye-Smith, 2014. ICT for Agriculture; Making it happen.

Cohen, L., Manion, L. and Morison, K., 2000. *Research Methods in Education*. London: Routledge Falmer.

Daniel, N., 2015. Factors affecting adoption of information communication technology system for Agriculture in Uganda. A thesis submitted to Michigan State University.

Dauda, G., Saddiq, N.M., Gomina, A. and Lawal, M., 2017. Impact of IFAD-Community Based Agriculture and Rural Development Programme on Participants and nonParticipants Farm Production Efficiency in Katsina State, Nigeria. *Net J of agric sci. 5(1): pp.1-7.*

David, 2017. What is the difference between population and samples? Online at https://www.statisticssolutions.com/what-is-the-difference-between-population-and-sample/

Davis, K. E. and Addom B. K., 2010. Sub-Saharan Africa. In R. Savanna, Ed. *ICTs for Agricultural Extension: Global Experiments, Innovations and Experiences*. New Delhi: New India Publishing Agency.

Davis, K.E and Asenso-Okeyere, K., 2010. Innovative Models of Agricultural Extension: Global Perspectives and Implications for Indian System. Paper Presented at The NAARM IFPRI Workshop on Redesigning Agricultural Extension in India. Challenges and Opportunities, August, 20-21.

Egwemi, V. and Odo L. O., 2013. "Rural Development and Poverty Eradication in Nigeria". *JORIND Vol. 11(1).* www.transcampus.org/journal; *www.ajol.info/journals/jorind*

Ekong E. Ekong, 2003. *An Introduction to Rural Sociology*. Second Edition. Pp 274-284

Ekpa, D., 2017. Climate Smart Agricultural Practices and Poverty Status of Smallholder Farming Households in Northwest Nigeria. A PhD Thesis in the Dept of Agricultural Economics and Extension, North-West University, South Africa.

Ekpa, D., Abayomi, S.O. and Davis, N.Y., 2017. Poverty Decomposition for High and Low Users of Climate Smart Agricultural Techniques in Northwest Nigeria.

Ekpa, D., Oladele, O.I., and Akinyemi, M., 2017. Poverty Status of Climate Smart Agricultural Farmers in North West Nigeria. Application of Foster Greer and Thorbecke Model. *American Journal of Rural Development Vol. 5 No. 5. http://pubs.sciepub.com/ajr/5/5/3*

Enoch, Y., Tim, K., Naomi, H. and Collin, B., 2012. "eTransform Africa: The Transformational Use of ICTs in Africa."

Ezeh, A.N., 2013. Access and Application of Information and Communication Technology (ICT) Among Households of South East Nigeria. *Agric J. of North America* http://www.scihub.org/ABJNA

Evelyn, R. and Eliamringi, M., 2017. Factors Influencing Usage of Mobile Banking Services: The Case of Ilala District in Tanzania. *ORSEA Journal* Vol. 7 (1).

Everett M. R., 1962. *Diffusion of Innovation*. The Free Press. A division of Macmillan Publishing Co. Inc. New York. Collier Macmillan Publishers, London.

Faborode, H.F.B., Ojo, T.F., Adesoji, S.A. and Odelola, S., 2012. Assessment of Selected Cultural Non-Farm Income Generating Activities among Farmers in Osun State, Nigeria.

Falola, A. and Adewumi, M.O., 2012. Constraints to the Use of Mobile Telephony for Agricultural Production I Ondo State, Nigeria. *Journal of Research in Forestry, Wildlife and Environment.* Vol. 4, No. 2.

FAO, 2013. ICT uses for inclusive agricultural value chains. Rome.

FAO, 2015. Information and communication technologies for Agriculture and Rural Development.

FAO-ITU, 2016. E-Agriculture Strategy Guide

Fawole, O.P. and Olayide, B.R (2012). Awareness and use of Information and Communication Technologies by Farmers in Oyo State, Nigeria. *Journal of Agricultural and Food Information,* 13(4), 326-337. DOI:10.1080/10496505.2012.717003

Gerard Sylvester, 2015. Success Stories on Information and Communication Technologies for Agriculture and Rural Development. RAP PUBLICATION 2015/02. Food and Agricultural Organization of the United Nations Regional Office for Asia and the Pacific Bangkok. The Free Press. A division of Macmillan Publishing Co. Inc. New York. Collier Macmillan Publishers, London.

Gilwald, A., A. Millek and C. Stork, 2010. Gender Assessment of ICT Access and Usage in Africa. Towards Evidence-based ICT Policy and Regulation. Research ICT African. Volume One, Policy Paper 5.

Hafkin, N. J. and H.H Odame, 2002. Gender, ICTs and Agriculture. A Situation Analysis for the 5th Consultative Expert Meeting of CTA's ICT Observatory Meeting on Gender and Agriculture in the Information Society.

