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Use of ICT among Smallholder Farmers and Extension Workers and its Relevance to Sustainable Agricultural Practices in Nigeria

By

Samson Olayemi Sennuga

A Thesis submitted for the degree of Doctor of Philosophy (PhD)

April 2019

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By

Samson Olayemi Sennuga

A thesis submitted in partial fulfilment of the University's requirements for the Degree of Doctor of Philosophy

April 2019

Coventry University
in association with the Royal Agricultural University

DEDICATION

This thesis is dedicated to the former President of Nigeria, Dr Goodluck Ebele Jonathan (GCFR) for his unfailing passion for quality and world-class education in Nigeria.

ABSTRACT

In recent years growing attention has been given to use of ICT and adoption of improved technologies within the farming setting in both developed and developing countries. In the developing world this is generally in order to tackle low agricultural productivity amongst smallholders who are the major producers of food crops and to foster their adoption of GAP technologies to meet the food needs of ever-increasing populations. However, traditional approaches to knowledge exchange and extension has limitations in many countries. Given its potential amongst rural farmers, combined mobile phone-SMS text reminders and GAP participatory training could significantly promote greater adoption amongst farmers. Little is known about this unique approach in facilitating farmer adoption of GAP technologies in developing economies and, specifically, no Nigerian study has been found that examines such a role amongst rural communities.

The principal aim was to evaluate smallholder uptake of Good Agricultural Practices and whether tactical use of ICT (SMS text reminders) can improve adoption of practices to enhance the effectiveness of extension to farmers. Secondly, the study sought to evaluate the use of ICT in relation to market communications.

After a critical review of smallholder farming, extension and the use of ICT in communications, focus group discussions, household survey questionnaires and an in-depth constructivist case study were used. As such the study can be categorised as a participatory research methods using mixed methods triangulation strategy to address the study aims and objectives. Field studies in Nigeria involved three phases:

After introducing the purpose of the study to two communities, the first phase focused on baseline livelihoods survey and an evaluation of farming practices. From the two closely related communities (Bassawa and Shika) in northern Nigeria, a total of 200 smallholder farmers were selected for the survey. The communities were located close together; however,

in 2012 the Bassawa community had benefited from the NAERLS Adopted Village Concept community initiative.

The second phase focused on GAP participatory training, the development of a lead-farmer extension model, extension visits, SMS text reminders, focus group discussions and in-depth interviews with both extension workers and farmers.

The third phase included evaluation survey questionnaires of the effectiveness of GAP participatory training, impact of SMS text reminders and barriers to adoption of GAP technologies. In addition, the use of SMS linked to market strategies was reviewed.

Whilst quantitative data were analysis using SPSS and descriptive statistics, qualitative data were thematically analysed.

Overall, this study found that 13 GAP technologies were fully adopted, and the interviews as well as the evaluating survey provided a richer understanding of the motivating factors that triggered the adoption. These included GAP participatory training, access to timely information via SMS text reminders, access to extension visits and trust invested in the lead farmers. The study also found that the farmers who received SMS reminders estimated that they had a 42% increase in their agricultural productivity as a result of GAP intervention in the community. The thesis also identified a couple of barriers influencing extension delivery and found that mobile phones can be tactically used to support traditional extension and communication.

To address the identified barriers to smallholders improving the sustainability of their agricultural practices there is the need for a radical reform in agricultural extension in Nigeria. The focus of this reform should consider building capacity in good agricultural practices in extension staff and lead farmers so that they can disseminate such practices. Throughout, such capacity building should seek to empower decision making in farmers. In order to address the high farmer to extension worker ratios, there is a need to extend rural ICT facilities and link

extension staff to lead farmers while encouraging clusters of farmers around each lead farmer. In addition to facilitated training, the use of timely reminders via SMS has the potential to improve uptake of practices. The thesis develops a new model for mobile technology supporting traditional extension approaches in order to improve extension services to smallholder farmers in Nigeria. Currently, the extension officer ratio to famers in Nigeria is 1:3000, however, the new model revealed that if each extension officer has a portfolio of 300 lead farmers working with them and each lead farmer has 10 trainee farmers locally, then extension officer is directly communicating with 300 farmers and indirectly contacting 3000 smallholder farmers. Moreover, if the extension officer then have the ability to communicate with these smallholder farmers through Mobile phone technology as supposed to travelling to villages by car or motorcycle considering the restriction of bad roads network. Then the extension officer can remind farmers on what to do via contact of the lead farmers through SMS text. This actually means instantaneously all the farmers would get the text message at the right time. Meanwhile, extension visit to smallholder farmers in the villages would take the officer more than two weeks.

Key words: GAP participatory training, SMS text reminders, Lead farmers, Adoption.

DECLARATION

The work within this thesis is based on the author's independent research at the Royal Agricultural University, Cirencester under the supervision of Dr Richard N. Baines, Dr John S. Conway and Dr Rhiannon K. Naylor. The author is responsible for the model and tool development, field work and application, interpretation of results and the conclusion reached within this thesis. All assistance and advice from colleagues have been acknowledged.

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Samson Olayemi Sennuga
April 2019

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LIST OF ABBREVIATIONS

ABU - Ahmadu Bello University

ADP - Agricultural Development Project

ADAS - Agricultural Development Advisory Service

AEC - Agricultural Extension Centre

ATA - Agricultural Transformation Agenda

ATAP - Agricultural Technical Assistance Project

ATMA - Agricultural Technology Management Agency

CAP - Common Agricultural Policy

CBN - Central Bank of Nigeria

CDT - Cognitive Dissonance Theory

CIGs - Common Interest Groups

DFRRI - Directorate for Food, Road and Rural Infrastructure

DTPB - Decomposed Theory of Planned Behaviour

EMTP - Extension Management and Training Plot

FAO - Food and Agricultural Organization

FEC - Federal Executive Council

FFS - Farmer Field School

FFSEM - Fee-For-Service Extension Model

FGD - Focus Group Discussions

FGN - Federal Government of Nigeria

FMARD - Federal Ministry of Agriculture and Rural Development

FSR - Farming System Research

GAP - Good Agricultural Practices

GDP - Gross Domestic Product

GESS - Growth Enhancement Support Scheme

GR - Green Revolution

GSM - Global System for Mobile Communications

ICT - Information and Communication Technologies

IDT - Innovation Diffusion Theory

ITU - International Telecommunication Union

KADP - Kaduna State Agricultural Development Project

KSMA - Kaduna State Ministry of Agriculture

LGA - Local Government Areas

LGU - Land Grant Universities

MAFF - Ministry of Agriculture, Fisheries and Food

NAADS - National Agricultural Advisory Services

NAAS - National Agricultural Advisory Service

NAE - National Agricultural Extension

NAERLS - National Agricultural Extension and Research Liaison Services

NAFPP - National Accelerated Food Production Programme

NALEP - National Agriculture and Livestock Extension Programme

NASS - National Agricultural Advisory Service

NCC - Nigerian Communications Commission

NDE - National Directorate for Employment

NGO - Non-Governmental Organization

NITEL - Nigerian Telecommunications Limited

NPA - National Policy on Agriculture

NSPFS - National Special Programme on Food Security

NTP - National Telecom Policy

OEDRE - Operation Evaluation Department of Research and Extension

OFAR - On-Farm Adaptive Research

OFN - Operation Feed the Nation

PADETES - Participatory Demonstration and Training Extension System

PAR - Participatory Action Research

PhD - Doctor of Philosophy

RBDAS - River Basin Development Authority Strategies

RDEP - Rural Development and Extension Programme

REFILS - Research-Extension-Farmer-Input-Linkages System

RPP - Research Program Support Project

SCT - Social Cognitive Theory

SGP - Sasakawa Global Programme

SMS - Short Message System

SPAT - Small Plot Adoption Techniques

T&V - Training and Visit

TAM - Technology Acceptance Model

TPB - Theory of Planned Behaviour

TTFM - Task Technology Fit Model

UAES - Unified Agricultural Extension Service

UAES - Unified Agricultural Extension System

UK - United Kingdom

UN - United Nations

UNDP -United Nations Development Programme

US - United States

UTAUT- Theory of Acceptance and Use of Technology

WB - World Bank

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Chapter One. Challenges Facing Smallholder Farmers in Sub Saharan Africa

Smallholder farmers within Sub Saharan Africa (SSA) face a number of challenges both in terms of production and in marketing their surplus produce. Generally, the focus of agricultural policies are to guide farmers to optimise production without damaging the natural resources they depend on and secondly to assist farmers to access markets. In many developing countries the local face of these policies is the agricultural extension field officer; however, many of these field officers also face challenges in delivering extension messages to increasing numbers of smallholders. Therefore, it could be argued that both farmers and extension officers face a common challenge of developing effective strategies for information exchange and communication.

1.1 Challenges Facing Smallholder Farmers

Agricultural production in Nigeria has been largely dependent on the concerted efforts of small-scale farmers who are mainly in the rural areas. Ogungbile and Olukosi (2001) outlined the common characteristics of resource-poor farmers which include; stark poverty, illiteracy, malnourishment, financial inadequacies and low rates of return on their small investments. In order to address some of the challenges faced by stakeholders, a number of policies and extension strategies have been implemented (see Section 2.7); one of these was the World Bank assisted Agricultural Development Projects (ADP) that were introduced into Nigeria in 1975 including the component of the Training and Visit (T&V) extension system which was initially enthusiastically adopted in many states (Idachaba 2007). The popularity of the T&V system was perhaps due to its ability to promote and encourage professionalism, a well-defined structural and institutional arrangement, an inbuilt monitoring and evaluation system and for its flexibility in terms of accommodating other agricultural and rural development projects (Ilevbaoje 2008; Akintonde *et al*. 2012). However, this model of extension has subsequently been criticised on several counts including: being inefficient and ineffective, a rigid top-down and top-heavy process with too much focus on yield increases, a lack of attention to economics and marketing and not addressing the diverse service needs of smallholders (see Ejembi *et al*. 2006; Anderson *et al*. 2006; Musa *et al.* 2013). Indeed, the model is often referred to as "train and vanish" as there was no reinforcing of messages, mentoring or relationship building (Anderson *et al.* 2006) and no post extension monitoring. In Nigeria, for instance, the Government extension worker to farmer ratio is very high, estimated at 1: 3000 against a target of 1: 500 (Arokoyo 2005). This gap is extremely large to effectively reach out to the creasing needs of the rural communities and this is making direct communication difficult. However, the ICT concept infiltrates perfectly well for its reachability to complement the efforts by improving capacity to connect without costly visits. The ineffectiveness and inefficiency of T&V approach linked with the traditional extension models for subsistence have led agricultural extension scholars to advocate the application of ICT as a complementary tool in maintaining farmer contact (Anderson *et al.* 2006; Davis 2008; Aker 2011). This is a key area that this thesis will explore in detail.

A second challenge facing smallholders centres around inadequate market access, lack of market information, collusion among middlemen, and lack of transportation facilities (Ton 2011, Kavoi *et al.* 2014, Yankson *et al.* 2016). Indeed, millions of smallholder farmers in SSA face incredible challenges in marketing their farm produce while the concerted efforts by local market traders seek to reverse this. Developing value markets to link smallholders to profitable outlet and market information are particularly important for trading all products produced by smallholder farmers, including the high-volume value grain and pulse crops, vegetables and meat products (Kawa and Kaitira 2007, Ferris *et al.* 2014 and Gyau *et al.* 2014). Linking smallholder farmers to markets can help drive sustainable productivity and profits, improve livelihoods and increase household incomes. Furthermore, market access by smallholder farmers is generally considered a critical part of long-term development strategies to reduce poverty and hunger in rural communities in SSA.

There are several other factors affecting market access and performance amongst smallholder farmers. Studies by Barreties (2008) and Chapoto *et al.* (2013) outlined key factors including, location; farm size; financial and linkages to financial services; ability to manage water resources; costs of inputs; transaction costs; price volatility; access to and adoption of production technologies and the use of ICT. Many farmers now have access to mobile technologies (Mugwisi *et al.* 2015) and smallholders are using this technology to communicate with extension workers, traders, colleagues, and to learn about technology and market opportunities (Fu and Akter 2016). As such, the secondary aim of this study is to evaluate smallholder use of ICT for market information.

1.2 Challenges Facing Agricultural Extension Workers

A key failure point of traditional extension models is the number of farmers per extension officer – they cannot visit all the smallholder farmers effectively and in a timely manner. The ratio in Nigeria is currently 1 extension worker: 3000 farmers (Fawole and Olajide 2012, Ogbe 2016). This ratio of extension worker to farmers is grossly inadequate and highly disturbing considering the World Bank's standard which is 1:500 (Word Bank 2010). Where extension workers act as bridges between researchers and farmers, for example, in traditional T&V extension the ratio should be 1:200 farmers within a cluster so that they can have a meaningful impact by effectively teaching and monitoring the farmers' progress (Ogundele 2016); furthermore, by focussing on lead farmers backed up by farmer to farmer extension, then a ratio of 1: 500 advocated by the World Bank could be effective.

Key challenges facing extension workers include: extremely low extension agent to-farmers ratios; a lack of essential technical and communication skills for efficient functioning; a lack of a definite plan of work; too few qualified and trained extension staff using outdated information; under resourced transport and logistics; poor, weak and deteriorated infrastructure; extension organization and management problems; unclear extension mandates; lack of job descriptions for staff; poor remuneration of the personnel; and a high rate of absenteeism among staff (see Naswem *et al.* 2008; Anandajayasekeram *et al.* 2008; Chowa et al. 2003, Baig and Aldosari 2013). Consequently, in a reaction to the worrisome performance in the agricultural sector, the Nigerian Government has embarked on several agricultural interventions and reforms, with policies and programs explicitly designed at reinvigorating the sector to its enviable position in the Nigerian economy between 1959 and 2003.

The use of ICT potentially allows extension workers to contact more farmers with appropriate and up-to-date information in a timely manner. Asenso-Okyere and Ayalew-Mekonnen (2012) stressed that ICT, particularly radio, can enable extension worker to reach about half a million smallholder farmers simultaneously in their local language with knowledge and information which enables farmers, strengthens them, assists smallholders in problem solving and allows farmers to make informed decisions (Oladele 2015). Therefore a third aim of this study is to evaluate the potential of ICT to support extension efforts.

1.3 Information and Communication Technologies in Africa

Today's world is widely information-driven where information and communication technologies (ICT) are increasingly becoming the underlying drivers of social and economic development including agriculture, not only in developed countries but across the globe (Sennuga 2012; Ajani 2014; Irungu *et al*. 2015; Francis 2016). Over the last two decades, Sub-Saharan Africa has witnessed a significant explosion in the use of ICT (Conger 2015). Many African citizens and people in various industry sectors now own personal ICT devices such as computers, tablets and mobile phones among others. This trend also includes smallholder farmers using ICT (mainly mobile phones capable of SMS texting) for a variety of uses from personal communications to market intelligence. Indeed, in Sub-Saharan Africa, the mobile telecommunication Global System for Mobile communication (GSM), is recognized as experiencing the largest increase in usage among all the ICT of any continent with some unique and innovative uses being found (Irungu *et al*. 2015).

In rural Nigeria, prior to 2000, ICT use was primarily limited to radio, television and landline telephones. It is important to note that the modern ICT were introduced into Nigeria in 2001 on the instructions of the office of President Olusegun Obasanjo as the new democratically elected president. From the year 2001 however, Nigeria opted for full sector reform and backed this up with a telecom policy. The draft of this National Telecom Policy (NTP) (National Telecommunications Policy 2007) was approved by the Federal Executive Council and released in September 2000, the hallmark of which was a blueprint for full liberalization of the telecoms industry. Ever since then, there has been tremendous progress in the telecommunication industry, economy and (to a lesser extent) the agricultural sector of the country (Dulle 2002; Hassan *et al*. 2011). However, little is known about the effectiveness of these technologies in underpinning smallholder development and agricultural extension; this is the main focus of this study.

1.4 Aims and Objectives

The main aim of this study is to evaluate whether tactical use of ICT can improve the effectiveness of extension to farmer communications and address the problem of high farmer numbers per extension officer. A secondary aim is to evaluate smallholder perceptions of GAPs and then use appropriate Good Agricultural Practices to see whether training followed by tactical ICT use would embed such practices in the farming community. The third aim is to evaluate the use of ICT by smallholder and agent in gaining market intelligence.

The study addressed these aims by setting the following objectives; to:-

1. Analyze the effectiveness of traditional extension models and communication in Nigeria from smallholders’ and extension workers' perspectives.
2. Identify the barriers and opportunities to the adoption of improved technologies and market information by smallholder farmers for sustainable development in Nigeria.
3. Evaluate the use of ICT by farmers and extension workers for market information.
4. Assess whether the use of mobile technology has a significant influence on the adoption of GAP technologies by smallholder farmers by examining the impact of ICT on agricultural productivity.
5. Develop a new model of using mobile phone technology as a communication tool to improve extension services to smallholder farmers in order to improve their productivity and livelihoods in Nigeria in relation to extension services and market access.

Therefore, this study addresses the following research questions:

1. How effective are traditional models of extension and communication in Nigeria from smallholders’ and extension workers' perspectives?
2. What are the barriers to and opportunities for the adoption of improved technologies in the agricultural development process in Nigeria?
3. How do farmers and extension workers use mobile technology in relation to market access and trading?
4. How has the use of mobile technology influenced adoption of GAP technologies and what is the impact of mobile technology on agricultural productivity of smallholder farmers?
5. Can a new model using mobile phone technology as a communication tool be developed to improve extension services to smallholder farmers’ in order to improve their productivity and livelihoods in Nigeria?

1.5 The Political Economy of Agricultural Development in Northern Nigeria

The Northern Region Nigeria is a region that contradicts its natural endowments. In spite of the existence of several economic resources such as tin, kaolin, a variety of agricultural products and a huge fertile land, the people remain in abject poverty leading to plethora of crisis in forms of insurgency, electoral violence and crime (Titus *et al*. 2017). Out of the six geopolitical zones in Nigeria, three are in the northern part of the country and they have the worst indices of poverty compared to the other zones. The Northern Nigeria, occupying 70% of Nigeria's land mass, with its huge solid mineral deposits, growing mining industry. The Northern region has 50 million Muslims, one of the largest Muslim populations in Africa. These Muslims are of Hausa/Fulani ethnicity, which is the largest ethnic subgroup in Africa and Nigeria. The Northwest with 77.7% North-central having 67.5% and Northeast with 76.3% (United Nation 2012). Northern Nigeria becomes a hub of joblessness, crime, illiteracy, maternal mortality, early marriage and recently, farmer herdsmen crisis. The political economy of agriculture in Northern Nigeria, this has been developed over the past four decades and has been important not only in the study of agriculture in Sub Saharan Africa but more widely.

Nigeria has long been a case of interest for the study of political and economic development. The political economy of the Nigerian society has suffered pitfalls resulting in an economy powered by visionless leaders, known for reckless spending, over-invoicing, diverting state finances into private account, thereby plunging the country into economic, social and political wretchedness (Ganiyu *et al*. 2014). It is a common knowledge to many across the globe that the Northern region performs at a level of productivity far less than its full potential and other part of the country. This is further exacerbated by population increase which outpaces food production per capita the latter of which is in decline; this situation also results in the concomitant effect of increased importation of food in the region (Delgado and Mellor 1984; Nwachukwu 2016).

Nigeria is a great example of a post-colonial developing nation and its developmental history encompasses very important lessons on the political and economic obstruction of the developing world (Ugwuanyi 2014). The country as a colonial entity enjoyed thriving and boom in the agricultural production and the mining of mineral resources such as iron ore, tin and coal. The Nigeria foreign exchange was earned from the aforementioned resources. Each region had a proportional advantage through which it made its significant contributions to the centre/federal government. The Northern Nigeria for instance, was known for groundnut production, the West for her cocoa while the East produced palm oil. During the British colonial era, the politics of development was already manifested even with the construction of railway line through those areas that had products that could yield some revenue to the centre (Osita-Njoku, 2016). According to Njoku (1998), the British political economy in Nigeria was along the line of economic exploitation of the colonized by foisting it into the path of the European capitalist economic system. Ezeanyika (2010) argued that the overall subordination of colonized nations by dominating foreign power is to "keep the colonized people in complete political subjection, and to maximize local human and natural resources".

In October 1, 1960, Nigeria gained her political independence from the British colonial master, the production of crude oil had changed the dynamics of the Nigerian political economy. Oil boom production is now the mainstay of the economy. Luqman and Lawal (2011) stated that hardly could anything be written about the political economy of Nigeria without reference to its history of oil production. Despite the fact that the oil industry remains the mono-economic fulcrum of the Nigerian economy, its contribution to economic development and improvement of the living standards and welfare of Nigerians remain doubtful. This was because Nigerians case is simply a situation of poverty amidst plenty. Instead of our visionless leaders reinvesting the resources from excess crude oil sale into development of infrastructure like power, education, health, public transportation, water, housing, good roads and national security, among other sectors, what the country witnessed is a political class deeply entrenched in corruption and siphoning oil income abroad, whereas country like Indonesia turned crude oil income into productive investment for the benefits of the citizen (Luqman and Lawal 2011; Ganiyu *et al*. 2014). This unpleasant situation can not augur well in the development of a stable political and economic institution necessary for building a strong and successful nation.

1.6 The Political Economy

The political economy of agriculture has long been a puzzle and the concept is not new in sociological and political discourse. Political economy can be understood as the art or study of the management of a country in the sense of macro or public household but taking into account political, economic, social, cultural, institutional and other factors that come into play and not forgetting the complex interactions between them (Swinnen 2010; Nwachukwu 2016). The term emerged as a distinct field of study and was developed in the 18th century as the study of the economies of states, or politics (Groonwegen 2008). In the present day, political economy, where it is not used as a synonym for economics, may refer to very different things including Marxian analysis, applied public choice approaches emanating from the Chicago School and the Virginia school, or simply the advice given by economists to government or public on general economic policy or on specific proposals (Groonwegen 2008; Osita-Njoku, 2016). However, political economy is applied here as the study of the social relations, particularly the power relations, that mutually constitute and impact the production, distribution and consumption of resources in agricultural development. According to Maier (2008), political economy approach interrogates economic doctrines to disclose their sociological and political premises. Basically, the term is refers to as economic ideas and behaviour, not as frameworks for analysis, but as believes and actions that must themselves be explained. Consequently, it deals with the interactions between economic policies and their social and political context. Eboh (1999), maintained that political economy is an approach-cum-subject concentrating on the structure of markets and government, the incentives, abilities and behaviour of economic agents, policy makers, civil servants and society at large. Fundamentally, political economy provides a more critical understanding of the foundation upon which all social and political life is built. Hence, offering a more distinct analysis than that offered by mainstream approaches that are patently failing a majority of people at the behest of a minority (Aregbeshola 2011).

1.7 Post-Colonial Situation of Agricultural Development in Nigeria

Nigeria became independent nation in 1960. At this point, it was the expectation of the citizens that the country will turn around for good. The nation was led to believe that following independence in Nigeria in 1960, the nation would continue to progress into greater magnitude of prosperity that would usher in quality standards of living for the citizens. This believe was not just a mere wishful thinking simply because of the much foreign exchange earned through agricultural exports and both cash and food crops were massively produced. It was very convenient for the world to perceive Nigeria to be the future giant of Africa (Osita-Njoku 2016). The citizen strongly believed that an indigenous leader who have taken over the mantle of leadership had an answer to the way forward from where the British colonial masters left the country. Indeed, the different regions of the country experienced financial explosion till the late 1960's from engaging in the agricultural production and export of agricultural produce they cultivated under colonialism (Iwuagwu 2008). At that time, through concerted effort of the organisation of land and labour by peasant farmers, Nigeria was one of the world's major producers, not only of palm oil, but also of cocoa and groundnuts, as well as cash crops for domestic consumption.

However, in 1970's the country experienced the abandonment of the aforementioned agricultural resources with all attention focused on oil income which now made the crude oil the mainstay of the Nigeria economy, that is, a mono-product economy (Dodo 2009; Osita-Njoku 2016). As a result, all the developmental programmes initiated at different points in time by different administrations could not be implemented to achieve anticipated results. At this juncture, a close attention will be given to the developmental programme implemented after independence; their level of success and the reasons for their failure. Post-colonial development strategies in Nigeria were articulated under the various national development plans namely, the first National Development Plan (1962-1968); second National Development Plan (1970-1974); the third National Development Plan (1975-1980); the fourth National Development Plan (1985-1990).

The main objective of Nigeria's National Development Plan was to preserve and possibly, to surpass the average rate of growth of 4% per year of its gross domestic product at constant prices. To achieve the aim, government planned annually investment of approximately 15% of Nigeria's gross national product. Given that agriculture was the major strength of Nigeria's economy, and which was largely identified with the rural areas, policy attention and governmental investment in it were seen as direct and indirect avenues of developing the rural areas.

FIRST NATIONAL DEVELOPMENT PLAN PERIOD (1962-1968)

The first National Development Plan was strategically put in place. The Plan succeeded at first raising the rate of economic growth, and to increase control of the economy. Looking at the first plan critically it was simply a continuation of the British colonial development policy that placed emphasis on transportation and communication, such as facilitating the movement of raw materials out and finished product into the country (Ibietan and Ekhosuehi 2013). As a result, instead of moving the nation forward in her developmental effort in terms of achieving the main objectives for which it was set up, the nation experienced some structural inconsistencies (Dodo 2009, Ugwuanyi 2014). The plan itself did not articulate any clear statement or policy on rural infrastructural development. Instead, emphasis was placed on encouraging the assemblage of agricultural produce for export purpose, without strengthening the real agricultural base of the country by providing necessary infrastructures such as good road network, electricity, agricultural processing facilities, and potable water, among several others.

SECOND NATIONAL DEVELOPMENT PLAN (1970-1974)

The second National Development Plan (1970-1974) came as a post-civil war development ingenuities. It was also during this plan period that Nigeria had the 'phenomenon of oil resource boom'. Principally, the plan was aimed at: a) building a united, strong and self-reliant nation; b) building a great and dynamic economy; c) building a just and egalitarian society; d) building a land of bright and full opportunities and; e) building a free and democratic society (Marcellus 2009; Ikeanyibe 2009). The plan placed high priority on reducing the level of inequality among the social classes and between urban and rural areas. Basically, one important feature of the second National Development Plan as perceived by Marcellus (2009) was its democratic content, having emerged from a participatory process that involved stakeholders at every level of governance. According to Leonard (2006), the discovery of oil in the 1970's the nation's economy has been a mono-economy because of the over dependence on the oil sector, which provides 95% of foreign exchange earnings, and about 80% of budgetary revenues. He further stated that, the oil boom, as it has killed other resources of revenue for the country. 'Oil boom' soon translated into struggle for 'oil rents' which led to massive corruption at every levels of governance (Oyefusi 2007, Akinyetun 2016). Huge spending and import of food characterized the state activity while agriculture that served as the mainstay of the economy was relegated to the background. Given the consistent poor funding of agriculture with rural development in Nigeria, government massive dependence on oil revenue during this period meant that all policies on rural development could no longer be on the agenda of government. Moreover, oil boom has been key to Nigeria's political economy since 1970's, giving rise to syndrome called the ''resource curse''. This includes a revenue monoculture, endemic corruption, political uncertainty, communal tension and heightened conflict (Akpan 2012).

THIRD NATIONAL DEVELOPMENT PLAN (1975 – 1980)

The third National Development Plan (1975-1980), rural development was reconsidered based on government egocentric conviction that such investment will make substantial contribution in closing the yawning gap between the demand for food and the supply capacity of the home-based industries. Consequently, government developed interest in modernizing agriculture and introducing original initiatives to strengthen the agricultural and food base of the nation (Lewis 1977). Even though the objectives of the plan looked similar to those of the second national development plan, there was a considerable and comprehensive approach as the plan give emphasis to the need to lessen regional disparities with the intention of promote national unity through the adoption of unified rural development. Increased budgetary allocations was provided to fund diverse and interrelated rural development sectors as the provision for nationwide agricultural programmes (Ugwuanyi 2014). However, during the third national period, some agricultural development programs were initiated include:

- Operation Feed the Nation (1976).
- River Basin and Rural Development Authorities (1976).
- Agricultural Development Project (ADP) which was funded by the World Bank.
- Green Revolution Programme (1980).

It is imperative to note that from the first to the third national development plans, there was observable progressive budgetary improvement to boost agricultural productivity. Olorunfemi and Adesina (1998) observed that there were increasing financial allocation for agricultural development; and the third national development plan had the highest allocation for agricultural development. However, such inconsistent development interest was not enough for transforming rural communities without corresponding investment in rural infrastructures such as motorable roads, electricity, health care, pipe borne water, among several others (Leonard 2006).

THE FOURTH NATIONAL DEVELOPMENT PLAN (1981 – 1985)

The Fourth National Development Plan (1981-1985): This was a civilian government development plan which emphasized among other things the need for balanced development of the different sectors of the economy and of the various geographical areas of the country. Unfortunately, the fourth development plan period was threatened by fall in oil revenues and equally delays in agricultural modernization due to decline in funds in-flow and consequently an increase in the quest for imported foods (Eneh 2008). The plan laid emphases on the need for rural infrastructural development as a means of increasing the standard of living in the rural communities. As a result, the following allocations were made:

- ₦924 million was released by Federal Government for eleven River Basin Development Authorities towards construction of boreholes, dams, feeder roads and jetties.
- Federal and State Government’s allocation of ₦645 million and ₦700.4 million respectively for electrification purposes.
- For rural water supply schemes, ₦2, 805 million was allocated while the local governments in some states allocated a total of ₦311, 824 million for water projects (Olayiwola and Adeleye 2005).

Many local governments and various states governments stated numerous policy issues that could improve the standard of living of the rural dwellers. However, the Fourth national development plan was characterized by huge debt servicing which resulted from various foreign loans obtained in the previous years; increased import bills in the midst of a drastic fall in crude oil export revenue (Iheanacho 2014). However, it is imperative to note that the overthrow of Nigeria’s second civilian administration, the Second Republic headed by President Shehu Shagari, at the end of 1983 and of the military government of General

Muhammadu Buhari in 1985 brought to an end the fourth development plan (Eneh 2008; Ikeanyibe 2009; Lawal and Abe 2011).

1.8 Why Nigeria Development Plan Fail

Although Nigerian developments plans have assisted in moving her forward positively change, however the plans still have various defects:

- **Misplacement of Priorities**

Like the colonial ones, the policies of the post-independent plans also demonstrated a basic lack of urgency. For instance, the iron and steel industry that was in the first and second development plans and was initiated for projected completion during the fourth plan. This characterized a lag of twenty years; however this project was repeatedly acclaimed the cornerstone of Nigeria's industrialization (Ejumudo 2013). Another good examples closely related to the aforementioned include petrochemicals, fertilizers, the petroleum refinery, liquefied petroleum gas and other heavy industries.

- **Systems Corruption**

Nigeria is a country where corruption has been institutionalized and raised to the level of a structural parameter. As a matter of fact, corruption has become part of the value-system of a society, a condition par excellence. It could be stressed that from the strategic corruption of the cement armada to the mega tonic corruption of the second Republic the nation have consciously or unconsciously, created systemic corruption in every sphere of the sector and the trend has continued through the third and fourth republic (Ejumudo 2013).

- **Absence of Relevant Data**

Planning relies essentially on accurate data. It is unfortunately however to note that accurate data is a very scarce commodity in Nigeria due to problems arising from the inadequacies of the federal office of statistics, the disinclination of Nigerians to reveal information and the outright manipulation of data for financial or other gains. Furthermore, due to the challenge of relevant data since independence, government has not been able to as answer the simple question "How many are we in Nigeria?" Unfortunately, a nation that does not know its population would certainly not be in position to determine the other important statistics essential for strategic planning (Ejumudo 2013).

- **Flaws in the Strategies adopted by the Government, particularly in Rural Infrastructural Development Programmes**

The fusion of government activities reveals that since independence, several developmental programmes have been initiated the government to combat rural infrastructural problems, which are far from solving the problem due to flaws in the strategies adopted by the government including; (1) using only the development plans as an instruments for programming resource allocations for different sectors of the economy hence failing to recognise the facts that various rural communities having different ecological situations in Nigeria, differ in the nature and degree of their needs (Okafor, 1985); (ii) duplication of programmes between the different tiers of government (Olayiwola and Adeleye 2005).

- **Inadequate Executive Capacity**

This is one of the greatest problems of development plans in Nigeria in the area of implementation. In reality, it is frustrating to plan the execution of programmes which require the availability of organization, institutions and skills which the economy does not possess and cannot normally be expected to generate during the plan period. Executive capacity also encompasses the existence of knowledgeable contracting firms and basic socio-economic infrastructure including competent hands to run the civil service and allied government machinery (Ejumudo 2013).

1.9 Boko Haram Insurgency and Agricultural Development in Northern Nigeria

Since 2009 Nigeria has been in the grip of a violent Islamic insurgency by the extremist sect widely known as Boko Haram. More than 15,000 people have been killed in Boko Haram attacks across Northern Nigeria with thousand displaced. The insurgency have negatively impacted on agricultural productivity and distribution networks from the north to the southern part of the country and vice versa (Adebisi *et al.* 2016; Kah 2017, Adelaja *et al.* 2019).

Boko Haram literally means "Western Education is divinely forbidden" and therefore should not be allowed to prevail among nations; particularly, Muslim dominated states. This evil group has attacked and destroy churches, mosques, schools, police stations and private and public owned facilities. In fact, Boko Haram is the most dangerous insurgent group in Nigeria which has led to the displacement of smallholder farmers in Northeast of Nigeria and subsequently affects the agricultural development of the region. This insurgency has made many farmers relocate to other places where there is peace in other to save their lives, causing them to leave their farmlands behind as it is not mobile (Adetiloye 2014, Mustapha 2015). The activities of Boko Haram insurgency and the Fulani herdsmen has negatively influence agricultural development in the Northeast of Nigeria and its environs. Honestly, the destructive effect of Boko Haram insurgency in the North East Nigeria continues to be a source of worry to all and sundry.

The menace caused by Boko Haram insurgency in the North has been a great threat to the Nigeria business environment as farming and other business activities are being harmed. Nomadic cattle rarer who have been taking their cattle out for grazing have abandoned their businesses, as the environment is no longer safe for them. The lives of those that are still involved in the agri-business are also at stake, because an attack of Boko Haram can occur at any moment. This has led to decreases in milk production, meat production and by extension an increase in the price of the cattle (Kah 2017). Poultry farmers in the region also do not find their business lucrative anymore, as the people purchasing the goods have been displaced. As a result, this has led to poor transportation, high transport cost, displacement of properties and high risk to lives (Babagana *et al.* 2018).

The evil activities of Boko Haram is not only felt in Nigeria but in some other parts of the Africa. Particularly, the neighbouring countries such as Cameroon, Chad, Niger Republic other countries sharing border with Nigeria in the North East part are also affected. Traders from these countries can no longer come to Maiduguri (Nigeria) to buy or sell. The border was closed some time ago, restricting importation or exportation from the countries which affected their economy (Adebisi *et al*. 2017).

1.10 Approach to Research

This section presents an overview of the research methodology employed in this study. The research is exploratory and descriptive in nature, however it adopts a mixed methods research approach (see methodology chapter 4). A triangulation of data collection method was adopted after conducting an extensive review of relevant literature. The study adopts an interpretivist epistemological stance which stresses the need to comprehend the social world through an examination of the interpretation of that world by its participants (Creswell 2003, Bryman 2004). The research also employs a case study method which allows for in-depth, multi-faceted explorations which is appropriate for investigating contemporary issues in their real-life setting. Collection of data involved three phases including; baseline livelihood survey, 4 focus group discussions (2 with farmers and 2 with extension workers), in-depth interviews with 4 senior extension managers and 4 farmers and an evaluation survey.

In the first phase of the research, a baseline livelihood and farming practices survey was conducted. Focus group discussions, in-depth interviews, GAP participatory training with farmers, extension visit and SMS reminders were conducted in the second phase involving extension workers and farmers. Finally, in the third phase of the research evaluation surveys were conducted utilizing face-to-face questionnaires. This is discussed more fully in the methodology chapter (Chapter 4).

1.11 Thesis Structure

Chapter 1: Introduction: This chapter has highlighted the main challenges facing smallholder farmers in Sub Saharan Africa and extension workers in terms of sustainable agricultural development. The political economy of agriculture in Northern Nigeria. The aims and objectives have also been outlined along with a thesis map.

Chapter 2. Theory and practice: This chapter reviews various literature related to the study from different theoretical perspectives and models. It explores the challenges facing agricultural extension in Nigeria and sets this against the evolution of agricultural extension in developed countries using experiences from the UK and USA as exemplars.

Chapter 3. *Use of ICT amongst extension workers and smallholder farmers.* This chapter explores the use of ICT by extension workers, the key agricultural information needs of farmers and farmer, community and industry engagement based on existing literature.

Chapter 4. *Research strategy* - This chapter describes the methodology, including the epistemological stance and mixed method approaches and discusses the profile of Kaduna State and the two case study communities where the study was conducted.

Chapter 5. *Baseline and traditional extension services - Effectiveness of traditional extension services:* The demographic characteristics of the sample farmers and extension workers are introduced and the study findings relating to current extension services delivery in Nigeria are presented.

Chapter 6. *Impact of GAP training and SMS intervention on technology adoption among smallholder farmers:* Data are reported relating to the situation in the study area prior to the GAP training intervention which is then compared to the level of adoption of the GAP following the intervention and market information.

Chapter 7. *Discussions.* This chapter discusses the key findings in relation to existing studies including the impact of the participatory extension approach on GAP adoption, the impact of SMS technology on adoption of technologies and factors affecting the adoption of improved technologies. Theoretical considerations for the study findings are also discussed and a new model of ICT supporting traditional extension approaches is put forward.

Chapter 8. *Conclusion and recommendations.* Finally, this chapter summarizes the study findings, illustrates the strengths and limitations of the methodology adopted, and notes the significant contribution of the study. It proposes ways of conducting future research in the area to ensure continuity in exploring other new areas.

The Timeline of the study is further illustrated (Figure 1.1)

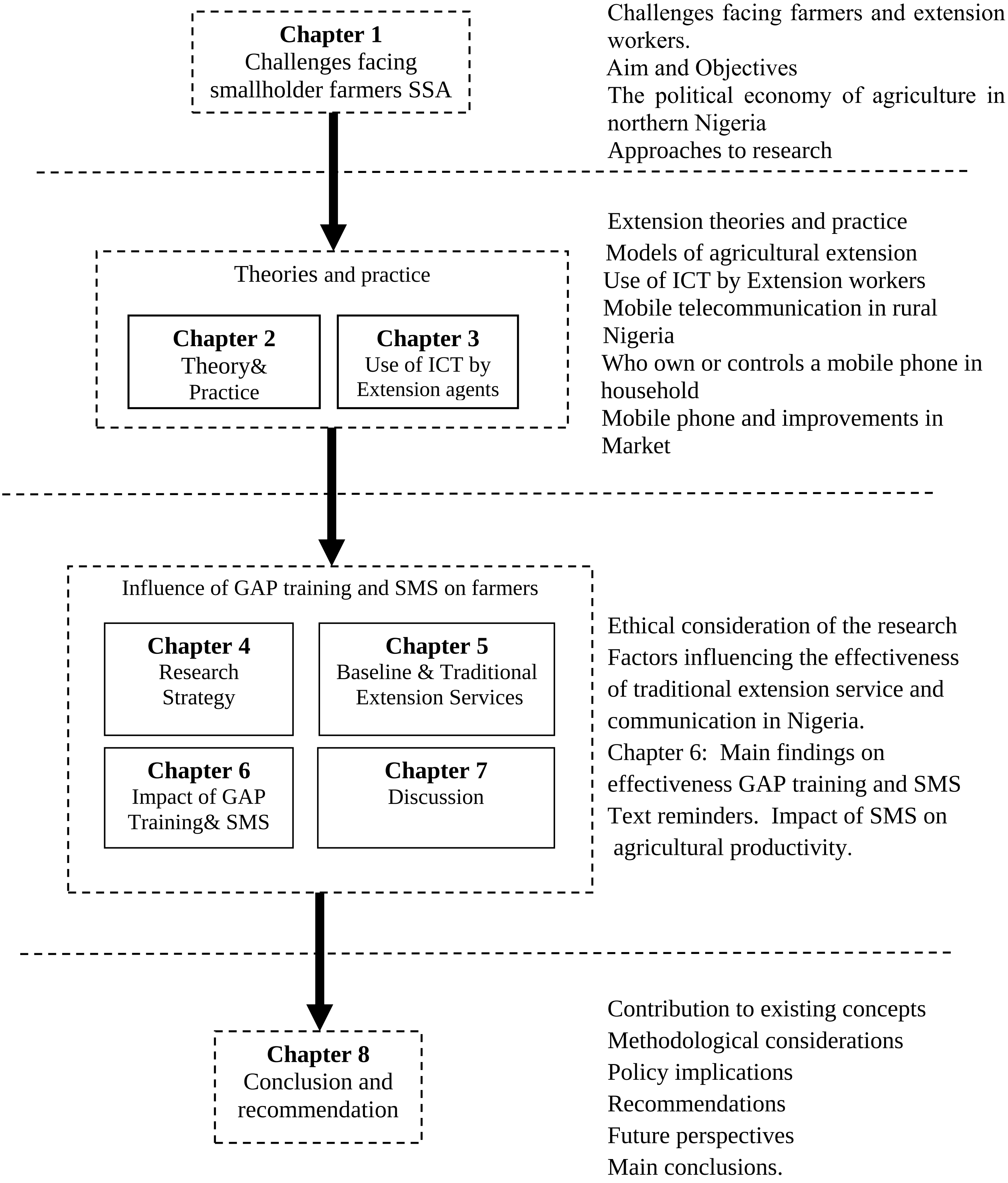


Figure 1.1: The Thesis Timeline

Chapter Two. Extension Theories and Practice

Agricultural extension is one of the enabling processes to roll out agricultural policies within a country. It complements other programmes such as infrastructure support, market development, financial services and new entrant/retirement schemes for example. This chapter focuses specifically on agricultural extension theory and practices leading to a critical review of extension practices in Nigeria.