Hafkin, N. and N. Taggart, 2001. "Gender, Information Technology and Developing Countries. Washington, D.C: Academy for Educational Development, 2001. http://ict.aed.org/infocenter/pdfs/Gender Book Photos.pdf,

Hassan, A.A., Ahmad, H.J., Kagbu, H.J., Sani, I. and Ugbabe, O.O., 2015. Information and Communication Technology and Family Farming in Nigeria: A Review. Proceedings, 20th Annual National Conference of the Agricultural Extension Society of Nigeria held at the National Agricultural Extension & Research Liaison Services (NAERLS), Ahmadu Bello University, Zaria (15th-17th May, 2015).

Hoffmann, V., 2005. *Rural Communication and Extension*, Reader, University of Hohenheim, Stuttgart Germany.

Hoffmann, V., 2006. *Knowledge and Innovation Management*, Reader, University of Hohenheim, Stuttgart Germany.

Hycenth T. N., Johnannes S., Sandra U. and Peter Z., 2010. Adoption Decision Theories and the Conceptual Models of Innovations Systems. Leibniz-Centre for Agricultural Landscape Research (ZALF) e. v. CA2Africa Inception Workshop, 2nd-4th March Nairobi, Kenya. Session 3: Overview of existing modelling approaches.

Ifekija, P.I., Asadu, A.N., Enibe, D.O., Ifekija, L.I. and Sule, A.M. 2019. Analysis of Social Media Mainstream in E-extension by Agricultural Development Programmes in North Central Zone, Nigeria. *Journal of Agricultural Extension and Rural Development,* 11(4), 78-84.

ITU, 2010a. Partnership on Measuring ICT for Development. Core ICT Indicators, 2010. International Telecommunication Union (ITU), Geneva, Switzerland

ITU, 2010b. World Telecommunication/ICT Development Report 2010. Monitoring The WSIS Targets - A mid-term review. International Telecommunication Union (ITU), Geneva, Switzerland

International Rice Research Institute (IRRI), 2011. Higher rice production a phone call away for Filipino farmers. http://irri.org/news events/media releases/higher rice productionap honecallawayforfilipinofarmers?SMS_ss=twitter&at_xt=4d3d584ea58ae1b8,0.

Isaac, M.M., 2016. Context of mobile phone use and its effects on smallholder farmer's livelihood outcomes in Kenya. *International Journal of Scientific Research and Innovative Technology, Vol.3 No.4; April 2016.*

Jaji, M.F.O., S.A. Abanigbe and B.O. Abass., 2017. Mobile Phone as an Extension Tool among Female Agricultural Practitioners in Lagos Nigeria. *Journal of Agricultural Extension, Vol.21(3).*

Jonathan, C.K, Jason, M.G. and Arnold, M.O., 2018. Usability Attributes Influencing the Adoption and Use of Mobile Apps for Dissemination of Agricultural Information. *Int'l J. Agri. Ext. 06 (01) 2018.33-41.*

Karen, V. 2013. Options and Strategies for Information and Communication Technologies within Agricultural Extension and Advisory Services. FEED THE FUTURE. The U.S Government's Global and Food Security Initiative. MEAS Discussion Paper (of USAID).

Kerlinger, F.N., and Rint, N., 1986. *Foundations of Behaviour Research* London: Winston Inc

Kithuka, J., Mutemi, J. and Mohamed, A.H., 2007. 'Keeping up with Technology: The use of mobile technology in delivering community-based decentralized animal health services in Mwingi and Kitui Districts, Kenya.' FRAM-Africa Working Paper 10. London:

Kwadwo, A.-O. and Daniel, A. M., 2012. The Importance of ICTs in the Provision of Information for Improving Agricultural Productivity and Rural Incomes in Africa. Working Paper of the United Nations Development Programme, Regional Bureau for Africa. WP 2012-015: January 2012.

Kwon, T. H. and Zmud, R. W., 1987. Unifying the fragmented models of information systems implementation. In: Borland and Hirshhiem (1987). *Critical issues in information system research*. New York: John Wiley 1987 Pp. 252-7.

Lokanathan, S., H. de Silva and Fernando, I., 2011. Price transparency in agricultural produce markets: Sri Lanka. In D. J. Grimshaw and S. Kala (Eds.), *Strengthening Rural Livelihoods. The impact of information and communication technologies in Asia* (pp. 15-32). Practical Action Publishing Ltd.

M. K. Othman, 2018. Peeping at research and Development Centres: NAERLS Presents 2017 Agricultural Performance in Nigeria.

Maina, R.W., 2015. Factors affecting the adoption of mobile phone technologies by smallholder Diary Farmers in Limuru Sub-County. Thesis submitted to the School of Business, University of Nairobi.

Marilyn, K. and Jim, G., 2013. Dissertation and Scholarly Research: Recipes for Success. Seattle, WA: Dissertation Success LLC.

McMillan, J.H and Schumacher, S., 2000. Research in education: Evidence-Based Inquiry, 6th Ed. New York: Pearson Education. Amazon Publishing.

Mercy, E.E., 2015. Determinants of Adoption of Cassava Technologies by Male Farmers in Nasarawa State, Nigeria. *Journal of Agricultural Extension* Vol.19 (1) June, 2015

Mukesh, P., Deepati, T.P. and Kanini, B., 2010. ICT for Agricultural Technology Dissemination (http://pagropedia:litk//aq=content//ICT-agriculture-technologydissemination)

Muktar, B.G., Mukhtar, U. and Ahungwa, G.T., 2015. Stimulus Role of Social Media in Attracting Youth into Agri-Entrepreneurship. 20th Conference Proceedings of AESON.

Nigerian Communications Commission (NCC), 2020. Subscribers Statistics. https://www.ncc.gov.ng/statistics-reports/subscribers-data#

Nwachukwu, I., 2010. Communication for Development: Concept, Principles and Practice. Proceedings of the Southeast Zonal Workshop on Effective Extension Communication Methods and Techniques for Agricultural Staff/Personnel from ADPs, LGAs, RBDAs, NARIS, Polytechnics and NGOs, Umuahia, Abia State (pp. 14-20)

Nyirenda-jere, T., 2010. Unlocking the Promise of ICTs for Transforming Agriculture in Africa Knowledge for Development. CTA

Obayelu, O.A. and Taiwo A., 2010. "Spatial Dimension of Poverty in Rural Nigeria. *Journal of Economic Development.* Vol. 2(6): 231-244

Obinne, C. P. O., 1991. Adoption of improved cassava production technologies by small-scale farmers in Bendel State. *J. Agric. Sci. Technology*. 1 (1): 12 – 15

Oduwole, J.A. and Fadeyi, A.O., 2013. "Gender, Economic Activities and Poverty in Nigeria. *Journal of Research in Peace, Gender and Development*, Vol. 2(7): pp. 106-125.

Ogbonna, O.I. and Awgu, A.E., 2013. Availability, Level of Use, Importance and Constraints to Utilization of Information Communication Technologies by Farmers in Enugu State, Nigeria. *Direct research journal of Agriculture and food sciences*. Vol.1 (4), pp.44-48.

Ogbonna, O. I., Dimelu, M. U., Agwu, A. E. and Enwelu, I. A., 2015. Potential of Information Communication Technologies in Family Farming and Agricultural Development in Enugu State, Nigeria. 20th Conference Proceedings of AESON. Pp. 9.

Ojeleye, O.A., M.K. Akintunde and M.K. Saleh, 2015. Per Capita Calorie Intake and its Determinants Among Rural Farming Households in Kaduna State, Nigeria.20th Conference Proceedings of AESON.

Okeke, M. N., Hyacinth, U. N. and Uzuegbunam, C.O., 2015. Emerging Role of Information Communication Technologies in Extension Service Delivery in Nigeria: A Review. 20th Conference Proceedings of AESON

Okoro, B.O., Chukwu, G.O., Odueche, T.C. and Okafor, C.N., 2015. Role of Youths in Family Rice Production in Anambra State, Nigeria. 20th Conference Proceedings of AESON

Oladeji, J. O., Olagunju, O. E. and Olagunju, O. S., 2015. Livestock Production among Rural Women in Chikun LGA of Kaduna State, Nigeria. 20th Annual Conference of AESON.

Olayide, S.O., 1992. A quantitative analysis of food requirements supplies and demands in Nigeria 1968-1985. Federal Department of Agriculture

Olusola, A.O., 2016. Economics of Food Utilization, Nutrition and Farm Households' Health in Southwest Nigeria. A PhD Thesis of the Department of Agricultural Economics and Extension, North West University, South Africa.

Onu D. O., 1991. Communication and adoption of improved soil conservation technology by small-scale farmers in Imo State of Nigeria. *J. West Afr. Farm. Syst. Res. Network*, vol. 2

Opara U.N., 2008. Agricultural information sources used by farmers in Imo State, Nigeria. Inform. *Dev*. 24(4):289-295.

Orisakwe, L and Agumuo, F., 2004. Adoption of improved agro-forestry technology among contact farmers in Imo State, Nigeria. *Asia Journal of Agriculture and Rural Development* 2 (1): 1 – 9

Osadebamwen, A.O. and Ideba, E., 2015. Smallholder farmers and mobile phone technology in Sub-Saharan Agriculture: *May fair Journal of Information and Technology management in Agriculture.*

Oyewole, M.F, M.G. Olujide and J.A. Oyedeji, 2015. Youth Participation in Watermelon Production in Ado-Odo-Ota LGA of Ogun State, Nigeria. Proceedings of the 20th Conference of AESON.