2.1 Introduction

Agricultural extension services have long been recognized as the most important and critical channel to reach smallholder farmers worldwide (Hassan *et al*. 2011). Extension services have a significant catalytic role in present-day and future world development especially in terms of food security and prosperity (Shinn *et al.* 2009). In addition, extension services are an indispensable mainstay for agricultural development across the globe. Agricultural extension directly influences seven of the United Nations' Sustainable Development Goals (UN 2015). As a result, the fundamental role of agricultural extension cannot be overrated.

Furthermore, Cunguara and Moder (2011) and Chowdhury *et al.* (2014) asserted that agricultural extension services play a significant role in, and are often credited with, improving food security, reducing poverty and improving livelihoods. This assertion was sustained in the work of Ngugi *et al.* (2014) which maintained that participatory extension services are the most effective mechanism and package which assist smallholder farmers by exposing them to various educational techniques that equip farmers by making it possible for them to improve their farming enterprises; cultivation methods; rapidly increase productivity and increase income levels; improve livelihoods; and promote social and economic standards (Anderson and Feder 2004; Baig and Aldosari 2013). The consensus view seems to be that, agricultural extension has a momentous role in: encouraging the adoption of improved technologies and innovations; addressing rural poverty; increasing agricultural (mainly food) production and providing critical access to knowledge. This should lead to enhanced productivity, quality of life and livelihoods (Anderson and Feder 2007; Davis *et al.* 2010; Aker 2011).

Currently, there is evidence from developing countries corroborating the notion that understanding extension services goes beyond the aforementioned roles to also include the subjects of training and learning, technology transfer and helping farmers in forming groups (Davis *et al.* 2010, Chowdhury *et al.* 2014). Agricultural extension services in its broader working sphere now create initiatives dealing with marketing issues, in partnership with a wide range of service providers and other relevant organizations that address farming issues and rural development (Birner *et al.* 2009; Baig and Aldosari 2013).

Extension services have been publicly funded and implemented in Nigeria since the pre-independence era of 1960's through the Ministry of Agriculture. In this traditional system of extension the national government was situated in the department of the regional government, and later adopted by the State Ministry of Agriculture (Okwu and Ejembi 2001). There are changing trends and challenges facing the provision of coherent and quality delivery of extension to farmers that is aimed at ensuring sustainable agricultural development in Nigeria; these are often connected to social, economic and environmental performance (Chowdhury *et al.* 2014). Key challenges include: extremely low extension agent to-farmers ratios; a lack of essential skills for efficient functioning; a lack of a definite plan of work; too few qualified and trained extension staff; under resourced transport and logistics; poor, weak and deteriorated infrastructure; extension organization and management problems; unclear extension mandates; lack of job descriptions for staff; poor remuneration of the personnel; and a high rate of absenteeism among staff (Naswem *et al.* 2008; Anandajayasekeram *et al.* 2008; Baig and Aldosari 2013).

Consequently, in a reaction to the worrisome performance in the agricultural sector, the Government has embarked on several agricultural interventions and reforms, with policies and programs explicitly designed at reinvigorating the sector to its enviable position in the Nigerian economy between 1959 and 2000. These policies are described later (see section 4.1.5)

It is important to note that various extension approaches exist and are increasingly being shown to play essential role in agricultural sector. These extension approaches are related to the extension theories. These are explored in the following section.

2.2 Theoretical and Conceptual Framework

This section provides an exploration of the theoretical context for this study. A number of theoretical models relating to technology adoption and communication are presented and critiqued. These theories are then applied to various extension approaches.

2.2.1 Technology Adoption Theories

Technology can be described as an enabler or a vehicle to dissemination of information, knowledge and skills to smallholders in order to increase agricultural productivity (Rogers 2003). In the same vein, technology adoption could be viewed as a process of decision-making by farmers that requires cognition, i.e. it necessitates the use of an individual's abilities to perceive, comprehend and interact with their environment in an intelligent way (Botha and Atkins 2005, Samaradiwakara and Gunawardena 2014). In order to understand the process of technology adoption, a number of theories have been put forward.

Abdellah (2015) defined theory as "an explanation of a phenomenon or abstract generalization that systematically describes the relationship among given phenomena, for purposes of explaining, predicting and controlling such phenomena". Moreover, the function of theory in research is to identify the starting point of the research problem and to establish the vision to which the problem is directed. According to Roling (1988) extension science evolved from rural sociology and over time extension has become more and more associated with social psychology and communication. Consequently, extension theory helps us to comprehensively understand the contextual factors of the innovation process and provides valuable insights into to the factors that influence adoption and decision-making amongst smallholder farmers. Traditionally, it was believed that all farmers would eventually see the benefits of the new technologies and for this reason adopt them (Irungu *et al.* 2015). However, more recently, theories suggest that adoption is more complex. Samaradiwakara and Gunawardena (2014) reviewed and analysed the most accepted theories/models being used historically and currently for studying technology adoption decisions amongst smallholder farmers. These theories/models include:

- Cognitive Dissonance Theory (Festinger 1957)
- **Diffusion of Innovation Theory (Rogers 1962)**
- Task Technology Fit Model (Strong *et al.* 1973)
- Expectation Disconfirmation Theory or Expectation Confirmation Theory (Oliver 1980)
- **Theory of Planned Behaviour (Ajzen 1985)**
- **Social Cognitive Theory (Bandura 1986)**
- **Technology Acceptance Model (Davis 1989)**
- Model of PC Utilization (Thompson *et al.* 1991)
- Decomposed Theory of Planned Behaviour **(**Taylor and Todd 1995)
- **The Unified Theory of Acceptance and Use of Technology (Venkatesh, Davis and Davis 2003).**

For the purpose of this research study only five theories are discussed here (highlighted in bold above) in order to give a general overview.

The foremost rationale for chosen these five theories as the focus of the study was mainly because they could embrace elements from anywhere and are more relevant and important to this research study and also provides the underlying principles for conducting the study to investigate the research questions. It also provides the background that supports the investigation and offer justification for the study.

2.2.2 Diffusion of Innovation Theory

According to Rogers (1962) and Rogers (2003), diffusion is the process by which an innovation or new idea spreads through certain communicated channels over time among smallholder farmers or members of a social system. The diffusion of new ideas alters the structure and function of a social system, ensuing the consequences that lead to social change (Rogers 2003, Rogers 2004). Roger's "Diffusion of Innovation Theory" has played a central role in extension theory and practice (Roling 1988). Diffusion of Innovation Theory deals with innovation-development stages (Haider and Kreps 2004, Sundstrom 2016). The diffusion research provided feedback to agricultural researchers about the fate of their recommendations. *The theory also provides a basis for creating coherent body of generalisations, without which, the huge body of completed research might be "a mile wide and an inch deep"* (Rogers 1995).

According to Rogers (1995) diffusion is not a single, all-inclusive theory. Rather, it is several theoretical perspectives that relates to the general concept of diffusion; it is a meta-theory (Yates 2001). Researchers identified four factors that influence adoption of an innovation (Rogers 1995, Yates 2001, Botha and Atkins 2005, Nutley *et al*. 2012), including:

- **The innovation itself**: Understanding the nature of innovation and its ultimate goal to the well-being of smallholder farmers and rural community could help to predict the likelihood of adoption of such innovation. In addition, the rate at which innovation is adopted by smallholder farmers broadly depends on the innovation itself, its traits, the personal characteristics of the rural farmers, and the local environment in which the technology/innovation transfer process takes place (Palis *et al.* 2010). However, without an excellent understanding of how an innovation and the potential users (smallholder farmers) interact in their own local setting before and during an innovation process, any attempt by extension workers to transfer an innovation may not succeed. This is a top down approach of innovation diffusion theory and the target users may not adopt the innovation (Rogers 2003). Consequently, effective participation of the rural farmers in the development process of an innovation cannot be overemphasized. Similarly, the fundamental goal of agricultural technology/innovation diffusion among rural community is to improve the welfare of the households, and this is done by validating and promoting the use of agricultural innovation that could possibly enhance crop productivity and farmer's income (Palis *et al.* 2010).

- **The communication channels**: utilized to spread information about the innovation**:** The use of accurate and appropriate channel of communication helps in facilitating and influence the rate of adoption of innovation among rural communities. Therefore, in the opinion of Olajide and Oresanya (2017), the right communication channels have the inherent potential in disseminating timely and up to date information to smallholder farmers. Literature revealed that there are various communication channels employed by researchers and extension workers ranging from mass media, traditional media, print media, on-farm researcher-led demonstrations, farmer-to-farmers information sharing system, community leaders, community broadcasting, modern ICT, interpersonal and small group communication (Ajani and Agwu 2012, Nyambo and Ligate 2013, Ilahiane 2013, Mwombe *et al.* 2014, Kiptot and Franzel 2015, Mingxiang *et al.* 2016). However, Mwombe *et al.* (2014) argued that the use of modern ICT, particularly mobile technology text messaging was found to be very effective and influence the rapid spread of agricultural innovation and subsequent adoption among smallholder banana farmers in Kenya. On the other hand, Kiptot and Franzel (2015) opined that farmer-to-farmers extension is playing a complementary role to formal extension services in facilitating the spread of agricultural technologies and improving farmers' capacities.

- **Time:** Diffusion is a process by which innovation is communicated through channels over time among members of a social system (Rogers 2003). The time taken to propagate the information of innovation may influence the adoption of such innovation among smallholder farmers. Furthermore, the more complex an innovation is, the more likely the farmers have to change their attitude and belief to receive timely information before adopting the innovation. On the contrary, the easier an innovation is for farmers to experiment, the more likely the innovation will be adopted (Palis *et al.* 2010, Saravanan 2013). Smallholder farmers may be classified into categories based upon the time of adoption of innovation as innovator, early adopters, early and late majority and late adopter or laggards (Rogers 1995).
- **The nature of the society** to whom it is introduced or the social system: The local setting of the smallholders to which the innovation is communicated may influence significantly the adoption of innovation. Success of innovation diffusion is subjected to a wide range of factors; the nature of the society, social norms, beliefs, attitude and knowledge of the target users (Palis *et al.* 2010). Therefore the nature of the society of the farmers may influence their decision to adopt an innovation.

However, Agarwal (2000) argues that "the potential users make decisions to adopt or reject an innovation based on beliefs that they form about the innovation or technology". On the other hand, Lee *et al.* (2011) identified five characteristics of innovations theory; the relative advantage, compatibility, complexity, trialability and observability. In the same light, Rogers (1995) illustrates that there are four main theories that concord with the diffusion of innovations. These include; the innovation-decision process theory, the individual innovativeness theory, the rate of adoption theory and the theory of perceived attributes. However, Rogers failed to reveal how knowledge has been acquired. The significant limitation of the theory is that it does not consider the possibility that people will reject an innovation even if they fully comprehend the idea behind the new technology (Waterman 2004). Similarly, inadequate consideration is given to the innovation characteristics and how these change over time (Botha and Atkins 2005).

2.2.3 Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) is one unique case of multi-equation theory that attempts to describe people's cognition. The theory was first postulated by Ajzen (1985); the theory explains why a person behaves in a certain way, takes into consideration available information and considers the resultant effect of their actions (Figure 2.1). In addition, the theory proposes that "*a person's intention to perform (or not to perform) a behaviour is the most important immediate determinant of that action. Basically, the theory predicts a person's intention"* (ibid. 2005). Furthermore, it recognizes and integrates other determinants of behaviour in the conceptual model to account for attitudes, social influence and perceptions over control. The motivating factors are: attitude towards the behaviour, subjective norm and perceived behavioural control. Altogether, they impact on the behaviour of an individual, which depends on the situation under consideration (ibid. 2005). The theory also provides a standard framework to explain the relationship between decision variables. There are three key concepts that determine the intention of an individual, these include: their attitude towards the particular behaviour, their subjective norms and their perceived behavioural control (Ajzen 2005, De Cannière *et al*. 2009). The Theory of Planned Behaviour has strength in describing and predicting technology adoption behaviour of farmers, yet it clearly disregards the eccentricity behaviour as well as the complexities of interconnection between farmers, workers, families and third parties (Ukohal *et al.* 2011 – see later).

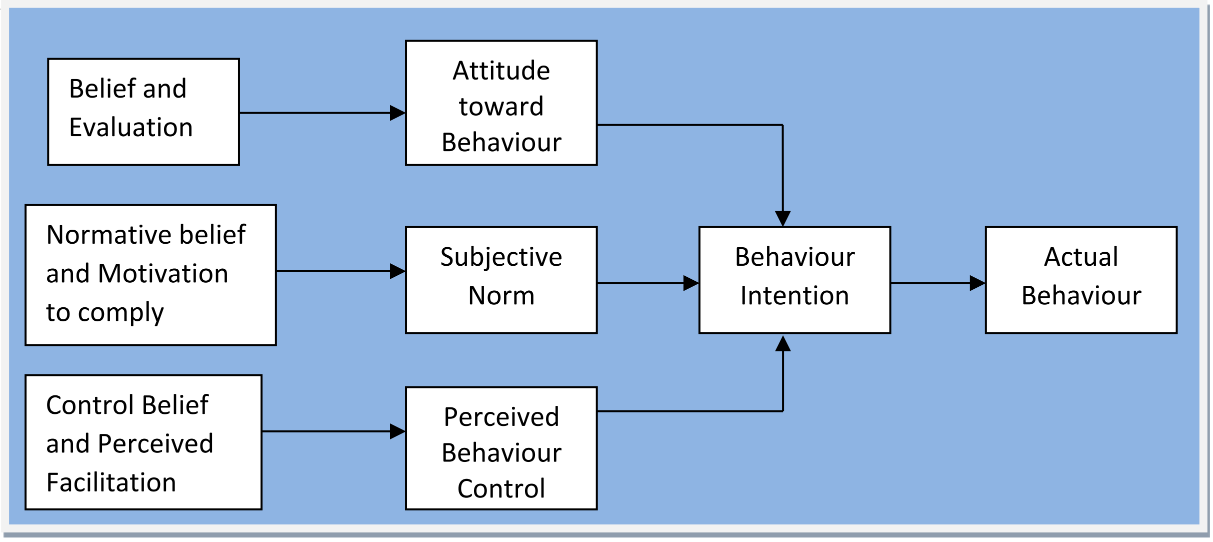


Figure 2.1: Theory of Planned Behaviour (Ajzen 2005)

2.2.4 Social Cognitive Theory

The Social Cognitive Theory was postulated by Bandura (1986) and the theory suggests that environmental conditions, demographic characteristics (in the form of cognitive and affective factors etc), and behaviour are determined communally. Furthermore, studies have shown that variables such as gender, age and experience play an important role in the explanation of technology acceptance and adoption amongst rural communities (Venkatesh and Davis 2000, Colley and Comber 2003, Samaradiwakara and Gunawardena 2014). An individual's cognitive competences influence the behaviour of technology acceptance and adoption and a productive interplay with the technology (Compeau and Higgins 1995, Long 2005). The Social Cognitive Theory gives importance to the concept of self-efficacy; where self-efficacy is defined as the perception of one's capability to utilize a technology to achieving a distinct task (Compeau and Higgins 1995).

Social Cognitive Theory has been criticized for its inadequate to account for age-related development differences, inadequate specificity of cognitive process, failure to clearly explain differences between behavioural competency and performance, and implications that social conformity is a developmentally achievement (Carillo 2015). The theory was also criticized for giving too much focus on the situation and very little explanation around a person's inner traits and does explain a substantive amount of variance in health behaviour (Bandura 2001). Critics also emphasized that the theory focuses on one or two constructs such as self-efficacy while ignoring the others, and is not a fully systematized, unified theory and is also slackly organized (Nabavi 2012, Carillo 2015).

2.2.5 The Unified Theory of Acceptance and Use of Technology

Based on eight other theories and models, another important theoretical model called the Unified Theory of Acceptance and Use of Technology (UTAUT) was proposed by Venkatesh *et al.* (2003). This has four central determinants of intentions to use information on technology; these are (1) performance expectancy, (2) effort expectancy, (3) social influence, and (4) facilitating conditions. All of these are influential and have been theorized in formulating the UTAUT with the core aim of determining user acceptance and usage behaviour on technology (Figure 2.2). These four constructs are defined as follows:

- **Performance expectancy:** the degree to which the user expects that acceptance and usage of the system will help him attain higher yields in agricultural produce (Venkatesh, Davis and Davis 2003). Interestingly, this new construct has five source constructs from the other theories (Technology Accepted Model and Social Cognitive Theory) and models: perceived usefulness, extrinsic motivation (theory/model), relative advantage (theory/model) and outcome expectations (theory/model) (Venkatesh *et al.* 2003, Long 2010).
- **Effort expectancy:** the degree of ease connected with the acceptance and usage of the system.
- **Social influence:** the extent to which an individual perceives that important others believe that he or she should use the new system (Venkatesh *et al.* 2003).

- **Facilitating conditions:** the age and experience of an individual influences the usage of a system. Basically, the moderators of this model are gender, age, voluntariness and experience (Samaradiwakara and Gunawardena 2014).

The UTAUT also provides a refined view of how the determinants of intention and behaviour change over time, however most of the relationships in the model are moderated (Venkatesh *et al.* 2003, Kriponant 2007).

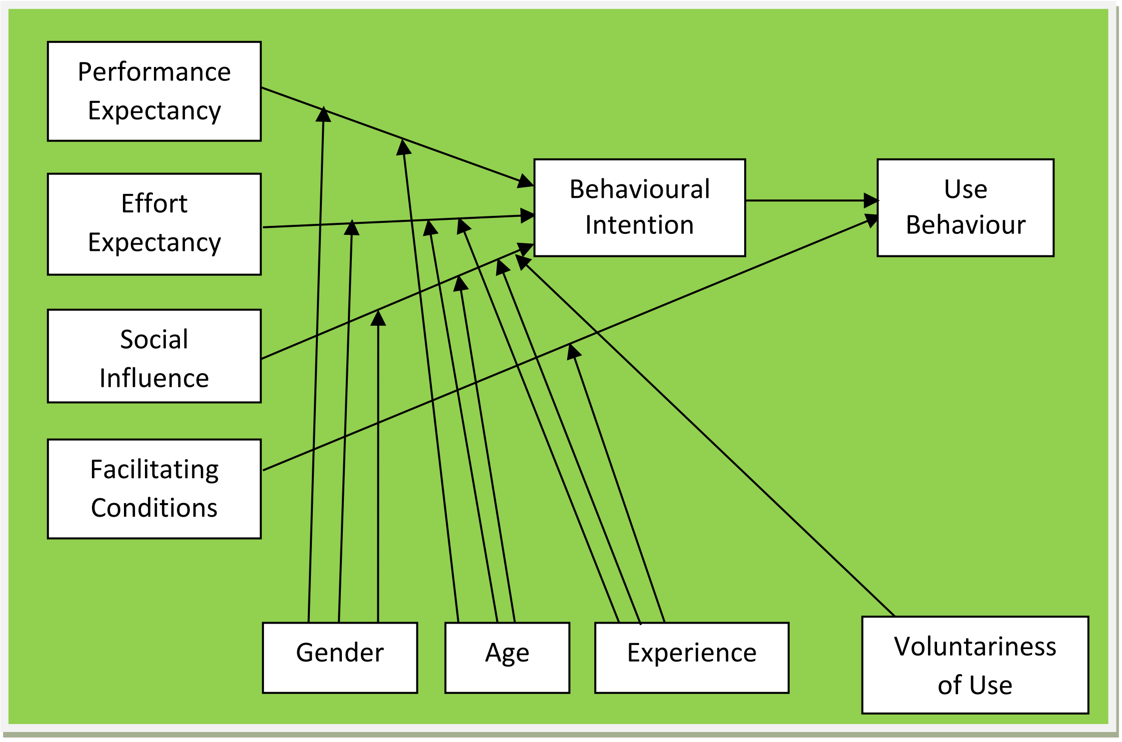


Figure 2.2: The Unified Theory of Acceptance and Use of Technology model (Venkatesh *et al.* 2003)

2.2.6 Technology Acceptance Model

The Technology Acceptance Model (TAM) was proposed by Davis (1989) as the first model to identify psychological factors affecting technology acceptance amongst farmers and it was developed from the Theory of Reasoned Action postulated by Fishbein and Ajzen (1980). The model is an information system theory in which the users (smallholder farmers) come to adopt and put into practice a technology. The TAM argues that when smallholder farmers are presented with a new technology, a number of motivating factors influence their decisions about how and when they will implement and use the technology, primarily:

- ***Perceived Usefulness (PU):*** refers to the degree to which a person believes that using a particular system would result in enhanced job performance and output efficiency (Lederer *et al.* 1998).
- ***Perceived Ease of Use:*** the degree to which a person feels that the technology will need little or no effort determines Perceived Ease of Use (PEU).

Both perceived use and perceived ease of use influence the farmers' attitude towards new technology, which affect the intention to adopt the technology (Venkatesh and Davis 2000, Liu and Ma 2006). The Technology Acceptance Model also suggests that users could choose to adopt a specific improved technology based on individual cost-benefits thoughtfulness (Compeau *et al*. 1999). This signifies that individuals are more likely to adopt or accept technology if there is added value to a process (Figure 2.3).

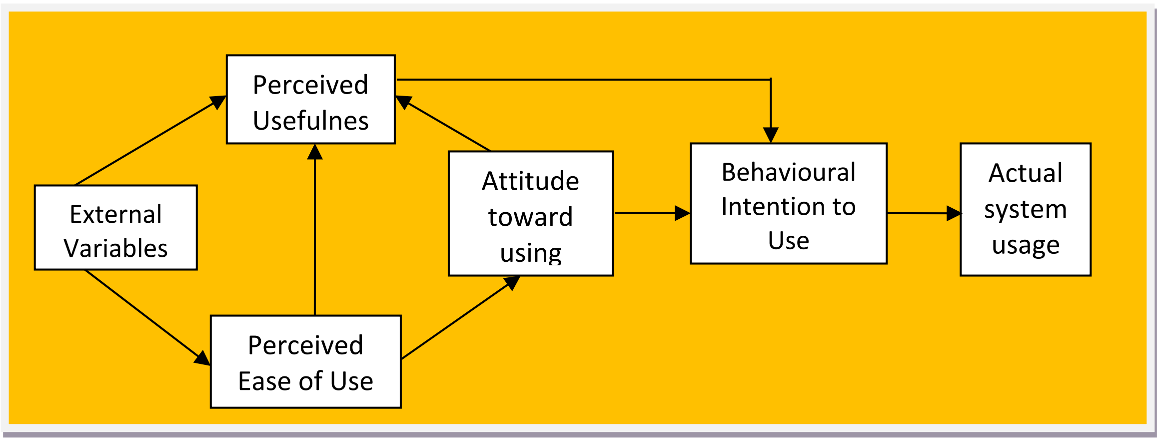


Figure 2.3: Technology Acceptance Model
Source: Davis (1989)

The underlying correlation between two key constructs and users' attitudes, intention and actual technology usage behaviour, were specified using the theoretical underpinning of the previous version of the Theory of Reasoned Action (Davis 1989). In addition, perceived usefulness is likewise seen as being impacted by perceived ease of use (Davis 1989, Venkatesh and Morris

2000). The TAM has been widely studied by many researchers for various technology adoption situations and has perhaps become the most influential theory; It has also been upgraded to the TAM2 and TAM3 (Venkatesh and Davis 2000, Venkatesh and Morris 2000, Plouffe *et al*. 2001, Mathieson *et al.* 2001). According to Venkatesh and Davis (2000) the main contribution of TAM2 was that it incorporates additional theoretical constructs spanning social influence processes (such as subjective norms, voluntariness and image) and cognitive instrumental processes (such as job relevance, output quality, result demonstrability and perceived ease of use). The TAM3 has also been proposed in the context of e-commerce (Wixom and Todd 2005, Venkatesh and Bala 2008). Basically, TAM3 focuses on the determinants that influence Perceived Usefulness and Perceived Ease of Use of an innovation/new technology.

According to Trakulmaykee *et al.* (2015), the model can be analysed as follow:

- **TAM 1:** is the original model which has two factors (Perceived Usefulness and Perceived Ease of Use) to influence users' intention to use new innovation.
- **TAM 2:** has three factors (Perceived Usefulness, Perceived Ease of Use and Perceived Control P). As mentioned previously, the model has three generic perceptions which are two original perceptions from TAM and PCP.
- **TAM 3:** has five factors (Perceived Usefulness, Perceived Ease of Use, PCP, PCP and PAQ), two factors are original factors in TAM and the other three factors are extended factors.

2.2.7 Justification for the Technology Acceptance Model

The adoption theories/models discussed above individually have both user acceptance with some overlapping constructs (Dillion and Morris 1996). This section presents a critique of the main model used for this research study - TAM. The Technology Acceptance Model was developed by Davis in 1989, the theory attaches high importance to understanding the different sets of new technology acceptance and adoption determinants. However, the theory has been widely criticised despite its frequent use amongst researchers, for its questionable heuristic value (approach to problem solving, learning, or discovery that employs a practical method not guaranteed to be optimal or perfect, but sufficient for the immediate goals), limited explanatory value and lack of any practical value (Chutter 2009). Also, TAM is considered to be limited in providing significant information about the users' acceptance of a particular technology and its inability to consider other factors such as time or lack of funds that could hinder an individual from utilizing information and adopting a new innovation (Mathieson *et al.* 2001, Koufaris 2002).

Benbasat and Barkin (2007) opined that "TAM has diverted its attention away from significant research issues and has created an illusion of progress in knowledge accumulation". The author stated further that the independent efforts by many researchers to expand TAM in order to adapt it has led to a state of theoretical chaos and mystification. In the same vein, Lunceford *et al.* (2009) argues that the framework of perceived usefulness and ease to use neglect other important issues, such as cost and structural requisite that force users into adopting the new technology.

Another limitation noted by Chuttur (2009) was that many researchers are uncertain about the application and theoretical precision of the model; as a result, it is persuasive to conclude that research on the Technology Acceptance Model (TAM) may have attained a saturation stage. This suggests future research may focus on developing new models that that would take advantage of the strong points of TAM. Bogozzi (2007) acknowledged specific noticeable limitation of the TAM and emphasised that the model is inadequate in explaining technology adoption by ignoring the societal influence that dictates technology adoption. He stated further that aside from individual perspective that influence adoption of technology, other factors such as user's community, exposure, environment and economic status of the target population can collectively influence the adoption and use of technology. However, Benbasat and Barkin (2007) criticized the TAM for inadequate to accommodate and adapt to the regularly changing Information Technology environment which has led to hypothetical disarray and chaos.

Generally, the TAM has been criticised and the limitations identified by many scholars initiated the development of Unified Theory of Acceptance and Use of Information Technology (UTAUT).

2.2.8 Rationale for the Adopting the TAM

The Technology Acceptance Model (TAM) has been cautiously selected as the main model for this research study. The theory suggests that there are a number of factors that influence the adoption and use of technology among smallholder farmers. As a result, the theoretical grounding for this study is based on the application of TAM. The strength of the TAM in predicting technology acceptance has been claimed to rest on reliable psychological data (Davis 1989). The TAM is gaining recognition among researchers for its capability to understand the relationship between human and technology through the two most important individual beliefs; Perceived Ease of Use (PEU) and Perceived Usefulness (PU) (David 1989, Durodolu 2016). The foremost rationale for adopting the TAM was to apply the theory to guide the study thereby presenting a theoretical foundation for ascertaining the impact of external variables (cultural affinity, social influence, experience, educational level) on internal beliefs, attitude, personal characteristics and intention of the farmers. The Technology Acceptance Model is one of the mostly widely used and validated models for investigating the adoption of improved technologies among smallholders. This tool, developed by Davis is extremely relevant to this study as it explores the adoption of Good Agricultural Practices (GAP) and mobile technology among smallholder's farmers. The TAM has been widely used by researchers in the Information System (IS) to study the adoption of various technologies among rural communities, and TAM has arguably become the most influential theory in the information system theory (Venkatesh and Bala 2008). However, there are a number of critiques to be addressed. In order to address the criticism noted earlier, Venkatesh and Davis (2000) improved the TAM to Extended Technology Acceptance Model (TAM2), which adequately make available a detailed explanation of the key factors underlying judgments of perceived usefulness. The authors incorporated additional theoretical constructs into TAM2 including social influence processes (subjective norm, image, voluntaries and experience) and cognitive instrumental processes (job relevance, output and result demonstrability), which were not available in the original TAM (Venkatesh and Davis 2000). However, the social influences were integrated in TAM2 such as subjective norm and image to influence an individual's perceptions of usefulness in order to overcome the limitations of the original TAM.

The current study would strategically overcome these limitations by using participatory approach in which smallholders farmers actively involved in the GAP technologies development and implementation and perceive themselves as part of the project. This was found to be significant with the perceived usefulness and attitude in the original TAM. Similarly, TAM2 incorporated diverse variables in order to enhance the explanatory power of the original TAM, while Unified Theory of Acceptance and Use of Technology model was developed to address the limitations of TAM2 (Venkatesh *et al.* 2003).

2.3 Education and Early Extension History

This section presents the review of general concept of extension evolution, history and role of extension services in the development process. Agricultural extension in developed countries; using the experience from the United Kingdom and United States are considered as early innovations of extension. In addition, the colonial influence of the UK on Nigeria and the influence of USAID will logically impact extension models in country. The section addresses the evolution of extension in relation to theories and models previously discussed. It also introduces the key actors in the process of extension i.e. academia, government, NGO and the private sector.

2.3.1 Evolution of Agricultural Extension

The genesis of agricultural education could be traced to the era when a movement of early researchers started to relate education to the needs and desires of human beings and the application of science to practical issues. Hence, this became apparent in the establishment of schools which gives prominence to teaching and application of science to agriculture, founding of agricultural societies and publication of agricultural literature in the 17th and 18th century (Ayansina 2011). The first agricultural society was founded in the United Kingdom in 1826 by Lord Henry Brougham, named the Society for the diffusion of useful knowledge, aimed to provide information to all classes of society. In 1843, Rothamsted Agricultural Research Station was established, and in 1845, Royal Agricultural College was founded (Jones and Garforth 1998). Coincidentally, between 1845 and 1851 the Irish potato crop was destroyed by blight, a fungal disease, and extension services were used to assist farmers during outbreaks across Europe.

The term "*extension"* originated in England in 1867 when a system of university extension was taken up by the Universities of Cambridge, London and Oxford and subsequently by other educational institution in England and other countries. The actual use of the term *"University extension"* was first used in 1873 by Cambridge University to describe this particular innovation. The core objective of university extension was to take the educational advantages of the University to common people.

2.3.2 Evolution of Extension in the Developed World: UK and US

Following on from Cambridge, in 1876, the University of London adopted extension and established the London Society for the Extension of University Teaching. The work grow in fits and starts, but quite rapidly overall; hence, by 1902, the two ancient Universities of Oxford and Cambridge had established well over 900 extension centres across the United Kingdom (Jones 2008). As described previously, theories and models are tightly linked to the evolution of agricultural extension which gives accelerated success to the extension system and approaches.

Historically and prior to 1946, extension services were well-known in the United Kingdom as advisory services implemented free-of-charge by the agricultural scientists who were engaged by the constituent county councils with technical and scientific support from agricultural academic institutions (Garforth 2004). In October 1946, under the Agricultural Act 1944, the government's National Agricultural Advisory Service (NAAS) was inaugurated and mandated to make available free technical and scientific advice to farmers in Great Britain, in order to promote agriculture and enhance farm productivity through the adoption of improved technologies and innovations. This initiative was the consequence of government concern that farmers in the country were not really producing abundant food, sufficient to meet the demand of the populace (Garforth 2004; Naswem *et al.* 2008). In response to this, the Ministry of Agriculture provided grants for agricultural academic institutions to make available free advice, and this was given not only to farmers on their farms but also on the University campuses (Dancey 1993).

Counties were grouped into regions with the regional offices sited near the Universities and the regional Director controlling and managing both staff and facilities in his district (Dancey 1993; Bamber 2009). Some academic institutions, like the University of Reading, were encouraged to set up Agricultural Extension Centres to assist in training people so that they could apply what was learned in the classroom in a practical manner (Needham 1998). The main objective of the NAAS was to educate farmers with skills on good farming/agricultural practices and new technologies in order to ensure maximum productivity. The NAAS was highly instrumental in encouraging efficiency within the agricultural sector in England, perhaps because of its complete reliance on well-trained agricultural scientists that had practical experience of farming and were thus able to command respect from farmers (Jones 1994; Hall and Pretty 2008). The available evidence seems to suggest the linkage between the evolution of extension and the behavioural theories and models discussed previously.

2.3.3 UK Models: Development and Advisory Service (ADAS)

Following on from the historical approached discussed earlier, extension delivery in the United Kingdom has constantly gained respect from experts and professionals across the globe (Garforth 2004). Historically, there are two models of extension in Britain namely; the Scotland extension model and the England and Wales extension theory (Ingram 1992). The two models are related to the extension theories. The Scotland extension model is categorized largely by the use of Agricultural Colleges and a central research institute, the personnel of which engages in research, teaching and offering extension services. Meanwhile, the England and Wales extension model is perhaps recognized as the biggest of the extension and advisory services in the United Kingdom; characterized by unique attributes that make a different which has made commercialization of extension services work in the United Kingdom (Naswem *et al.* 2008).

The Agricultural Development and Advisory Service (ADAS) (originally known as the National Agricultural Advisory Service) was established in 1946 as part of MAFF. When extension became more technical and management orientated – many extension officers who were stronger in farmer group organisation and socio-economic development jumped ship to International development (ODA - DfID). Here they had more freedom (and less top down control) and hence developed the now successful livelihoods and participatory development models (DfiD 2015). This is worth including as it informs international development and donor support of development. ADAS was fully privatized in 1997 and broken up through tendering from the National Agricultural Advisory Service from England and Wales (Shao and Bruening 2002; Garforth 2004). The process of progressive commercialization of ADAS actually began in 1986 when it was partly privatized to about 50% cost recovery, following several years of providing free technical and scientific counsel to farmers (Needham 1998; Rivera and Alex 2004). The core mission of ADAS as described on its website is to be "the leading independent provider of consultancy and research to the land-based industries, working across the United Kingdom and worldwide" (ADAS 2015).

The successful transition of ADAS from government agency supplying free services to a commercial company was as a result of two significant factors which actually began in 1986 (Garforth 2004).

First, was the rapid development and performance in the agricultural sector in the 1980s particularly in terms of food surpluses, which was largely due to improved technology in the UK post-World War 2, leading UK farmers to record increasingly high levels of production. UK farmers were producing an impressive excess and the cost of extension services was ever-increasing. Indeed, there was over-production and food mountains to the extent that the government had to think of how to deal with the situation, and concluded that profitable farmers were benefitting more from extension than the nation, and so it seemed right that they paid for the extension services rather than the taxpayer (Garforth 2004). ADAS began charging for the majority of its advisory services, invariably it was partly commercialized, moving from providing free advisory services to cost recovery, and in 1997 the organization became a fully commercial consultancy with very strong technical expertise and contacts with a very high proportion of farmers in England and Wales (Garforth 2004). This new development moved agricultural extension services to a clientele-supported basis (Ingram 1992; Shao and Bruening 2002).

The second reason for the successful transition of ADAS was that the government policy at that time was committed to reducing the scale of government activities. This transformation was more political because several public utilities like telecommunications, water, gas and electricity were privatized during this era (Garforth 2004). The government decided that it would only make available goods and services which private companies were not willing to provide, and other services that are within government parastatals should be contracted out to the private sectors. Furthermore, in 1992 the Common Agricultural Policy (CAP) continued to fund the provision of programs related to the public sector such as support for agricultural prices; market protection; animal welfare; environmental protection and Conservation (Garforth 2004).

However, a chorus of concerns has arisen over the ability of private extension services to meet the needs of all farmers. Critics claim that privatisation of extension system may be at the detriment of some resource-poor farmers. According to Chapman and Tripp (2003) the concerns include the skills and incentives available for the extension providers, the capacities of the farmers to take advantage of a privatised system and contract for the services, and the ability of governments to manage the transition, the fact that some types of services are much more amenable to private provision than others, and no single model is adequate to describe private extension, and the empirical evidence illustrates a range of experience regarding the adequacy of private providers. Indeed, private extension will be more concerned with serving the information needs of only resource-rich farmers because of the primary interest in generating profits (Rivera and Alex 2004).

2.3.4 Extension Work in the United States

In 1890, US launched extension education services and Land Grant Universities. Shortly afterward, the American Society for Extension and University Teaching was established. In the same year, the Universities of Chicago and Wisconsin commenced organizing University extension programmes. It is interesting to note that, the underlying theories and models that were previously discussed were correlated to the evolution of the French National Agricultural Extension service was set up in 1890. The US Land Grant Universities are principally funded by the Federal, State and Local governments (Hillman 1989), and they were modelled on the England and French National Agricultural Extension services to develop the system. From 1890, the Hatch Act funded agricultural experiment stations and various categories of agricultural and veterinary research in conjunction with Land Grant Universities in each state. The Hatch Act became law which authorized the Land Grant Universities to carry out research in scientific agriculture. Additionally, Congress passed the Smith-Lever Act in 1914, which established Cooperative extension services in virtually every county of each state to be operated by the universities (Garforth 2004). The rapid increase in agricultural productivity resulted from the diffusion of innovations theory to American farmers. The rural sociologists (Ryan and Gross 1943) helped to show extension workers how to communicate new technological ideas to famers, hence how to speed up the diffusion process.

The legislation gave Cooperative extension services the mandate to focus on, among other things, extensive education and dissemination of knowledge and skills to improve farmers' and the general publics' awareness of new technologies and innovations in agriculture (Caparoon and Jorgenson 1947). The main purpose of the Smith Act was to assist in disseminating knowledge among the people of the US, providing useful and practical information on subjects relating to agriculture and home economics, in addition to encouraging the application of the same (Caparoon and Jorgenson 1947). These can be closely linked to the underlying assumptions of the behavioural theories and models of extension.

The Smith-Lever Act was modified in order to acknowledge the fundamental role of extension services in research and the following phrase was incorporated: ‘development of practical applications of research knowledge’ recognizing a developing role of extension in research

(Hillman 1989). The Cooperative extension service became the avenue for new agricultural knowledge which was made available through research and experimentation demonstrated among the rural youth and farming communities. The core mission of extension services is to help farmers with the most up-to-date and accurate information so that they may be practically useful to themselves and farm families. This goal was accomplished through demonstration, showing, and practices (Shao and Bruening 2002). The number of extension specialists linked with agricultural colleges increased significantly in all states. Specialists were available in virtually every sphere of agricultural extension and they participated effectively and efficiently in various meetings, assisted by county agents in various special problems (Bicakci and Brint 2005). The specialist facilitated the training of the county agent and spent quality time with them assisting in planning projects, as well as contributing to the preparation of publication and extension bulletins (Caparoon and Jorgenson 1947). Generally speaking, agricultural research and educational activities have been well coordinated by the Land Grant universities perhaps because of its exceptional institutional structure (Hillman 1989).

Following on from the historical approach and models discussed earlier, the Land Grant Model was criticised at the time the grants were established on the grounds of the separation of races in America. For example, in the South, blacks were not allowed to attend the original land grant institutions. According to (Vining 2014) there was a provision for separate but equal facilities, but only Mississippi and Kentucky set up any such institution. This situation was rectified when the second Morrill Act in 1890 was passed and expanded the system of grants to include black institution (Vining 2014). In recent decades, critics claim that land-grant institutions have turned their back on solving the practical challenges faced by the residents of their state and sacrificing cultivating citizenship to the task of training the future workforce in favour of international development and research (Colasanti *et al.* 2009). In addition, university funding models tend to create pressure on academics to chase research grants that are not necessarily local or state based.

2.3.5 Summary of Extension services in UK and US

The concept of extension theories and services was to bridge the gap between farmers and the sources of information through extension professionals. Semana (1998) asserted that this involved both teaching and learning. In the US, an extension agent is a university employee who develop and deliver educational programs to assist people which may not necessarily be just farmers in relation to economic in community development, building knowledge and skills and leadership, but also in addressing family issues and agriculture and the wider environment. Most of extension agents work for cooperative services programmes at land-grant universities (Jones and Garforth 1997); however, extension experts are subject matter professionals usually employed as scientists and university professors in various departments in the land-grant university system and as such may not be proficient in the wider socio-economic issues they may confront.

In England, the Government initially arranged for "practical instructors" at the county level to travel to rural areas and teach small groups of farmers in improved husbandry practices. This was backed up by state run Experimental Husbandry Farms for research, extension and farmer demonstrations. However, ever since privatization of extension in 1997 in England. Private sectors provide on-the-ground advice and support their contracted farmers but are often not engaged in cutting-edge research. They work in the field with farmers, agreeing contracts, supplying seed and offering advice on propagation and good agricultural practices as well as advice on markets and market access. In addition, farmers explore diverse means to access agricultural information relevant to their needs via internet, workshops and conferences/seminars.

2.4 Evolution of Agricultural Extension in Africa

The section presents the evolution of agricultural extension in Africa in relation to the underlying extension theories and models previously discussed. The linkage reiterates the challenges facing agricultural extension in Africa. It also introduced the key actors in the process of extension i.e. academia, government, NGO and private sector.

Africa is the only continent in the world where agricultural productivity is largely stagnant whilst populations grow rapidly, resulting in food insecurity and malnutrition among the populace (Veeman 2004; Madhusudan 2005; FAO 2015). Agricultural production has been limited by various constraints, which include lack of adequate research in science and technology; lack of dissemination of research; ineffective utilization of soil resources; low commodity prices and unstable markets for agricultural products; and storage and marketing issues (Okuneye *et al.* 2003; Sanginga *et al.* 2003; Awoyinka 2009; Saingbe 2010; Awerije 2014).