Ozo, N., Ozioko, R. and Acheampong, E., 2015. Rural-Urban Interdependence in Food Systems in Nsukka Local Government Area of Enugu State, Nigeria. *Journal of Agricultural Extension* Vol. 19(2) Dec. 2015

Payne, J. and McCarthy, S., 2010b. Agriculture and ICT. An Overview Briefing Paper, USA, D. November *https://communities*

Pooja R., 2018. Quick Strategy guide for Any Company Seeking Sustainable Growth. Quora Online.

Premkumar, G. and Margaret R., 1998. Adoption of New Information Technologies in Rural Small business. *Omega Journal of Management Science* (1999) 467-484.

Rebekka, S. and Saravanan, R., 2015. Access and Usage of ICTs for Agriculture and Rural Development by the tribal farmers inMeghalaya State of North-East India. *Journal of Agricultural Informatics* (`ISSN2061-862X)2015 Vol.6, No.3: 24-41.

Reem, R. A. and Jocelyn, F. A., 2016. CTA Technical Report Pp. 42.

Rogers, E. M. 2003 *Diffusion of Innovations*, fifth edition. Free Press, New York, U.S.A.

Salau, E.S., Kachiro, S.L., Darason, Y.M and Cyril, J.E., 2017. Benefits of Mobile Phone Usage among Cassava Processors in Lafia Local Government Area of Nasarawa State. *Proceedings of the 22nd Annual Conference of AESON.*

Saleh M. K., Olagunju, S. O., Oyewole, S. W. and Lyocks S. W. J., 2015. Factors Influencing the Adoption of Sasakawa Global 2000 MAIZE Production Technologies in Selected Communities of Kaduna State, Nigeria. Proceedings of AESON 20th Annual Conference. Pp. 217

Saravanan, R. and Suchiradipta, B., 2013. Mobile Phone and Social Media for Agricultural Extension: Getting Closer to Hype or Hope? International Conference on Extension Education Strategies for Sustainable Agricultural Development: A Global Perspective. December 5-8, 2013, University of Agricultural Sciences, Bangalore, India.

Seidman, S., 2016. *Contested Knowledge: Social theory today*. John Wiley and Sons

Senanu, R.O. and Ann O.A., 2012. Adoption of Mobile Technology by Farmers in Southwest Nigeria: A Cross Sectional Study. *International Journal of ICT Research and Development in Africa (IJICTRDA)*, 3(2), 32-44.

Shawn, A. C. and A. Nilesh, F., 2016. Mobile'izing Agricultural Advice: Technology Adoption, Diffusion and Sustainability. Working Paper 13-047, Harvard Business School.

Siwel, Y.N. and Malongo, R.S.M., 2012. Factors Influencing the Use of Mobile Phones in Communicating Agricultural Information: A Case of Kilolo District, Iringa, Tanzania. *International Journal of Information and Communication Technology Reaerch, Vol.2 No.7; July 2012*

Sirajul, M.I and Ake, G., 2011. Factors Influencing the Adoption of Mobile Phones among Farmers in Bangladesh: Theories and Practices. *International Journal on Advances in ICT for Emerging Regions* 2011 04 (01): 4-14.

Sokoya, A.A., Onifade, F.N. and Alabi, A.O., 2012. Connections and Networking: The Role of Social Media in Agricultural Research in Nigeria. Session: 205— Social Networking for Agricultural Research, Education and Extension Service: An International Perspective — Agricultural Libraries Special Interest Group.

Sulaiman, U. Micheal, W. M. Yetunde T. O and Rabiu S., 2015. Awareness and Use of Information Technologies among Extension Agents in Kaduna State of Nigeria. *Proceeding of the 20th National Conference of AESON.*

Surabhi, M. and Mamta, M., 2016. Socio-economic Factors Affecting Adoption of Modern Information and Communication Technology by Farmers in India: Analysis Using Multivariate Probit Model. *The Journal of Agricultural Education and Extension,* 22:2,199-212, DOI: 10.1080/1389224X.2014.997255.

Susan, W. and Charles, S., 2016. Why Don't Farmers Use Cell Phones to Access Market Price? Technology Affordances and Barriers to Market Information Services Adoption in Rural Kenya, Information Technology for Development, 22:2, 320-333, DOI:10.1080/0268102.2015.1048184

Swanson, B. E., 1994. Information System Innovation among Organizations. *Management Science* 1994; 40 (9): 1069-92.

Thatchinamoorthy, C. 2018. E-Extension. Accessed online on the 08th of February, 2020 at https://www.slideshare.net/tmthatchupeacefeul/eextension-cthatchinamoorthy-agricultural-extension

Thompson, R. L. and Higgins, C. A., 1994. Influence of experience on personal computer utilization: testing a conceptual model. *Journal of Management Information Systems1994;* 11 (1): 167-87

Tomatzky, L.G. and Klein, K. J., 1982 Innovation Characteristics and Innovation Adoption Implementation: a Meta analysis of findings. *IEEE Transactions on Engineering Management;* 29(11): 28-45

Tyobo, I.S., G.B. Adesiji., M. Ibrahim., I.S. Umar and Ndanista, M.A., 2015. Perceived Effects of Mobile Phone on the Livelihood of Rural Dwellers in Niger State, Nigeria. 20th Proceeding of AESON.

Udeogu, C.U., Adibe, R. and Ike, C.C., 2017. Press Freedom and Nigeria' Cybercrime Act of 2015: An assessment. African Spectrum, 52(2), 117-127. http://nbn-resolving.org/urn:nbn:de:gbv*:18-4-10521*.

UNDP, 2012. Promoting ICT based Agricultural Knowledge Management to Increase Production and Productivity of Smallholder farmers in Ethiopia. Development brief, UNDP Ethiopia 3: 1-3.

Williams E. N. and Opeyemi, S., 2015. ICT Use In Livestock Innovation Chain in Ibadan. *Advances in Life Science and Technology*, Vol. 32, 2015.

World Bank, 2011. ICT in Agriculture: Connecting Smallholders to Knowledge, Networks and Institutions. Report No. 64605 DC (e-sourcebook).

Xioalin, F and Shaheen A., 2012. Impact of mobile telephone on the quality and speed of agricultural extension services delivery: Evidence from the rural e-Services project in India.

Yusuf, O. J. Abdullahi, K. A. and Haruna, S.K., 2015. Effectiveness of E-wallet scheme in curbing sharp practices associated with agricultural input accessibility among small holder farmers in Kano State Nigeria. *Journal of Nigerian rural sociology*. Vol. 15, No. 2, March, 2015.

Zmud, R. W., 1985. An Examination of Push-Pull Theory Applied to Process Innovation in Knowledge Work. *Management Science* 1984; 30 (6): 727-38

APPENDIX A

Questionnaire on Awareness and Use of Mobile Phone Apps by Farmers in North West Zone, Nigeria

Dear Respondent,

This interview schedule is designed to collect relevant information on the above topic. I would remain most delighted if you would su pply all the information required as accurate as possible. I can assure you that information collected will be used for student research work only and will be treated with absolute confidentiality; and if required, the outcome of the research will be shared with you. Thank you for your attention and consideration.

Interview Schedule No:..…… Date: ……..

State & Name of Community/LGA: ……..

Agricultural Zone/Extension Block No: ……

Please tick ( ) as appropriate or fill in the gaps where necessary.

SECTION A Socio-Economic Characteristics of Farmers

1. What is your age? ……
2. Sex? (a) Male [ ] (b) Female [ ]
3. Nature of Educational attainment?
    a) Arabic education [ ]
    b) Primary education [ ]
    c) Secondary education [ ]
    d) Tertiary Education [ ]
4. What is your marital Status?
    a) Married-monogamy [ ]
    b) Married-polygamy [ ]
    c) Divorced [ ]
    d) Single [ ]
    e) Widowed [ ]
5. What is your Religion? [ ]
    a) Christian [ ]
    b) Muslim [ ]
    c) Traditional Religion [ ]
6. How many persons live in your household on a regular basis? .....
7. What is your estimated personal seasonal expenditure (₦)? ……..
8. What is your estimated personal seasonal income (₦)? ……
9. What is/are your source(s) of income? ……..
10. Do you own farm land? Yes [ ] No [ ]
11. What is the size of your entire farm land (ha)? …….
12. Tick as appropriate.
    a) Agriculture is my primary occupation [ ]
    b) Agriculture my secondary occupation [ ]
13. Fill in the table below with respect to farm land cultivated for the listed crops.

Crop	Size of farm land (ha)	Yield	Qty consumed	Qty sold	Income realised
Maize					
Sorghum					
Millet					
Rice					
Cowpea					
Soya Beans					
Sugar Cane					
Leafy Vegetables					
Tomato					
Onion					
Potato					
Others(specify)					

14. How long have you been involved in farming activities (i.e. your years of farming experience)? …… ……
15. Land acquisition methods
    a) Rent [ ]
    b) Inherited [ ]
    c) Purchased [ ]
    d) Gift [ ]
16. Type of labour
    a) Family [ ]
    b) Hired [ ]
    c) both a & b [ ]
    d) rotated group [ ]
    e) both a & d [ ]
17. Are you a member of any farm group/association? (a) Yes [ ] (b) No [ ]
18. Identify which farmer group/association you belong to in the table below.