All these constraints are frequently emphasized by the lack of capital which is fundamental for agricultural development (Kennedy 2005). According to Simpson and Owen (2002) there are six key challenges facing agricultural extension in Africa:

1. Relevance and responsiveness of research to local concerns.
2. Systems learning and the generation of new knowledge.
3. Information flow and farmer-to-farmer communication.
4. Institutionalization and Local Organizational Development.
5. Changes in relationships.
6. The integration of the Farmer Field School into the existing program.

Experience from other parts of the world, particularly in the developing countries of Asia and Latin America, shows that agriculture has been rapidly transformed in recent years into a progressive commercial industry and treated as a full business (Thirtle and Piesse 2003). Investment in the agricultural sector with adequate agricultural information technology has enabled farmers to intensify production and lead to sustainable development which enhances their standard of living as well as contributing significantly to national and rural prosperity within environmental constraints (Ali 2011). This could also happen in Africa if smallholder farmers could be assisted with the necessary resources to intensify their farming activities through increased use/effectiveness of agricultural extension services delivery and information technology. However, agricultural extension is needed in order to help smallholder farmers increase their agricultural productivity and attain sustainable development. There is a general consensus that extension services, if successfully applied, should result in outcomes which include observable changes in attitudes and adoption of Good Agricultural Practice technologies and improve the quality of lives of farming households (Yegbemey *et al.* 2014). Similarly, it has been recognised that effective agricultural extension services could accelerate development in the presence of other important factors such as markets, agricultural improved technology, availability of supplies, production incentives (quality seeds, fertilizers and herbicides) and transport.

Over the years, a number of extension models have been adopted in developing countries to enhance the effectiveness of agricultural extension services and service delivery. According to Anandajayasekeram *et al.* (2008) a model may be defined as a schematic description of a system, or phenomenon that accounts for its known or inferred properties and may be utilized for the further study of its characteristics. Table 2.1 shows an illustrative review of various extension approaches around the world including government driven; private or supply driven; with several extension systems in Sub-Saharan Africa. This emphasises the broad range of extension models that have been implemented in the past or are currently used, ranging from top-down to participatory approaches.

Table 2.1: Typologies of Extension by Various Scholars

Criteria	Rivera (1988)	Axinn (1998)	Gêmo *et al.* (2005)
Top-down	Training and Visit (T&V)	Training and Visit (T&V)	Training and Visit (T&V)
	Conventional	Commodity	Commodity
	University	Educational institute approach	Farmer field schools (FFS)
	Technical innovation		NGO
	Integrated agricultural development program	Cost-sharing	Private sector
			NGO
Participatory	Farming system research-extension	Farming systems research and extension (FSR/E)	
	Farmer information dissemination system		
Contract farming	Commodity development	Project approach	Commodity
Rural development	Integrated development programs		
	Community development		

Source: Adapted from Davis 2008

Currently, there are six basic extension approaches/models in diverse stages of development and implementation in developing countries (Eicher 2007). These models have been structured in a more analytical way around key themes; top down; participatory; demand-led; group versus individual targeting; private sector and free/paid extension services. It is, however, important to note that there is no superlative extension model for a particular country, as several countries are trying to identify the best extension model and as yet, there is no best practice (Davis 2008). The reality is that pluralism of models has been employed in various forms in most countries in Sub-Sahara Africa (Birner *et al.* 2006; Davis 2006; Birner and Anderson 2007; Baig and Aldosari 2013). Smallholder farmers in Sub-Saharan Africa now enjoy a mixture of extension delivery assistance from the public, NGOs and private firms (e.g. seeds and fertilizers dealers). However, the various extension models currently being developed or implement in Sub-Saharan Africa are summarised (Table 2.2) and can be divided into two main types:

- Top down approaches i.e. from international institutions or national governments.
- Participatory approaches that engage farmers.

Table 2.2: Top-down and Participatory Approaches

Top-down Approach	Participatory Approach
National Public Extension Model	Non-Governmental Organisation Extension Model
Training and Visit (T&V) Extension Model	Farmer Field School Model
Private Sector Model	Commodity Extension and Research Model
Fee-For-Service Extension Models	Agricultural Technology Management Agency (ATMA)
	National Agricultural Advisory Services (NAADS), Uganda
	Participatory Demonstration and Training Extension System (PADETES), Ethiopia
	National Agriculture and Livestock Extension Programme (NALEP), Kenya

Source: Author's own

2.5 Top-down Extension Approach

Top-down extension approach is a system whereby agricultural information from the Universities or ministry of agriculture is disseminated to farmers through extension agents and is directly related to the diffusion of innovation theory. This extension structure is known as Transfer of Technology (TOT) through extension workers who are also passive recipients of technology from the researchers to farmers. Top-down methods characterized the United

States extension model, which was also instituted by many colonial governments in Africa (Anandajayasekeram *et al.* 2008). In Africa, the system helps promoting agricultural messages that have been designed and developed by research scientists, with limited input by the ultimate users (farmers) of the technologies. Technologies are spread vertically in the top-down approach (Anandajayasekeram *et al.* 2008).

In most cases, farmers are often persuaded through incentives or forced by authoritarian extension workers to adopt new agricultural technologies. Transfer of Technology models are robustly linked to the Diffusion of Innovations theory postulated by Rogers. This Diffusion of Innovations theory says that technologies are communicated over time among the members of a social system, and adopted according to various characteristics of both the technology and the ultimate end users (farmers) (Rogers 2003, Anandajayasekeram *et al.* 2008). The Roger's Diffusion of Innovations model was focused on a very linear process of technology development. However, Roger's model has been criticized for employing linear technology transfer and for other inadequacies, such as the pro-innovation bias, blame of smallholder farmers for non-adoption and incorrect implementation of technologies, lack of recognition of farmers' vast indigenous knowledge and innovation, and too much emphasises on change agents (extension workers) instead of the users (farmers) of the technologies (Anandajayasekeram *et al.* 2008). Generally, the results of top-down approach to innovation development and diffusion are:

- The adoption rates of technologies remain low on the whole. The technology was not effective and the success in most cases not sustainable.
- The cultural, societal, organizational and power structure at the rural community level are mistreated and neglected.
- Farmers' experiences are not valued. Often, farmers are discouraged and feel inferior.

The following extension models are also distinctive examples of top-down approaches:

2.5.1 The National Public Extension Model

This model was introduced by the US Land Grant system and works on three interconnected processes; agricultural research, extension, and agricultural higher education. However, in developing countries, agricultural extension services have been the exclusive domain of the public sector and government responsibility, while in most developed countries, extension services are mainly privatized (Swanson and Samy 2002) as agriculture becomes more commercial. Public extension deals with a broadrange of policy issues, including: responsiveness; relevance; cost-effectiveness and accountability (Swanson and Samy 2002). The overall objective has constantly been to contribute to the increase of agricultural production and productivity of the rural population (Shinn *et al.* 2009), utilizing mainly a top-down approach, through the Transfer of Technology (TOT). As mentioned previously, this model is strongly linked to the diffusion of innovation theory proposed by Rogers. This theory is known for the linear technology transfer which tends to work better only in the developed nations. Rogers himself moves away from linear technology process with the convergent model in the latest version of his theory (Roger 1995, Rogers 2003, Anandajayasekeram *et al.* 2008). In this model, technologies are generated at research stations and diffused to extension agents who in turn disseminate them to the farmers (Davis and Place 2003); in other word a one way transfer of information.

The information flow from the Ministry of Agriculture is absolutely supply-driven and not area-specific (Raabe 2008), meaning that in most cases the technical knowledge transferred into the field is distorted, outdated and often wrong for the specific situation. Thus, farmers see the quality of the information provided by the public extension staff as a major shortcoming (NSSO 2005), where a top-down approach continues to hinder the full potential of the extension service delivery system (Hall *et al*. 2000; Raabe 2008). Under the Ministry-based extension model, smallholder farmers' access to extension is also an issue, because of the low level of outreach by public extension services. The public extension model often has little to offer in terms of messages to a large section of the rural population. In fact, there is no specific answer to farmers' problems because it has not been a research concern to reach the farming community (Eicher 2007).

As a result, public extension came under attack in the 1980s because of the cost of financing it coupled with condemnations of insignificance, inefficiency, ineptness and lack of equity (Rivera 2001). In addition, the current ratio of extension agents to farm families is extremely low in most developing countries and this has been a continual threat to efforts in achieving food sufficiency. In Nigeria, for example, the current ratio is 1 to 3000 farmers (Oladele 2015). However, in Lagos state, Nigeria, Ogundele (2016) reported that the ratio is 1 extensionist: 10,000 farm families. These ratio are far higher than the ratio of 1:500 recommended by the World Bank. Ideally, the ratio should be 1:200 farmers within a cluster so that they can make a meaningful impact by effectively teaching and monitoring the farmers' progress (Ogundele 2016).

Since the mid-1980s, agricultural extension has become a "pluralistic" method (Birner and Anderson 2007); public extension leaders have recognized the interdependent economic and social roles of NGO and private sector extension models in agricultural and rural development projects. The new ideas include decentralization; cost-recovery; outsourcing and involvement of other key stakeholders (Ferroni and Zhou 2012). According to Swanson and Samy (2002), collaboration among the three key stakeholders to effectively work together in partnership for the development of the agricultural sector and rural community (Figure 2.4).

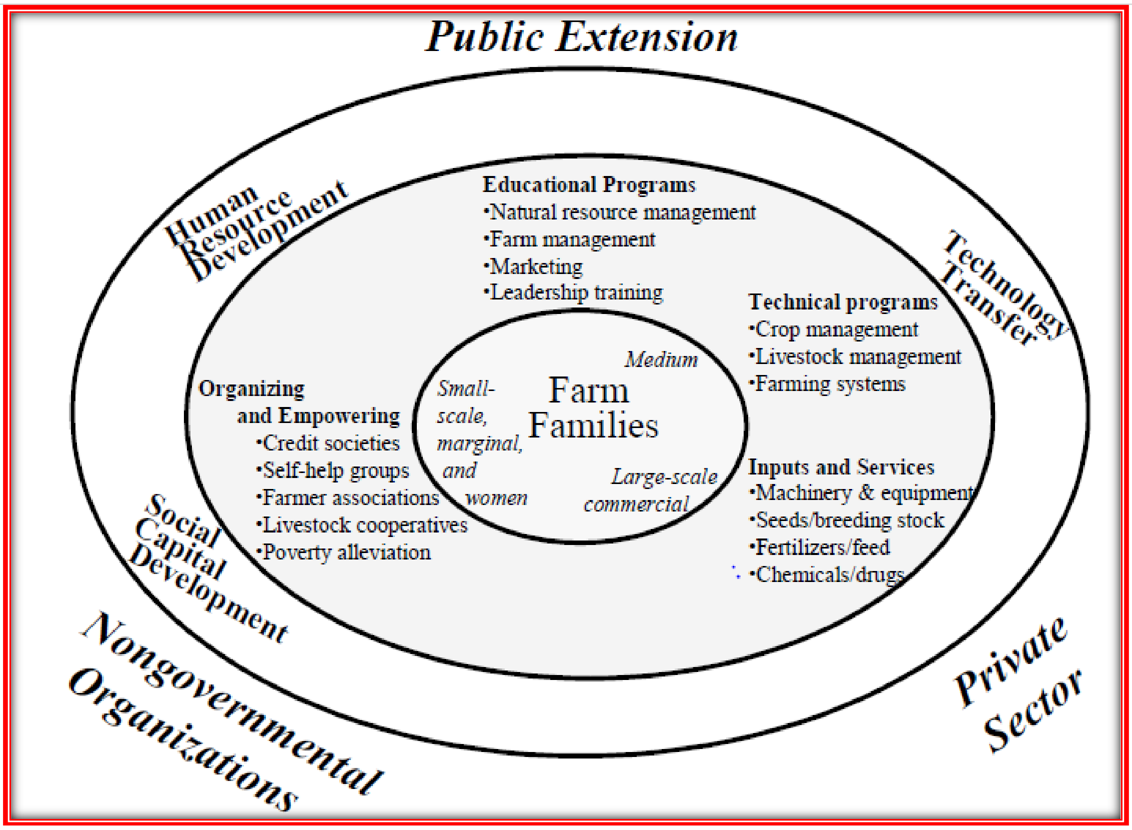


Figure 2.4: Conceptual framework depicting a Public, Private and NGO Partnership Adapted from Swanson and Samy 2002

This model also describes the partnership between the key players in agricultural extension and advisory services for sustainable agricultural development. The major responsibility of public extension is typically human resource development, technology transfer and educational programs in order to complement the social capital development of NGOs and the role of private sector extension model (Swanson and Samy 2002; Figure 2.4). In developing countries, there is a lot of collaboration between private sector, government, non-governmental organization and international donors to address food security issues and sustainable development.

Many Public extension models employed the Training and Visit (T&V) delivery system to perform its activities. The T&V system has been adopted by more than 70 countries around the globe (Umali and Schwartz 1994). The system employed a traditional approach in which research findings are transmitted to farmers through extension workers after training. The predominant one-way paradigm of technology transfer which is insufficient for addressing complex agricultural problems has been widely criticized (Chambers and Jiggin 1986; Roling 1988; Mattock and Steele 1994). According to World Bank (2010), public extension is incapable of serving resource-poor farmers due to inadequate linkages between research and extension; inadequate finance support; and poor human resource and facilities. In addition, the system's designer stressed the following characteristics: a single line of command, with several tiers of management between the field and supervisor; in-house technical expertise, whereby subject matter specialists are to provide training; exclusive dedication to information dissemination; and, a seasonal workshop with research personnel among others (Anderson and Feder 2003). The T&V model has proven to be financially unstable in many cases (Anderson *et al.* 2006).

There are several criticisms against the public extension model due to its inefficiencies and poor formulation and implementation of extension programmes (Ayansina 2011). In the same vein, Richardson (2005) enumerated other problems of traditional extension model. These include:

1. Failure to meet the needs of smallholder farmers.
2. Poor funding and extremely weak government commitment.
3. Inadequate human resource capital.
4. Lack of continuity of most of the government projects, which resulted in non-sustainability of these projects (Benor *et al.* 1984).
5. Non-involvement of farmers in the planning and technology development. Indeed, the services are supply driven rather than demand-driven. Farmer are not allowed to participate in technology planning.

Following the above review of the past extension models and current thinking in extension, the extension models employed in some selected Sub-Sahara Africa are summarised (Table 2.3).

Table 2.3: Extension models in some selected Sub-Saharan Africa countries

Country	Current Model (s)
Angola	Rural Development and Extension Programme; FFS
Benin	Participatory management approach; decentralized model; FFS
Burkina Faso	FFS
Cameroon	National Agricultural Extension and Research Program Support Project; FFS
Ethiopia	Model based on SG-2000 approach: Participatory Demonstration and Training Extension System; FFS
Ghana	Unified Extension System (modified T&V); pluralistic with NGOs and private companies part of the national extension system; decentralized; FFS
Kenya	Pluralistic system including public, private, NGOs; FFS; stakeholder approach (NALEP): sector-wide, focal area, demand-driven, group based approach
Malawi	Pluralistic, demand-driven, decentralized; "one village one product;" FFS
Mali	Modified T&V; both private and parastatals services for cotton; FFS; SG-2000
Mozambique	Government-led pluralistic extension; FFS
Nigeria	FFS; participatory; SG-2000
Rwanda	Participative, pluralistic, specialized, bottom-up approach; FFS
Senegal	FFS; government-led demand-driven and pluralistic system; FFS
Tanzania	FFS; group-based approach; SG-2000; modified FSRE from Sokoine University of Agriculture's Centre for Sustainable Rural Development; private extension; decentralized Participatory District Extension; pluralism
Uganda	Pluralistic; National Agricultural Advisory Services (NAADS) is demand-driven, client-oriented, and farmer-led; SG-2000; FFS
	Participatory Extension Approach; FFS

Source: Adapted from Davis 2008

2.5.2 The Training and Visit (T&V) Extension Model

The Training and Visit extension (T&V) system in agriculture extension was conceived for building a group of professional extension personnel that is capable of guiding farmers in agricultural production and raising their productivity and income through appropriate, effective and efficient planning. The principle of the model was to create a professional agricultural extension service which has the perspective of supporting farmers to increase production and incomes and also deliver proper advice, assistance and support to the farmers for agricultural productivity and rural development (Naamwintome and Millar 2013). The T&V model of extension was promoted by the World Bank in the 1970s as a national public extension system (Umali and Schwartz 1994). The T&V model was implemented through field demonstrations, farm visits, group and individual meetings. The T&V model expended about three billion dollars of donor assistance over the 1975 to 1995 period (Anderson *et al.* 2006; Eicher 2007; Anandajayasekeram *et al.* 2008).

According to Ilevbaoje (2004) the T&V model was characterized to be a single line of command; supply-driven and top-down approach; promoting agricultural messages that had been planned and developed by research scientists, while farmers (technology users) were usually not involved. Recommendations were sent down to farmers for adoption; it focused on effective training and visiting the contact farmers; time-bound work; field and farmers' orientation; consistent and regular training and strong linkages with agricultural research institutions and devotion primarily to extension work. The T&V model is centralised in a manner that the subject matter specialist would visit a group of "contact farmers" from surrounding villages on a fortnightly training session schedule (later every month) to train them and provide the most up-to-date information (Davis 2008; Ashraf *et al*. 2009).

The T&V extension model forbids front line extension officers from selling seeds and fertilizers, and instead places the emphasis on professionalism. Extension agents are required to concentrate on introducing improved technologies and innovations and training is provided regularly and continuously at all levels and field and farmers' orientation should be maintained (Ashraf *et al*. 2009). The T&V system was found to very effective in disseminating Green Revolution technologies, particularly irrigated areas in Asia (Davis 2008). However, the T&V extension model was criticized for being top-down; too rigid; labour intensive, and too expensive as it involves high levels of recurrent expenditure; many countries saddled with huge debts; autocratic in appearances and the one-way flow of innovation and information; thus, the system was irrelevant, unproductive and lacked equity (Reijntjes *et al.* 1995; Rivera 2001; Mengal *et al.* 2014). It is often referred to as "training and vanish" (Anderson 2007). Additionally, the withdrawal of the World Bank support from the T&V extension model confirmed that the model was financially unsustainable (Anderson *et al*. 2006).

In Kenya and Somalia, T&V was perceived slightly satisfactory (Gautam 2000) meanwhile in Rwanda and Cote d'Ivoire, T&V was considered unsatisfactory. However, it was successful in Kenya because the government put enabling environment in place such as provision of infrastructure, most notably improved roads. Better roads can reduce transaction cost associated with agricultural activities including travel for extension officers. Also, public investment can play several roles in creating the enabling environment necessary to stimulate agricultural growth. For instance, by providing agricultural extension services, advise them on best farming practices, and assist them in dealing with adverse shock such as insect infestation and plant disease.

Similarly, in a study conducted in Ethiopia, Dejene (1989) found out that in the Training and Visit (T&V) extension model communication system from contact farmers to the non-contact farmers in the villages did not work as effectively as anticipated; the author reported further that about 25% of contact farmers did not have the essential knowledge, skills and ability to disseminate the information acquired to the wider farming community (Dejene 1989). Likewise, in Cameroon evidence from a pilot study confirmed that merely 20% of respondents had contact with the extension workers, and even they found it extremely challenging to apply the knowledge acquired (Davis 2008).

In Nigeria, Asiabaka and Bamisile (1992) argued that a lack of communication skills, transportation issues, extension to farmer's ratio and cultural barriers contributed significantly to the failure of the T&V extension model. Historically, Nigeria adopted the World Bank assisted T&V system as the major approach for agricultural extension delivery to increase agricultural production and spread the benefits of improved farming techniques more widely to farmers nationwide. Undoubtedly, during that era T&V was comprehensively tested, monitored and evaluated in the country (Adejo *et al*. 2011). The central objective of T&V extension approach was based on transforming and improving upon the efficiency of the traditional agricultural extension system in the country. In Nigeria, the T&V extension model was implemented typically by the public-sector agency namely; the Agricultural Development Project (ADP) which was directly responsible for the dissemination of extension and advisory messages to farmers. ADP is the last chain of command, possibly the most significant element in the T&V management system of an extension in Nigeria (Fabusoro *et al.* 2008). The ADP adopted the T&V system though with modification after a while. The T&V is combined with the Unified Agricultural Extension System where extension workers are trained for necessary skills and knowledge in all enterprises of agriculture. The in-service training was organized by the ADP on a fortnightly basis to equip village extension agents with skills to prudently impart information to the farmers (Issa 2008; Fabusoro *et al.* 2008).

2.5.3 The Private Sector Model

The private sector assists in providing input and transfer technology to farmers and develops a sustainable and profitable business, selling extension services which go beyond the traditional mission of providing production technology to include market services and linkages (Ferroni and Zhou 2012). The private sector employed a marketing strategy of selling their products and extension services as one efficient package. Agro-dealers and input suppliers frequently provided vested advice and delivered extension services to farmers for productivity growth and improved links to markets (Ferroni and Zhou 2012). These relationships will sustain in the long run and give benefits to both parties. The private sector also provides extension as part of sales or stewardship schemes to ensure appropriate use of their inputs. Moreover, the private sector strategically maintain farmers' profiles and records centrally and provided solution packages targeted to the farmers according to their profiles. They maintain records of activities for each contact farmer. However, in the context of public extension services such practices are not available due to a large number of farmers serviced (Gemo *et al.* 2005). The private sector model is sturdily correlated to the top-down, transfer-of-technology model of technology dissemination, many following the theory of Diffusion of Innovation.

Adebayo (2004) identified three main advantages of private sector extension models from fund providers' and farmers' perspectives. These are:

a. Efficiency, that is the competition and decrease in public funding, leading to substantial reduction in costs which the private sector paid for.

b. Flexibility: the government and clients have a choice of service providers.

c. Accountability: the relationship provide transparent and levels of service.

In the same vein, the key issues in private sector participation in agricultural extension services have been identified by Adebayo (2004) including confusion due to a multiplicity of services providers, primarily due to the array of knowledge and information system; credibility of information sources and conflict of interests. Furthermore, sustainability is a crucial factor and the sustainability of the private sector in extension service delivery requires a completely new orientation among staff members who will deliver the service.

This model has been spreading around the globe especially in the very industrial countries like the Netherlands, New Zealand, and the United States, and more recently in some middle-income countries such as Chile and unindustrialized countries such as Uganda (Eicher 2007). Under this model, the farmer is anticipated to pay some of the cost of extension delivery services acquired with the expectation that public expenditures on the extension could be reduced (Anderson and Crowder 2000; Eicher 2007; Anandajayasekeram *et al.* 2008). However, there is no concrete evidence from the literature that smallholder farmers could pay for the extension advice which perhaps could help them alleviate extreme poverty (Anderson 2007).

2.5.4 Fee-For-Service Extension Models

Fee-for-service extension is provided by both public and private initiatives whereby farmers pay for extension services in an approach that makes services more affordable while minimizing long-term risks inherent in the credit model (Anderson and Feder 2005; Aker 2011). In this model, a small group of farmers normally contract extension workers with specific information and service requests. The fundamental goal of this extension model is to deliver the most up-to-date and appropriate information to the right farmer or a group of farmers via the formation of a demand driven extension service system which is cost effective, efficient and of high quality (Umali and Schwartz 2000, Foti *et al*. 2007). This model originated from New Zealand in 1986 where it was totally privatized. The UK's advisory services, ADAS, initiated a system of charge in 1987 and became full private sector company in 1997 and began cost recovery efforts (Garforth and Jones 2008). The Fee-For-Service (FFS) model does not only provide feedback to farmers but also makes available additional sources of profits to a public extension. However, charging for extension services will obviously ensure that the service is getting to those farmers or the groups of farmers that are actually interested in the information and would also implement the practice (Foti *et al.* 2007).

In an empirical study conducted in Zimbabwe, Mitei (2001) found that when farmers pay for the services rendered to them, the attendance and application rates was greater than 70%. Additionally, some scholars have argued that globally paid extension services is not in the public interest, nevertheless, there is a perfect combination of public, private and paid extension services (Hanson and Just 2001; Davis 2011). The challenge envisaged with this type of model was that subsistence farmers especially the poor-resource farmers may not be able to purchase services (Anderson and Feder 2005). It was suggested that farmers should be categorised, thus permitting the commercial farmers to purchase services while the resource poor farmers be given adequate service by public extension agents. This is certainly related to the diffusion of innovation approach (Davis 2011).

2.6 Participatory Research Methods

Participatory research is a methodology that deals explicitly with the relation of knowledge and action. The term Participatory research was coined by Farrington and Martin in 1987. Ever since then participatory research has been making significant impact among the rural communities. Participatory research methods can simply be defined as the process of doing research in collaboration with the smallholder farmers or community members (Okali *et al.* 1994). It treats smallholders as research participants rather than consumer of new technology. Participatory methods is smallholder farmer-centred in the sense that the process of critical inquiry is informed by and responds to the experiences and needs of people involved (Brown

1997). A participatory research method is viewed as a potential source of change and empowerment for the smallholder farmers.

Consequently, participatory research empowers smallholders by involving them in the knowledge creation process (Cornwall 2008). According to Bentley (1994) smallholder farmer participatory research can be defined as "the collaboration of farmers and scientists in agricultural research and development". However, in participatory research methods the emphasis is on a 'bottom-up' approach with a focus on locally defined priorities and local perspectives (Cornwall and Jewkes 1995). Therefore, involving smallholder farmers as participants in research and planning has been shown both to enhance effectiveness and save time as well as funds in long term. Participatory research approach emerged as a response to the limitations of earlier top-down approach (conventional research), such as on-farm and farming systems research and the ''Training and Visit extension model'' that often failed to deliver significant improvements among smallholder and poor rural dwellers. In the same vein, participatory research methods addresses the inadequacies inherent in the top-down approach by actively involving smallholder farmers in the research process, integrating their views and representation into priority setting, reviews, research dissemination and how results should be used for the benefit of smallholders and community members (Chaniei 2015).

McTaggert (1997) argues that the goal of participatory research approaches is social transformation. As a result, we are particularly interested in how knowledge affects behaviour and how behaviour affects knowledge. Consequently, it is not enough simply to elicit and appreciate smallholder's knowledge; we also need to link that knowledge to definite behaviours and vice versa (Bellon, 2001). According to Ton (2005), in participatory research there are two directions: a pragmatic direction and a political direction. In the pragmatic approach participatory research is seen as a way to strengthen the cooperation between smallholder farmers and researchers in order to produce more appropriate technologies that will improve the standard of living of farm families. Therefore, farmers are able to communicate their needs to the researchers and the researchers can develop solutions in collaboration with the farmers. Meanwhile, in the political direction participatory research could be define as an approach to create social change in the rural community. In participatory approach, smallholder are the principal decision-makers at all stages of the process, including defining goals, planning, prioritization, setting of research objectives and problem-solving capacities. Technology development process, adoption and use of technology need to be tailored to meet their specific needs and conditions of smallholder farmers, who live in complex, risk prone environments (Chanie 2015).

It is imperative to note that this approach fosters on greater efficiency and effectiveness of research investment and contributes to a process of empowerment of resource poor farmers. However, there are various strategies currently developed and practise at a wider scale to form strong alliance with smallholder farmers in the process of making agricultural research and extension client oriented and demand-driven including; Farmers' Field Schools (FFS), Participatory Rural Appraisal (PRA), farmer-to-farmer extension, Participatory Technology Development (PTD), Farmer's Training Centres (FTC), farmer participatory research (FPR), Farmers Extension Group (FEG), Agroecosystems Analysis (AA), Participatory research and extension approach (PREA) (Mweri 2003; Ashby and Lilja 2004; Conroy and Sutherland, 2004; Chimbol *et al.* 2005; Gonsalves *et al.* 2005; Kamara *et al.* 2008). These approaches, can effectively deliver scientific research oriented to smallholder farmers, empower local ownership, as well as boost improved technology adoption (Okeoghene 2013). For instance, Participatory research and extension approach has been successfully utilised in Nigeria to improve weed management (Chikoye *et al*. 2007) and control Striga hermonthica (Kamara *et al.* 2008).

2.6.1 Importance of Participatory Research

Nowadays participatory research has become a widely accepted strategy for conducting research among smallholder farmers and currently creating great news in Sub Saharan Africa (Chanie 2015). For example, in a study conducted in Kenya among maize and livestock production subsistence farmers, Chimdo *et al.* (2005) highlights the benefits of Farmer Field School (FFS) to includes, increased in household food security, increased in income of farmers from high value crops; increased adoption of technologies; technical and financial empowerment of farmers and an increase of farmers' participation in extension system in spite of illiteracy levels. In the same vein, Ashby and Lilja (2004), enumerated the benefits of Participatory Plant Breeding (PPB) among resource poor women in Ghana including; increased effectiveness of reaching women and the poor, improved research efficiency, varieties developed being more acceptable and adopted faster, and changed costs without lowering cost-benefit ratios.

A very important purpose of participatory methods is the empowerment of rural dwellers and other resource-poor community members. Abera (2001) showed that smallholder participation in research enhance income of participant farmers. In his research paper, the author indicated that participants were able to tactically increase crop yields and seasonal incomes. With this additional farm income, they have been able to purchase more oxen, increase their level of investment in farm production and improve overall household income (Chanie 2015). Another benefit of participatory research as indicated by FARM-Africa (2001), was that participatory research methods brought a vast, positive change in attitudes and behaviour of rural farmers and their farming system, as well as among researchers and extension workers, combine with the wide spread of practical experience and appropriate knowledge. According to Chimdo *et al.* (2005) participatory research improves communication and information exchange thus improving social relations and empowers resource-poor conditions. Participatory methods have been used to empower stakeholders in ways that conventional development approaches do not.

2.7 Participatory Extension Approach

Participatory extension is basically a combination of technology transfer, advisory services and human resources development and involves two main elements. The first element addresses how extension systems are organized and emphasizes the fact that smallholder play significant role in shaping extension programmes, and also take ownership of the extension programme and operations. The second core element includes more participatory extension such as farmers-to-farmers exchange and experiential learning. It highlights that knowledge is acquired through interactive processes that include extension agents and progressive smallholder farmers.

In the same vein, the term participatory extension approach could be defined as involving the ultimate users and rural communities in all stages of the development process (Narayan 2016). Participatory projects contribute to empowerment of the individuals and communities involved in the project. Cummings (1995) defines a participatory project as one initiated and owned by the beneficiaries. On the other hand, the reputation of participatory extension models is based on the presumption that they eradicate the weaknesses of the traditional "top-down approach" to research and development (Anandajayasekeram 2008). The input of the ultimate users and beneficiary are highly valued in participatory approach and are related with increasing the respect for and incorporation of farmers indigenous knowledge in every aspect of the development project.

The significant features of the participatory approach include putting emphasis on people rather than things, it is also a decentralized system which ensure involvement of the key stakeholder in problem solving and implementation, empower the participants, to value and work on what matter to the beneficiary (subjective perspective), and also learn from the recipient rather than to teach them (Anandajayasekeram 2008). Similarly, farmers facilitated by outsiders where extension agents encourages farmers to share knowledge and experiences. This approach is distinctively related to TAM3 model, a modified version of the TAM proposed by Venkatesh and Bala (2008). The participants (farmers) also involved in the problem identification, decision making, implementation, monitoring and evaluation. The following extension models are examples of participatory approaches:

2.7.1 The Farmer Field School Model

The Farmer Field School (FSS) extension model emerged in 1989 and originated from Indonesia and the Philippines during the rice mono-cropping farming era when extension agents offered advice to a group of farmers on a strategy to control pest in irrigated rice farming using Integrated Pest Management (IPM). The FFS extension model is a participatory methodology of technology development and dissemination, which gives the farmers an opportunity to learn practical field activities. The members of the group fund the school and the group tend to show high levels of ownership. FFS was remarkably active in reducing insecticide use in Indonesia and Philippines (Feder *et al.* 2004). Around 70 developing countries are currently using the model and found it very effective and efficient for extension delivery services (Eicher 2007). The FFS model had successfully produced about 4 million competent graduated farmers by mid-2000s according to Braun (2006). FFS is strongly correlated with Technology Acceptance Model (TAM) theory with long-term development achievement.

The FFS model has intensive training activities which utilize participatory methods to assist farmers to develop their analytical knowledge and skills, critical thinking and creativity and; as a result, help them learn how to make healthier and better decisions, not only in their farming operations but also in their daily activities (Kenmore 2002; Anandajayasekeram *et al.* 2008), at least once a week on the farmland of a member. There are usually between 20 and 2). FFS is an informal school within the farmers' location, a school without a wall, community-based learning where alike-minded group of neighbouring farmers gather together periodically 5 farmers in attendance with facilitators during the crops and animal cycle.

However, Anandajayasekeram *et al.* (2008) outlined some challenges encountered in implementing FFS in the developing countries including; inadequate exposure of research and extension personnel to the concepts and procedures of FFS; competition and conflict of interest between different donor agencies; sharing of proceeds from the school approach; lack of coordination of FFS activities at the national level in Kenya, gender inequalities and low level of participation and the involvement of policy makers. In Nigeria, the FFS approach gained acceptance and became the foundation of field based food security programmes (Dimelu and Okoro 2011). Various FFS's are established in many states in Nigeria, although, the attributes, prospects and implementation and constraining factors have not been evaluated (Dimelu and Okoro 2011).

2.7.2 The Non-Governmental Organisation Extension Model

NGOs are recognized for being relatively well endowed with financial resources for their programs and their crucial role in agricultural and rural development has been largely acknowledged by experts (Swanson and Samy 2002; Davis and Place 2003; Swanson and Rajalaht 2010). Giving the dwindling public extension services, a number of national governments and international donors view NGOs as more effective and efficient in rural community mobilization (Swanson and Rajalaht 2010). Moreover, NGOs have great mobility and drive for bottom-up approaches and play an increasingly significant role in agricultural research and extension in less developed countries especially in localities where the institutional infrastructure is weak (Mattock and Steele 1994). In addition, NGOs are filling a critical gap and offer considerable services in the area of agricultural development and rural community development. NGOs often utilize a “Farmer First” extension service approach; a participatory, demand-driven and client-centred approach, which perhaps explains why they have been more effective and efficient than a top-down approach to the Transfer of Technology (Davis and Place 2003). The opposing approaches of farmer first and Transfer of Technology are summarised (Table 2.4). The participatory approach of NGOs explicitly aims to enable smallholder farmers to become self-teaching experimenters and to train peers (Anderson 2007; Ferroni and Zhou 2012).

Table 2.4: Philosophy of TOT and Farmer First by NGOs

Factor	Transfer of Technology	Farmer First
Diffusion of technology	Top down	Bottom up
Farmer’s role	Beneficiary	Client; colleague
Scientist’s role	Technology generator	Consultant; collaborator
Extensionists’ role	Deliver technology & demonstrate	Facilitate and network
Determination of research priorities	Perceptions of scientists	Perception and needs of farmers
Main research location	Research station	Farmers’ fields
Explanation of non-adoption	Failure of farmer to learn, farmer’s constraints	Failure of technology and of scientists

Adapted from Davis and Place (2003)

The Farmer First (bottom-up approach) is a unique model in the view of farmers and agricultural development experts. It is a participatory approach that sees smallholder farmers as part of the technology generation process, using their farmland as a central location to the model, providing essential resources and inputs and evaluation of new technologies. The Farmer First approach has been utilized heavily by NGOs to meet the needs of smallholder farmers and enhance rural development. Davis and Place (2003) reported that NGOs have numerous advantages over other extension providers, for example; NGO staff members tend to be better motivated with improved salaries; the organization is often ready in assisting the resource poor farmers through community organization and poverty alleviation programs; and there is often there was the availability of funds and access to facilities. In addition, NGOs tend to use a unique method of identifying the needs of farming families and then assist the poor families in bringing to more sustainable development (Swanson and Samy 2002). However, critics stated that often NGOs fail to develop procedures for monitoring and evaluating their performance, accountability and conducting strategic planning (Davis and Place 2003).

2.7.3 The Commodity Extension and Research Model

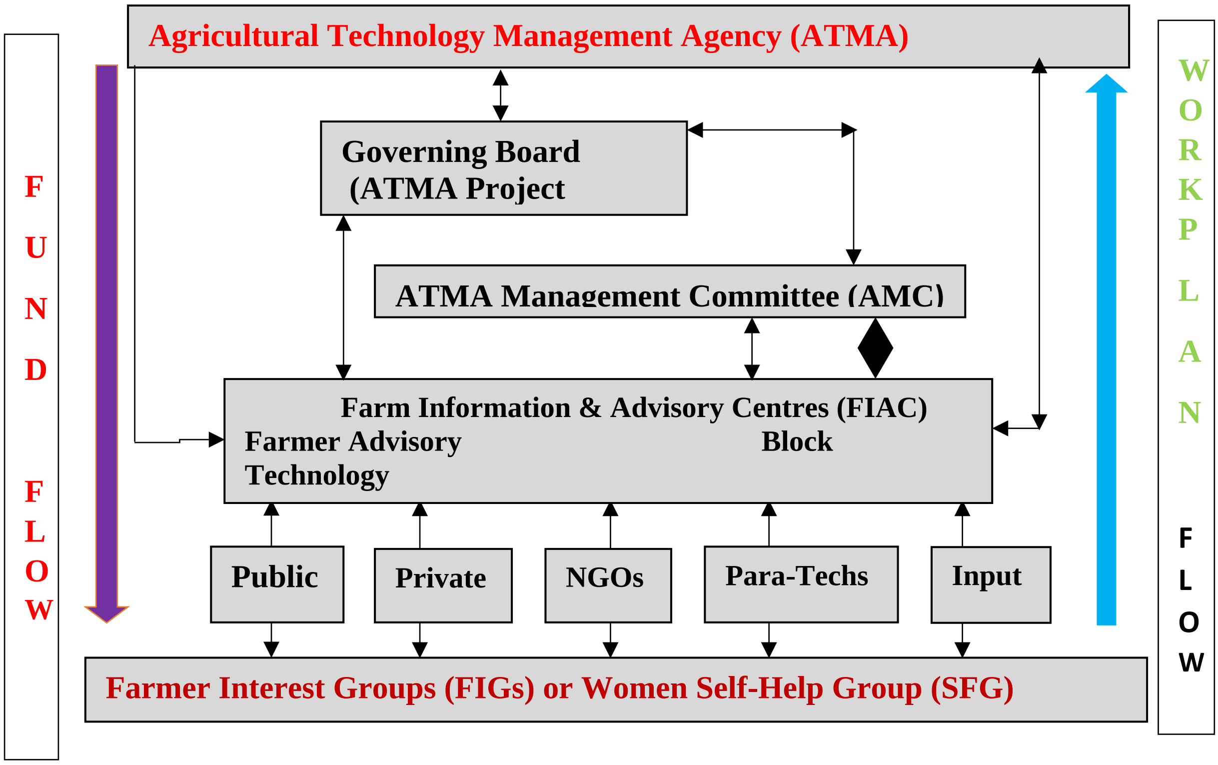
This model was initiated among smallholders' farmers producing cotton in Mali, Malaysia and other Francophone countries by the colonial powers (Eicher 2007; Anandajayasekeram *et al.* 2008). It is a type of farmer organization at village-level dealing with inputs needed by the members (the resource owners), to increase the productivity and livelihoods of the rural community. The focus is generally on a single crop or one aspect of farming. Extension delivery tends to be effective and focus on only a single commodity and the organization is generally small and predominately concerned about inputs (Kenmore 2002). This type of association generates income from the sale of inputs and outputs. The model is participatory, democratic, responsive and community-based.

In this model, the interest of the association supersedes farmers' interest. Research, extension and production are effective and closely interconnected. Similarly, all the functions related to the commodity are combined together such as research, extension, input supply, output marketing and prices. However, the model is not without some disadvantages including less priority for farmers' interests, conflict arising among members if not properly handled, the needs of or the whole farmers may not be considered, and extension services are usually determined by the agents not farmers.

2.7.4 The Agricultural Technology Management Agency (ATMA)

The Agricultural Technology Management Agency (ATMA) is an Indian self-governing decentralized participatory and market-driven extension approach which symbolizes a transformation from transferring technologies to better coordination of research and extension activities (Singh *et al*. 2006). The primary objective is to increase significantly farm income and rural development; integrate extension services across departments; link research and extension and the involvement of farmer organizations to enhance productivity (Swanson *et al*. 2008; Birner *et al.* 2009). The ATMA is primarily a government extension initiative to support the state extension reform which aims to assist the states to revitalize its extension system (Gupta and Shinde 2013). The ATMA extension model employs a bottom-up planning technique which combines decentralization with the continuous use of public sector extension agents, to encourage agricultural modification and the improvement of rural livelihoods (Eicher 2007; Birner *et al.* 2009). Interestingly, the ATMA approach has been considered as the most successful agricultural extension reform in India because within five years of establishment the model had spread out rapidly and been adopted in all 600 districts in the country (Anderson 2007; Davis 2008).

ATMA was formed as a registered society outside of the customary government organization as an autonomous group who can receive, apportion and even authorize to expend government funds (Figure 2.5). The ATMA Governing Board, which is composed of a cross-section of stakeholder representatives, determines priorities and can also take decisions on extension activities (Swanson 2006; Ferroni and Zhou 2012). However, the ATMA started experiencing challenges of which the notable ones are a lack of qualified local manpower; delivery mechanism issues; technical and financial support and a clear framework for partnerships (Kapoor 2010; Ferroni and Zhou 2012).