Group/association	Yes	No
All farmers' association of Nigeria		
Rice farmers' association of Nigeria		
Maize farmers' association of Nigeria		
Wheat farmers' association of Nigeria		
Millet farmers' association of Nigeria		
Sorghum farmers' association of Nigeria		

Soybean farmers' association of Nigeria		
Cowpea farmers' association of Nigeria		
Apiculture farmers' association of Nigeria		
Tomato farmers' association of Nigeria		
Pepper farmers' association of Nigeria		
Vegetable farmers' association of Nigeria		
Water users' farmer association		
Fadama users' farmer association		
Rice parboiler association		
Rice miller association		
G/nut oil extraction association		
Others(specify)		

19. Identify your means of transportation with respect to the following:

Items	**Bicycle**	**Motorcycle**	**Vehicle**	**Animals**	**Human**	**Nil**
farm workers						
Inputs						
Farm produce						
Farm waste						
Others(specify)						

20. Identify types of housing materials used for building your:
    a) Living home .....
    b) Store.....
    c) Farm shade.....
21. Sources of information

Sources	**Yes**	**No**
Radio		
Extension agent		
Phone		
CD ROM		
Internet		
Television		
Family and friends		
Association		
Agencies(ADP,NAERLS etc)		

Others(specify)		

22. Do you have access to credit? (a) Yes [ ] (b) No [ ] 23. If yes, identify the source(s).

Sources of credit	**Yes**	**No**	**Amount (₦) per source**	**Total Credit from sources (₦)**
Bank				
Micro-Finance				
Non-Governmental Organization				
Co-operative society				
Family/Relations				
Others(specify)				

SECTION B

Determine the extent of use of mobile apps by farmers

23. Do you have mobile phone? (a) Yes [ ] (b) No [ ]

24. Can you use your phone? (a) Yes [ ] (b) No [ ]

25. What type of phone can you operate very well?

- **a)** Analogue [ ]
- **b)** android/digital [ ]
- **c)** both (a) & (b) [ ]
- **d)** none [ ]

26. What type of phone do you have?

27. a

- **a)** Analogue [ ]
- **b)** android/digital [ ]
- **c)** both [ ]
- **d)** none [ ]

b. How many types of apps do you have on your phone?

- a) 1-5 only [ ]
- b) 6-10 only [ ]
- c) 11-15 only [ ]
- d) 16-20 [ ]
- e) > 20 [ ]

28. What do you use the app(s) for?

- a) farming purposes only [ ]
- b) non- farming purposes only [ ]
- c) both purposes [ ]

29. What kind of apps would you like to see more?

Apps	**Response**
Agric-related apps	
Dairy app	
Social media apps	
Metrological apps	
Others(specify)	

30. Generally, how much would you be willing to pay for apps?
    a) ₦{50-100} [ ]
    b) ₦{100-150} [ ]
    c) ₦{150-200} [ ]
    d) > ₦200 [ ]
31. Where do you go to look for app to download?

Source of Apps	Yes	No
Just use ones on phone		
On the platform(apps store)		
Social media websites		
Word of mouth(friends, families and colleagues)		
Agencies(ADP, NAERLS etc)		
Association		
Others(specify)		

32. How do you obtain the following?
    a) Seed .....
    b) fertilizer .....
    c) pesticide .....
    d) Labour .....
    e) Farm implements.....
    f) Working capital.....
33. Using the table below identify where you normally get the above input from?

Input/Source of input	Seed	Fertilizer	Pesticide	Labour	Capital	Implements
Farmers market						
Open market						
Black market						
Agencies						
Association						

Online via apps						
Others(specify)						

34. Have you ever been trained on the use of mobile phones? (a) yes [ ] (b) no [ ]
35. If yes which of the phone were you trained to use?
    a) android/digital [ ]
    b) analogue [ ]
    c) both [ ]
36. Which of the apps can you use very well?

App	Yes	No
Call app		
Facebook		
WhatsApp		
YouTube		
Tubenet		
Imo		
Email		
SMS		
VMEDU		
Tweeter		
Radio for all farmers		
TV for all farmers		
Instagram		
FarmerHelpLine		
NAQAS		
E-wallet		
Mobile Banking app		
Bill payment codes		
Bank transfer codes		
Others(specify)		

37. Do you have access to extension agents and services? (a) yes [ ] (b) no [ ]
38. How frequent do you meet with the extension agent(s)?
    a) Daily [ ]
    b) weekly [ ]
    c) fortnightly [ ]
    d) monthly [ ]

e) others, specify [ ]

39. How many of the extension agents do you meet during your meetings?
    a) 1[ ] b) 2 [ ] c) 3 [ ] d) 4 [ ]
40. Do you communicate with the agent(s) through your mobile phone? (a) yes [ ] (b) no[ ]
41. If yes, through which of the apps do you do that?