Adapted from Singh and Swanson (2006)
Figure 2.5. Organizational Structure of Agricultural Technology Management Agency (ATMA)

2.7.5 National Agricultural Advisory Services (NAADS), Uganda

NAADS is an innovative farmer-driven extension service initiated in 2001 by the government of Uganda, and constituted a promising new approach with the goal of improving the productivity and livelihood of farmers through the adoption of profitable agricultural enterprises and improved technologies (Benin *et al.* 2012; Swanson and Rajalaht 2010). Moreover, as part of a wide-ranging Plan for the Modernization of Agriculture (PMA), whose priority included; promoting agricultural research and technology; improved access to quality agricultural advisory services; promoting agricultural skills and knowledge through formal and informal education; improving access to available rural finance; promoting agro-processing and improving access to markets; promoting the sustainable use and management of natural resources and improving supportive social amenities (Larsen *et al.* 2009; Kasirye 2013). The NAADS is sponsored by donors, which creates a decentralized and operating through product-based farmer groups. It is usually considered as a farmer-owned private sector delivery which addresses all the needs generated by grassroots farmers. Technology development was an integral success element of NAAD, which was provided inthe form of revolving credit and provided the opportunity for direct farmer involvement in learning new skills and new technology adoption, productivity and per capita income. The features of NAADS were further enumerated by Anderson (2007) including decentralization; outsourcing; subcontracting; farmers' empowerment; market orientation and increasing cost recovery.

Furthermore, apart from availing up-to-date information to farmers, the programme also significantly enhances farmer access to productivity via technologies, and empowers farmers with skills and knowledge in order to shift from subsistence to commercial farming (Kasirye 2013). NAADS, provides an interesting example for other African countries to emulate in their effort to enhance rural communities and ensure sustainable agricultural development (Anderson 2007, Benin *et al.* 2012).

2.7.6 Participatory Demonstration and Training Extension System (PADETES), Ethiopia

PADETES was initiated in Ethiopia based on the experience and publicized success story of Sasakawa Global programme (SG-2000) as an extension approach which promoted cereals production using on-farm demonstration plots and links technologies to inputs through a package deal (Kiptot *et al.* 2013). PADETES aimed at increasing productivity of smallholder farmers; improve incomes through enhancing productivity; empowering farmers to actively participate in the development process; ensure self-sufficiency in food production; establish farmer organizations; increase production of export crops; conserve natural resources; and encourage farmer organizations and women's participation in development (Davis *et al.* 2010). The model promoted cereals production via the Extension Management and Training Plot (EMTP), usually half hectare on-farm demonstration plots which were managed by farmers and used to train other farmers and extension workers on good agronomic and farm management practices (Egziabher *et al.* 2010).

The beneficiaries were mostly those smallholder farmers who reside in high rainfall areas of the country, though, the yields on the upscale plots were not as high as those on the original demonstration plots, perhaps because of lack of sufficient supervision by the extension staff (Davis *et al.* 2010; Egziabher *et al.* 2010). The programme focused primarily on increasing the productivity of smallholders through better access to improved production technology such as improved seeds; fertilizer; pesticides and other improved production practices (Wubneh 2007). Extension agents saw their role typically as distributors of fertilizers rather than technical advisors (Davis 2008). However, other studies found that extension workers and rural services contributed significantly to the massive increase in agricultural production (Ayele *et al.* 2005).

According to Davis *et al.* (2010) PADETES employed a related extension system to Sasakawa Global programme (SG-2000), in conjunction with a modified T&V extension model. Several studies (Swanson and Rajalaht 2010, Kiptot *et al.* 2013, Lucky and Achebe 2013) have been conducted to review and evaluate PADETES' programme, notable among them was EFA/EEPRI 2006. The results of the study revealed the following significant achievements of the model:

- Reach several smallholder farmers equitably
- Quick increase in productivity
- Increased production of cereals

- Rapid use of fertilizer and improved seeds
- Increased numbers of participating households in extension packages.

Weaknesses

- The majority of extension packages are on crop production and extension is supply-driven and limited training for extension workers.
- Extension packages are formulated at the federal level and there is lack of regional strategies
- Limited focus on cereals crops, cash crops and animals
- Limitations in infrastructure, marketing and inputs affected implemented
- Limited participation of women farmers (Lucky and Achebe 2013).

2.7.7 National Agriculture and Livestock Extension Programme (NALEP), Kenya

The current Kenya extension program, National Agriculture and Livestock Extension Programme was established in the year 2000 which encourages common interest groups (CIGs) among farmers. Groups are generally believed to extend technologies faster than individual farmers (Anandajayasekeram *et al*. 2008). The NALEP approach supported in part by Swedish International Development Cooperation Agency (SIDA) focuses on supporting demand-driven, pluralistic and farmer-led extension system involving all stakeholders which facilitate a gradual transition from predominantly public extension to private provision of agricultural extension services (Anandajayasekeram *et al*. 2008). The NALEP mission was to transform agriculture and livestock to a sustainable system to achieve food security, wealth creation and national economic growth through science-based market-oriented, competitive and profitable agricultural systems (Chhettri 2011).

The main objectives of NALEP was to guide the establishment and implementation of the programme of pluralistic extension systems through national agricultural and livestock goals;

significantly contribute to poverty reduction; develop and improving the efficiency of sustainable agriculture as well as livestock, water, forestry and rangeland resource (Cueller *et al.* 2006). These objectives will be achieved via diverse strategies including; organizing farmers into viable rural organizations; empowerment of farmers to adequately respond to food security through the transfer of adapted research technologies; inclusion of other stakeholders in the activities; bottom-up planning system; involving the farmers at all levels in the project; ensuring farmers participate fully in the decision-making processes and group-based approaches in focal areas (Chhettri 2011; Ngugi *et al.* 2014).

However, it is imperative to acknowledge that NALEP is not without its own challenges including; lack of financial strength to support farmers, a declining attendance of the farmers in training, field days and seminars; too short time framework for NALEP officials to implement the programme and lack of demonstration materials (Chhettri 2011). The training and retraining of the extension personnel on issues of marketing, packaging and emerging crops and animals to ensure they meet the expectations of farmers also came up as a challenge to be noted (Ngugi *et al.* 2014).

2.7.8 Summary of Extension Approaches in SSA

The section has highlighted the various agricultural extension approaches in SSA and put forward the evolution of extension in Africa. The section further considers various extension models currently implemented in the developing countries and their correlation with different extension theories and models, particularly Diffusion of Innovation Theory and Technology Acceptance Model. In addition, a review of top-down and participatory extension approaches has been presented which shows that all the paradigm of participatory extension were considered to be most beneficial to smallholder farmers. This section has so far, put into context the way in which extension models operates in Africa and the underlying theories previously discussed.

2.8 Nigerian Agricultural Research and Extension (NARES)

The Federal Government of Nigeria (FGN) has divided its agricultural research institutes into five agro-ecological zones, and these zones are liable for effective linkages between research and extension components. There are eighteen agricultural research centres in Nigeria that are solely responsible for improving local crop varieties and developing new ones that are conducive to the existing farming situation (Faturoti 2013; Ali 20014). According to Arokoyo (1988), in addition to large human and natural resources, with 17 commodity based research institutes, 18 facilities of agriculture in federal universities, 1 specialized agricultural extension institute and 1 international research centre, Nigeria is considered to have the largest NARES in Sub-Saharan Africa. In related findings, Arokoyo (2009) emphasised that despite such resources, sustainable agricultural development has not progressed. The reasons according to him were; uncoordinated links between the various actors in agricultural sectors, ineffective public agricultural extension services that are mainly top-down and supply driven, and untimely and insufficient release of funds to the agricultural and rural development sectors. Establishing a federal department of agricultural extension to monitor and ensure effective agricultural extension service delivery and demand responsive extension systems has been recommended for transforming the extension services in Nigeria.

In his effort to describe the distinctive functions of the research and extension components in the agricultural development of Nigeria, Lawal-Adebowale (2008) explained that the research component is responsible for providing science-based innovations, which is significant for creating the much-needed change to agricultural productivity. While extension conveys innovation to farmers from research, in order for the former to be effective, there is a need for active coordination linkages between the two. In an effort to develop and strengthens the links between these bodies, the FGN established various systems, such as the On-Farm Adaptive Research (OFAR), the Farming System Research (FSR), the Small Plot Adoption Techniques (SPAT) and the Research-Extension-Farmer-Input-Linkages System (REFILS). Although these systems provide much-needed interaction, the FGN has failed to support the linkages financially.

As a matter of fact, there is a need to provide effective means for less cost and a highly satisfactory result (Arokoyo 2005, Faborode and Ajayi 2015, Nnadozie *et al.* 2015). This can be achieved through an integrated ICT system. Moreover, the establishment of Agricultural Development Project (ADPs) in Nigeria by the World Bank is important in the provision of adequate extension services to farmers which according to World Bank Group (2011) occurred when the World Bank has expended $1.2billion in 1974 for the project, aimed at increasing farm production and smallholders' welfare. The group further observed that between 1979 and 1990 five ADPs and supporting Agricultural Technical Assistance Project (ATAP) were reviewed and implemented, out of which only two yielded satisfactory results.

World Bank Group (2011) emphasises that ADPs in Nigeria started as an enclave project, covering specific locations in the states. The success of these enclave projects motivated the FGN and State Governments to establish ADPs in all the then 19 states. The ADPs in the Northern States of Nigeria expanded on the earlier model employed by FGN to enclave projects. However, with the extension services delivery in Nigeria continuing after the World Bank ceased funding the extension farming families' ratio increase rapidly to 1:3000.

2.9 The Development of Agricultural Extension in Nigeria

This section critically reviews the development of agricultural extension in Nigeria from the colonial and pre-independence era to the current state-wide Agricultural Development Project (ADP). It also attempts to review the various extension approaches in Nigeria to date, the underlying theories and models used at each stage identifies the major actors and their roles and responsibilities. This provides a context for the field study.

Agriculture remains the key driver of Nigeria's economy and currently contributes about 42% to the GDP with about 70% of the population engaged in agricultural production. The sector has however drastically underperformed its potential (CBN 2007; Ugwu and Kanu 2011). The Nigerian Agricultural Extension System has advanced over four centuries from a rudimentary, export crop-focussed service to what can now be described as a professional service although its effectiveness and efficiency remain just average at best (Arokoyo 2005). The evolutionary development of agricultural development is intertwined with the political history of the country in general and can be easily divided into three main eras:

1) The colonial and immediate post-independence Era (1893-1968)
2) The oil boom era (1970-1979)
3) The state-wide Agricultural Development Project (ADP) Era (1980-Present).

The major attributes of the extension approaches and strategies that categorized the three eras are described below:

2.9.1 The Colonial and Immediate Post-Independence Era (1893-1968):

This epoch of agricultural development is characterized by the extension strategies and approaches which included:

a) **The colonial commodity extension approach**:

During the colonial era by the British, the initial part of this period clearly marked the origin of scientific agriculture in Nigeria and the genesis of direct government involvement in agricultural development in the country. Evidently, the agricultural policy of the British government focused principally on some agricultural development initiatives to encourage only export crops such as cocoa, cotton, rubber and palm oil to support the agro-industries in Europe (Arokoyo 2003). The extension approach was a distinctively commodity based approach coupled with some requirement to obey and an enforcement component.

However, the extension delivery, particularly at this emergent phase, had the roles of education and law enforcement.

b) **The Ministry of Agriculture approach**:

The colonial government commenced with the creation of the agricultural research stations in Samara (1921), Umudike (1923) and Moor Plantation (1924) together with the Regional Ministries of Agriculture in the North, East and West (Arokoyo 2003). However, the extension delivery at this stage was dispersed, not fixed and integrated advocacy and advisory roles with input and credit distribution, and regulatory functions. The main characteristic of this extension strategy during this era was compartmentalisation of the service into segments of agriculture, livestock, forestry, fisheries etc. along with corresponding extension services (Ugwu and Kanu 2011).

c) **The Revitalized Commodity Extension Strategy**

(Post-Independence): Once more, the prominence was on selected export crops - cocoa in the old West Region, oil palm in the East, and groundnut in the North. There was an obvious neglect of the food crops to the detriment of the nation (Egbuna 2005)**.**

d) **The farm settlement/Farm Institute Leavers' Extension Strategy (1959-1965):**

This was a community development concept to entice young school leavers to farming as a career and to serve as models for concentrated extension services. Regrettably, the approach adopted during this era failed mainly because:

- Planning was rigid, top-down and had no involvement of farmers.
- There were conflicting roles of extensioneducation and law enforcement.
- There was little or no involvement of research experts in all the approaches resulting in the development of inappropriate technologies or innovation (Obijiofor 2009).

2.9.2 The "Oil Boom" Era (1970-1979):

The near absence of active research and an effectual extension strategy for food crop production in the earlier part of this era was worsened by the oil boom, which meant agriculture suffered a severe setback and ever since thenthe sector has significantly underperformed its potential. The government of the day felt that the rate of oil production and price would remain ad infinitum and sustain the nation's economy (Obijiofor 2009). However, the situation has turned out to be an "oil boom" with agriculture suffering as a result. Conversely, the major extension approaches of the era included:

a) The National Accelerated Food Production Programme (NAFFP):

The (NAFPP) was initiated in 1972 by the military regime as a well-conceptualized strategy which incorporated research, extension and input supply (through a network of agro-service centers) with farmers only minimally involved in participatory technology development. The programme involved training farmers in modern approaches to arable production through result demonstrations, variety trials and fertilizer and herbicide trails. The programme focused on bringing about a significant and rapid increase in the production of six major crops: sorghum, millet, wheat, rice, maize and cassava in the country through subsistent production within a short period of time (Iwuchukwu and Igbokwe 2012).

b) Operation Feed the Nation (OFN):

This program was inaugurated in 1976 under the military regime of General Olusegun Obasanjo as an extension strategy to substantially boost food production and significantly increase productivity to serve the food needed by the people in the country and possibly encourage food exportation (Fadiji 2010). Regrettably, however, the programme died a natural death due to lack of sustenance of agricultural policies, inadequate provision of fertilizers to farmers, poor execution as well as over-centralization of implementation. There was nothing in the program that can be identified as an articulated extension strategy (Kareem and Akinbile 2015).

c) The River Basin Development Authority (RBDA) Strategies:

The RBDA was initiated in 1976 in eleven states across the nation for the utilization of water resources for irrigation**.** However, it was between 1984/85 that extension responsibilities were assigned to them to offer extension services to farmers in their catchments area. They utilized the diffused Ministry of Agriculture strategy but because of their poor performance, their extension responsibilities were removed (Iwuchukwu and Igbokwe 2012).

d) The Green Revolution:

The Green Revolution program which was launched in 1979 replaced Operation Feed the Nation with the main objective to achieve food self-sufficiency for Nigeria in five years. Similar to the Ministry extension strategy, it placed emphasis on input supply, improvement of infrastructure and provision of price incentives. The approach failed due to lack of focus and diversification of efforts that could not be sustained (Fadiji 2010; Arokoyo 2002).

e) The Pilot (Enclave) Agricultural Development Projects (ADPs):

The main ideas behind the ADP extension system rest on the premise that a combination of indispensable factors made up of the right technology, effective extension, and access to physical production enhancing inputs, adequate market and other infrastructural facilities are essential ingredients to get agriculture moving in the country (CBN 2006). ADP beganpilotprojects in three states, Funtua, Gombe and Gusau in 1975. The initial success recorded led to the establishment of the enclave ADPs in six more States. They all employed the T&V extension delivery approach (Arokoyo 2002). The myriad approaches, which followed one another in quick successions, left the rural populace probably more confused even though there were some noticeable marginal increases in food production in the operational areas of the ADPs (CBN 2007).

2.9.3 The Statewide Agricultural Development Project (ADP) (1984-Present)

The ADPs is a veritable and formative structure, in which its extension service was characterized by the rapid rural development and spread across the nation; with full responsibility to reach the grassroots with extension delivery using different extension theories and models to disseminate innovation (Yakubu *et al.* 2013). The primary objectives were to accelerate food production, increase farmers' income and industrial crops through systematic and comprehensive extension programmes, adapt research components and input delivery systems as well as rural infrastructure components for rural feeders roads and water supply and extension delivery using essentially the T & V approach as put forward by Benor and Baxter (1984) and funded by the World Bank in Nigeria and other developing countries (Arokoyo 2003; Egbuna 2005). Prior to the withdrawal of the World Bank support, aside from the 'one-size fits all' concepts of the strategy adopted, ADP literarily proved to be well-organized but expensive (Arokoyo 2003).

In 1989, Unified Agricultural Extension Service (UAES) was introduced as a strategy which made provision for the inclusion of other sectors such as livestock, fisheries, forestry, natural resource management etc. Extension activities with the ADPs were characterized by unique features; strong research-extension-farmer linkage, regular training (capacity building) of extension workers and farmers, regular visits to farmers by extension workers and constant and consistent planning, monitoring and evaluation. Arokoyo (2003) stated that to avoid conflicting messages to the farmers by multiple agents and make the system more cost-effective, one Village Extension Agent was expected to deliver extension messages in all agricultural disciplines to the clientele. This extension approach is in actual fact a top-down approach and farmers remained passive receptors of information, which may not necessarily meet their needs. It was also expected to make the system move cost-effective by eliminating duplication of efforts. The involvement and participation in technology development remain low (Fadiji 2010; Iwuchukwu and Igbokwe 2012). This leads us to ask how important is involvement of stakeholders in effective extension strategies?

2.10 Farmer, Community and Industry Engagement

The importance of engaging farmers and community members in all stages of technology development and the research process cannot be underrated. In practice, the idea of engagement guides the formation of a partnership among farmers, extension workers, industry and policy makers. However, the successful engagement of farmers and community members at the early stage of technology and innovation development can play a significant role in providing constructive advice to farmers and promoting on-farm technologies, while at the same time providing valuable information to extension workers and other stakeholders both in research and policy-making. Thus, the proper conduct of such studies can help to establish lasting trust and partnership between all players in research processes. In farmer engagement research, the end user and researcher work closely together to ensure the relevance of the research and development. This effective engagement take place where there is two-way communication and mutual trust between the researcher and the community members, as well as where the results of the research can be shown to benefit the community. Farmer engagement research allows for the proper understanding of the cultural, social, environmental, economic, political factors and the impact of the imposition of values and beliefs of the participants.

In order to improve the adoption of good agricultural practices among community members, it is essential to have a better understanding of farm practices that are directly under the control of farmers and the community. As discussed in the previous chapter a top-down approach has a negative influence on farmers' adoption of technology. Hence, engaging farmers or end users in research and extension activities through participatory research and extension (PR&E) is highly encouraged. Farmer engagement should also be considered right from the outset, from concept development and planning stages, through implementation, to monitoring and evaluation of the project. However, the involvement of farmers as early as possible in decision-making has been frequently cited as important if community engagement in research processes is to lead to viable solutions (Reed 2007). In spite of the poor linkages between farmers, extension services and research, successful farmer engagement can be achieved by adopting the principles of Participatory Action Research which provide a dynamic relationship between farmers and stakeholders.

2.11 Summary

A critical discussion and review of the models and theories in relation to approaches to agricultural extension and the challenges facing extension particularly in Nigeria and other Africa countries has been performed in this chapter. Based on the evolution of extension theories and models in developed economies, consideration was also given to strengths and limitations of the models of agricultural extension adopted in Sub Saharan Africa and elsewhere in emerging economies. This chapter has also identified some findings that related to strengthening extension including: the use of qualified, competent and experienced extension workers; extensive grassroots coverage with district and village-level representation; empowering of rural communities to demand specific services; understanding the need for rural development and working to improve it; and, public research systems that has a broad spectrum of researchers. However, noted from the review is that many studies concentrated on the weaknesses or limitations of extension including: poor logical support; no transport and equipment; lagging technical knowledge in new technologies; bureaucracy and long channels of communication, numerous but uncoordinated intervention resulting from a scramble for the farmers; inadequate/poor grassroots representation; outdated communication methods preventing extension messages from reaching intended farmers and a lack of integrated approaches.

In addition, there is need for effective communication between researcher, extension workers, and farmers; as Ajani and Onwubuya (2013) described, effective communication as an essential tool for the establishment and safeguarding of good social and working relationship which enable people to exercise control over their environment. Consequently, adequate communication strategies are required by the extension workers in order to effectively disseminate agricultural information to smallholder farmers.

The chapter explicitly reviewed the underlying models and theories used at various stages in extension. This contributed significantly to the design of this study showing that appropriate use of participatory approaches and modern technology could promotes crop productivity and agricultural development. More importantly, the chapter explored explicitly the Technology Acceptance Model (TAM) and its extended revision the TAM3 and concluded that understanding technology acceptance will lead to better prediction of the adoption of improve technologies among smallholder farmer which could consequently lead to better agricultural productivity and incomes.

In the light of the above, the next chapter will critically examine communication and the evolution of ICT among smallholder farmers and extension workers.

Chapter Three. Evolution of ICT in Relation to Extension in Nigeria

This chapter explores the evolution of ICT in the context of smallholder farmers in extension starts off with the historical radio and mobile technology. According to World Bank (2002), Information and Communication Technologies (ICT) consist of hardware, software, networks, and media for collection, storage, processing, transmission and presentation of information (voice, data, text, and images). ICT includes computers, the internet, Compact Disk Read Memories, email, telephone, radio, television, video, digital camera etc. (Okyere and Daniel 2012). This research focused on farmer use of mobile phones to receive all forms of agricultural information from extension services which then implies that the source of the information is using the full range of ICT to gather, process and disseminate the information that smallholders receive through their phones.

3.1 The Potential Role of ICT

Information is essential for the uptake of relevant and suitable innovations by farmers and rural communities; consequently, communicating necessary agricultural information to farmers is one of the primary roles that extension workers are expected to perform. Agricultural extension has been at the position of prominent within the agricultural sector as the programme aimed at bringing economic growth to several developing countries. In Nigeria for instance, the public-sector extension system (ADPs) was recognized by the Government as the key player to bridge the production gap that exists between agricultural research output and farmers (Annor-Frempong *et al.* 2005). Communication between the key actors involved in agriculture and rural development must be interactive, an exchange of ideas, emphasizing discourse and creating the opportunity to understand several opinions and providing honest feedback (Moemeka 2000; Annor-Frempong *et al.* 2005).

The strong desires for ICT in the agricultural extension services are due to their features that have the prospect to influence extension services. Colle and Roman (2003) stated that ICT are capable of improving rural areas and reaching millions of people concurrently, overcoming geographical boundaries, providing frequent and repeated contact, capturing the reality of the event, storing and the sending and receiving of information. Agricultural extension, whether public or private sector, cannot suitably function without a continuous flow of reliable information and technology, as a result, the extent to which farmers progress depends mainly upon their access to the most up-to-date and relevant information (Annor-Frempong *et al.* 2005; Lucky and Achebe 2013). ICT have been invaluable in much rural development efforts to bridge the information gap (Bhatnagar and Schware 2002). Indeed, ICT have been employed as tools and sources of information and knowledge to extension workers, to reach a wider audience (end-users), and for addressing rural development goals (Nissila *et al.* 2009).

Communication planners have argued in support of ICT and policies that encourage the involvement of intended beneficiaries in the planning and implementation of communication development projects to promote an effective transition to an information society (Annor-Frempong *et al.* 2005). Moreover, Melody (1996) argued that the expansion of ICT services and appliance must be demand-driven. In the same vein, the rate at which the use of diverse sources of information depends largely on the users' access, expertise and interests. Hence, it is essential to conduct a study of the users' needs and consideration of issues that may prevent them from participating in the design and implementation of technological applications (Annor-Frempong *et al.* 2005). As previously noted in Chapter 2, there are significant benefits of participatory approaches over top-down communication only.

Adam and Wood (1995) singled out some constraining factors affecting the utilization of ICT including: a lack of awareness; an underdeveloped legal framework for information sharing; infrastructure problems; poor connectivity to a global network; maintenance problems; weak research and development; and high taxes. Similarly, Murdock *et al.* (1996) stated that material resources and economic power play a fundamental role in determining whether people use ICT and the nature and pattern of that use. Poorly resourced farmers and low-income earners are incapable of paying for equipment costs, access costs and telephone costs incurred in the access and use of ICT (Selwyn 2002); however, there are other schools of thought that believe that poor people do not necessarily require ICT (Okyere and Daniel 2012, Lucky and Achebe 2013). In addition, Saker (2002) elucidates the role and the relation between information and development; explaining that:

- Information leads to resources;
- Information leads to opportunities that generate resources;
- Access to information leads to access to resources;
- Access to information leads to access to opportunities that generate resources.

Fortier's (2003) findings show a number of obstacles limiting the adoption of ICT ranging from finance; community ownership and relevance; technology; organization and management. ICT in general clearly have great potential.

This study focuses specifically on mobile phone technology. Almost half of the world's population make use of mobile phones in their day-to-day activities which have contributed significantly to their endeavours (Ajayi 2013). Mobile phone technology facilitates innovative business models, advances technology; and creates new employment, all of which have affected economic growth and productivity, not only in urban areas but also in rural communities (Ekoja 2007). Undeniably, mobile services have transformed every sphere of human endeavour, facilitating access to speedy information, connecting people to one another and empowering them with accurate and up-to-date information. Furthermore, Smart phones such as Android, BlackBerry, Apple iOS etc. have changed people's approach to accessing information: mobile applications; social media; the internet; mobile photography; online transactions and navigation; have all become increasingly essential to function in today's world (GSMA 2013a). The following sections explore the role of two ICT specifically, firstly the use of radio, followed by mobile phone technology with a particular focus on their use in Nigeria.

It has been argued that the available evidence on the theme of ICT is primarily anecdotal and dominated by promises rather than reality (Walsham and Shaay 2006, Francis 2016). It is also argued that much of the available evidence focuses on those who use ICT and as a result of particular development initiatives such as telecentres.

There are clear distinctions between new ICT such as computer and mobile phones and old ICT such as radio, television and landline telephony although the current technological convergences progressively blur such divisions. Hence, single devices such as mobile phones can now receive information, process, store and display text, image and sound at the same time. In Nigeria, there is ample evidence that several emerging radio users are found in rural areas (Safe *et al.* 2010); therefore, it is important to evaluate "Old ICT" technologies before considering the importance of mobile phone technologies.

3.1.1 Detailed Account of Differences between technologies (ICTs) and their Limitations

ICT is an umbrella term that includes all technologies for the communication of information. It encompasses: any medium to record information (computers, printers, projectors, magnetic disk/tape, optical disks - CD, DVD, flash memory etc.); and also technology for broadcasting information - radio, television; and any technology for communicating through voice and sound or images- microphone, camera, loudspeaker, telephone to cellular phones (Lubbe 2009). The table below presents detailed account of differences, limitation of each technologies and how the technology work together.

S/N	Technologies	Use of Technologies/Advantages	Limitations
1.	Radio	• Radio is one of the media which covers huge population. • Radio can be enjoyed at home, in office, while driving car and can be enjoyed anywhere. • Radio channels varies from region to region, hence you can listen radio in your regional language. • Like other entertainment media, Radio is also favourite of large number of population. • You can advertise your product on radio and the rate of advertisement is usually lower than other medium of communication. • Important information or news can be easily spread on radio. • For local market radio is one of the powerful medium of communication	• Only an audio medium for communication. • During bad weather you cannot listen radio properly. Often unclear and is affected by weather. • You need to adjust frequency properly. • Less and limited radio channels are available compared to other communication medium.
2.	Television	• Television is a system for converting visual images (with sound) into electrical signals, transmitting them by radio or other means, and displaying them electronically on a screen. • Allows for active demonstration of product • Large national audience reach (network) • Large local audience reach • Messages stand alone • Some audience targeting • Prime source of news • High impact • Spectacular medium – sound, animation, motion, colour etc.	• Messages have short life plus time shifting • Long lead time • Cannot provide details • Not portable • High production costs • Most stations in urban.

3.	Mobile phones/technology	Mobile technology is that technology which is movable or portable. It includes all those technical gadgets and modern devices which are handy to carry. They are convenient to use and they make work easy. Mobile phones are undeniable today. Almost everybody has a mobile phone. You can use them for your multiple tasks. Laptops, mobiles, computers, tablets, and smartphones (Android IOS phones) are a few examples of Mobile technology. Without a doubt, these devices have completely changed the way we live and interact, giving us convenient means of calling, sending text messages, reading emails, playing games as well as reading and editing documents and so on. In fact, leaving home without them would feel like leaving without our shoes on. • They make communicating with family, friends and colleagues a lot easier. • They combine numerous useful applications in a single device They offer constant internet access. • They are really useful in emergency situations	• They hinder real human interaction • They have become instruments for constant interruption. • They carry risks of privacy and security breaches. • They can increase risk of getting into traffic accidents.
4.	Internet	Internet can be used as a medium of language learning via email, world wide web, text, audio and video conferencing. Information on almost every subject imaginable.	The following are disadvantages of internet; • There are a lot of wrong information on the internet. Anyone can post anything they like.

		Advantages of internet includes: • Availability of information on almost every subject imaginable. • Powerful search engines. • Ability to search from the comfort of your home and to get wide range of opinions. • The internet provide the ability of emails. Free mail service to anyone around the globe. • Platform for product like Skype, which allow for holding a video conference with anyone in the world who also has access.	• Watching pornography is very bad. • There are predators that hang out on internet waiting to get unsuspecting people and dangerous situation. • Some people are getting addicted to internet and thus causing problems with their interaction with friends and loved one. • Internet is very easy to waste a lot of time. • There are a lot of unscrupulous businesses that have sprung up on the internet to take advantages of people. • Hackers can create viruses that can get into your personal computer and ruin valuable data.
5.	Desktop computers	Computer can be utilized with other multimedia learning devices or it can stand alone (a standard PC) and still serves its basic purpose as an electronic medium of language learning (Hartoyo 2012).	
6.	E-book	Electronic book or e-book is one that utilizes computer technology to deliver multimedia information in the form of a compact and dynamic. In an" e-book can be integrated impressions" sound, graphics, images, animations, and" movie"	

		so that the information presented is richer than conventional books. Type e-book of the simplest is a mere transfer of conventional books into electronic form displayed by the computer. With this technology, hundreds of books can be stored in a single piece of solid disc/CD” or” compact disk (capacity of about 700MB), DVD or digital versatile disc’’ (capacity 4.7 to 8.5 GB) and ‘ ‘flash” (currently available capacity up to 16 GB).	
7.	Laptop computers	A laptop computer is a small, portable personal computer (PC) with a ‘clamshell’ form factor, typically having a thin LCD or LED computer screen mounted on the inside of the upper lid of the clamshell and an alphanumeric keyboard on the inside of the lower lid.The clamshell is opened up to use the computer. Laptops are folded shut for transportation, and thus are suitable for mobile use. Laptops combine all the input/output components and capabilities of a desktop computer. Advantages of Laptops: • Mobility • Finished product with built-in mouse. • Internet Access • Offline Operation • Low power consumption	• Sensitivity • Unpredictable battery • Performance • Reinstalling the native operating system • Upgradeability • Durability • Security and privacy

		• Quiet	
8.	Keyboard	Keyboard are used to input data into applications. • Keyboard can also be used to enter commands into the computer. The advantages of keyboard includes: • Enables fast entry of text into documents. • Very easy to use (you just press the keys). • Information that you input instantly appear on the screen. This lets you quickly check that what you are entering is correct.	The limitations of keyboard includes: • People with wrist and hand problems can find keyboards painful to use. • Keyboards are quite large and can take up a lot of desk space. • Entering data is slow when compared to automatic methods, for example – a barcode code scanner will input data into the computer almost instantly.
9.	Mouse	• Relatively fast • Has low error rates for large targets. • Allows user to concentrate attention on VDT screen.	
10.	Remote control	Remote control is used to control other devices using infra-red signals. Button on the remote control can be used to perform functions such as: • Changing the channel on a TV • Increasing/Decreasing the volume on a music player. • Selecting a different chapter on DVD player.	The limitations of Remote control • People with limited hand movement can find them difficult to use. • The infra-red signal between the remote control and the device it operates can become blocked.

		Advantages of Remote Control includes: • Devices can be operated without having to go to them. This is useful for people with disabilities. • They can operate devices that are in an unsafe environment. For example; Explosives to demolish a building can be set off at a safe distance.	
11.	Interactive whiteboard	An interactive whiteboard (IWB), is a large interactive display (such as a touch screen monitor) which is connected to a computer and projector. A projector projects the computers' desktop onto the board's surface, where users control the computer using a pen, finger or other devices. Laptop computers generally cost more than desktop computers with the same capabilities because they are more difficult to design and manufacture.	
12.	Graphics tablet	A graphics tablet consists of a flat pad (the tablet) on which the user draws with a special pen. As the user draws on the pad the image is created on the screen. Using a graphics tablet a designer can produce very accurate on-screen drawings as if they were drawing on paper. Advantages of graphics tablets • It is much more natural to draw diagrams with a pencil type implement (the stylus) rather than with a mouse.	• Not really suitable for general selection work such as pointing and clicking on menu items • Graphics tablets are much more expensive than a mouse.

		• A great level of accuracy can be achieved.	
13.	E-mail	• Inexpensive. • Wide range of editorial material aimed at a broad audience. • Complex information can be communicated. • Pass-along audience. • Can be demographically selective. • Can read at leisure.	• Short life. • Credibility in question due to abuse of medium. • Not geographic selective.
14.	E-learning modules	E-learning stands for "electronic", e-learning would incorporate all educational activities that are carried out by individuals or groups working online or offline via networked or standalone computers and other electronic devices. Brandon (2017) defines E-learning as "instruction that is delivered electronically, in part or wholly through a web browser, through the Internet or an intranet, or through multimedia platforms such as CD-ROM or DVD."	• High costs for establishment, enquiry for high funding to conserve. • The Net is not right for all training. • Low bandwidth. • The need for computer literacy. • The Need to learn English Language. • Lack of access to computers and Internet in all areas.
15.	Digital Camera	A digital camera takes pictures and can usually record video too. The pictures it takes and the videos it records are stored in files. These files can be copied to a computer and later edited. Uses of Digital camera:	Disadvantages of digital camera: • A corrupted memory card may result in lost photos.

		• Used to capture digital images, which can be transferred to a computer for editing. • By connecting directly to a photo printer, images can be printed straight from the camera (no need to upload to a computer). Advantages of digital camera: • Digital images can be improved and edited easily using editing software. • Digital images can be easily transferred through Bluetooth, Emails and mobile phones. • Memory cards in digital cameras can store thousands of digital photographs.	• The battery can run out meaning that you cannot take any more photographs until it is recharged.
16.	Scanners	A scanner can be used to digitise images. They're similar to a photocopier but they make a digital copy instead of a physical copy. They can also be used with optical character recognition (OCR) software to scan in text that is then editable. Uses of Scanner: • Used to convert printed images on paper to electronic form. • Old photos and important documents can be scanned into the computer. This means you still have a copy if the original is damaged or lost. Advantages of scanners • Flatbed scanners are very accurate and can produce reasonably high quality images.	Disadvantages of scanners • The accuracy of the data input is unlikely to be verified. • Images lose some quality in the scanning and digitizing process. • The quality of the final image is dependent on the quality of the original image.

		• Any image which is digitized by the scanner can then be included on electronic documents. • Images once digitized can be enhanced with a graphics application.	
17.	Touch screen	A touch-sensitive visual display unit (VDU) or screen has a grid of light beams or fine wires criss-crossing the screen that are used to detect touch. Many mobile phones use touch screens and do away with the keypad entirely. They're often used on cash machines and in shopping centres too. Touch screens are robust, easy to operate and easy to reprogram.	Disadvantages of Touch Screen: • Limited number of options available on the screen. • Expensive compared to other input devices. • Screen can become dirty and full of germs due to people touching it.
18.	Flash memory /USB	Flash memory is an evolving technology that is finding its way into our lives on an increasing scale. From USB-adapted devices for computers to digital cameras and gaming consoles, flash-memory technology is ubiquitous. As with most things related to computers, flash memory sticks have a particular set of advantages and disadvantages. Having a basic idea of these parameters allows the consumer to make a more informed choice about which is best for their needs.	Disadvantages Since it is still a fairly new technology, the cost megabyte of storage is more than a traditional computer hard drive. As is the usual case
19.	Loudspeaker	• They are provided with the computer. • They're very simple to operate.	• The can take up a fair amount of desk-space, compared to headphones.

		• They help blind people who would otherwise have difficulty using a computer. • They can be useful for alerting computer users, even when they're busy, such as in pop-ups.	• They can distract people around you therefore disrupting a communal work area.
20.	Printers	• **Laser printers** are quite expensive to buy and run but produce a high quality output and are quiet and fast. • **Ink-jet printers** offer black and white or colour printing with reduced levels of quality and speed. Colour ink jet printers are cheaper to buy than colour laser printers. • **Dot matrix printers** are not so common today. They are comparatively noisy and low quality but are cheap to run and are used when carbon copies or duplicates need to be made, such as for wage slips.	•
21.	CD/DVD	DVD (Digital Versatile Disc) is a digital optical disc storage format invented and developed in 1995. The medium can store any kind of digital data and is widely used for software and other computer files as well as video programs watched using DVD players. DVDs offer higher storage capacity than compact disc while having the same dimensions. CDs and DVDs are types of optical storage media. Optical storage media are written and read with an extremely fine,	•

		precisely aimed laser beam. Data storage consist of millions of indentations burnt into a reflective metallic surface.	
22.	Overhead Projector	Overhead projectors are devices used to project texts and images onto a screen. The size of the display is dependent on angle of projection and the distance between projector and screen. Overhead projectors are typically used in classrooms and conference rooms. An overhead projector enables you to present individual, static transparencies that contain business information and statistics. If you're accustomed to sharing movies, sound files and illustrated documents from your notebook computer through a digital projector, stepping back to older technology may prove challenging.	•
23.	Satellite system	Satellite communication uses satellite placed above earth for communication by VSATs placed on the earth. It is also used for TV broadcasting. Satellites uses microwave frequencies for communication with each other using inter-satellite links and with earth stations or VSATs. There are different types of satellite based on applications and their orbits. Advantages of Satellite:	

		• It is used for mobile and wireless communication applications independent of location. • It covers wide area of the earth hence entire country or region can be covered with just one satellite. • It is easy to install and manage the ground station sites. • It is used for voice, data, video and any other information transmission.	
24.	Video-conferencing	A video-conference has the following advantages: • It avoids the participants having to spend time travelling to meet each other. • Save travel cost and time. • The participants in different locations are able to work on the same electronic document. • It can be used to allow an expert to investigate a problem without making a site visit, for instance, an engineer could view components that have failed so that the correct replacement parts can be supplied.	Disadvantages of video-conferencing are: • Lack of personal interaction. • Technical problems may occur. • International time zones.
25.	Magnetic disk/tape	Magnetic disk/tape has the following advantages. • A single magnetic tape cartridge can store large amounts of data up to 1 Terabyte. Large cartridges are used by	Disadvantages includes:

		big companies and institutions that require continuous recording and backup of data. • Data collection can go on without interruption overnight or for an entire weekend. • Magnetic tape can be recorded over and reused repeatedly. • Large amounts of information is stored. • Magnetic tape is inexpensive and budget friendly.	• Special equipment must be purchased and set up for recording and storing data. The data can only be read on the special equipment. • If the data is stored near a strong magnetic field or a large speaker, the tape can be damaged. • Magnetic tape has a lifespan of 15 years. Data quality gradually erodes over time. • It is necessary to keep older tape equipment just to be able to read the stored data.
26.	Joystick	Joysticks have similar functions to that of mice and tracker balls, to control a pointer on a screen. There are two main parts to a joystick: Handle/Stick and Buttons. Uses of Joysticks includes: • They can control characters of object in video games. • Can control industrial machinery (cranes for example). • Can be used comfortably with minimum fatigue. • Does not cover parts of the screen in use. • Expansion or concentration. • Ball control is an efficient use of space	Disadvantages includes: Slower than the light pen and other "point-to-devices" for simple input and option selections. - The displacement of the stick controls both the direction and the speed of cursor movement. - Trackball and joystick controllers are difficult to use for accurate free-hand graphic input
27.	Personal Digital Assistants (PDA)	Personal digital assistants, known as PDAs, perform many functions which formerly required paper and pen. Other uses for	

		PDAs make it possible for individuals to keep their personal information sorted while away from their computers. While smart phones and ultra-small note books have cut into some of the market for PDAs, they still hold a number of advantages for their users.	

3.1.2 How technology (ICTs) work in Combination

Technology has positively impacted countless of farmers by increasing efficiency and effectiveness, which allows for more sophisticated information and thus more agricultural productivity and advancement. Technology (ICTs) work in combination to make agricultural sector interesting for farmers and reduce their challenges. Today, smallholder farmers use tractors and other motorized equipment to help with field work. In fact, ICTs are currently transforming the lives of farm families, giving them better access to information, markets, services and input, as well as making smallholders more resilient to external shocks. Africa has experienced the fast growth in the global telecommunications market, especially due to the tremendous growth of mobile telecommunications sector (Arokoyo 2005). Without a doubt, technologies help farmers sell and market their produce, boost their ability to cope with dwindling access to water, land and soil nutrients, and deal with the extreme climate events, pests and diseases that affect their crops. ICTs are ushering in a new paradigm for farming and agriculture. The flow and use of information and knowledge in this new paradigm resembles that of a network and therefore calls for new forms of collaboration and partnership (Nakasone and Torero 2016).

Technology very much enables agricultural sector and makes experiments possible nowadays that would have been unimaginable 60 years ago but basic science makes these technologies possible (Chavula 2014). Better technology has allowed farmers to feed more people and requires fewer people to work on farms to feed their families. Farmers use technology to make advances in producing more food for a growing world. Through research with animals, scientists have discovered what types of housing make the animals comfortable, crop production has improved as well. For example, biotechnology in agriculture is the manipulation of a living organism to improve the quality of human life through advances in crop and animal production. The combination of technology (ICTs) have been able to assist smallholder farmers to make the most out of their resources. Technologies have huge potential to provide knowledge-based services to farmers and others earning their livelihoods in activities related to agriculture, such as agri-businesses, agro-industries and financial services. Studies have shown that technologies (especially mobile phone technology) play a significant role in a country's development, and the strategic application of technology to the agricultural sector, which is the largest economic sector in most African countries (Chavula 2014).