App	Yes	No
Call app		
Facebook		
WhatsApp		
YouTube		
Tubenet		
IMO		
Email		
SMS		
VMEDU		
Tweeter		
Radio for all farmers		
TV for all farmers		
Instagram		
FarmerHelpLine		
NAQAS		
E-wallet		
Others(specify)		

42. Fill the table below with respect to crops you get extension support on via apps on your phone

Crops	**WhatsApp**	**email**	**call**	**SMS**	**Facebook**	**Tweeter**	**Others (specify)**
Millet							
Sorghum							
Maize							
Cowpea							
Rice							
Wheat							
Spinach							

Tomatoes							
Cabbage							
Onion							
Red Pepper							
Mellon							
Water melon							

43. What is the quantity of your animal production on the average as influence by the use of mobile apps?

S/No:	Livestock	Herds (#)	0	(i)	(ii)	(iii)	(iv)	(v)
i.	Cattle							
ii.	Sheep							
iii.	Goat							
iv.	Donkey							
v.	Carmel							
vi.	Fowl							
vii.	Others (specify)							

SECTION C

Inventory of mobile phone applications in the area; awareness and usage status

44. Fill the table below by ticking the appropriate option.

Mobile Apps	Awareness status		Date of awareness	Use		Date of 1st use	Use intensity		
	Yes	No		Yes	No		All activities	Most activities	Few activities
Voice call app									
SMS									
Facebook									
WhatsApp									
VMEDU									
Opera									
Flash share									
Bluetooth									

Tubenet									
Imo									
E-mail									
Bank transfer codes									
iCow									
Rural eMarket									
Instagram									
E-Wallet									
NAQAS									
mFishery									
Radio for all farmers									
TV for all farmers									
Facebook youth & educated adult									
WhatsApp youth & educated adult									
YouTube youth & educated									
adult									
Tubenet youth & educated adult									
Mobile banking apps									
Bill payment codes									
Bank transfer code									
Farmer line									
Farmer Help Line									

Others (Please specify)									

SECTION D

Purpose of Mobile Apps Use

45. Fill the table below with respect to the purpose for which mobile apps are used

Apps	**Contacting Family Members**	**Purchase of Farm inputs**	**Extension Advisory Services**	**Marketing and General information**	**Read weather condition**	**Pay Bills**	**Spread of vital info to/fro other farmers**	**Get updates on agric newsletter**	**Coordination of the farm day to day activities**
Voice call app									
SMS									
Facebook									
WhatsApp									
Instagram									
Opera									
YouTube youth & educated adult									
Bluetooth									
E-mail									
Tubenet youth & educated adult									
iCow									
Rural eMarket									
Tubenet									
E-Wallet									
NAQAS									
VMEDU									
Flash share									
Farmerline									
File Explorer									

Sound									
Recorder									
Radio for all far mers show									
TV for all farmers show									
Facebookyouth &educated adult									
WhatsAppyouth&educated adult									
FarmerHelpLine									
Mobile banking apps									
Bank transfer codes									
Bank bill payment codes									
Others(Please specify)									

SECTION E

General attitude of farmers towards mobile applications

46. Fill the table below by ticking the appropriate option

Statements on Apps	SA	A	U	D	SD
Apps have enhanced contact with extension workers.					
With App we have access to current information on improved farming activities					
With Apps, our farm produce is improving in quantity					
Apps have greatly help us improve the quality of our produce					
Availability of Apps has no impact on our production					
Apps help us to monitor market situations effectively					
Apps help in speedy spread of information amongst farmers					
Apps have helped to facilitate information transfer within farm families					
Apps aid significantly in input sourcing at good price.					
Apps help to monitor weather conditions					
Appropriate and timely weather forecast is aiding good response by farmers in terms of timely and appropriate decision making					
Apps help to get update on global trend on agric development					
With apps payments of bills are made easy					
Apps help to easily access government initiatives on agriculture					
Apps help to ensure togetherness of association members					
With apps members of the farmer group are effectively carried along					
International organizations can easily reach to farmers with the aid of apps					
Apps help to monitor trend of growth in the farm					
Apps help to timely detect production problem for prompt response					
With apps it is easy to access insurance cover for our farming process					
Apps aid timely delivery of farm inputs					
Apps not necessary in farming					
App are detrimental to our local ways of farming handed over to us					
Apps are causing complexity in farming operations generally					

I do not need apps to be able to enhance my production in quantity					
Apps not significant in improving quality of production					
Apps have greatly enhance extension activities in our area					
With apps, it is now easy to get information on any new problem in farming					
Apps have aided speedy transfer of fund for timely input delivery					
Apps have aided speedy disposal of farm produce at desirable price					