3.1.3 Who owns or controls a Mobile Phone in Farm Household

According to FAO (2016) gender do have some effect on how the mobile phone is used. Urban women use it more for coordination. Men on the other hand seem to use it more for livelihood activities and for making and maintaining social connections. Interestingly, women mobile phone use has stronger positive effects than men mobile phone use (Sekabira and Qaim 2017). Men in general have greater decision-making power in a phone purchase even for their spouses (FAO 2016). However, equal access to mobile phone can foster economic, broader social development and improve household income. Mobile phones are mainly communication tool, however the utility derived by users of mobile phones are typically varied (Aker 2011; Aker and Ksoll 2016). In the urban area, women with children used it to play music to keep their young children entertained. In fact, both men and women used it as an alarm clock and calculator.

However, in rural Nigeria men typically owns and control mobile phone as the head of households while women take care of the children and engage in house core. Most women in my study area do not have income they depend largely on whatever their spouse give to them. They are extremely poor, depend on their husband for virtually everything and live a difficult life. During field research in Nigeria, rural dwellers especially men found great use for phone with in-built flashlights, making/receiving calls or sending/receiving SMS messages (Field

Survey 2016). Rural farmers in Nigeria have reported a number of benefits resulting from mobile phone use in agricultural businesses (Asa and Uwen 2017). This include, elimination of travel costs, saving of time and market access rise to the top positions. Mobile phones lead to observable increases in “contacts and opportunities”, “market access” and increases in “efficiency resulting in greater output” (Nakasone and Torero 2016).

According to Jansen *et al.* (2006), access to mobile phone improves agricultural productivity, increases market access and expand marketing options for rural producers. Mobile phone saves energy and time of smallholder farmers, and ultimately improves their income. It provides an opportunity to farmers to communicate directly with market brokers, extension workers, researchers and consumers for selling their products at good prices (Chhacchar and Hassan 2013; Asa and Uwen 2017). Mobile applications can promote agricultural and rural development, including better access to extension services; better market links and distribution networks; and better access to finance, including credit, insurance and payment methods (Qiang 2011). In fact, the role of mobile phones in supporting access to information about agricultural technologies and extension services is immense (Aker 2011).
However, the literacy level of the smallholder farmers is very important to their use of mobile phones for information access and can also impact their level of difficulty in navigating through the phone menus, often written in international languages like English. For that reason the literacy level of farmers affects mobile phone use differently and can influence the level of adoption in rural Nigeria (Okello *et al.* 2009; Kirui *et al*. 2010; Ogbeide and Ele 2015). Additionally, the low literacy rate in the rural villages where most of the farmers cannot read and write is itself a major challenge. Therefore, most rural farmers in the case study were using simple mobile phones (e.g Nokia 105, Huawes Ascend Y300, Doro Phone Easy 740) because they strongly believed that the Smart phones are expensive and difficult to operate.

However, due to their low literacy rural farmers do not know how to access information using latest technology that could improve yields to get better market rates for their harvested crops. The smallholder farmers mainly rely on conventional information systems and are not really familiar with the new technologies such as use of IT, WhatsApp, Instagram, tweeter and other social media, whereas farmers in developed countries have realized the importance of information driven economies (Shaukat and Shah 2014). Duncombe (2012) argue that illiteracy was the cause of use of ICT among smallholder farmers because some of them find it extremely difficult to contact related officers and department and get information about market price, weather or pesticides even some farmers were not knowledge about use of mobile phone to contact with their family and friends due to illiteracy.

On the other hand, radio was and still is one of the most accessible communication media for the smallholder farmers (Balan and Norman 2012). Radio as a mass media channel is repetitively finding itself as the most widely preferred medium among rural dwellers for communicating and disseminating information about agriculture innovations as its reach far exceeds any other mass media channel, and as such - a powerful tool for information dissemination and access especially for hard to reach rural audiences (Myers 2008). Indeed, even in very poor communities, radio penetration is vast. Radio is an excellent, cost-effective means of sharing knowledge and supporting the adoption of good agricultural practices. According to Nakabugu (2001) radio has a vast geographical coverage with diverse broadcasting languages which has the potential to reach a large number of audience. Moreover, 98% of the smallholder farmers in the study area have radio and listen to diverse broadcasts from different radio stations particularly agricultural broadcasts from ABU, Zaria radio station which specifically designed for agricultural broadcasts for rural farmers (Field survey 2016). ABU radio is used extensively as a communication medium to support educational programmes in teaching, literacy training, market information, nomadic information and the promotion of changes in farming practices to improve agricultural production. All these information, especially market information obtained on time assists rural farmers to determine the cropping pattern, estimate input price and plan what to sell and at what price (Qiang *et al*. 2011).

3.1.4 How and Why Mobile Phones within ICTs have different Impact

The immense contributions of mobile phone technology within the broader bracket of ICTs makes it the most exceedingly preferred after radio. It was estimated that about 50% of the world population have their own mobile phones (Duncombe 2012). On the other hand, it was revealed that 80% of the population live in the range of mobile phones networks (GSMA 2006, Chhacchar and Hassan 2013). Nowadays almost all smallholder farmers have access to this significant new ICT on daily basis and it played important role compare to land line phones. Farmers are getting a good benefit from the perspective of market, weather information and communication with family and friends. Furthermore, by using mobile phone farmers made informed decision, save time, energy and transport cost. This current study therefore utilised mobile phone as the main focus because of its contributions. With this new ICT farmers can communicate with customers to sell their product and as well keep up to date each other's about market and weather pattern (Chhacchar *et al.* 2014). It can be said that Mobile phones have brought substantial changes in the prices of the agricultural produce and farmers are now getting reasonable prices of their product from market and this eliminate the challenge of middlemen. Without any doubt by using mobile phones smallholder farmers have improved their agricultural and product. The impact of mobile phone cannot be underestimated, it enables smallholder farmers to access agricultural information from a host of information providers such as scientists/researchers from seed and pesticide companies, cooperative committee office-bearers, input dealers, government agriculture extension officers, market-commission agents/traders, veterinary doctors and a host of others. During fieldwork in Nigeria, rural farmers reiterated that such information is readily available when they are needed, not only does it reduce transaction costs, it also improves the returns smallholder farmers can obtain for their agricultural produce. Furthermore, in the discussions with rural farmers, they indicated that timing of actual information is central to reducing agricultural wastage and as a result increasing efficiency. In the perspective of Nigeria, where the agricultural extension are unable to satisfactorily fulfil their responsibility of providing appropriate information on improved technology for farming to all the farmers due to resource constraints and the operative inefficiencies. (Chhacchar *et al.* 2014).

3.1.5 Use of Radio - Farmer Programmes

Globally, countries with advanced agricultural technologies take hold of the vast potential existing in farm radio broadcasting to reach out to farmers with crucial information to enhance their farming activities. Radio is a powerful communication tool for spreading agricultural information to farmers throughout Africa including participatory approaches (Chapman *et al.* 2003). Indeed, radio is a household item throughout Africa and the most effective media in promoting broad based agriculture and development policies amongst the rural communities (Nakabugu 2001). In Sub Saharan Africa, there are more radio sets than televisions. Given its unique latent qualities among rural dwellers, radios have the greatest potential to reach millions of smallholder farmers across different regions simultaneously providing the audience with valuable agricultural information that can boost production and improve livelihoods. In the same light, radio is the most widely used ICT through which general agricultural information is being transmitted to rural communities. Beyond this, Oyeyinka *et al.* (2014) reported that extension workers find radio very useful at the local level to communicate local problems and solution to smallholders. Farm radio programmes can help farmers not only to improve soil quality but also provide market information and new agricultural practices; in addition, radio allows for transmission of information and knowledge in a variety of languages including the local language which are better understood by the target smallholder population. Furthermore, there are various radio-farmer programmes which are part of farm broadcasting design specifically to provide smallholder farmers with agricultural information and knowledge. According to Manyozo (2007), farm broadcasting can be defined as the whole system and structure within broadcasting institutions via which agricultural radio programmes are produced and disseminated to the general public, primarily as part of agricultural extension approaches to boost crop yields. In the Kaduna State (the study area) there are 19 radio stations, however, ABU radio station had been singled out as the best radio station providing agricultural information in a local language to the target population. Box 1 summarizes the various agricultural information through radio-farmer programmes.

Box 1: Radio - Farmer Programmes from Monday - Friday

- From our markets to you - Every Monday (8.am - 10am)
- Let's go farming - Every Tuesday (9.45am - 11am)
- Modern Agricultural - Every Wednesday (3.30pm - 4.15pm)
- Rich man of the dry season- Every Thursday (12pm -12.30pm)
- Programme for nomads - Every Friday (1.30 - 2.15pm)

Figure 3.1: Radio- Farmer programme in the study area.

3.1.6 The use of Mobile Phone Technology in Nigeria

There has been a spectacular growth in mobile phone technology usage in Nigeria in the last decade (Figure 3.2). The mobile telecommunications industry has rapidly improved communication, social inclusion, economic activity and productivity in many sectors; for example agriculture, health, education and finance (Meera *et al.* 2004).

According to the Nigerian Communications Commission (NCC 2012), the telecommunication sector has recorded phenomenal growth, both in terms of the subscriber base and infrastructural development in the country. Indeed, mobile phone ownership has been democratized. Ten years after the launch of telecommunication in Nigeria that is, by the end of August 2011, the active subscriber base was 92.1 million (equivalent to 65.8% teledensity) (Nigerian Communications Commission, NCC 2012). This rapid growth has been made possible by the injection of some 18 billion US dollars equivalent of private sector investment in license fees, building infrastructure, development of local manpower, and empowerment of local companies that provide support services (NCC 2012).

Today, Nigeria has the highest number of mobile phone subscriptions in Africa with more than 167 million subscribers representing 87.5% of the population with 31% using the internet on Smartphones, which is predicted to rise to 84.3% by 2018 (NCC 2014; Figure 3.2). Indeed, mobile phones are as widespread in Nigeria as they are in the United States (Pew Research Center 2015). Furthermore, the mobile industry across Africa is booming and is a catalyst for immense growth, however there is a scope for even greater development. This rapid growth has led to problems with network congestion and quality of service, prompting the telecom regulator to impose fines and sanctions (Hassan *et al*. 2011, Ebikabowe and Benake-ebide 2013). Unfortunately, Nigeria has allocated far less spectrum (wireless communications signals that travel over the air via radio frequency) to mobile services than Europe which hinders connectivity to rural communities. Katengeza *et al.* (2011) suggested that sufficient spectrum should be provided for mobile broadband services which perhaps would assist the smallholder farmers to have access to network coverage and enjoy the power of mobile technologies.

Despite the fact that Nigeria is the fastest-growing mobile phone market in Africa, mobile applications (apps) are scarcely used. This discrepancy with apps usage can be explained and justified by the mobile phones used in the country. A large proportion of the mobile audience is still using low-end phones because of cost factors. Low-end phones are mobile phones with limited capacities in contrast to a modern smarphone. Low-end phones are only capable of voice calling and text messaging, in addition to basic multimedia. This, therefore, compels the citizen to use the non-mobile web more, which is usually dominant over Smartphones.

Currently, Nigeria still suffers from low internet speeds but there is optimism that the country will see a shift to apps usage as the mobile markets mature with time (Mgbenka *et al.* 2013). As an illustration, one-third of English-speaking Nigerians own a smartphone, compared to 2% of the Nigerians who do not have the ability to read or speak English.

The study by Mgbenka *et al.* (2013) revealed that among mobile phone owners in Nigeria, the most popular activities aside from receiving and making calls are: sending text messages; taking pictures/videos; making or receiving payments (mobile money which requires apps and smart phones); accessing social networks on a mobile phone e.g. Facebook and WhatsApp; getting political news and information; searching or applying for a job and getting health information. According to the Federal Ministry of Agriculture and Rural Development (FMARD), in 2014, approximately 14 million smallholder farmers received subsidized inputs (seeds and fertilizers) using their mobile phones via the Electronic Wallet (e-wallet) system. This was initiated in Nigeria and as of 2014 over 14 million smallholder farmers were registered on the system despite issues such as poor network coverage, low levels of awareness and insufficient fertilizer supply in some areas (FMARD 2014). Nigeria is the first country in Africa to launch an electronic wallet system for the delivery of subsidized inputs to farmers.

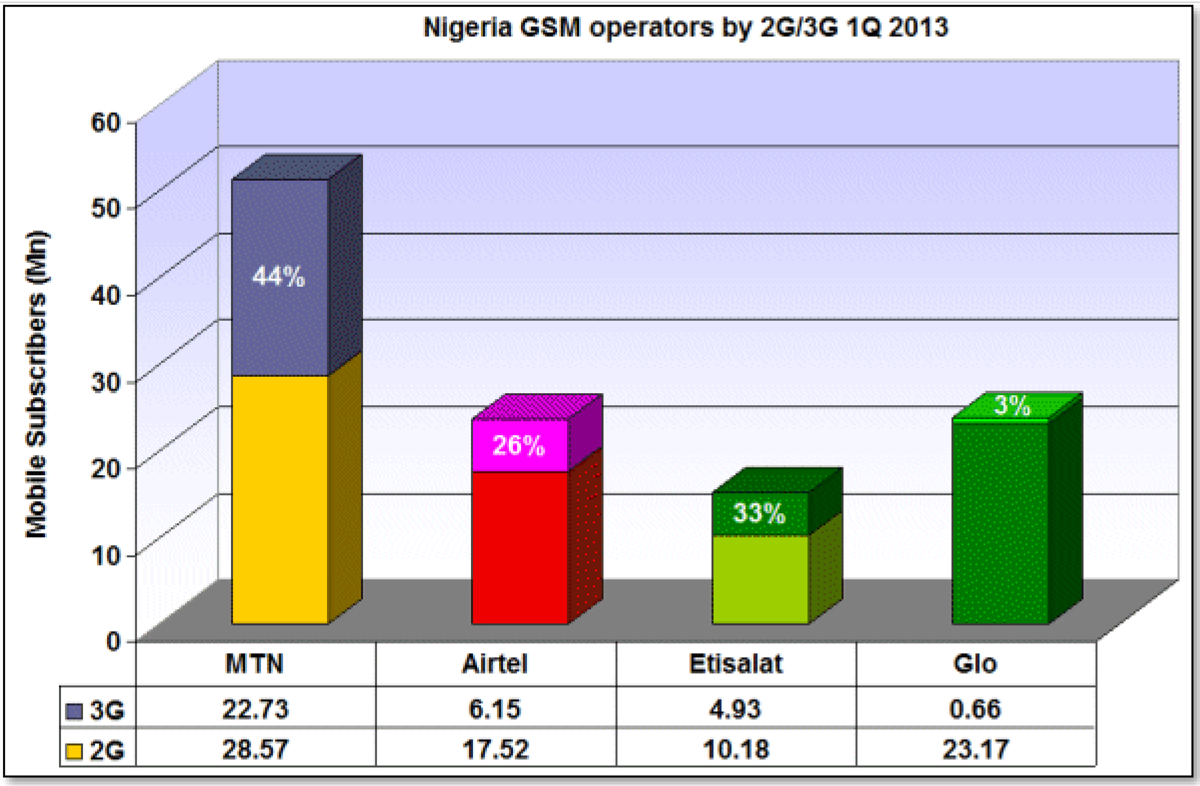


Figure 3.2: Nigeria GSM Operators
Source: NCC 2012

3.2 Understanding the Growth Enhancement Support Scheme in Nigeria

The Growth Enhancement Support Scheme (GESS) is a Federal government initiative to actualise the Agricultural Transformation Agenda (ATA) in the agricultural sector which employed the power of mobile technology to reach the unreached famers in the rural community (Fawole and Olajide 2012, Ajani 2014). It also aimed to subsidize the cost of major agricultural inputs, such as fertilizer and seedlings for smallholder farmers. With this system, farmers receive SMS alerts on their mobile phones and proceed to the nearest agro-dealer to redeem the input for 50% of its value. The system was designed to cut out the middleman and provide the latest agro market information directly to smallholder farmers' mobile phones. The e-wallet system has recorded huge success in Nigeria. The Minister of Agriculture, Dr. Adesina, stated that *"GESS had returned the dignity of Nigerian farmers and put an end to the age-long queue by farmers only to secure a bag of fertilizer for a group"* (Adesina 2013). The concept of the GESS scheme was to enhance capacity and alleviate the suffering of the poor smallholder farmers who could not afford to buy even a bag of fertilizer and seedlings on their own.

Through this scheme, farmers were able to produce 8.1 million metric tons of food, a sharp increase of 70% from the production level in the past i.e. 2000 to 2010 (Adesina 2013). This unprecedented transformation recorded in the agricultural sector in 2014 and the impact of GESS in Nigeria has caused several African governments to express interest in adopting the innovation in their own countries. The e-wallet system has had a significant impact on the Nigerian economy, contributing an estimated US $30-40 billions to the nation's GDP and helping to lower the food import bill from $16 billion in 2011 to $4billion in 2014 (Adesina 2013). This is how agriculture was transformed in Nigeria through mobile technology. The e-wallet system has also increased the productivity of smallholder farmers and expanded private sector opportunities.

The rapid spread of Global System for Mobile communication (GSM) coverage in Sub-Saharan Africa also provides an outstanding opportunity to facilitate technological adoption through ICT (Mobile technology) based extension models (Anderson *et al.* 2006; Aker 2011). Research and traditional extension services have been providing production guidelines and information to farmers on adoption of improved technology and innovations particularly on Good Agricultural Practices (GAP) over the past three decades. These have included traditional extension approaches used at various stages of development and implementation such as in Ministry Public extension model; Training and Visit extension model; Non-Governmental Organizations extension; Farmer Field School extension model etc., all of which have the potential (to varying degrees) to increase productivity, improve natural resources and generate higher income among smallholder farmers as discussed in the previous chapter (Ajani 2014). Adopting sustainable farm management practices often requires farmers to make difficult decisions but these practices can lead to abundant safe, healthy food, improved quality and food security, whilst maintaining viable farming enterprises which protects the environment and contributes significantly to sustainable livelihoods (Titus and Adefisayo 2012). However, traditional extension models and public extension programs for smallholder farmers in Sub-Saharan Africa have been widely criticized by scholars as ineffective and inefficient (e.g. Arokoyo 2005; Anderson *et al.* 2006; Davis 2008; Aker 2011); leading others to advocate ICT-based extension programs (e.g. Aker and Mbiti 2010).

3.2.1 Mobile Phone Technology in Rural Nigeria

Mobile Phone Technology have the potential to significantly increase productivity, improve poor people's health, distribute locally relevant information and stimulate rural economic growth (Okyere and Daniel 2012, Ajayi 2013). Moreover, the sector has also claimed to contribute to a new urban and regional spatial organization (Guldmann 2001). Telecommunications are believed to promote rural development by attracting information-intensive service provider firms to rural areas and contribute to economic growth (Meera *et al.* 2004). According to Ajiboye *et al.* (2007), mobile telecommunication increases a rural community's access to information and assists rural businesses in serving non-local markets, as well as making it easier for urban firms to capture and serve rural markets. For example, this great improvement is most visible in rural India where rural dwellers are currently benefiting from the geographical penetration of mobile services which promotes awareness, marketing education and rural health services for rural dwellers. According to Ahuja (2008), Nokia Siemens Network works in India to find innovative ways to provide communication to the populace in rural areas in order to support agriculture and create employment opportunities. It is estimated that there are approximately six million new subscribers every month in India, which makes the country the second fastest growing mobile market in the world after the United States (Rao 2004, Tiwari 2008).

The situation is not the same in developing countries where many rural communities and villages are seriously lacking telecommunication infrastructure and network connectivity/coverage. Rural areas in many countries continue to be sparsely covered and are not considered as a viable business place for investors and telecommunication operators (Alleman 2005, Ahuja 2008). The key challenges for the provision of telecommunication services in rural areas are driven by both technological and economic issues. Rural communities face a variety of barriers in obtaining advanced telecommunications including; unreliable power supply or absolute lack of energy sources; lack of equipment; market obstacles; insecurity; regulatory obstacles and poor network planning and post-deployment maintenance (Safe *et al.* 2010). Mountains and hills create physical barriers for the erection of mobile tower lines which invariably affects mobile network coverage in the vicinity (Ahuja 2008). Setting up connectivity also remains logistically challenging and is a very expensive exercise.

These challenges can be overcome through a combination of strategies which, of course, vary from community to community. Zheng and Warner (2010) opines that the International City/County Management Association suggests some feasible strategies which include; the use of regulatory and property management procedures to enable community advantage; the use of government purchasing power to create buyers' markets; the interconnection of urban networks; the use of alternative technologies and working with alternative providers.

Information has become a valuable commodity both in developed and developing countries (Onwuemele 2011). Consequently, many developing countries that have acquired the necessary mobile phone technology infrastructure have experienced terrific and sporadic growth and are moving rapidly into the post-industrial information-based economy (Alleman 2005; Onwuemele 2011). ICT are making a significant impact as a major catalyst for information and knowledge which create development opportunities and choices for rural communities. These could perhaps under certain conditions assist in improving the livelihoods of the rural communities through better and sustainable strategies (UN 2004; Onwuemele 2011).

Nigeria has the fastest growing mobile phone market and subscriptions rates in Africa. Mobile phone technology is the fastest growing ICT sub-sector with seven mobile service providers - MTN Nigeria, Globacom, Etisalat, Airtel, Visafone, Multilinks and Starcomms. The mobile teledensity in the country had increased significantly from one - NITEL - to seven between 2001 and 2007 (Sennuga 2012). According to Safe *et al.* (2010) the phenomenal growth rate of mobile phone technology could be accredited to several factors including the liberalization of the telecommunications market; convenience of operation, the need for basic literacy in using the phones advanced payment modes; and usage of native languages in communication.

The connection between mobile phone technology, livelihood and poverty reduction springs from the recognition that information is a critical factor for development purposes (UN 2004). Mobile technology has the capacity to augment the speed and to introduce new modes with which information is communicated. Mobile technology can enable interactive communication flows without any impediment by space or time thereby influencing the existing communicative ecologies (Tacchi *et al.* 2003; Safe *et al.* 2010). Accelerated communication of information, in combination with other factors, can, among several benefits, increase productivity; enhance access to services; widen markets; simplify transactions; substitute for physical transport; prevent crime; improve governance and create new socio-economic opportunities. Similarly, the excitement about the potential of mobile technology for Africa's development is based on a view that many western countries experienced the positive impact of science and technologies during the industrial revolution. ICT would on this basis, assist Nigerians and other developing countries to overcome socio-economic related issues and boost economic growth (Obijiofor 2009; Safe *et al.* 2010).

The potential of mobile technology to improve livelihoods and reduce poverty, and the explicit way and degree to which these technologies contribute to sustainable livelihoods and poverty reduction in Nigeria is still controversial. However, there are also concerns that evidence from research on the linkages between mobile technology, livelihood and poverty in developing countries is still also very scarce (McNamara 2008, Aker and Mbiti 2010, Irungu *et al*. 2015). There is a relative scarcity of empirical studies on the impact of telecommunication on rural livelihoods; this is partly attributable to the recent advent of mobile phones and partly as a result of differences in the interpretations of the poverty and livelihoods conception (Souter *et al.* 2005; Safe *et al*. 2010).

However, empirical studies that do exist on the impact of mobile phones on rural livelihoods and poverty reduction reveals contrasting findings by authors that there is a positive relationship between telecommunication infrastructure development and economic growth. Among these studies are Noll (2000), International Telecommunication Union (ITU) (2003), Sridhar and Sridhar (2003) and Onwuemele (2011). In addition, a critical review of literature also reveals that Information and Communication Technologies such as mobile phones can have impacts on rural livelihoods and poverty reduction of rural communities in developing countries (Lustig and Stern 2000; Woverman *et al.* 2005). According to Information for Development (2006) there are several areas where mobile phones can have a significant impact and contribute to the improvement of rural livelihoods and poverty reduction in developing countries, including:

- Increased opportunities to access resources and use capabilities through improved access to timely information.
- Empowerment through information about choices that affect rural populaces themselves.

- Decreased vulnerability to risk due to the potential to send and receive information (InfoDev 2006; 2011).

3.2.2 Mobile Phones Potential as a Tool for Economic Development

BiztechAfrica (2013a) stated that it is very important to explore the capabilities of mobile phones for the populace in developing countries so that they can unleash their instinctive potential as productive citizens and maximize the benefits. According to Aker and Mbiti (2010), there are five economic benefits of using mobile technology in which both consumers and producers could equally drive economic benefits. These are:

- Mobile technologies can enhance access to and use of information, thus, reducing search costs, improving coordination and agents, and increasing market efficiency.
- Mobile devices create new jobs to tackle demand for mobile-related services, in that way providing reliable income-generating opportunities in rural communities and urban areas.
- Mobile phones also increase communication which invariably improves firms' productive efficiency by allowing them to better manage their supply chains.
- Mobile technologies can improve communication among social networks in response to shocks, thereby reducing households' exposure to risk.
- Mobile phone-based applications and development projects have the capacity to smooth the progress of the delivery of financial, agricultural, health and educational services."

The potential of mobile phones as a viable tool for economic development has long been recognized by African governments, non-governmental organizations and phone companies. In Africa, there are numerous mobile phone development projects in diverse sectors, including agriculture, education, health, emergency response and governance. Mobile phones have been utilized in a range of agriculture and health projects in Africa (Walsham and Shaay 2006).

Mobile technologies can be used in the collection, monitoring and measurement of agriculture and health data. In the same vein, households and companies frequently search information in a variety of areas: market information, potential buyers and sellers, market prices, input and output prices, new innovations, politics and the status of friend and family members (Perekwa 2016). Mobile technologies have unlocked new search technology compared with the traditional information search mechanisms such as radio, landlines, letter, television and personal travel. Farmers do not need to travel to markets to obtain price information, as mobile technology have greatly reduced the cost of searching for such information (Aker and Mbiti 2010; Perekwa 2016).

Mobile phones enable farming households in developing countries to have access to services and information they need in order to grow their crops effectively and efficiently, thereby improving the standard of living of the households. Mobile technologies have the potential to transform farming activities in developing countries to increase sustainability and make them more lucrative, thereby lifting millions of people, particularly smallholder farmers out of abject poverty (Aker *et al.* 2011); for example; the e-wallet system in Nigeria and M-Pesa in Kenya. Mobile phones play a significant role in disseminating timely and appropriate information to rural communities. In addition, smallholder farmers across developing countries can use their mobile phones to have access to key agricultural information such as the latest market prices; upcoming pest and diseases attacks and weather patterns; government and NGOs agricultural subsidies schemes on farm inputs; online trading and loan facilities; cropping patterns and fertilizer use; new crop varieties and irrigation frequency and setting up farm-based enterprises (Aker *et al.* 2011; World Bank 2012). Farmers can connect to better markets directly for their produce and create profit without middlemen. Moreover, there are some notable Mobile Financial Services (MFS) tools that enable farmers to invest in fertilizers, high-quality seeds and machinery, the tools are credit, payment, insurance and savings (Aker 2010). This will increase the productivity and livelihoods of farmers and benefit the agricultural sector (WEF 2012).

Employment opportunities in the mobile telecommunications sector are fast growing in Nigeria and other parts of the developing world. The industry has created employment in advertising and the distribution of online content; including applications, games and ringtones. According to GSMA (2013a), the mobile network has employed almost 9 million people worldwide. The positive economic impact and development created via the mobile industry in Africa in respect of job creation cannot be underrated. Mobile technologies can also create viable opportunities for private enterprises and small-scale businesses; in Nigeria for instance, citizens use prepaid mobile phones and airtime cards. There are several small shops which sell mobile phone credits, repair and even charge mobile phone handsets and batteries. According to Aker and Mbiti (2010) mobile telecommunication applications provide possibilities for distributing agricultural price information, transferring money and monitoring health care in poor countries. Furthermore, since 2005, mobile financial applications such as "m-money" or "m-banking" have been used in some developing countries (Foster and Rosenzweig 2010).

3.2.3 Mobile Phones and Improvements in Market Access for Agricultural Products

Smallholder farmers require information on a range of themes at each stage of the agricultural production process. In Africa, such information has conventionally been made available through traditional ICT such as radio, newspapers, landlines and personal exchanges. When compared with these communication methods, mobile phones can considerably reduce the costs of acquiring agricultural information. However, landlines are no longer readily available in Nigeria, while radio only provides market and price information for specific agricultural products on a weekly basis. According to Baye *et al.* (2007) the reduction in search costs related with mobile technologies could significantly increase farmers' access to market information through their private sources, for instance, a member of their social network.

Moreover, this could expedite or raise farmers' contact with other users of the social network, as a result allowing farmers to learn and gain additional practical knowledge from neighbourhood trials of new innovations or observe those trials more frequently. This could increase the rate of adoption of technology and innovation (Foster and Rosenzweig 2010; Nmadu *et al.* 2015).

Reductions in the cost of communication could not only increase farmers' access to public information, but also information made available through agricultural extension agents and advisory services. Reducing the costs of disseminating information could significantly increase the extension system's geographic scope and scale; also promoting more frequent, accurate and appropriate communication between extension agents and farmers. This could significantly improve the worth or quality of the information services provided to farmers. However, the impact of these reduced costs on farmers' adoption decisions will largely rely on the capacity of such information to serve as an alternative to face-to-face mechanisms (Foster and Rosenzweig 2010; Nmadu *et al.* 2015).

Consequently, this improves the reliability of extension services short message system (SMS) and voice messages which in turn can be used to collect data on farmers' adoption, cost and yields on a more regular basis, rather than waiting for annual end-of-year agricultural surveys, when recall data on costs and production are often subject to measurement error (Aker and Mbiti 2010). In the same vein, mobile technologies can be used to authenticate extension agents' visits. According to Dillon (2011) when communication flow is perfectly strengthened, mobile technologies could potentially improve and also reinforce the link between the three key actors; the research centres, extension agents and farmers, and vice versa - in so doing defeating criticism of the "disconnect" between the three stakeholders in agricultural production in the developing countries.

3.2.4 Nigerian Mobile Phone Markets

According to Adeyinka *et al.* (2007), the mobile phone market in Nigeria boomed in 2001 when licenses were issued to the first set of GSM operators. The major GSM operators in Nigeria (MTN, Etisalat and Globacom) cover more than 87%of mobile subscriptions (NCC 2009). Investment in the sector was initially slow in Nigeria due to inadequate infrastructure. With government intervention through privatization, the Nigerian Telecommunication mobile subscription has been increased significantly (Faborode and Ajayi 2015). Internet user penetration has increased accordingly, from 0% to 4% within the period of (2001-2009) and the number of internet service providers and cyber cafes has increased in urban areas (NCC 2009, Fawole and Olajide 2012).

In a similar finding, Adeyinka *et al.* (2007) considered Nigeria as one of the most important and attractive markets in Africa, mainly due to its growth rate and size. With over 100 million mobile subscriptions in 2008, Nigeria is the biggest mobile market in Africa, exceeding South Africa in the same year (Faborode and Ajayi 2015). However, in terms of revenue generation from mobile phone service in 2009, Nigeria was second to South Africa, with revenue of US$6.6 billion. In a related development, unified access licenses were introduced in 2006, after the NCC Act of 1992 had been replaced by the NCC Act of 2003. The unified licenses were awarded to 13 companies, which covered the provision of mobile technology, fixed and other telecom services (Obayemi 2014).

In an attempt to explain the rate of mobile penetration, Adeyinka *et al.* (2007) emphasizes that since GSM technology was introduced in Nigeria, the growth of mobile penetration has been raised from 0.33% of the population in 2001 to as high as 99.09% in 2016 of Nigerians adult have mobiles phones. Similarly, coverage of underserved areas has been expanded by the smaller operators, which caused an increase in competition among the service providers (Mabe and Oladele 2015, National Bureau of Statistics 2016).

Mobile services revenue has exceeded fixed telecom service revenue, mainly due to the limited internet penetration and fixed lines. It was observed that the major share of total telecommunications revenue in Africa is dominated by mobile services revenue. Considering the proportion occupied by mobile service revenue in total telecom revenue in 2009, among eight key countries in Africa, Pyramid (2010) found the mobile service revenue has contributed 4.2% to the GDP in 2009. However, the ratio was higher in some African countries like Ghana (7%), Congo (6.1%), Senegal (5.8%) and Cote de voire (5.1%). He further stressed that telecom services market has been the key pillar of growth for the Nigerian economy. The Pyramid's study found that mobile operators in Nigeria have increased total service revenue from $135 million in 2001 to approximately $7.0 billion in 2008.

It was further revealed that since 2003 mobile services overshadowed the fixed services not only in the rate of penetration but also in income generation. It further shows that 80% of the Nigerian telecommunication service market has been represented by the mobile market. The estimates in terms of revenue generation indicated that the service has rapidly grown, representing 8.83% of the country's GDP in 2016, which was higher than the 1.2% in 2001, shortly after the liberation of the sector. Hence, the contribution of the telecommunication sector to GDP was the fastest in growth between 2000 and 2009 (National Bureau of Statistics 2016).

As mentioned previously, agricultural extension and advisory services have the potential to provide smallholder farmers with timely and relevant information, access to credit and better market prices which could go a long way in addressing the persistent food shortage and poverty in rural Nigeria and improving agricultural productivity (Bell 2016). Mobile technology could help in the aspect of timely and relevant information, to connect smallholders with appropriate and up-to-date information they require. According to Vignare (2013) and IFPRI (2015), agricultural extension plays a significant role in improving the wellbeing of individuals and rural communities, improve agriculture and the social, economic and political status of rural communities, improve farmers' income and productivity on a sustainable basis and attain food security and improve rural livelihoods. However, extension alone cannot achieve the aforementioned role unless there is the right combination of sustainable agricultural policies, improved technologies (including ICT) and adequate market opportunities.

3.3 Summary

This chapter has explored the evolution of ICT and mobile phone technology specifically in extension, its use among smallholder farmers and its potential contribution to rural productivity and livelihoods. Literature revealed that more farmers now use simple mobile phone technology, therefore it appears to be the most effective way of improving communication. It is evident from this chapter that there is a gap in the literature on how rural farmers could obtain appropriate agricultural technologies to increase their productivity. The study will focus on how to reach smallholder farmers more effectively, through the use of mobile phone technology alongside a pluralistic extension approach focusing on how community-based mechanisms such as a farmer-to-farmers extension approach could be effectively utilized in extending technologies to other farmers in the village. This will be explored in this study using the methodological approaches outlined in the following chapter.

Chapter Four. Research Strategy

This chapter sets the scene for the field research and also discusses the various research strategies employed for data collection. These include community meetings, baseline livelihoods survey, focus group discussions, in-depth interviews and an evaluation questionnaire. Consideration was also given to the study area and communities, as well as gaining permission from the communities' elders and farmers, community and industry engagement. In addition, ethical considerations are discussed.

4.1 The Study Area

This section introduces the case study communities selected for this research and provides details of agricultural and extension activities.

4.1.1 Profile of Nigeria

The Federal Republic of Nigeria is located on the Gulf of Guinea in West Africa, lying between Latitude 4^0N to 14^0 and Longitude 2^0E and 14^0. It is bordered in the south by the Atlantic Ocean, in the north by the Niger Republic, in the east by the Republic of Cameroon and in the west by the Republic of Benin. Nigeria covers an area of 923, 769km^2 with a total land boundary of 4,047Km (FOS 1989). The climate of the country largely falls within the humid tropics as the country is located very close to the equator, while the vegetation of the country varies from mangrove forest on the coast to savannah grass in the faraway northern Guinea savannah zone.

Nigeria is the eighth most populous country in the world with an estimated population of 163 million people (NPC 2006). The country is generally dominated by three ethnic groups – Yoruba in the West, the Hausa-Fulani in the North and the Igbo in the East. However, the country's wide-ranging population is divided among 478 different ethnic groups. The population growth rate of Nigeria based on the UNDP (2010) increased from 2.2% in the period (1975-2005) to 2.8% in (2005-2015). The United Nations projected that the population of Nigeria would be 210 million by 2025 and 289 million in 2050, when it is predicted to be the sixth most populous country in the world (UN 2014).

The country has a federal form of government and is divided into 36 states (see figure 1), and a Federal Capital Territory (FCT) Abuja, comprising a total of 774 Local Government Areas. The country is grouped into six geopolitical zones – South-West zone, South-South zone, South-East zone, North-West zone, North-Central zone and North-East zone.

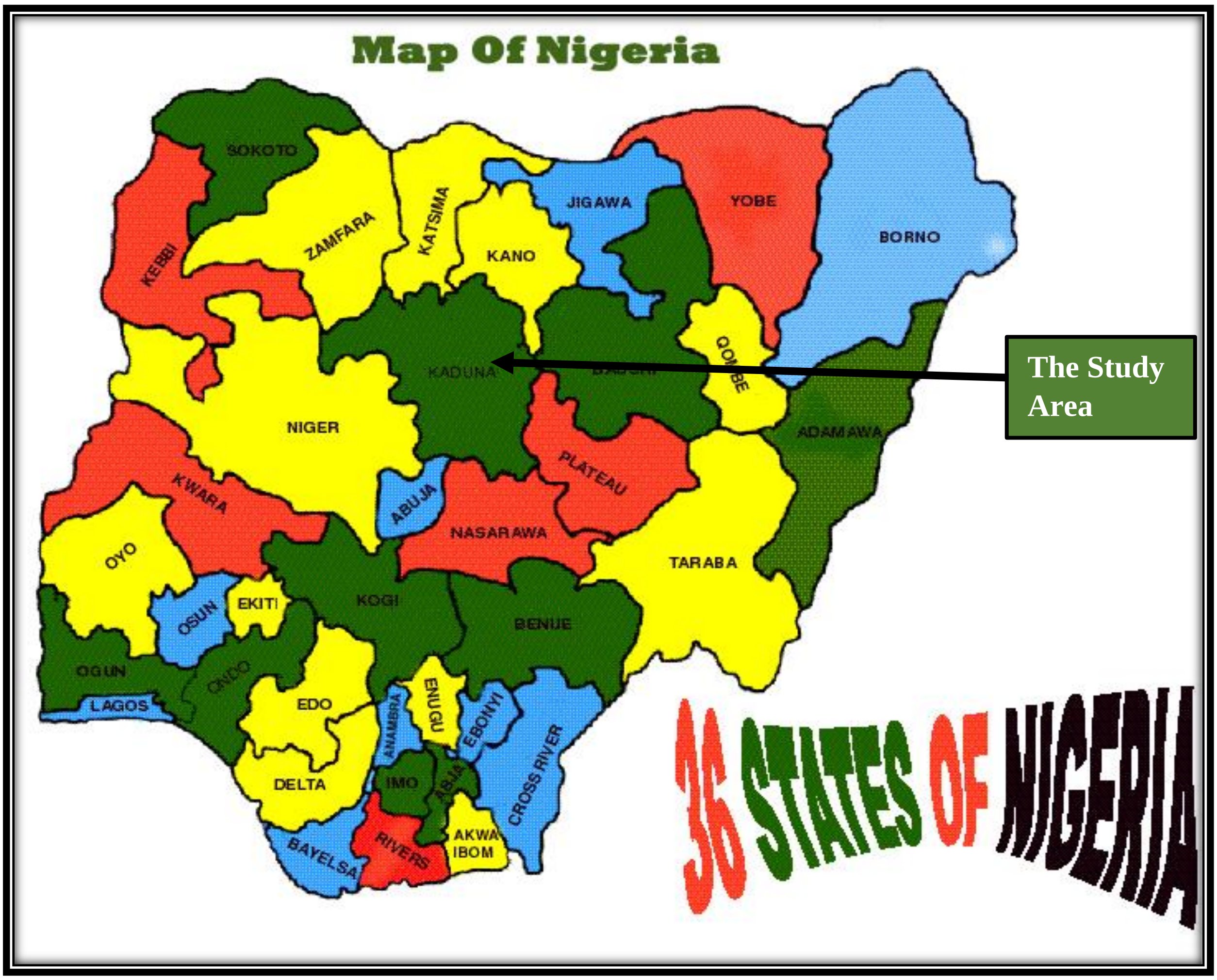


Figure 4.1: Showing the 36 states of Nigeria.
Source: FGN 2012

4.1.2 Role of Agriculture in Nigeria's Economy

Agriculture was the most important sector of Nigeria’s economy before the country attained independence in 1960, and contributed 75% of the country's earnings through export and produced more than 50% of the GDP (FGN 2012). However, the sector was neglected when the petroleum industry was rapidly expanded. Aregheore (2009) examined the relative decline in the sector which caused a high dependence on imported foodstuffs and consequently consumer preference increased for these imported food stuffs. The rate of population growth surpassed the food production in the country when growth rates in the early 1970s were 8% - 10% per year while agricultural production declined by 4% per annum (Aregheore 2009). The FAO (2001) found sharp recovery in production of major food crops from 1995 to 2004 as a result of a succession of good harvests, leading to a reduction in cereal imports, a surge in public and private investment in crop production and higher producer prices.

When outlining the increase in the contributions of the agricultural sector to GDP in Nigeria and subsequent increase in agricultural production in 1993, the World Bank (1993) emphasised the contribution of 33.5% to the GDP and in the same year, 63.7% of the population was employed in the sector. The World Bank (1993) further estimated that there was a 4.1% increase in agricultural output in the same year, which was higher than the increase of 3.5% and 3.7% in the years 1995 and 1996 respectively (World Bank 2010). The agricultural production value accounted for 38.7% of the country's GDP. Despite the increase in the performance of the sector, it has fallen short of the expectation of the proposed 5.5% growth rate outlined in the National Plan of 1997 to 1999. Lack of interest in farming among the youth also caused the sector to decline significantly (Aregheore 2009). The 2004 estimate shows the GDP real growth rate was then 1.7%, with agricultural production accounting for 30.8% of the country's GDP, industry accounting for 43.8% and services 25.4% (World Bank 2010).

4.1.3 The New Agricultural Policy

The new agricultural policy in Nigeria was launched in October 2015. The new policy reflects the hallmarks of the previous first National Policy on Agriculture which was adopted and launched in 1988, and remained valid for fifteen years before the new policy was inaugurated. The new National Policy on Agriculture is the combination of the framework for implementation of programmes and action plans by the Government to attain general and overall agricultural growth and sustainable development. Nigeria's policy therefore aims to achieve of self-sufficiency in food production and development in all the subdivisions of agriculture and the fundamental transformation of the country and the quality of life of Nigerians. According to the Federal Ministry of Agriculture and Rural Development the new document expanded the broad objectives of the Nigerian Agricultural Policy (FMARD 2001), which include:

i. The attainment of self-sufficiency in basic food supply and achievement of food security.
ii. Justifying the roles and responsibilities of the three key stakeholders (Federal, State and Local Government) and provide support in promoting agriculture and rural development.
iii. Formulation and implementation of integrated rural development as a matter of great importance to national programmes to improve the quality of life of rural dwellers.
iv. Increased production of agricultural raw materials for industry.
v. Agricultural technology development and transfer of valuable skills.
vi. Increased production and processing of export crops, using improved production and processing technologies.
vii. Creating gainful employment and increasing fiscal incentives to agriculture.

viii. Rational utilizing of agricultural resources, improved protection of agricultural land resources from drought, desert encroachment, soil erosion and flood, and the general preservation of the environment for the sustainability of agricultural production.

ix. Promotion of the increased application of modern technology to agricultural production and inputs through favourable tariff policy.

Given this new initiative, it important to set its objectives in the context of earlier policies and programmes; these are summarised below (Table 4.1).

Table 4.1: Agricultural policies and programmes in Nigeria

Policy	Purpose/Objective	Impact/Success	Challenges/Failure
Agricultural Development Project (1972)	• To increase production • To raise rural income and standard of living and welfare of the rural dwellers.	• The success achieved in the pilot projects and others led to the establishment of thirty-one state-wide ADPs in the country. • Through applied research, an improved extension system and a more efficient system of farm inputs distribution. • ADP is the major contributor to the significant growth recorded in the agricultural sector in the late 1980 to early 1980 (CBN 2000)	• Withdrawn of assisted funds by World Bank. • Dwindling funding policies • Low number of extension workers. • High frequency of labour mobility. • Rigged top down approach (Adejo *et al.* 2012).
National Accelerated Food Production Programme (1976)	• To accelerate the production of six major food crops namely rice, millet, sorghum, maize, wheat and cassava. • Increasing staple food production through the promotion of improved production technologies among the smallholder farmers (Olayiwola and Adeleye 2005)	• It led to an appreciable improvement in food production in the 1970s. • The programme laid a good foundation or an effective researcher-farmer linkage (Obiora and Emodi 2013).	• Unfortunately, NAFPP has been kept dormant since the regime that initiated it left the stage. • Abrupt withdrawal of funding by the Federal Government due to the introduction of another programme termed (OFN).
Operation Feed the Nation (1976)	• Increase food production and eventually to attain self-sufficiency in food supply.	• The impact of OFN was not profound. The programme only succeeded in keeping the nation aware of food shortage.	• The main challenges was that the objectives were not specific and therefore not measureable.

	• To create awareness about the importance of agriculture in national development. • The designed involved all the segments of the population including students who were engaged during the long vacations (Ogunsumi and Abegunde 2011).	• Everybody irrespective of profession/trade took of farming but it this did not last long.	• The programme naturally passed away with the regime that introduced it. • Farming was done on any available piece of land irrespective of it suitability for agriculture (Nwaeze 2015).
Nigerian Agricultural and Cooperative Bank (1978) Currently, is known as Bank of Agriculture	• To promote the overall growth and development of the Nigerian economy through the promotion of agriculture and rural development. • To improve incomes and quality of rural life. • Provision of finance for the processing and marketing of agricultural products. • Provision of technical and managerial services to farmers. • To provide micro-credit to farmers • Encourage the mobilization of saving and advances (Lawal *et al.* 2009).	Provision of loans for agricultural purposes only.	• Poor funding • Low loan recovery rate • Poor patronage on the part of farmers.
Green Revolution Programme (1980)	• To boost food production and make Nigeria self-reliance. • Wiping away hunger through credit supply to farmers. • Encourage and intensity cooperative education.	• Green Revolution did not achieve its objective of increasing food supply.	• The programme failed because government embarked on large-scale importation of rice and other food items from India and America. • Delay in execution of most of the projects involved in the programme.

	• Mobilizing the rural people to actively participate in agriculture. • Application of research on food and fibre. • To enhance abundance in food production, processing and distribution.		• There was no monitoring and evaluation of the projects (Nwaeze 2015).
The River Basin Development Authority (1985)	• To develop the water resources potential of the country for agricultural and domestic purpose. • To boost economic potentials of the existing water bodies particularly irrigation and fishery with hydroelectric power.		• A number of the authorities grew out of proportion and the operations of some suffered from intensive political interference.
Directorate for Food, Road and Rural Infrastructure (1986)	• The directorate was to help the rural communities to identify and evolve viable local level projects. • Provision of feeder roads, water and electrification in rural communities.		• Mismanagement of fund made the impact of the programme almost insignificant. • Shortage of fund for the implementation of rural infrastructural plan. • There was no effective programme of action and appropriate execution.
Better Life Programme (1987)	• To stimulate and motivate the rural areas towards achieving a better and higher standard of life. • Educate women on simple hygiene, family planning, and to increase literacy.	• Acquisition of more skills and knowledge through meetings, trainings and workshop programmes. • Help to bridge communication gap between the government and people.	• Over publicity of the programme was criticized by people who thought the programme might turn into a mere fashion parade. • Cultural and religious inhibition of the Muslims that do not allow easy access to women reduce level of participation.
National Special Programme on	• To increase food production and eliminate rural poverty.	• Provision of credit facilities to rural farmers. • Farmers were also given farm input and soft loan.	• Inability of majority of the beneficiaries to repay their loan on time.

Food Security (2002)	• Assisting farmers in increasing their output, productivity and income. • Strengthening the effectiveness of research and extension service training and educating farmers on farm management for effective utilization of resources. • Supporting government efforts in the promoting of simple technologies for self-sufficiency (Olayiwola and Adeleye 2005).		• Complexity and incompatibility of innovation and difficulty in integrating technology into existing production system.

There is ample evidence that these governmental interventions and policies have not yielded desired results (Ogunsumi and Abegunde 2011). This is partly due to the demise of the extension services but perhaps also because of the persistently high level of poverty and hunger, extremely high cost of food and neglect of smallholder farmers which has resulted in low standards and low productivity. The failure of these intervention programmes to achieve food security in the country has been attributed by Adejo *et al.* (2011) to several factors including political instability; corruption and embezzlement; unreliable and unsteady funding linked to the conduct of fraudulent officials; extension workers' salaries not being paid for months; and material for field work and transportation facilities not available.

Furthermore, most agricultural policies as suggested in the first chapter are really allowing farmers to take up Good Agricultural Practices (GAP). The GAP was the focus of engagement with the farmers and extensionists. The next section explores the theory of GAP.

4.1.4 The Adopted Village Concept and Good Agricultural Practices

It is worth mentioning that in the context of the field research to the study area Bassawa community participated in the Adopted Village Concept while Shika Community did not.

According to Mustapha *et al.* (2012), the ARCN issued directive stated that each research institute, university and college of agriculture was expected to identify two communities/high schools within its jurisdiction and mandate areas within which to promote best farming practices and government policies. In accordance with the directive, each institute is expected to identify farmers and engage them in a participatory rural approach using their farmland or field as a 'show room' for the other community members to demonstrate a particular technology. The National Agricultural Extension and Research Liaison Services (NAERLS) of the Ahmadu Bello University, ABU Zaria has been working is 5 geographical zones of the country but with a particular on villages in the North-West zone of Nigeria, in Kaduna and Katsina States.

The 'Adopted Village' concept is an extension approach and was introduced for disseminating and evaluating technology emanating from research institutes, through which villages are selected with the aim of enhancing the agricultural productivity and general livelihood of the rural dwellers in an integrated manner, focusing on health, education, drinking water supply and so on. Demonstrations are conducted in each Adopted Villages to encourage adoption of new technologies/practices among farmers. The principal aim of the 'Adopted Village' concept is to empower resource-poor farmers, enhance the economic and livelihood status of the beneficiaries' households, increase food security and market competitiveness, create job opportunities for youths and develop agriculture as a business and vocation. The 'Adopted Village' concept was introduced in Nigeria to expedite the adoption rate of new technique and technologies, through a participatory approach and demonstration plots of smallholder under farmers' environmental conditions, because farmers need to participate in the process of technology identification and development (Yila and Thapa 2008, Sterk *et al.* 2013).

The main objective of the 'Adopted Village' concept is to encourage large-scale adoption of improved technologies, economic empowerment of resource-poor farmers, create job opportunities for youths and ensure food security. Specifically, the 'Adopted Villages' concept is to:

- Create awareness in the rural areas and improve farmer's organizations development via communities' activities
- Empowerment of the communities through initial provision of some facilities and infrastructural development in the village.
- Facilitate the transfer and adoption of improved agricultural technologies in the adopted villages.
- Accelerate union and integration of differs programs of state/local government and other development agencies in the villages.
- Improve the economic status of the villagers through capacity building of the rural dwellers and communities.
- Enhance socio-economic status and livelihoods of the farmers with the provision of credit facilities for all farming families in the adopted villages.
- Operate an agricultural research outreach center including research based information flow.
- Ensure adequate monitoring of the progress of the implementation of the project in the villages.
- Build vibrant rural communities that are productive, self-sustaining and create new markets.

In Nigeria, the Adopted Village Concept was initiated to speed up and upscale technologies adoption under the farmers' environmental condition in a participatory rural approach and Bassawa community benefited in the Adopted Village Concept while Shika Community did not. The involvement of farmers in the concept is an additional advantage which in turn facilitates the rate of adoption and boost agricultural productivity of the participants.

4.2. Good Agricultural Practices (GAP)

GAPs are a collection of principles for on-farm production and post-production processes, aimed at delivering in safe and healthy food and non-food agricultural products, while taking into account economic, social and environmental sustainability (FAO 2010; Lefebvre *et al.* 2015). GAPs cover a range of areas including maintaining soil fertility, water resource and irrigation management, crop land management, degraded land restoration, animal production and welfare, integrated pest management, integrated fertilizer management and conservation agriculture (Montagne *et al.* 2007; FAO 2010). GAPs explicitly aim to increase the supply of safe and high-quality food by promoting more sustainable crop production (Ali 2014) while also helping to improve market access and farmers' livelihoods (Poole and Lynch 2003; FAO 2010). Although GAPs have the potential to play a significant role in improving agricultural practices, there is currently limited empirical evidence on the level of awareness and implementation of GAPs.

GAPs were introduced and implemented by the FAO in many agricultural producing countries across the globe in order to guide the production systems towards an ecologically safe and sustainable agriculture, which produces harmless products of higher quality, contributes effectively to food security, generating income through the access to markets and upsurges the working conditions of farming families (FAO 2005; Wannamolee 2008). GlobalGAP is a privatised version of GAP adoption formulated into audited standards linked to access to more formal markets including exports. As such they can underpin the production of safe high-quality food and non-food agricultural products for the producer countries (Amekawa 2010). GlobalGAP standards are economically, socially, environmentally responsible and widely accepted by international markets such as the EU and USA (Hobbs 2007; Wannamolee 2008). From all views, GAPs can be of significant benefit and high value if judiciously implemented by smallholder farmers as proponents of those good practices. They rely on four major principles:

- Economically and efficiently produce sufficient food security, safe food safety and nutritious food (food quality).
- Sustain and enhance natural resources
- Maintain viable farming enterprises and contribute to sustainable livelihoods.
- Meet the cultural and social demands of society.

The awareness of GAPs is relatively low in Nigeria due to dependence on traditional farming which results in low productivity among smallholder farmers (Oladele and Adekoya 2006). Evidence from studies conducted among smallholder producers indicates limited adoption of improved technologies (Omonona *et al.* 2006; Yila and Thapa 2008). However, land degradation, pests and diseases, lack of appropriate production technologies, lack of labour-saving technologies for field operations and processing, and inadequate supply of yield-enhancing inputs and poor harvest agricultural practices are major factors influencing low agricultural production Nigeria (Morse and McNamara 2004; Okello *et al.* 2010; Binam *et al.* 2011; Masette and Candia 2011). In addition, market-related constraints such as limited access to credit facilities, high cost of farm inputs, poor access to output markets; and weak linkage between farmers and markets (Udoh and Omonona 2008). Ineffective extension systems and lack of policy incentives also constrain agricultural productivity (Binam *et al.* 2011). These challenges adversely affect food security and sustainable agricultural development. For maximum benefit however, it is imperative to couple adoption of GAP innovations with an accompanying market uptake pathway for sustainable agricultural development and food security (Kassie *et al.* 2010). Therefore, it is evident that the adoption of market-driven GAP, agricultural production technologies coupled with natural resource management practices is essential for enhancing agricultural productivity in Nigeria.

4.2.1 Principles of Good Agricultural Practices (GAP)

These principles describe farming that uses available technology and optimally promotes sustainable agricultural productivity and natural resources management that contributes to: food security; access to sufficient, safe and healthy food; improved livelihoods, to achieve economic viability; agricultural and environmental sustainability; as well as social responsibility. According to FAO (2010), the key areas of concern when implementing a GAP program are:

- Soil Management
- Water Management
- Crop and fodder production
- Crop protection
- Animal production, health and welfare
- Harvest and on-farm processing and storage
- Energy and waste management
- Human welfare, health and safety

From a market perspective, many of the above are also considered important as articulated in private standards like Global GAP.

4.2.2 Relevant GAP’s for the Region and Justification

After a comprehensive analysis of possible GAPs technologies for the study locations based on the scientific evidence as to whether they are suitable for the region (see annex 1) and careful consideration of farm household in making improved decision about technologies adoption. The following factors were put into consideration in selecting 16 GAPs - climatic factors, economic factors, edaphic factors, socio-economic factors and government policies. However, these 16 GAPs were carefully selected and considered relevant to the region:

- Improved seeds
- Soil management
- Spraying of herbicide
- Pest use/pest control
- Improved planting spacing of crops
- Use of crop residue to feed livestock
- Fertilizer application
- Striga control
- Irrigation/water management
- Crop rotation
- Cover crops
- Improved storage
- Compost and green manure
- Zero tillage
- Spacing
- Mulching

4.3 Introduction to Case Study Locations

This study was conducted in two zones of Kaduna State Agricultural Development Project (KADP) in terms of population and land size (see figure 2). Kaduna State is located between latitudes $9^0\ 03^1$ and $11^0\ 32^1$ North of the equator and longitude $6^0\ 05^1$ and $8^0\ 38^1$ East of the Greenwich Meridian (Kaduna State Ministry of Agriculture 2014). The state capital is Kaduna - a status it has enjoyed since the old regional days. It covers an area of land estimated at 46,053 square kilometres which is approximately 5% of the total land area of Nigeria. According to the 2006 census the state had an estimated total population of 6,210,703 comprising of 3,139,041 males and 3,071,667 females (National Population Commission 2006). Using the 3.18% growth rate, the National Population Commission has projected that the population of Kaduna State will be 8,446,417 by 2018 (Kaduna State Government 2013). The land structure consists of an undulating plateau with major rivers in the state, including river Kaduna, River Wonderful in Kafanchan, River Kagom, River Gurara and River Galma. Administratively, the state is divided into twenty-three Local Government Areas. Among these are Giwa, Sabon-gari, Kaura, Kaduna North, Birni Gwari. These areas are largely dominated by Hausa and Fulani with other ethnic groups.

Kaduna State is politically classified as belonging to the North-West zone of the six (6) Geo-political zones of Nigeria which is located in the Northern Guinea Savannah agro-ecological zone of the country and experiences a tropical continental climate with two recognizable seasonal, dry and rainy reasons.

4.3.1 Climate of the Study Area

The rainy season (May-October) is extremely heavy in the southern part of the state with an average of over 1,524 mm, which is higher than in the northern part which has an average of 1,016mm (KSG 2014). The average annual rainfall and humidity are 1,272.5mm and 56.64%

respectively while the average daily minimum and maximum temperature are 15.1^0 and 35.18^0 (Kaduna State Ministry of Agriculture 2014).

The study area experiences typical tropical continental climate which is generally characterized by seasonal variation of the rain starting around May and ending in October, the length of the rainy season is 150-160 days, and the dry season starting around November and ending in April with monthly average temperature ranges between 20^0C and 32^0 (see figure 4.3) (Kaduna State Ministry of Agriculture 2014). The climate has distinct seasonal regimes, oscillating between cool to hot dry and humid to wet. The seasonality is more pronounced with the cool to hot dry season being longer than the rainy season. The area is also regarded as a natural and stable ecosystem with the mean annual rainfall of about 1000mm (KSMA 2013).

The driest month is January. There is 0mm of precipitation in January. In August, the precipitation reaches its peak, with an average of 284 mm (Figure 4.3). With an average of 28.6 °C, April is the warmest month at 23.3°C on average; August is the coldest month of the year. The area is dominated by open woodland with average rainfall of 1000-1270mm/annum usually between April and October (see figure 4.3).

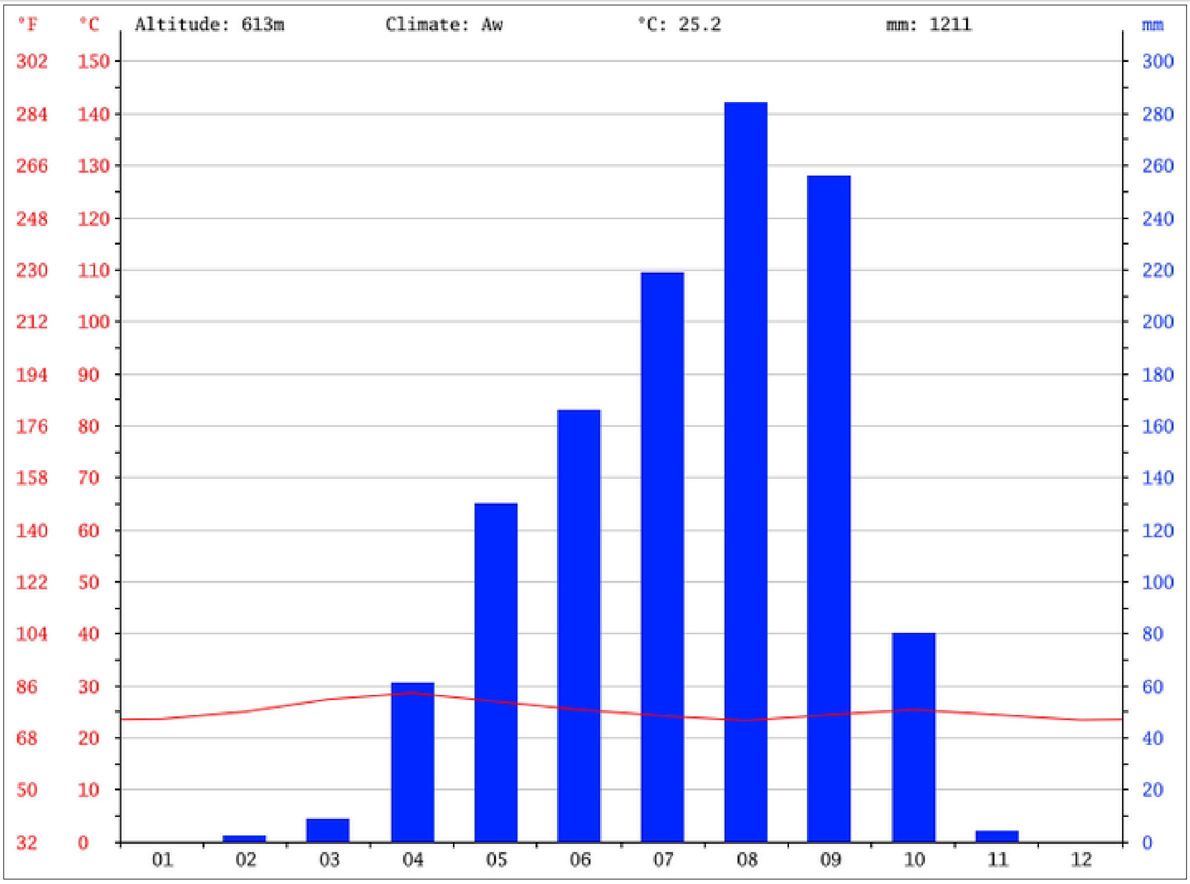


Figure 4.3: Precipitation per month
Source: Climate-Data Odekunle (2004)

The driest month is January which is typically dry and no precipitation. In August, the precipitation reaches its peak, with an average of 284 mm. The temperature normal is measured in the period 1961–1990. Also, the precipitation shows average amount of days (24h) with precipitation during a month. When precipitation has surpassed 1mm per day (24h) it is defined as a day with precipitation (see figure 4.3).

4.3.2 Soils and Vegetation

Generally, the soils are typical deep grey-brown to sandy loams which become heavier at depth. The vegetation type is savannah vegetation where trees, woody shrubs and grasses are scattered over space. The trees have characteristics thick bark and hard leaves to survive the harsh environment and fire. Trees and shrubs found in the study area include baobab, silk cotton and Shea-butter; *Isober loinadoka* (Yusuf 2013). The soils in the upland areas are rich in red clay and sand but low in organic matter. Fringe forests ("Kurmi" in Hausa) in some localities, and especially in the southern LGAs of the state, are presently at the mercy of increasing demands for fuel wood in the fast-growing towns and urban centres. The study area has a lot of rock outcrops which vary in height and an undulating landscape. The soils generally are freely drained in rocky, hilly areas, and well-drained in the plains.

4.3.3 Role of Agriculture in Kaduna State Economy

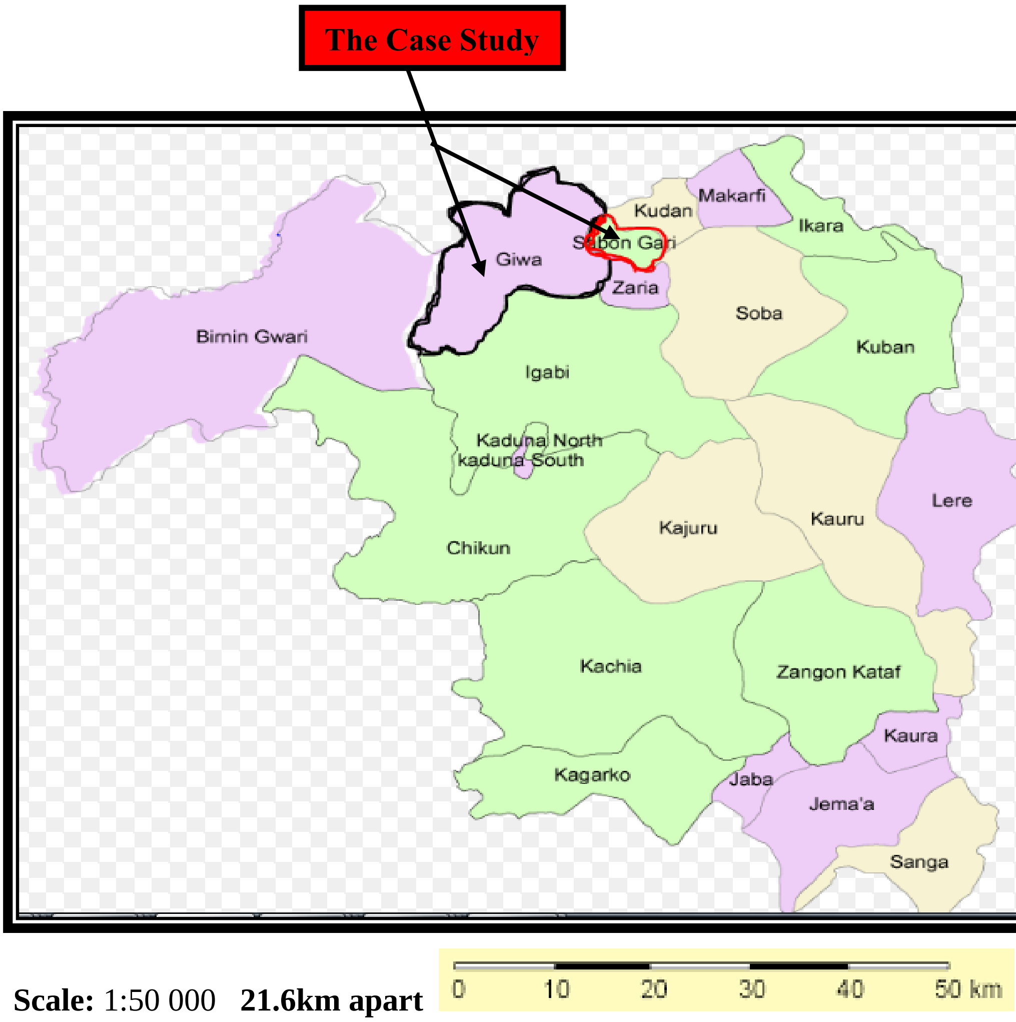
The major cash crop is ginger where commercial quantities of 1,728.930 metric tons are produced annually as well as food crops including yam, maize, millet, groundnut, rice, cassava, beans, guinea corn (Akinola *et al.* 2013). A substantial number of the population are engaged in livestock production with the most important being cattle, sheep, goats, poultry and pigs. The agricultural production of the state is principally dominated by smallholder farmers.

The State Government has given positive support to farmers in terms of extension advisory services however the World Bank recommended ratio of 1:500 extension agents to farming families has not been met. Currently, the ratio of extension agents to farming families in Kaduna State is approximately 1:3000 which is far above the World Bank recommendation (KSMA 2014). Modern livestock production systems in the state employ more capital and their productivity is significantly higher particularly ruminant and poultry production.

According to the Kaduna State Ministry of Agriculture (2013) the following are the major challenges facing agriculture in Kaduna state:

- The production system is dominated by smallholder farmers who cultivate small areas of land and depend primarily on primitive tools and low quality inputs which culminate in low productivity.
- Inadequate extension workers to farmers' ratio..
- Inconsistency of agricultural produce prices.

- Inadequate private sector investment
- Extremely poor maintenance, supervision and management of forest reserves and plantations.



Scale: 1:50 000 **21.6km apart**
Figure 4.4: Showing the Map of Kaduna State and the study area

4.3.4 The Case Study Communities

The study was conducted in two communities (Shika and Bassawa) in Giwa and Sabon-gari Local Government Areas respectively (see figure 4.4). This area were selected primarily due to active engagement of the rural farmers in agricultural production in the district and for its proximity to Ahmadu Bello University, Zaria to facilitate access for the researcher and his assistants. The researcher collected the list of smallholder farmers in the study area from the office of Agricultural Development Programme (ADP) the government extension sector who are working in the area. From the context of the fieldwork, the two communities were actually one because the only thing that differentiated them was the adopted village concept and that was in relation to extension, and therefore they are different in term of their extension experiences.

This study employed case study approach in order to explore and obtain in-depth information related to the use of mobile phone technology and GAP adoption among smallholder farmers and extension workers in their real-life settings.

The two communities are similar in agro-climatic, ethnic group, religion and cultural settings. There is no climatic or agronomic difference between these communities, they are just 300 metres apart. However, one is an Adopted Village from the National Agricultural Extension and Research Liaison Services (NAERLS) ABU, Zaria and the other is not. The Shika community gets only public extension services with about 3000 farm families per extension agent while Bassawa community receives extension services plus the research education establishment from Adopted Village Program with estimated ratio 1:85 farm families (field survey 2016).

As mentioned previously, the study areas are situated closely together and possess largely everything in common and could be described as one wide-ranging community in terms of the agricultural productivity; market and rural setting; farming activities, harvest and sales; households farm size and crop zoning; irrigation process; yield of crops and income sufficiency of the households; domestic livestock; traditional religious belief; socio-demographic characteristics of the participants; climate; soil and vegetation; landscape and variation; fragmented land-holdings capacity; land ownership and so on.

Socio-culturally, the indigenous people are predominantly the Hausa and Fulani tribes by language and culture. Development in the urban areas has led to intermingling of non-indigenes (Igbo and Yoruba tribes) who came to settle in Zaria. The group include military personnel, students and staff of various higher institutions. The wider study area Sabo-Gari LGA (Bassawa) is the home of several tertiary institutions and research institutes (Akinola *et al.* 2013), including; Ahmadu Bello University, Zaria, School of Aviation, Leather Research Institute, military college and barracks. Now that the study area has been introduced, the methodological approach is outlined in the following sections, starting with the epistemological stance.

4.4 Epistemological Stance

All research methods integrate a combination of epistemological and ontological suppositions. The interpretivist epistemological approach according to Bryman (2004) is a theory of knowledge and concern of what is considered as acceptable knowledge in a discipline. It helps to determine the true from the false by a proper method of evaluation. Saunders *et al*. (2007:102) stated that epistemology is a branch of philosophy that studies the nature of knowledge and what constitute acceptable knowledge in the field of study. However, a major concern in the epistemological context is how our minds are related to reality, and whether these relationships are valid or invalid.

In this research, mixed methods approaches (quantitative and qualitative) are employed to collect and analyse data. Aside from being interpreted as a quantification means of data collection and analysis, quantitative research has the unique attributes of positivism (natural science model) in epistemological approach (Figure 4.6). If carefully planned in the relationship with theory and research, quantitative research principally leans towards testing theories (deductive). Conversely, a qualitative research approach apart from using both words and numbers in data collection and analysis is considered as interpretive (inductive) from a epistemological standpoint. However, the pledge of the epistemological stance in this research is related to describing the links between social science research (interpretivism) and natural science (positivism) (Bryman 2004).

According to Bryman (2012), a mixed method approach should not be considered as a universally applicable method for a research project, but could provide a better understanding of a phenomenon when compared to the use of only one research method in a study. Apart from the fact that it may consume more time and resources, the mixed method approach should be suitable to provide an answer to the research questions for proper investigation.

A constructivist approach to this research study was used, which stresses the importance of how people construct their own understanding and knowledge about the world they live in and their personal experience and reflection on these experiences (Shoqirat 2009). Constructivists believe that knowledge is built, or constructed through experiences as oppose to discovery (Figure 4.5). This research methodology proposes a new way of thinking about issues and problems and the researcher is an active participant, not a passive observer.

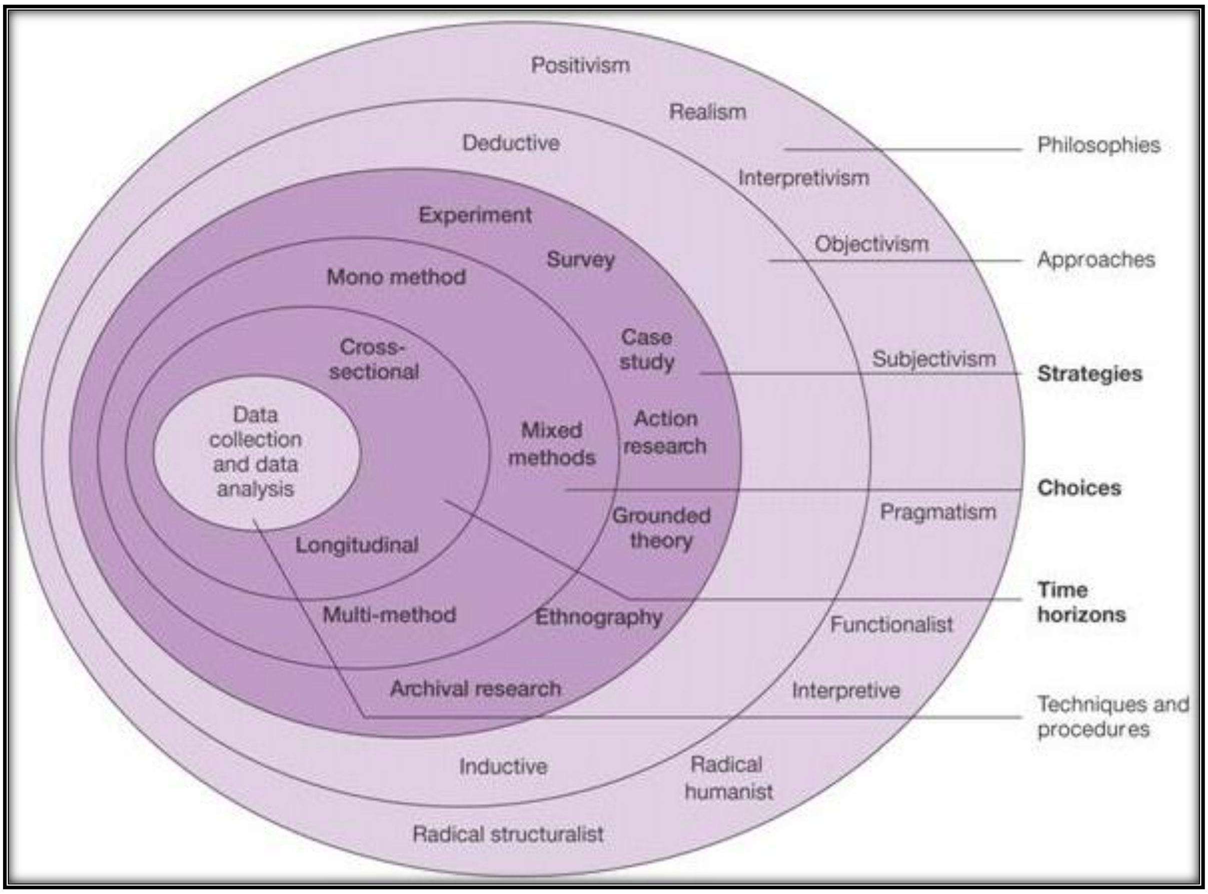


Figure 4.5: The research "onion" (Adapted from Saunders *et al.* 2007).

4.4.1 Validity of Mixed Methods Approaches

In order to address the research questions outlined in section 1.4, a mixed methods approach has been engaged in this study. A mixed method approach helps to explore relationships between variables in-depth and clarify relationships that are found to exist between variables. The approach cross-validates relationships discovered and allows further exploration.

Mixed methods approaches have grown in popularity in recent years and the field has been described as "entering into its full-fledged adolescence" (Teddlie and Tashakkori 2003) while Greene (2008) described the methods as *"multiple ways of seeing and hearing".* It is a methodology for conducting research that involves collecting, analysing and interpreting (or mixing) quantitative and qualitative research in a single study or a longitudinal program of inquiry. Another definition put forward by Teddlie and Tashakkori (2003, p. 3), was that mixed methods approaches could also be described as the "third methodological movement" and as a viable research paradigm in its own right (Johnson and Onwuegbuzi 2004). The use of mixed methods in a study can provide a coherent and better understanding of research problems than either approach alone (Creswell and Plano Clark 2007). The main purpose of mixed methods research is to provide an in depth understanding and enhanced description of a phenomenon while some researchers stated that mixed methods research should be conducted for the purpose of triangulation. For some, both approaches enhanced description and understanding of a phenomenon and triangulation and were valid reasons to conduct mixed methods research (Johnson *et al.* 2007, Schiazza 2013). Researchers advocating a mixed research regime argued that it is important to use both the exploratory and the confirmatory methods in one's research (Johnson and Onwuegbuzie 2004).

Triangulation is primarily a strategy for improving the validity and reliability of the research findings. The triangulation metaphor can also be referred to as multi-method research in which a quantitative and a qualitative research method are combined to provide a complete set of findings that could be arrived at through the administration of one of the methods alone (Bryman 2004). "Triangulation also provides a justification for the use of mixed methods" (Mertens and Hesse-Biber 2012). The use of triangulation can, therefore, enhance exactness and strengthen a study by combining methods (Fisher 2012). Bryman (2006) argued that triangulation can improve the credibility and persuasiveness of a research account. Triangulation is also known as convergent methodology (Creswell, 2002) as illustrated by figure 4.6. It has been argued that combining qualitative and quantitative research methods can be useful in getting a wider picture of a phenomenon under study (Idisemi 2012).

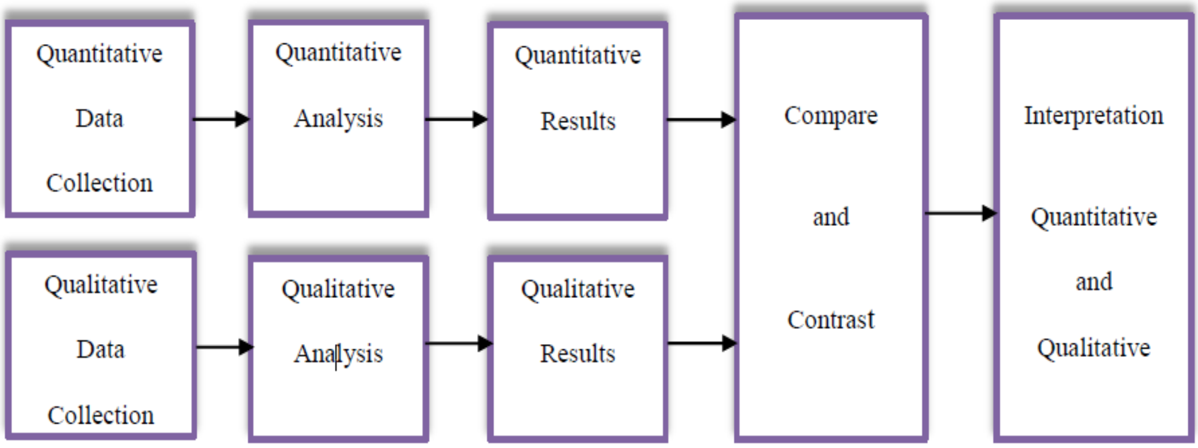


Figure 4.6: Triangulation – Convergence Model (Creswell 2002)

The methodologies employed for data collection in this study were based on quantitative evidence around Good Agricultural Practices and on profiling research communities through household surveys, while the qualitative research focussed on the behaviour of the communities in relation to scientific evidence along with an exploration of the value of mobile phone technology to extend communications between those with knowledge and those who need to use this knowledge. The research was divided into three principal phases:

1. Baseline livelihoods survey of farming communities and extension officers;

2. Feedback on the baseline studies plus training (GAP and ICT) of selected farmers and extension officers; and,
3. Evaluation of training and the use of mobile phone technology over the growing season that occurred after phase 2.

(See Figure 4.7a-c).

Participatory Research Methods

a) Summary of Phase 1 Data Collection
Baseline livelihood survey

A baseline livelihood survey was conducted in the study area (Bassawa and Shika communities) from June to July 2015. The following described the summary of the activities during the phase 1:

- A courtesy visit to the District head for permission to conduct research in his domain.
- Community meetings with the smallholder farmers were held at the village primary school.
- Selection of 200 smallholders from the two communities with the list provided by the extension workers working in the area.
- Livelihood survey was pre-tested with three farmers working with ABU, Zaria.
- Data collected:
- Socio-economic profiling
- Cropping system
- Awareness of GAP
- Use of ICT (specifically mobile phone technology)
- Sources of agricultural information
- Access to extension
- Farmers' copping strategies and available guidance

b) Summary of Phase 2 Data Collection
Workshop/GAP Training

During the second visit to the study area, the researcher assisted by two extension professionals from NAERLS who can communicate effectively in local dialect (Hausa language) undertook a participatory training programme on GAP.

- The workshop/ GAP training commenced at study area on Monday, 4 April 2016 and 50 farmers were carefully selected to avoid bias as potential "lead farmers", 25 farmers who use mobile phones and 25 non-mobile phone users, based on the analysis of the first baseline livelihood survey.
- Selection of 25 lead farmers from those participated in phase 1 from Bassawa and 25 from Shika. Criteria were: completion of secondary education, must be a respected farmer in the village, must belong to active age group, able to read and motivate others, must an active mobile phone user.
- The lead farmers were asked to train 3 farmers each (altogether 150 trainee farmers). The process was monitored. Altogether the researcher trained 200 farmers during the phase.
- This is called the farmer-to-farmer extension model of technology dissemination where lead farmers are trained and then pass on the technologies to the trainee farmers in the village.

  The 200 farmers were divided into 2 groups based on the analysis of baseline livelihood survey: with SMS and without SMS.
- The with-SMS farmers group received GAP Training, Action Plan, SMS text reminders fortnightly, extension visits and free mobile phone technology training on using mobile phones to unlock markets.
- 12 SMS text reminders were sent fortnightly on the next thing to do based on the Action Plan provided.
- The aim of this exercise was to evaluate the effectiveness of SMS reminders and the type of communication preferred by smallholder farmers. In addition, to investigate whether SMS reminders significantly improve adoption of GAP.
- The without-SMS group received GAP Training and Action Plan only.
- All farmers were also given improved maize seeds as an incentive for actively participating in the study.

c) Summary of Phase 3 Data Collection
Evaluation Survey Questionnaire

- The final visit took place between September to October 2016 at the end of the growing season to identify and evaluate the impact of the training on GAP adoption. This state incorporated both an evaluation survey and semi-structured interviews, and an organized community meeting with the farmers at the end of the study.
- All 200 farmers who participated in phase 2 responded to the survey.

The purpose was to evaluate the impact of GAP Training and influence of SMS text reminders on adoption among the respondents and to assess pre/post training GAP activities and pre/post agricultural productivity.

Figure 4.7a-c: Participatory Methods and Research Strategy in the Study Area

The following sections justify the approaches employed in this study.

4.5 The Case study Method

The overall aim of this study is exploratory in purpose, with an attempt to strategically explore how mobile phone technology could be used to improve the adoption of good agricultural practises in order to increase the productivity of smallholder farmers in Nigeria. The data obtained was used to develop a frame of orientation and model of communication for extension services in Nigeria.