SECTION F

Farmers' knowledge of mobile apps

47. Fill the table below by ticking the appropriate option

Statements on Apps	**True**	**False**
Internet is a source of information on all agricultural related issues		
You can us your phone to access information from the internet		
It is now easy to contact the extension agents via call		
It is now easy to contact the extension agents via SMS		
It is now easy to contact the extension agents via WhatsApp		
It is now easy to contact the extension agents via email		
I can open the e-mail page using my phone		
I can write and attach materials to be e-mailed		
I can store and retrieve numbers at any time using my phone		
I can place and receive calls with my phone		
I can use my phone to write and read text messages		
I can form WhatsApp group to facilitate flow of information		
I can access and read WhatsApp messages		
with the mobile phone, information easily transferred from one farmer to another and extension agents to farmers		
Framers can use all Apps at their disposal to enhance their farming		
Farmers can use their phone to access inputs and farm credit		
With the mobile phone farmers can plan properly before and after cultivation of their farms		
I understand when I am out of air time or data		
I can load air time and data		
I can download apps from Google stores		

I can search and fix minor network issues		
I can use service providers' codes to load airtime and data		
I can use codes to pay for bills		
I can use my phone to access insurance services		
I can use apps to transfer documents from desk/laptop to my phone and vice versa		
I can use apps to pay bills		
I can use apps to follow trends of prices of produce in markets around me		
I can use apps to monitor weather conditions		
I can use apps to measure growth trends in my yearly production process		
I can update apps when the need arises		
With apps I can monitor trends in prices at the international market		
With apps I can source for good market, locally and internationally, for input purchase		
Using apps, I can easily source for market for my produce, home and abroad.		
Mobile Apps have made it easy for farmers to get good price for their farm produce, home and abroad.		

SECTION G

Constraints faced by farmers in the use of mobile apps

48. Fill the table below by ticking the appropriate option

Description of constraints	**Yes**	**No**	**Very Serious**	**Serious**	**Neutral**	**Not Serious**
Poor network						
Poor power supply						
No power supply						
High cost of charging phone battery						
Apps are too complex						
Inability to operate apps						
No access to apps						
Lack of access to credit to be able get apps						

Lack of access to education						
Lack of access to extension services						
Lack of access to network						
Lack of access to functional apps						
Lack of time to practice use of apps						
Lack of technical know how						
Lack of information from radio						
Lack of awareness of apps						
Cost of training is high						
Cost of airtime is high						
Lack of social interaction						
Lack of willingness to learn						
Lack of demonstration of app usage techniques						
Lack of app update technology						
Lack of encouragement						
Problem of updating apps						
High cost of apps						
High cost of phones						
Complexity in operating phones						
Socio-religious values						
Customary values						
Political influence(state)						
Actions of association/grp						
Problem of acceptance by local leadership.						

APENDIX B

LIST OF PUBLICATIONS

The following manuscripts were extracted from the research results presented in this thesis and are to be presented for review process in notable journals.

1. Publication 1 – Chapter Four of the Thesis
   Factors Influencing the Use of Mobile Phones Applications by Farmers in North-West Nigeria. *Indian Journal of Humanities and Social Sciences (Published)*
   Authors: **Abdullahi, A.A., I.O. Oladele and S. Modirwa**
2. Publication 2 – Chapter Four of the Thesis
   Factors Influencing the Extent of Use of Mobile Phone Applications by Farmers in North West Nigeria. *Journal of Agricultural Extension Society of Nigeria* (Under Review)
   Authors: **Abdullahi, A.A., I.O. Oladele and Yusuf, J.O**
3. Publication 3 – Chapter Four of the Thesis
   Usability Indices and Attitudinal disposition of farmers towards the use of mobile phone applications in North-West Nigeria. *Journal of Agricultural Education and Extension* (Tentative Publisher)
   Authors: **Abdullahi, A.A., I.O. Oladele and Mudashiru, A.**
4. Publication 4 – Chapter Two of the Thesis
   Adoption and Diffusion of mobile phone apps in rural farming communities: review of Nigerian situation. *Journal of Agricultural Research and Development* (Tentative Publisher)
   Authors: **Abdullahi, A.A., I.O. Oladele and S.S. Letsoalo**
5. Publication 5 – Chapter Four of the Thesis
   Use of mobile phone apps by farmers in North-West Nigeria.
   Authors: **Abdullahi, A.A., I.O. Oladele and Yusuf, J.O.**
6. Publication 6 – Chapter Four of the Thesis
   Usage Factors Influencing the Usability of mobile phone apps for extension advisory Services by farmers in North-West Nigeria. *Indian Journal of Advances in Computer Sciences and Technology* (Published)
   Authors: Abdullahi, A.A., L.K Mabe and S.S. Letsoalo.
7. Publication 7: Chapter Four
   Usage Construct and Mobile Telephony Technology Knowledge' Status of Farmers in North West Nigeria. *Journal of Agricultural Education and Extension* (Tentative Publisher)
   Authors: **Abdullahi, K.A., O.I. Oladele and S. Modirwa**
8. Publication 8: Chapter Four
   Incursion of Mobile Telephony among Farmers in North West Nigeria: Prospects and Challenges. *Journal of Agricultural Research and Development* (Tentative Publisher)

Authors: **Abdullahi, K.A., O.I. Oladele and L.K. Mabe**