The case study method according to Yin (1994), is the choice of the right research strategy generally based on five strategies, namely; survey methods, experimentation, history, archival analysis and case studies, and is reliant on satisfying three conditions of research programmes. These conditions are: the type of research questions posed; the degree the investigator directs control of the participants' behaviour; and finally the degree of the research focus. Table 4.2 summarised the type of research strategy under these three conditions:

Table 4.2 - The three conditions that determine choice of research strategy

Research method	Form of research question	Requires control over behavioural events?	Focuses on contemporary events?
Experiment	How, why	Yes	Yes
Survey	Who, what, where, how many, how much.	No	Yes
Archival analysis	Who, what, where, how many, how much	No	Yes/No
History	How, why	No	No
Case Study	How, why	No	Yes

Source: Adapted from Yin (1994)

Yin (2003) reiterated that the use of the case study method would be the most useful and appropriate if the study under investigation is structured around these four factors that determine the best research methodology to employ:

- How and why research questions.
- The researcher cannot manipulate the behaviour of those involved in the study.
- When the investigator wants to cover contextual conditions because you believe they are relevant to the phenomenon under study.
- When the focus is on a contemporary phenomenon within a real-life context.

Indeed, the types of research questions are the most important factors in determining the appropriate methods in any viable research project. Table 4.2 summaries the conditions that determine the choice of research strategy and the most appropriate methods according to Yin (1994). On the other hand, research questions with who, what and where can be investigated via survey, documents, archival analysis, interviews (Rowely 2002). The research study however, endeavours to offer reasonable and statistical answers to 'why' and 'how' questions as clearly stated in the research questions in chapter one. It can be considered as a robust research method particularly when a holistic, in-depth examination is required. Indeed, the case study method is a recognised and viable tool when issues with regards to community-based problems such as poverty, illiteracy and youth unemployment were raised (Johnson 2006; Zaidah 2007). Consequently, the use of this method for this study is appropriate because it sought to provide insight into issues, plays a supportive role to the rural dwellers and looks at the case in-depth; explains real-life interventions programmes and explores the adoption of GAP among rural communities as aforementioned (Baxter and Jack 2008). In the same vein, this study seeks to have a deeper understanding, exploration and in-depth analysis of a real-life situation which involves farmers' engagement and adoption of GAP innovations.

The careful design of the case study is therefore very important. This is because the case study method through focus group discussions and interviews observations, must be able to prove that:

i. It is the only viable method to elicit implicit and explicit data from the subjects.

ii. It is suitable to the research questions.

iii. It follows the laid down procedure with proper application.

iv. The case study method is linked to a theoretical framework (Zaidah 2007).

4.5.1 Challenges/Limitations of Case Study Research

Despite the relative merits of the qualitative case study (Neuman 1991; Gable 1994), the method has been criticized. Kerlinger (1986) pinpoints three main limitations of the case study method: (1) the lack of flexibility to handle independent variables, (2) the risk of erroneous interpretation, and (3) the incapacity to randomize. Similarly, Lee (1989) singled out four equivalent weaknesses of qualitative research - a lack of: controllability, deductibility, repeatability and generalisability, although the last two weaknesses occur primarily from the aforementioned incapability to randomize. On the other hand, Lee went further to justify the case study approach by putting forward that the challenges are neither endemic nor insurmountable, and remain proportional to other research methodology (Gable 1994). On the other hand, Yin (1994) identifies three major arguments against a case study approach.

First, case studies research is frequently accused of a lack of rigour. Yin (1994) further reiterated that case study researchers have allowed inappropriate evidence or biased opinions to sway the direction of the findings and the conclusion of their research. However, counter to the claims regarding lack of rigour, Scholars have noted that many case study researchers have allowed their personal views to influence their findings (Yin 2009). While this is often one of the major limitations, it is not unique to this school of research. However, safeguards must be built into the research design to minimize any research biases (Sudman and Bradburn 1982).

Second, the approach provides very little basis for scientific generalisation considering the sample size for the study with some conducted with only one subject. The question repeatedly asked is “How can you generalise from a single case? (Yin 1994). Counter to the claims regarding lack of ability to generalize, case studies are generalizable to theoretical propositions.

Case studies rely on analytical generalisations and can be designed to allow for the improvement of assumptions of a body of similar cases (Yin 2009).

Third, case studies are usually accused of being too long and time consuming, difficult to conduct and generating a huge amount of unreadable information (Yin 2009). However, consistent effort and perseverance delivers the best result in case study research.

The most common limitations of the case study approach is its absolute dependency on a single case exploration which makes it extremely difficult to generalize the result for the wider population (Tellis 1997; Zainal 2007). Likewise, a researchers' subjective feelings may influence the case study and may be biased in the interpretation of data. Yin (1993) viewed the case study method as "microscopic" on account of the limited sampling cases.

Many of the limitations of the case study approach were addressed through the collection of both qualitative and quantitative data.

4.5.2 How the Case Study Method was conducted in the Study

The case study method is capable of accommodating mixed methods, that is, qualitative and quantitative research methods which allow the researcher/investigator to obtain inherent and rich mix data (Gerring 2007). This research study utilized a single-case design because the case studies villages are similar in everything: the agro-climate, ethnic group, religion; cultural setting they are just 300 metres apart. The only difference between these communities is the extension contact where one (Bassawa) is under adopted village from National Agricultural Extension and Research Liaison Services (NAERLS) ABU and the other is not. However, Zaidah (2007) stated that a single-case design may not be able to lead to a generalized conclusion especially where events are rare. To overcome this, the study incorporates a triangulation approach. Consequently, both quantitative and qualitative data were collected using several methods such as baseline surveys, focus group discussions, in-depth interviews and structure surveys. The approaches employed are discussed extensively in the following sections.

4.5.3 Baseline Survey

A baseline survey is a study conducted at the beginning of a project to establish the current status of the population before a project is finally rolled out. The principal purpose of baseline studies is to provide an information base against which to monitor and assess an activity's progress and effectiveness during implementation and after the activity is completed. The Food and Agricultural Organization (FAO) simply defines a baseline study as *"a descriptive cross-sectional survey that mostly provides quantitative information on the current status of a particular situation-on whatever study topic-in a given population. It aims at quantifying the distribution of certain variables in a study population at one point in time"* (FAO 2013). Baseline data provide the minimum information required to assess the quality of the activity implemented and measure the development results.

4.5.4 Sample Size and Sampling Techniques

This study was conducted in two randomly selected Local Government Areas of Kaduna State, Northern Nigeria (figure 4.4); however, in June 2015, two rural communities (Bassawa and Shika) were purposely selected out of 18 villages/communities primarily on the basis of their age-long agricultural practice and presence of adoption practices noted there. Moreover, Bassawa community benefited in the Adopted Village Concept project initiated by NAERLS, ABU, Zaria in 2012, while Shika community did not. Conversely, the two communities are the same in every respect except that one (Bassawa) is an adopted village from NAERLS.

4.5.5 Participatory Methods and Data Collection

Within each community, farm families were invited to participate in the study through community meetings, in which 107 attended from Bassawa and 103 from Shika, and 8 extension workers were in attendance (see section 4.6.2). In July 2015, from each community, 100 farming households were randomly selected giving a total of 200 smallholder farmers; primarily on the basis of volunteer families and the list of active users of mobile phone technology and their status in the community provided by the extension workers (Government KADP office) working with the farmers in the study area. The other criteria for individual participants were as follows: age between 18 and 65 years, farming experience, interested in participating, and permanent resident in the community. The foremost rationale for selecting 100 farmers per community were based largely on the number of farming households that volunteered and showed interest during the community meetings, as well as conformed to the previously mentioned criteria.

An adapted livelihood survey was administered to create a baseline for the research study. According to Chambers and Conway (1991), a livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living: a livelihood is sustainable when it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base. Moreover, a key feature of a livelihood survey is that it includes an analysis of household assets, strategies, priorities and goals of rural communities. The second key feature is that it is participatory in order to understand the needs and priorities of the rural communities.

The key themes in the baseline survey included household demographics, household assets, farm characteristics, extension advice, income generating activities and the enterprises farming households were involved in, along with additional questions on market information. Specific questions were also asked on Household heads' level of awareness of GAP, available guidance on how mobile phone technology could improve the adoption of appropriate GAP. The literature review on smallholder livelihoods, GAP and extension practices informed the development of the livelihood survey and the questions that were included: *Do you think the use of mobile phone has improved your adoption of GAP technologies? Does the information you get through mobile phone have significant impact and increase your agricultural productivity? Do you get market information through mobile phone?*

In order to ascertain the appropriateness and reliability of the questions set for the baseline livelihood survey, the survey were pretested among three smallholder farmers working with Ahmadu Bello University, Zaria, to correct aspect related to verbal understanding and to ensure the interviewees' performance, and some minor corrections were effected before administering the survey to study participants. The pretested survey took about 1 hour 28 minutes and after the pretested, the respondents were asked a series of questions regarding the survey as well as the process of data collection. Some minor corrections made included, rewording ambiguous or difficult questions; discarding any unnecessary questions and forsaking any sensitive questions. Generally, the pretesting provided an opportunity to give feedback to the researcher in order to make sure that he followed the appropriate protocol of data collection techniques to ensure objectivity in data collection. The researcher and four trained extension workers with professional skills in agriculture conducted the survey. In few cases, additional visits were made when it was compulsory to clarify and review incomplete information.

4.5.6 Community Mapping

Village mapping was conducted with the youths in the community; this is a participatory rural appraisal method that involves the sketching/drawing of houses and other social facilities and infrastructure (worship centre, community school, markets, irrigation etc.) in the village. The rationale is that it helps to visualize and situate the location of households and other social facilities in the village (Cavestro 2003). It can also be used as a baseline for planning, implementation, monitoring and evaluation of village development activities as well as a way of introducing the specific research project.

Central to the thesis is the use of ICT among smallholder farmers particularly the use of mobile phone technology to improve adoption of GAP technologies and increase their crop productivity. This first research phase allowed the researcher to gain a thorough understanding of livelihoods issues, use of ICT and awareness of GAP's. This phase and the preceding literature review subsequently informed the development of the second phase of the study. Together the two phases provided greater insight for the evaluation of GAP adoption and the value of ICT communication which was conducted through a further survey during the final phase.

4.5.7 Initial Community Meetings

To evaluate the current farming systems, activities, scope and GAP relevant to agriculture and their relevance to the agro-climatic zone of the study area, community meetings were undertaken. The two communities are the same in every respect except that one is an adopted village from National Agricultural Extension and Research Liaison Services (NAERLS).

Two initial community meetings (one in each community) were held with the smallholder farmers in the study communities and the objectives of the research study were made know to the farmers (see figure 4.8).

There are several advantages accruing from community meetings ranging from; providing an opportunity for rural dwellers to share ideas and experiences; provide a quick, intensive picture of community concerns; effectively involving local people in planning, moderating, implementation and evaluating. It is also useful to identify problems, assess needs or to suggest questions requiring further study (Ohmer *et al.* 2009).

Figure 4.8: Initial Community Meetings

4.6 Focus Group Discussions

Focus group meetings are a qualitative research methodology. They are inductive, using a phemological epistemology position. Focus group discussions can be used to seek social meanings and answer 'why' questions. In order to explore this study to its fullest and obtain substantial data and information, 8 focus groups were organized with the extension workers as well as with smallholder farmers (4 for extension agents and 4 for farmers). Focus groups are a form of group interview organized to explore a definite set of issues, for example, individual views and experiences of the participant based on the topic supplied by the researcher (Shoqirat 2009). The members of the group are the "focus" because it involves some kind of collective activity or social event (Powell *et al.* 1996; Goss and Leinbach 1996) and an interaction - such as examining the extension delivery to farmers or debating a specific set of questions (Kitzinger 1994). Unlike interviews, focus group discussions can reveal a wealth of detailed information, a deep insight, and create a more dynamic and lively social interaction, which explicitly draws upon respondents' feelings, attitudes, experiences and reactions to the topic or subject matter. Therefore, a cumulative comprehension of the topic can be accomplished (Gibbs 1997; Shoqirat 2009). Specifically, extension workers' and the farmers' interaction during the focus groups turned out to be extremely crucial in the empirical contribution to the effectiveness of extension services delivery and ICT in Nigeria.

As extension workers (theoretically) disseminate up to date information to the farmers and assist them in making informed decisions on the adoption of technology, the focus group discussions were able to generate viable results based on their diverse knowledge and experiences, and hence additional comprehensive and durable evidence was noted. This is possibly because the approach of the discussion permits the participants to express their opinions and comment on and critically judge any topic or issue. In fact, there is a consensus that the focus group is the most suitable exploratory method to use for data collection. This benefit is not ascribed to a questionnaire or face-to-face interviews (Gillham 2000; Burns and Grove 2001).

There is no consensus about the appropriate sample size for a focus group discussion. The sample size varies and indeed, a number of qualitative research authors recommend the use of point of saturation or theoretical saturation methods wherein focus groups persist until no new or relevant data becomes available (Strauss and Corbin 1990; Barbour and Kitzinger 1999). This study, however, did not adopt the point of saturation approach, this is due to the fact that other qualitative research methods were incorporated into this study in order to have coherent information and therefore utilizing the saturation method is beyond the timetable of this study. Saturation has also been vigorously criticised for being too vague to explain (Charmaz 2005) and that a saturation method could actually lead to a limitless number of discussions and interviews when a complex phenomenon is involved, thereby rendering the analysis procedure a complicated assignment (Ressel *et al.* 2002). Hjelm *et al.* (2005) recommends that four focus group meetings are sufficient to provide reliable information, especially within mixed method research. Accordingly, in the current research study, focus group discussions were utilized amongst extension workers and farmers with the four major issues: agricultural extension in

Nigeria; how to improve it and the role of ICT; motivation for extension workers and summary of discussion were considered during the focus groups.

4.6.1 Selection of Focus Group Discussion Participants

The selection of focus groups participants for this study was conscientiously tackled in order to achieve excellent discussion among the members and hence gather a large amount of data (Burns and Grove 2011). According to Shoqirat (2009), the more uniform the participants of the focus groups are, the more likely they are to express their opinions. In the light of this assertion, and in order to achieve an outstanding and self-motivated focus group discussion, a homogenous focus group was used for the study. Specifically, extension agents working within the study areas and smallholder farmers from the two communities had independent focus group discussions.

The first two focus group discussions were organized with extension agents at Ahmadu Bello University. Each member of the group was comparable in terms of their knowledge area of extension services and experience. Similarly, farmers from the two communities had their focus group discussions separately. This is in accordance with the case study paradigm emphasizing that each case design should be studied independently at the beginning and later evaluated and used in comparison with others in sequence (Yin 2003).

4.6.2 Sample Size and Sampling Technique: Extension workers and farmers

The sample size for this study was carefully addressed in order to yield useful data. Extension agents were purposively selected - 5 agents each from 4 institutions that provide extension and advisory services in the country namely; the government (ADPs), Non-Governmental Organization (NGO), Academia and the Private sector. A total number of 20 extension agents participated in the focus group discussions at Ahmadu Bello University – All 20 extension agents took part in the two focus groups in which different subjects were discussed. In addition, 8 smallholder farmers were purposively selected from the two case study areas (16 farmers in total) using the results of the initial baseline livelihood survey data. Farmers were selected according to whether they were active users of mobile technology and their status in the community (see findings: Chapter 5). However, a problem of language barrier was envisaged before the farmer focus group commenced and an interpreter was used who was an extension agent working in the study areas. However, the researcher acknowledge the fact that the interpreter may be bias and translate what put him in a good light. This sample size is in line with the view of Barbour and Kitzinger (1999) who stated that a considerable sample size, for example, 15 members more usually supplies informative data. However, it is important to make sure that all participants would effectively contribute to the conversation. Accordingly, in order to achieve a dynamic and successful discussion among members, the sample is not too small or too large to control (Singh and Masuku 2014). How the extension workers and farmers were selected is described below:

During the first visit to the study area, contact was made with the KADP Zonal manager in the study areas to discuss the current research study with them in order to facilitate the process of data collection. A similar contact was made to the director of Extension and Liaison Services at NAERLS, Ahmadu Bello University, Zaria; the Non-Governmental Organization and the Private sector to aid the procedure of data collection. It was presumed beforehand that extension workers had not experienced any issues associated with the adoption of GAP in the study area. However, this did not inhibit the focus group discussion, because the main purpose of the discussion was to draw out opinion and different views regarding the subject matter (Barbour and Kitzinger 1999).

Initially, it was assumed that a simple random selection technique would be used in order to prevent choice bias. Regrettably, this was not achievable because the extension workers were not available as they were resolving their 7-months unpaid salary issue and allowances with the state government while it was also very difficult to make contact with representative from the NGO and private sectors. By and large, the extension workers were extremely busy during data collection with the exception of those from academia. The extension workers were contacted by a formal letter to their respective extension directors/zonal managers and subsequently contacted via telephone calls. After one week, the researcher was able to assemble all the extension agents for the focus groups. The focus group discussions were held at the Ahmadu Bello University, NEARLS complex B and the location was carefully chosen because of its proximity to the town and also all the extension workers were familiar with the location. The smallholder farmers were available for their own focus group discussions. As a result, purposive sampling techniques were utilized to select both extension workers and farmers, with the author of this report ensuring that there was no selection bias in the study as previously explored. The researcher was unknown to both extension workers and farmers.

Figure 4.9: A cross section of the extension workers during the focus group discussions

4.6.3 Preparation and the Design of the Focus Group Discussion

The seats at the focus group location were arranged in a semi-circle in two rows and the researcher stood at the front. According to Sampson (1978) the location for focus group must be a place where people should be seated as comfortably as possible in full view of each other and the leader. The demographic information of the participants was collected before each focus group discussion commenced.

The layout of the focus group discussion was structured around a set of carefully predetermined questions which could be described as a 'funnel structure' (see appendix 4). All the discussion questions followed each other in distinct stages. The formation of the discussion guide was informed by the research questions as well as literature review. At the preparatory stage it was less structured in an attempt to gather information on the participants’ general views of the effectiveness of extension services and delivery systems in Nigeria. Immediately after the introductory stage, a brainstorming technique was employed in order to fire up the discussion and conversation among the participants (e.g. the meaning and effectiveness of traditional extension models: what is it? what is working in Nigeria? and what is not working? no wrong or right answers) (see appendix 3). The researcher who moderated the focus group then wrote on a flip board as the participants were discussing what was working or not working in the extension system in Nigeria. However, the moderator was careful not to show better knowledge of extension systems than the participants. The main reason was to increase the flow of the interaction and not restrain the emergence of data for the research study (Morgan 1997). The technique adopted in moderating the group was minimal but the moderator made sure that all research questions for this study were satisfactorily covered in-depth (Burns and Grove 2001).

The two smallholder farmer focus group discussions were held at the community primary school in both villages of the study areas. The location was carefully chosen because of its proximity to the village centre and also all the smallholder farmers are familiar with the location. The same discussion guide was used as for the extension agent focus group.

An oral summary was produced by the participants at the end of all of the focus group discussions which combined and established the important themes found during the discussions. This ascertains the major aspects of the research topic and that the research questions have been considered and discussed by the participants (Barbour and Kitzinger 1999). In order to create a friendly atmosphere for the participants, refreshments were circulated during the group discussion. An honorarium was given to both the extension workers and the farmers for their effort and assistance.

4.6.4 Recording Focus Group Data

Following the approval from the participants, information was collected through a digital voice recorder (Lyche 8GB recorder). Tape recording allows the researcher to be able to review all the group discussions. In addition, all the focus groups were carefully saved in different files (e.g. FGD 1, FGD 2, FGD 3 and FGD 4.). For clearer and fairer comprehension of the messages, all the recordings were moved to a laptop computer, and specialized software used to fine-tune the quality and speed of the conversation and their expression. However, tape recording the focus group did not show the body language and spoken behaviour (Shoqirat 2009). Therefore, in addition to recording, the researcher also made hand written notes of the issues discussed and non-verbal actions such as shaking of the head as an indication of consensus and disagreement. Finally, the reflected accounts of the interactions were documented immediately after each focus group. The recording were transcribed verbatim.

4.6.5 Problems Associated with the Focus Group Discussion

Like any other research methods, focus groups present some technical problems which must be considered. Firstly, the sample size for a focus group is generally small and the data collected can be extremely challenging (Gills and Jackson 2002). In the same vein, Morgan (1997) argues that group discussion data must be securely contextualized and scrutinized in a definite social situation. This means that the group interaction needs to be put in a specific context and to reflect a good description of group discussions. In the context of this study's objectives and techniques, the above constraint is of limited concern. The principal purpose of the focus group was to gain an in-depth understanding and insight into the effectiveness of traditional extension models in Nigeria and how ICT could complement them, it is not a generalized finding of the subject matter. The cross-discussion analysis of the focus group data provided valuable exploratory information about the subject matter rather than statistical generalizations.

Secondly, another potential concern is that the composition of the focus groups may have an influence on the validity of the data collected, the reason being that some participants could agree with the majority of opinions. To address this, the moderator's skills came into play and were able to control the situation by encouraging all participants to express their opinions.

Thirdly, focus group discussions often suffer from group thinking and socially desirable responses (Morgan 1997). This concern was addressed by conducting face-to-face interviews with the senior extension mangers/directors in their offices in addition.

4.7 In-Depth Interviews

The collection of data from multiple sources using diverse methodological tools as employed in this research study works very well when adopting a case study methodology, and at the same time allows triangulation of data collected for a comprehensive analysis (Bryman 2004). Coupled with the focus group discussion described above, the study used in-depth interviews in order to obtain detailed information and get a better understanding of the subject matter. An in-depth interview is one of the major techniques used in qualitative research (Ritchie *et al.* 2013). It is often described as a form of conversation with people to seek their opinions, views and beliefs (Legard *et al.* 2003). In-depth interviewing also permits the free flow of data by the respondents when the researcher adopts probing methods to obtain useful information for developing a deeper understanding (Bryman 2004).

In-depth interviews were also employed as a method of data collection because the author wanted to explore and gather diverse points of view, experiences, feelings and perceptions from several experts and stakeholders in the field of the agricultural extension system in Nigeria by asking "what is working and what is not working" and "can ICT complement the traditional extension systems in Nigeria for efficient delivery to our fifteen million smallholder farmers". Interviews also helped to address any concerns about group thinking and social desirable responses that may be associated with focus groups.

In order to gain a detailed depiction of the subject matter, in-depth interviews were conducted with one manager/director of extension service division in each sector (government (ADPs), Non-Governmental Organization (NGO), Academia and the Private sector), who were purposely selected, the criteria was based on their wealth of experiences in the field of agricultural extension. The author was able to explore research questions more deeply with the senior officers coupled with the focus group discussion with extension workers. There was a free flow of ideas and opinions about the extension system in Nigeria hence, in-depth information was collected. The in-depth interview explored how and why questions (Ritchie *et al.* 2013).

Interviews are a most suitable tool when trying to understand personal accounts, arrive at individual opinion and thinking, and exploring topics in more detail. Adams and Cox (2008) observed that in-depth interviews could also provide a quiet location and solitude which permit the respondents to discuss sensitive issues. The in-depth interview can be used to explore a range of issues and gain individual experiences. However, the in-depth interview method is not without its own challenges as identified, during the fieldwork as, this technique may lack generalizations about the results are usually not able to be made due to the small samples chosen and random sampling method (Omair 2014). This concern was addressed by listening to the recordings of the four in-depth interviews several times. The questions used for the interview guide were informed through research questions and literature review. The senior extension managers were contacted via formal letters and the meetings were scheduled. (see appendix 5).

The environment for in-depth interview needs to be conducive, quiet and physically comfortable in order to ensure maximum concentration and avoid interruption. Therefore, the participants and researchers agreed that the interview should be conducted at Ahmadu Bello University, Zaria. Further to receiving the permission of the interviewees and reassuring them of confidentiality, a digital recorder was used during the interviews. This allowed the researcher to devote his time and full attention to listening to the participants and use in-depth probing where necessary (Legard *et al.* 2003). This provided accurate, verbatim documentation of the interview, capturing the verbal communication, tone and the real language used by the interviewee. Note-taking was not given priority in order not to give participants unintended cues. The researcher used his skill and provided the interviewees with a clear and logical explanation of the questions.

An in-depth interview is simple with no prearranged limit or end. It is a discovery-oriented technique to acquire complete and detailed data regarding an issue from the stakeholder. However, there are certain limitations or disadvantages associated with the method, including a small sample size, the duration of each session and the related expense meaning that the sample size was small. However, there is no consensus among the qualitative researchers on the standard number of the interviews for any research project (Shoqirat 2009).

Secondly, interviewing necessitates a highly developed training and set of skills and it is essential to have well-trained, exceptionally skilled interviewers because using inexperienced or less skilled interviewers may increase the likelihood of bias. The researcher undertook specific training in interview skills before undertaking this study.

Thirdly, the coding and analysis can be an extremely challenging and time-consuming task for the less experienced researcher. Careful planning and time management were therefore employed to ensure that the coding and analysis was undertaken accurately and comprehensively.

4.8 Farmer Participatory Research Methods

During the second visit (May-June 2016) to the study area, the researcher, assisted by two extension professionals from academia (NAERLS) who communicate effectively in local dialect (Hausa language) and are also familiar with the targeted study area, undertook a farmer participatory training programme on GAP technologies. The farmer participatory training was strategically designed by the researcher as a farmer-centred process of purposeful and creative collaboration between the researcher and smallholder farmers. During the in-depth interviews and focus group discussions with the extensionists, the farmer participatory approach received several invaluable suggestions from the extensionists. Eight extension workers also participated in the workshop. The main purpose of this collaboration was to develop GAP technologies that would meet the local environmental conditions of the farmers via exchange of experiences with the farmers and to actively involve the end-user in the development process. Rather than developing and releasing "perfected" technology packages which may eventually not meet the farming and living conditions of the farmers (a typical top-down approach), the workshop/training commenced in the study area on Monday, 4th May 2016. The session was designed to allow the researcher and farmers to effectively work together to develop 16 GAP technologies and an Action Plan to implement the technologies. The detailed procedure was as follows:

1. Prior to the training session farmers were asked whether they were aware of GAP technologies.

2. Farmers were requested to list all the agronomic practices (GAP) they were aware of.

3. The researcher helped them to organise and capture the list on the flipchart (Figure 4.12).

4. Following the list mentioned by the trainees, the research assistant discussed extensively the merit and demerit of each technology listed by the participants and also showed them the pictures of the improved technologies on the slide presentation. (Figure 4.11)

5. Following the discussion, the researcher pointed out major conclusions and, together with the participants, 16 GAP technologies were defined. Since farmers were part of the decision-making and development process, it was hoped that response to the uptake of the GAP technologies would increase significantly.

Figure 4.10: Farmer Participatory Research Methods (Shika)

4.8.1 Developing Good Agricultural Practices (GAP) and Action Plan with Farmers

As mentioned previously, 16 GAP technologies and Action Plan were collectively defined with the farmers. These technology packages comprised of fertiliser application; water management; soil management; crop rotation; spraying of herbicide; pesticide control; mulching and so forth. A distinctive aspect of the current research is that the study utilised "lead farmers" in the communities to spread knowledge and support the adoption of GAP technologies to trainee farmers. Moreover, another unique part of the evaluation survey is that the study surveyed “lead farmers”, as well as “trainee farmers”. The two groups allow the study to investigate the effectiveness of the training and extension services provided by the researcher on GAP technology adoption.

- 50 “lead farmers” 25 from each community were cautiously selected by the researcher and extension staff from NAERLS who were also recruited as a research assistance and enumerator. The “lead farmers" were carefully chosen according to the following criteria: completion of secondary education; respected farmer in the village; belonging to the active age group; ability to read and motivate others and must be an active user of a mobile phone. Village chiefs were prioritised since they normally have the aforementioned abilities.

It is imperative to highlight the fundamental roles of the lead farmers. The lead farmers acted as “ambassadors” for the current research. It is particularly difficult for foreigners or outsiders to come to the villages and tell the rural people what to do without having someone there to establish trust. Therefore, the lead farmers have such trust and they were also the exemplar for other farmers in the communities in terms of technology adoption. The major role of the lead farmers among others was to advise and train other farmers (trainee farmers) in the village on GAP technologies.

- On Tuesday, 5th May 2016, intensive participatory training on GAP technologies was directly given to the lead farmers. The training sessions had wide-ranging contents. Lead farmers received training on the 16 GAP technologies.
- Each lead farmer was then asked to train three other farmers (trainee farmers). The exercise was thoroughly monitored by the researcher and his team. Altogether, 200 farmers were trained on 16 GAP technologies during the second phase of this study. This is called the lead farmer extension model of technology dissemination whereby knowledge is diffused by trained lead farmers to untrained farmers.
- All participating farmers were also given an Action Plan detailing specific tasks to do during the growing season. Farmers were also given improved maize seeds as an incentive for actively participating in the study.
- The 200 participants were divided into 2 groups based on the analysis of the baseline livelihood survey into with-SMS group (Bassawa) and without-SMS group (Shika) (Table 4.5). Extension visits and SMS text reminders were given to the with-SMS farmers fortnightly.

Figure 4.11: Workshop on GAP Technologies in the Study Area

Table 4.3 Total sample size of the beneficiaries according to the study

Category	Without-SMS Farmers (**Shika village**)	With-SMS Farmers (**Bassawa village**)
Lead farmers	25	25
Trained farmers	75	75
Total	100	100

Source: Field Survey, 2016

Table 4.4: Summary of the key stages of the research

Key stages of the research	Number	Number of participants
Baseline livelihood survey	1	200 farmers
Focus group discussion	4	4 farmers
Farmer in-depth interviews	4	4 farmers
Semi-interview with the farmers	2	2 farmers
Evaluation survey	1	200 farmers
Focus group discussion with extension workers	4	20 extension workers
In-depth interviews with extension workers	4	4 senior extension mangers

Source: Field Survey, 2016

4.9.1 Researcher Positionality

Positionality can be defined as the position that the researcher has chosen to adopt within a given research study (Savin-Baden and Major 2013). In the same, the term positionality could also be described as the individual's world-views or the perspective where the researcher is coming from that is, ontological assumptions (the nature of social reality), epistemological assumptions (the nature of knowledge) and assumptions about human nature and agency (Sikes

2004). The world-view which the researcher - the main orchestrator of collecting, collating, analysing and interpreting data – is broadly engrained (Grimaldi *et al.* 2015). In addition, positionality is usually identified by pinpointing the researcher in relation to three distinct area: the subject, the participants and the research structure and process (Savin-Baden and Major 2013). These relational positions can also be described as the power positions between the researcher and the participants (LeCompte and Schensul 2010). Positionality is "relational, unstable, not fixed and contextually situated" (Grimaldi *et al*. 2015), determined by where the researcher stands in relation to power; this can shift throughout the process of conducting research (Merriam *et al*. 2001; Greene 2014). Moreover, the positions are relative to the cultural values and norms of both the researcher and participants (Merriam *et al*. 2001). According to Sikes (2004) some aspects of positionality are culturally attributed or fixed, for instance, gender, race, nationality, whereas others such as personal life history and experience are subjective and contextual. Positionality identifies the researchers as part of the social world that they are researching and that this world.

However, in ethnographic research one of the key debates has been that of the researcher's position as an insider or outsider to the 'culture' being studied and whether perhaps one position provides the researcher with an advantageous position or otherwise and more importantly its effect on the research process (Hammersley 1993). The study will critically examine the researcher's position and participatory ethics as an outsider, and how the challenges of working in another culture were met.

4.9.2 Positionality and its relationship with Reflexivity

Reflexivity is considered an integral aspect of qualitative research. It involves researchers to understanding how the processes of conducting research shape its outcomes (Hardy *et al.*, 2001). It helps the researchers to reflect upon the ways in which we carry out our empirical research projects. Researcher positionality and reflectivity fundamentally impact all aspect of social science researchers do in qualitative research. Interacting with research participant at community events and at various data gathering sites became part of the experience of the fieldwork. Reflecting on the interactions and relationships in the field with smallholder farmers in Northern Nigeria, particularly in the context of this research study cannot be overemphasised. Self-reflection and reflexive approach is both a necessary prerequisite and ongoing process for the researcher to be able to clearly identify, construct, critique and articulate their positionality. Therefore, the relationship between positionality and reflexivity is an organic one: the researcher engages in the process of self-analysis and self-scrutiny, thereby reflecting on their research in the context of their own positionality (Pillow 2003; Silva *et al.* 2016).

Field research allows on to interact with the participants in the own social setting and in their own language. A reflective methods proposes that researchers should acknowledge and disclose their selves in the research, aiming to comprehend their own influence on and in the research process. Moreover, reflexivity entails explicit self-consciousness and self-assessment by the researcher about their own views and positions, as well as how these might have influenced the design, execution and interpretation of the research data (Greenbank 2003). In fact, the researcher's cultural, political beliefs, social value, personal integrity as well as competency influence the research process (Ibid p. 278). The process of reflexivity encapsulates an ongoing procedure whereby the researcher attempts to gain a full understanding of their work (Lather 1991a; 1991b).

4.9.3 Researcher Positionality as an Outsider and Strategies Employed

It is becoming increasingly important for social and behavioural researchers to clarity their personal motivation for their research, particularly for those utilising qualitative methodologies that require reflexivity (see Creswell 1994; Crotty 1998; Etherington 2004; Patton 2002). As a component of clarifying their role in the research, these researcher often position themselves as either insiders or outsider to their research domain (Bonner & Tolhurst 2002). However, insider researcher has been defined as the study of one's own social group or society (Naples 2003). Basically, insider-researcher are those who chose to study a group to which they belong, while outsider-researchers do not belong to the group understudy.

I considered myself as an outsider-researcher coming from another cultural background. My research focuses on use of ICT among smallholder farmers and extension workers and its relevance to sustainable agricultural practices in Nigeria. The study was conducted in Bassawa and Shika communities in Kaduna State, Northern Nigeria. The fieldwork involved three phases in the study area. The rationale and motivation for the study came from many years' experience of assisting my father (a veteran farmer)in his farmland and working with smallholder farmers in our village in the Southern Nigeria, and more recently, as an high school tutor/teacher, teaching Agricultural Science subject at Federal Government College, Niger State, Northern Nigeria. Significantly, I chose my study area because of the proximity to Ahmadu Bello University, Zaria and my place of work. During my first fieldwork, because it was important for the rural dwellers to trust and have confidence in me, therefore considerable skills were required to negotiate access to the villagers, particularly when visiting community of ethnic and religious group different from mine. As a result, some strategies were adopted by the researcher, aside from the letter of introduction presented to the community leaders (village head) and community meeting conducted with the farm families, the researcher also developed a close working relationships with the smallholder farmers, the youths and strong friendships with many community members. As a rural participatory research, I spent five weeks in the village, watching and observing rural dweller's cultural value and behaviours. I also dine and wine with the villagers, fed on their local food popularly known as 'tuwo shinkafa' and drank 'fura' in Hausa language. As aforementioned in section above, I equally paid courtesy visit to the community head in company of my four research assistants (extension workers).

Another strategies for gaining participants trust was that during most of the interviews and focus group discussions, I had to dress in such a way that is acceptable to the community and by so doing avoid drawing unnecessary attention to myself. I visited their local market, the only primary school, conducted village mapping with the help of the youths. I conducted baseline livelihood survey, workshop on 16 GPA and trained lead farmers. However, their cultural value, religion and societal norms do not allow the researcher to interact with their women. This however prevented women from participating in this study. This was probably the only challenge experienced. Northern women are more likely to be excluded from taking part in research unless the researcher is willing to adjust the recruitment procedure, engage fellow women as research assistants, appointing timing and interview venues.

During the data gathering process I did not experience any serious challenge aside from the aforementioned and may be little language and communication barriers. This was sorted out immediately with the help of my research assistants. However, I had to conduct almost all my interviews and focus group discussions myself, because I noticed with some of the respondents that they needed a little push during the interviews. During the three phases of the field research, I took detailed fieldwork notes through which I reflected on the research process. On reading them on my return to the UK, I recognised my positioning and, significantly, how the villagers viewed me. This has led me to reflect on my positioning and consider how I represented a number of different identities and what processes contributed to these. As an outsider researcher, I had the privilege of seeing the advantages and shortcoming of the Northern cultures with which I identified. This opens up new possibilities for constructing a better world for myself as a researcher and for others.

4.9.4 How the Challenges of Working in another Culture were overcome

The major challenge encountered during my fieldworks was the unapproachable and inaccessible of women as cultural norms precluded contact with women in the community and these women were being monitored by their husbands or families members - sometimes in order to ensure their compliance, but more frequently in consideration of their safety. I often noticed that the women the community were not allow to interact with other men that are not there husband. They stay at home (in doors) with the children and doing household chores. As illustrated above, the women remained inaccessible to me throughout my data gathering. However, the only limitation of this study that might have stemmed from this challenge was simply that women were not part of the research due to cultural norm. Nevertheless, if opportune to conduct this research for my post-doctoral study in the Northern Nigeria, I will strategically utilise the women civil society groups and Muslim youths trained by the Institute of Governance and Social Research (IGSR) in collaboration with the Kaduna State Government to overcome this challenge.

4.10 Evaluation of Training and ICT

Although focus groups and in-depth interviews drew out empirical and practical knowledge as to how ICT could complement traditional extension models and the effectiveness of extension in Nigeria, and how mobile technology could be used to improve the adoption of GAP among smallholder farmers, the generalisability of the findings is limited. The reason for this is understandable given the sample size of the focus group participants and in-depth interviews. In order to fully address the research questions for this current study, structured questionnaires survey were used to complement the focus group discussions and in-depth interviews.

An evaluation survey was employed in the final stage of this research in order to evaluate what was adopted and was not adopted following the intervention and why. That is, what are the barriers to the adoption of agricultural technology? This allowed the gathering of more quantitative data coupled with the qualitative information obtained using focus groups and interviews. The evaluation survey was also used to evaluate the impact of GAP training and influence of SMS text reminders sent to smallholder farmers. The evaluation survey was informed by the literature review, workshop on GAP and focus groups. The author expected that a fuller picture about the effectiveness of the extension systems and use of ICT amongst extension workers and farmers would be addressed. The survey offered little about the context in which responses were received (Gillis and Jackson 2002), but this was made up for by the qualitative data gathered by the other methods employed.

4.10.1 Evaluation Survey Construction

The questionnaire used in this study included four sections. The first section examined respondents' demographic data such as gender, age, marital status and educational level. The second section examined quantitatively the GAP adopted after the GAP training, the impact of the GAP training among the participants through using a Likert scale (see appendix 4). The third section, used part of the questionnaire to consider the GAP that were not adopted by the farmers despite the GAP workshops and what the barriers are to the adoption of technologies among smallholders. The fourth section of the questionnaire was designed to shed light on the role of ICT, especially mobile phone technology, in the adoption of GAP, the type of communication the farmers prefer and the potential roles of farmer-to-farmer extension models. This also adds to the investigation and explores some specific issues raised by the focus group discussion and interviews. The last section of the questionnaire endeavoured to examine the impact of mobile phones technologies on GAP adoption (see appendix 5).

The structured questionnaire was constructed using the Likert scale as a guide. The survey used 5 point Likert scales and varied from "strongly agree” to strongly disagree”. Ambiguous and confusing questions in the same items were avoided in order to increase the trustworthiness of the scale. Effort was made to maximize the validity and reliability of the questionnaire. The research questions and the literature helped to inform the development of the survey. The survey was prepared using the English language, and was simple to understand.

4.10.2 Distributing the Questionnaire

The questionnaire was distributed during the final stage of the field research to the study areas specifically to find out what was adopted and barriers to adoption of GAP. The survey was distributed to 200 smallholder farmers (all 50 lead farmers and 150 trainee farmers), both the farmers that received training and visits and those farmers that received mobile phones calls and SMS message, and the farmers that received only training without a mobile phone call and SMS. The evaluation survey was simple and administered face-to-face, not too long in order to increase the likelihood of participation (Shoqirat 2009).

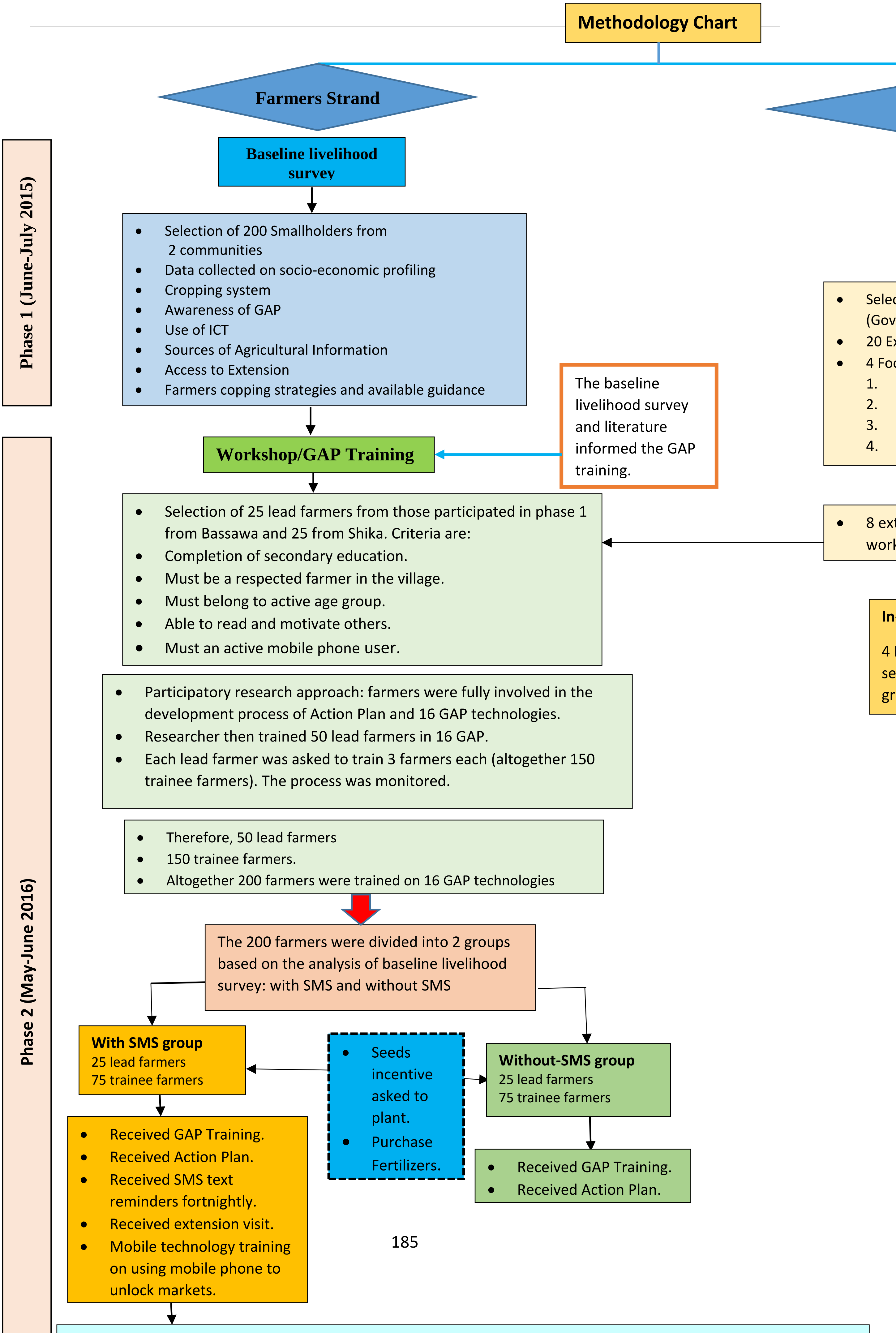
4.10.3 Ethical Considerations of the whole Research

Following the ethical research principles guidelines of the RAU, the researcher presented ethical approval and a letter from the Director of Studies to the community leaders (See appendix D). During the first field visit, permission was sought from Kaduna State Agricultural Development Project (KADP) zonal manager and cooperation of the extension workers to actively participate in the research study. During the visit to the District head on the 10th of June 2015, the researcher explained the research study and the benefits that the communities and what farmers stood to gain from participating in the research study. The researcher requested an initial community meeting to personally introduce the research study to the smallholder farmers. Similarly, he gave the elders a letter of introduction given to him by the Director of Studies (see appendix 1). The District head gave his consent and approval letter to conduct the research in the communities.

A community meeting was organized as an entry point in which the research objectives and process were made clear to the participants, and the benefits and alternatives, with an extended opportunity, to ask questions, wherein all the villagers attended including nearby residents. In addition, all members of the community provided their informed consent for participation in the study. The participants received an honorarium of ₦200 (< 1 US dollars) for their transportation and inconvenience in attending the meeting: a value consistent with other research (Evans 2013). The researcher ensured that the participants were treated with all due respect and dignity throughout the study (Given *et al.* 2014). In addition, the meeting encouraged participants to maintain their interest which encourages more effective recruitment of participants. The community meeting enabled a better response to emerge from the community.

Similarly, the study also contributed to an increase in generalized knowledge by engaging extension workers in focus group discussions and in-depth interviews on the effectiveness of traditional extension models in Nigeria. However, because the study involved the interaction of individuals, the ethical dilemmas in the research were considered (Grinyer 2001) and sensitive information was safeguarded by maintaining confidentiality and anonymity. It is also imperative to mention that the ethical approval was gained from the Royal Agricultural University. The whole research strategy is summarised in Figure 4.7a-c.


Figure 4.12: Courtesy visit to the District head for permission to conduct research in his domain


Methodology Chart
Farmers Strand
Phase 1 (June-July 2015)
Baseline livelihood survey
Selection of 200 Smallholders from 2 communities
Data collected on socio-economic profiling
Cropping system
Awareness of GAP
Use of ICT
Sources of Agricultural Information
Access to Extension
Farmers copping strategies and available guidance
The baseline livelihood survey and literature informed the GAP training.
Phase 2 (May-June 2016)
Workshop/GAP Training
Selection of 25 lead farmers from those participated in phase 1 from Bassawa and 25 from Shika. Criteria are:
Completion of secondary education.
Must be a respected farmer in the village.
Must belong to active age group.
Able to read and motivate others.
Must an active mobile phone user.
Participatory research approach: farmers were fully involved in the development process of Action Plan and 16 GAP technologies.
Researcher then trained 50 lead farmers in 16 GAP.
Each lead farmer was asked to train 3 farmers each (altogether 150 trainee farmers). The process was monitored.
Therefore, 50 lead farmers
150 trainee farmers.
Altogether 200 farmers were trained on 16 GAP technologies
The 200 farmers were divided into 2 groups based on the analysis of baseline livelihood survey: with SMS and without SMS
With SMS group
25 lead farmers
75 trainee farmers
Seeds incentive asked to plant.
Purchase Fertilizers.
Without-SMS group
25 lead farmers
75 trainee farmers
Received GAP Training.
Received Action Plan.
Received SMS text reminders fortnightly.
Received extension visit.
Mobile technology training on using mobile phone to unlock markets.
Received GAP Training.
Received Action Plan.

4.10.4 Methods Used in Data Analysis

Considering the mixed methods techniques and the triangulation approach used in this study, the analysis procedure required detailed reflection on the issues of significance raised by each technique. Originally, the qualitative and quantitative approaches were separated and handled in a conventional way.

The quantitative data drawn out by the questionnaire were analysed using SPSS (version 24). Four diverse levels of data measurement were drawn out by the questionnaire. They included nominal characteristics such as gender, interval e.g. age group and ordinal data, and that produced by the use of Likert scales.

The questionnaire was coded, thereafter descriptive statistics were used to obtain the demographic data (percentage, mean and standard deviation). All the items integrated in the Likert scale were scored. While positive items were scored from 5-1, negative items were reversely scored from 1-5. These indicate that the sum total may not be the same. At the same time, considering the mixed methods and triangulation strategy employed in this research the answer for each item needed more attention than the total or overall score.

The two communities were compared by utilizing the socio-economic variables to identify the demographic variables that may be associated with decision about the adoption of GAP among the respondents. Furthermore, in order to test for the statistical significance of the ordinal data, a non-parametric statistic test of the Spear-man Rank correlationin addition to Chi-square were utilized to investigate the correlation between the variables. The probability (P) value was calculated using a two-tailed test of significance.

Regarding the open-ended qualitative questions, the author employed a thematic analysis. This will be discussed in more detail later. At the same time, it is fundamental to mention that coding the questionnaire's unrestricted questions is extremely complicated and involves significantly more work than close-ended questions. This is due to the inherent features of qualitative research and the very large number of responses that the respondents will provide. For that reason, all the answers received were scrutinized in the beginning to identify the main themes and the similarities between them. Thereafter, identified themes were coded and input into SPSS (version 24) for additional analysis.

Considering that a substantial portion of this study is largely informed by qualitative research, trustworthiness of the data is important. The components of trustworthiness in quantitative research are:

a) Dependability (reliability);

b) Confirmability (objectivity);

c) Credibility (internal validity);

d) Transferability (external validity/generalisability) (Given *et al.* 2014).

As a matter of fact, to achieve the credibility of qualitative research participants must be given prolonged engagement so as to gain adequate understanding of the culture, social setting or phenomenon of interest (Polit *et al*. 2001; Burns and Grove 2001; Shoqirat 2009). The development of early acquaintance with the culture of those participating is essential. In line with the time recommended, the researcher spent adequate time observing various aspects of the local setting through farmer engagement and participatory action research methods and spent four weeks with farmers in the two rural farming communities during the first and second weeks of fieldwork. It was a participatory research approach and significant time was spent with farmers. Initially the author had community meetings with the farmers where the research objectives and associated ethical issues were discussed, and the benefits that the community would derived from the study. The researcher used this time and opportunity to gain an in-depth understanding of the culture; to develop relationships and rapport and to build trust with the farmers. The author visited the village market, primary school, village river/stream and also engaged with the children who assisted him during village mapping (see appendix 2). According to Gillis and Jackson (2002) spending sufficient time in the field to lean the culture and language could enhance the development of relationships, trust and rapport. Therefore, more genuine answers could be received from the respondents.

Similarly, the inherent features of the methodology employed in this study is to enhance the credibility of the qualitative research by using different methods; that is the use of a triangulation approach in this research, focus groups, interviews etc. Checking through all the sets of data collected, triangulation demonstrates an increasing level of convergence. For instance, in order to draw indisputable evidence about the significant of mobile phone technology's in extension services to farmers in Nigeria and the adoption of GAP, data analysis procedures integrated diverse sets of data generated via focus groups and in-depth interviews that are relevant to such an understanding. This was not only to ensured comprehensiveness but at the same time enabled the "convergence" to materialize through analysis.

4.10.5 Profile of the Smallholder Farmers

In order to better understand the communities, it is necessary to profile them through the baseline study. This also allows the communities to be compared to those profiled in similar studies.

(a) Age

Age has a crucial role to play in the farming activities and production process. It is measurable in terms of number of years of the respondents (Household heads). Good agricultural management practice is built on knowledge and experience; particularly it requires modern knowledge of management, production and marketing. In contrast, the adoption of new innovation entails risks, but older people are often risk averters because they tend to be reluctant in adapting improved technology (Hassan *et al*. 2011). As a result, age is suggested to influence the adoption of GAP technologies.

(b) Education

Educational level of the individual is one of the most essential factors to receive and utilize new innovation and productive approach to be more efficient and effective. Moreover, it represent the level of formal schooling completed by the smallholder farmers at the time of this study. Education exposes farmers to more information and enables them to accumulate knowledge about new technologies. Educated farmers are more likely to understand easily the technical used during the GAP training sessions, read the label on fertilizer bags and follow direction accordingly.

(c) Farmer's Experience

This is measure in a number of years since the farmers started practicing farming activities under consideration. Farming experience of the respondent is likely to have a great influence on enhancing new information. Moreover, experience will improve respondents' knowledge in farming management practices. Lefebvre *et al.* (2015) reported that the adoption of maize technology positively affected by farmer's experience.

(d) Household size

Household size is among the essential socio-economic characteristics which influence agricultural productivity of the farmer because a fairly large family size suggests that more family labour available for the household farm activities. Indeed, smallholder families are usually large and a fairly large household size is an understandable possible advantage in terms of farm labour supply for the household farm activities. On average in country like Nigeria, smallholder families have seven members. These families live in houses which in their majority, they own themselves.

(e) Farm size

Smallholder families live in farms which is significantly smaller than 2 hectares. In Nigeria, farms are very small with the average size of 0.35 and 0.90 hectares respectively. Farm size is directly associated with higher probability of yield production and practices. It is generally assumed that the larger farm size the farmer has, the better he is initiated for the adoption of GAP technologies.

4.11 Summary

This chapter has introduced the case study method in the context wider policy, extension and how it affected the community. The chapter also outlined the methodology and research design employed in this study in order to address the research questions. The establishment of a robust research methodology was the main focus of this chapter. The research employed a mixed methods approach in order to achieve the overall aim of this study and to address the various conceptual issues that have been identified. There was an in-depth explanation of the methodological approach used for the purpose of this research and justification. Similarly, the chapter has identified the various data sources that were used in the research and choice of research strategy which was based on the findings from the literature review presented in the preceding chapters. A baseline livelihood survey was used in the first phase which subsequently informed the second phase; GAP workshop/training, focus group discussions, in-depth interviews, SMS text reminders and extension visits, and an evaluation survey was used to complement the results of the qualitative methods. The chapter also discussed the criteria employed for selecting the cases and participants. Furthermore, the rationale for the choice of Bassawa and Shika Communities as the study area for this research was highlighted. Finally, ethical concerns with the regards to data collection were emphasised as well as the method of data analysis, emphasizing the various steps that were involved. The findings that emerged from the data collection are reported in the following chapters.

Chapter Five. Smallholder Baseline and Traditional Extension Services

This chapter presents the findings from the baseline livelihood survey, farmers' interview, focus group discussions and in-depth qualitative interviews related to research questions one and two. The chapter is divided into four sections:

- Profile of the 200 households who participated in the baseline livelihood survey.
- Current extension service delivery in Nigeria, detailing farmer contact with extension workers and farmers' perceptions regarding extension agents' performance.
- Present sources of agricultural information among smallholder farmers and current problems affecting agricultural extension services in the study area, as well as a potential solution on how to improve extension services in Nigeria.
- A summary of the participatory extension approach among smallholder farmers adopted in this study in order to develop appropriate GAPs and an Action Plan for participating farmers to adopt.

5.1 Profile of the Households

Two hundred farmers participated in the baseline livelihood survey conducted during the first phase of the study; the survey focussed on Socio-economic characteristics including age, education level, marital status and farming experience, along with farm profiles and the family use of ICT linked to their livelihoods. These communities were actually one typical community in Nigeria, West Africa (Ajaero and Onokala 2013) in that they had virtually everything in common and there is a lot of interactions going on between them. The only thing that differentiated the two communities was the level of extension that the farmers had received as the Bassawa community had been selected as an Adopted Village by NAERLS in 2012 and therefore received extension support. This therefore provides an interesting comparison between the two villages in terms of this policy initiative.

(a) Age

From the case study communities' baseline survey, the age of the farmers in households ranged from 20 to 70 years. 59.2% of them fell within the middle age of 31-50years in both communities. This suggests that the majority of the respondents were within their economic active age and this enhances their productivity in order to be food secure (Figure 5.1). The old age group (51-70) had the lowest impact in farm work with 24.2% contributing to active farming among the sampled population and the age group looks similar in both communities. However, it is generally assumed that younger people tended to be more productive than their older counterparts. Although, there are some variance in the figures (between the communities), the finding of the chi-square analysis revealed that there was no statistically significant difference between the two communities.

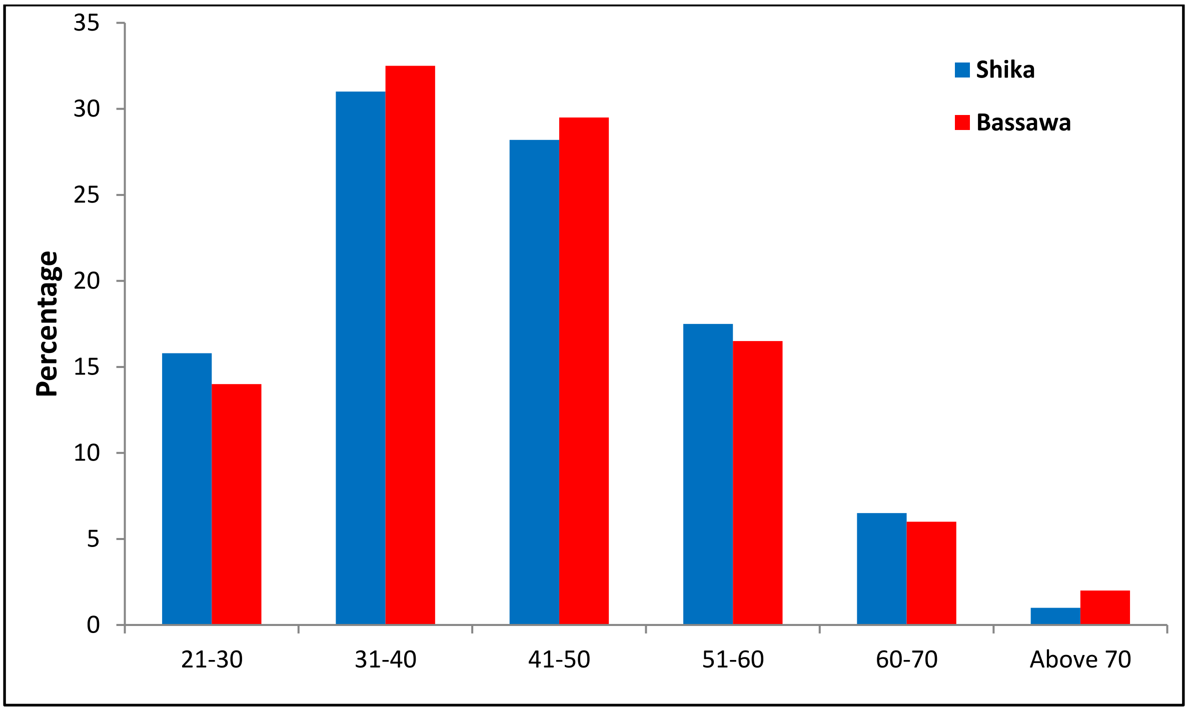


Figure 5.1: Age distribution of the respondents. Scale:%
Source: Survey; Shika n=100, Bassawa n=100

(b) Educational Status

Educationally, 40% and 37% of the respondents had acquired primary education in Shika and Bassawa respectively, while 14% and 10% had secondary education in both communities. Only 6% and 4% of the respondents possessed higher education (Figure 5.2); however, a chi-square test shows that there was no statistically significant differences between the farmer's educational levels of the two communities. There is tendency to consider that less education may affect a household's ability to embrace innovation especially the adoption of GAP modern farming technology. It is generally thought that the level of education enhances the ability to understand and also adopt new methods of farming. Indeed, according to Olumba and Rahji (2014) and Kalungu and Filho (2016), highly educated farmers tend to adopt innovation better than more illiterate ones.

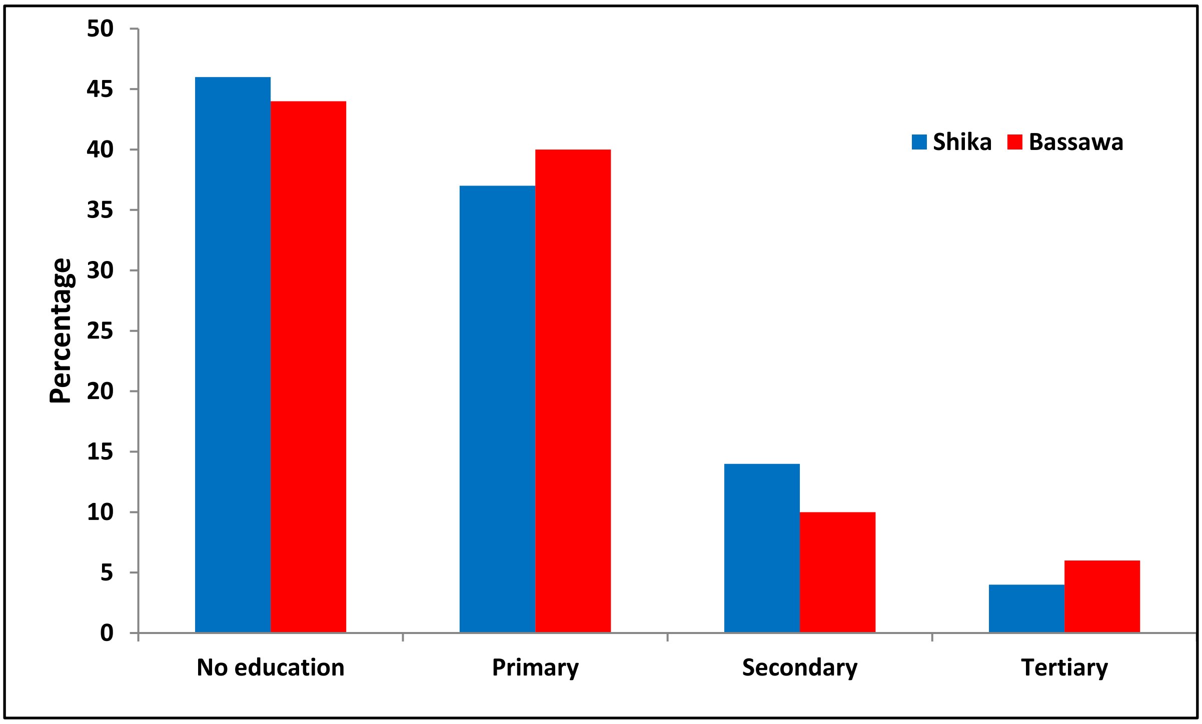


Figure 5.2: Distribution of the respondents by educational status Scale:%
Source: Survey; Shika n=100, Bassawa n=100

(c) Household Size

Household sizes reveal that the dominant class range is 1-10 persons and represents half of the households; this is followed by 11-20 persons in the family representing over a third of households. Farmers in both communities have fairly large household sizes (Figure 5.3). The result is not surprising because large family sizes are the norm in the Northern part of Nigeria and large families provide accessible workforces. Also the cultural tradition allows the men to marry at most four wives. The use of household labour for several activities was very common in the study area with activities such as ploughing, harrowing, planting, weeding, chasing away straying domestic animals, irrigation activities and harvesting. The finding of the chi-square analysis shows that there was no significant difference between the household sizes of the two communities.

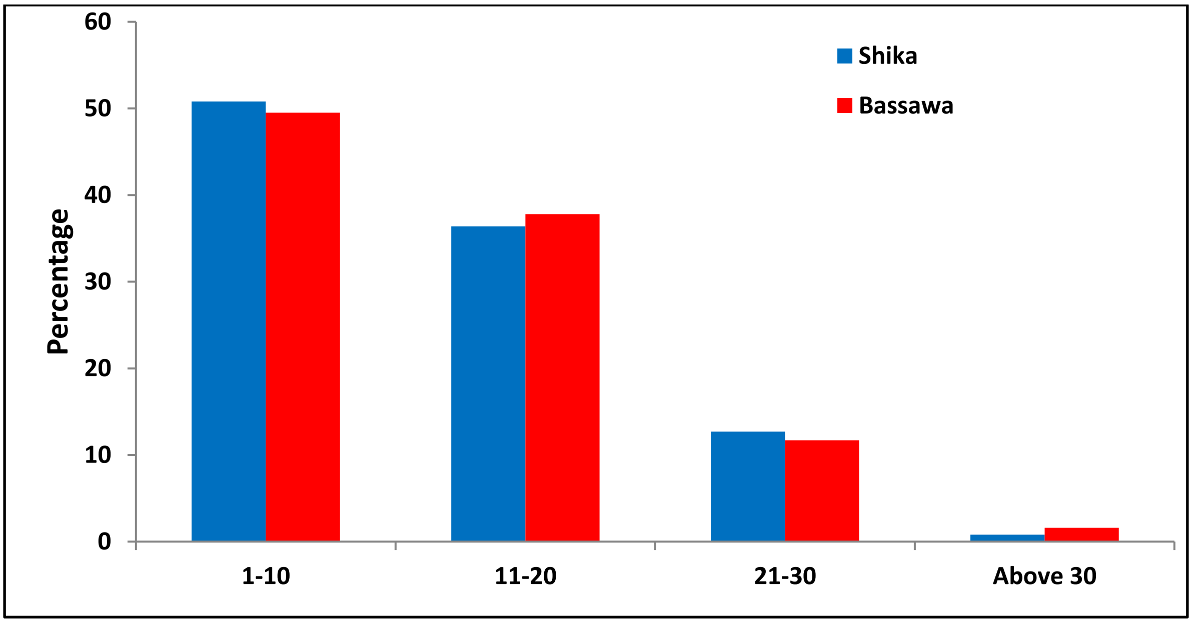


Figure 5.3: Distribution of the respondents by household size Scale:%
Source: Survey; Shika n=100, Bassawa n=100

(d) Farm Size

59.2% of the participants from Shika have a farmland holding of less than 2 hectares compared to 61% of the farmers from Bassawa (Figure 5.4). The mean size of farm was 2.65 and 2.48 hectares for Shika and Bassawa respectively. The results shows that the vast majority of the respondents in the area were small scale farmers. Chi-square analysis again revealed that there was no significant difference between the farm sizes of the two communities.

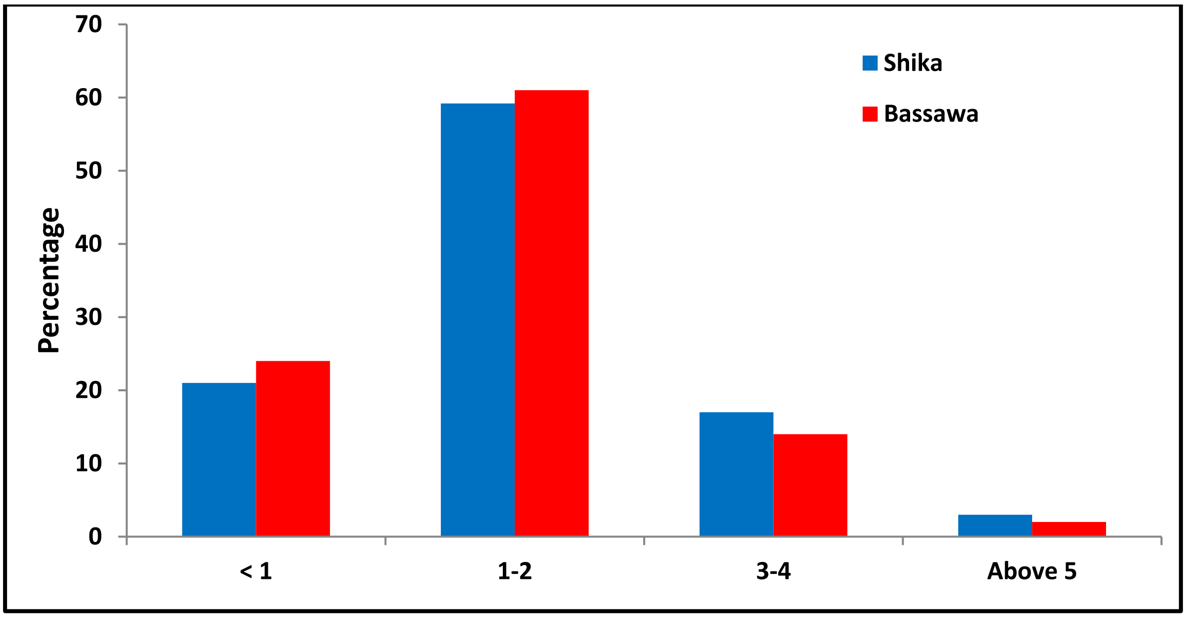


Figure 5.4: Distribution of the respondents by farm size in hectare Scale: %
Source: Survey; Shika n=100, Bassawa n=100

(e) Household Assets

The result shows that 58% and 54% of the households from Shika and Bassawa respectively keep chickens (Figure 5.5). Meanwhile, 46.5% of the farmers interviewed keep sheep and goats in Bassawa. A sizeable proportion of the respondents (35%) from Bassawa also indicated that they rear cattle and only 6% specified that they keep other livestock such as camel, duck, turkey etc. Also, 7.5% respondents from Shika also kept similar livestock. The baseline livelihood survey shows that no single household keeps pigs in the study area. This was attributed to the religion of the respondents. The result of the chi-square analysis revealed that there was no statistically significant difference between the two communities.

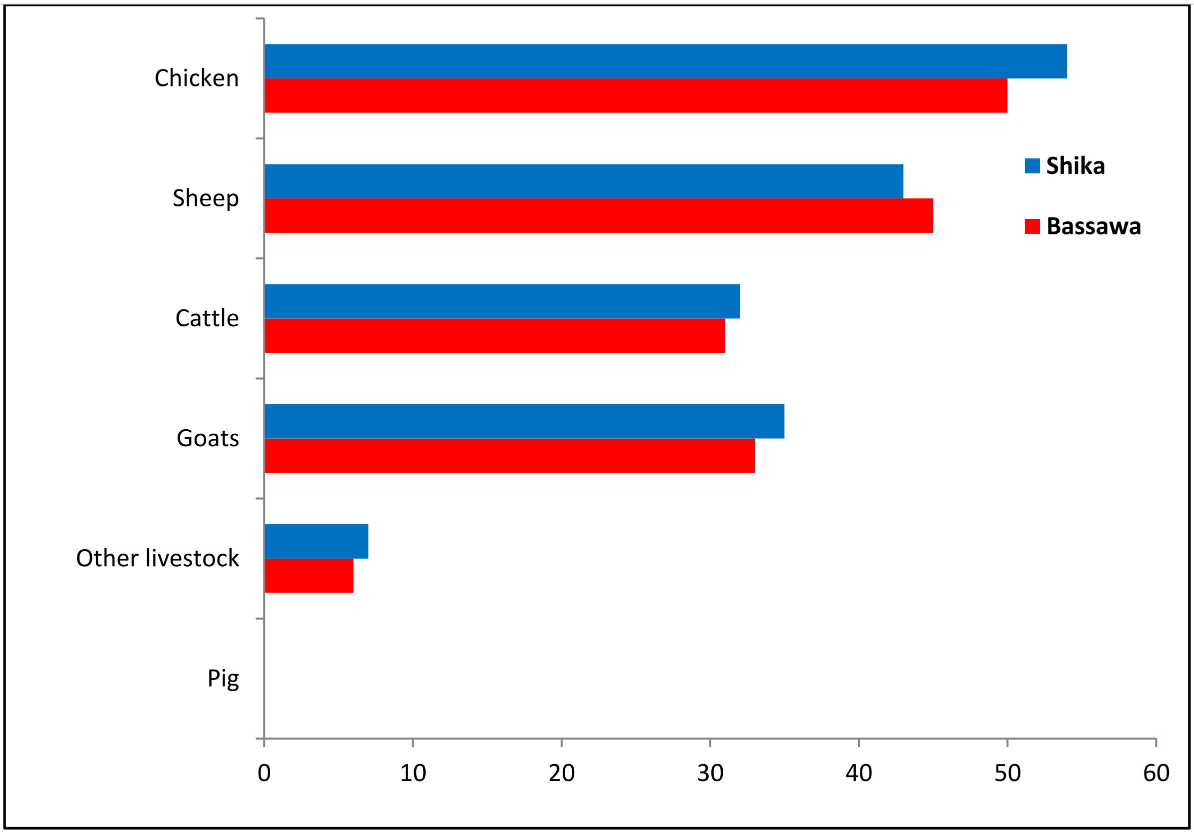


Figure 5.5: Distribution of the respondents' main household assets Scale: %
Source: Survey; Shika n=100, Bassawa n=100

(f) The major crops cultivated

The study shows the seven major crops cultivated by the households in the study. As illustrated in figure 5.6, the findings indicate that maize, millet, cowpea and groundnut were prevalent and dominated the study area with 27.3%, 19.6%, 14.7% and 13.3% respectively of respondents growing them, while sorghum, tomatoes and onions were also actively cultivated in the area. The chi-square analysis shows that there was no statistical significant difference between the two communities in terms of crops cultivation.

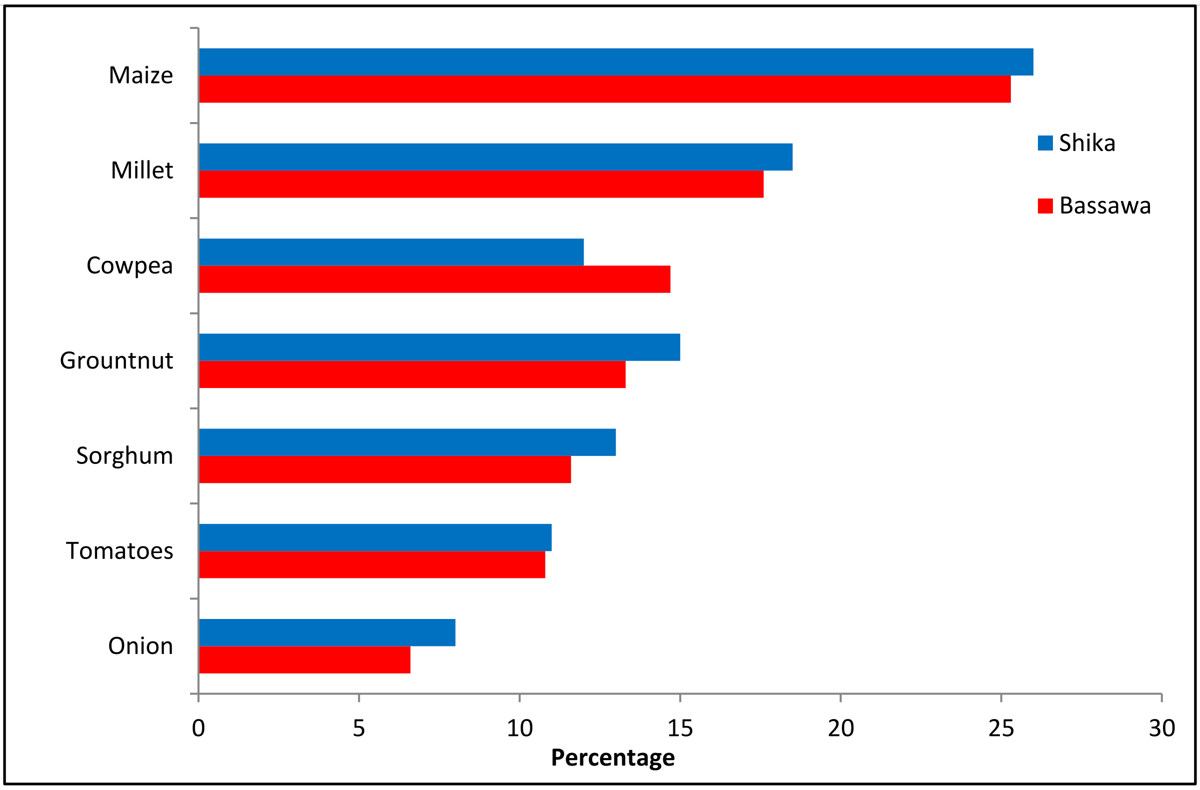


Figure 5.6: Distribution of the major crops cultivated to the households Scale: %
Source: Survey; Shika n=100, Bassawa n=100

(g) Type of irrigation system used by farmers

The findings reveals that 58.3% of the households interviewed used portable water pumps for their farming operations while 13.3% and 10% used sprinkler and bucket techniques respectively during the dry season. However, 12.2% of the farmers indicated that they do not use irrigation systems for their farming production. The erratic, late onset or early withdrawal of the rainy season in the study area caused frequent crop failures. This suggests that farmers using portable water pumps have the potential to improve their crop productivity and income. However, those farmers who do not use any irrigation system during the off season indicated that they alternatively engaged in some petty trading in the communities and its environment during the dry season. Chi-square analysis shows that there was no statistical significant difference between the two communities in terms of cropping.

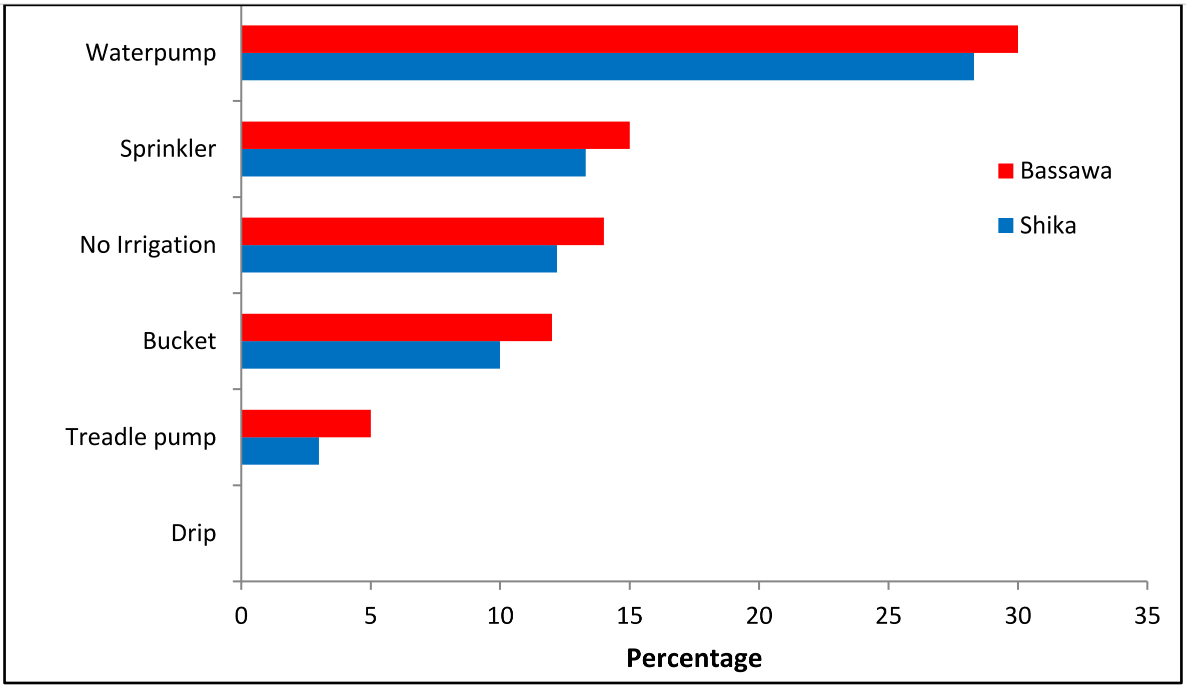


Figure 5.7: Distribution of the type of irrigation used by farmers Scale: %
Source: Survey; Shika n=100, Bassawa n=100

(h) Household Economic Assets

The data revealed that a very high percentage of the respondents from both communities owned ICT, particularly mobile phones and radios as the main household economic assets. 85.8% of respondents owned mobile phones and 90% owned radios respectively (Figure 5.8a-b). Evidence from the field study shows that on weekly basis smallholder actively listen to information from radio broadcast programmes such as: *From our markets to you; let's go farming; Modern Agricultural; Rich man of the dry season and Programme for nomads.* Mobile phones and radios play a major role in diffusing information in rural communities (Mbiti 2012, Chhachhar and Hassan 2014, Aldosari *et al.* 2017). This suggests that mobile phones and radios could help farmers make well informed decisions on adoption of GAP and influence farmer's productivity positively. Again, a chi-square test shows that there was no statistically significant differences between the two communities.

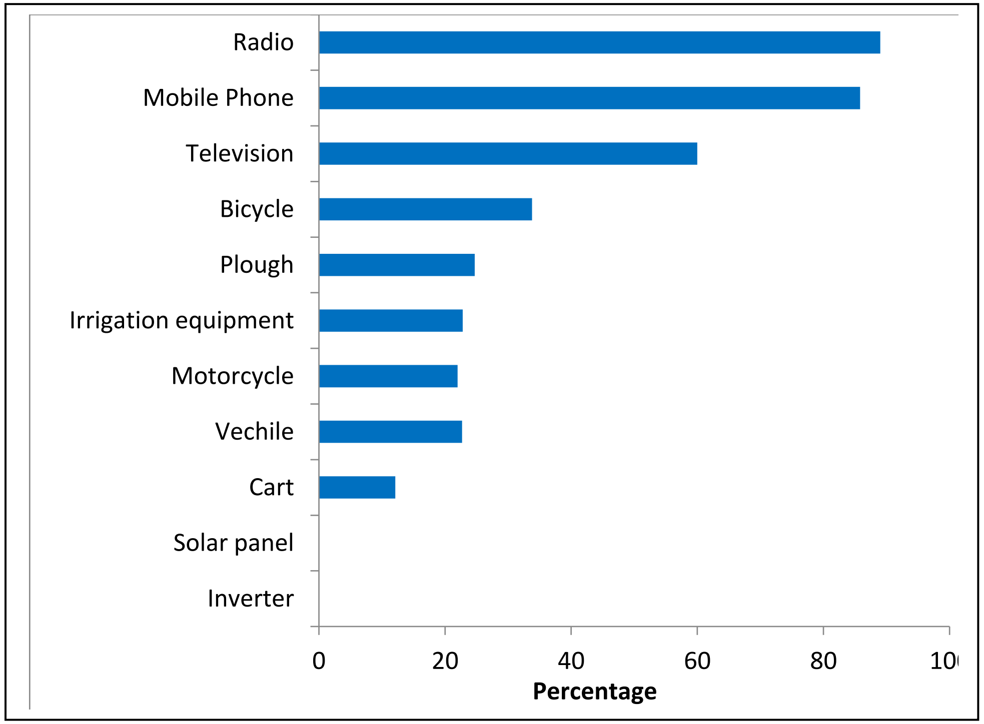


Figure 5.8a: Distribution of the respondents by household Assets
Source: Survey; Shika n=100 Scale: %

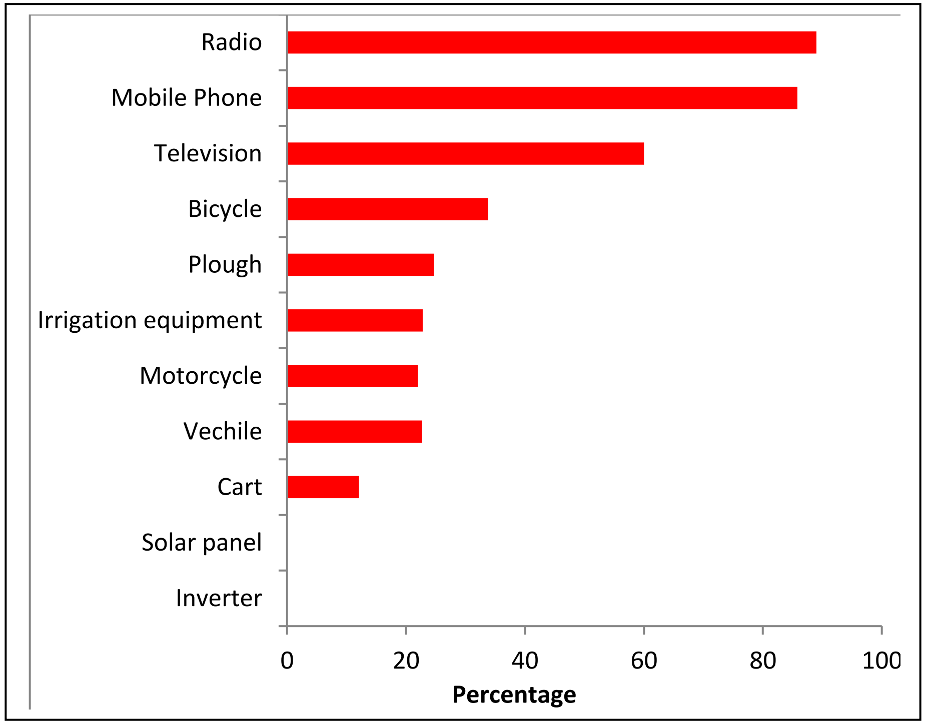


Figure 5.8b: Distribution of the respondents by *household Assets*
Source: Survey; Bassawa n=100 Scale: %

Distribution of the Respondents According to Extension Contact for the Adopted Village (Bassawa) and Non-Adopted (Shika)

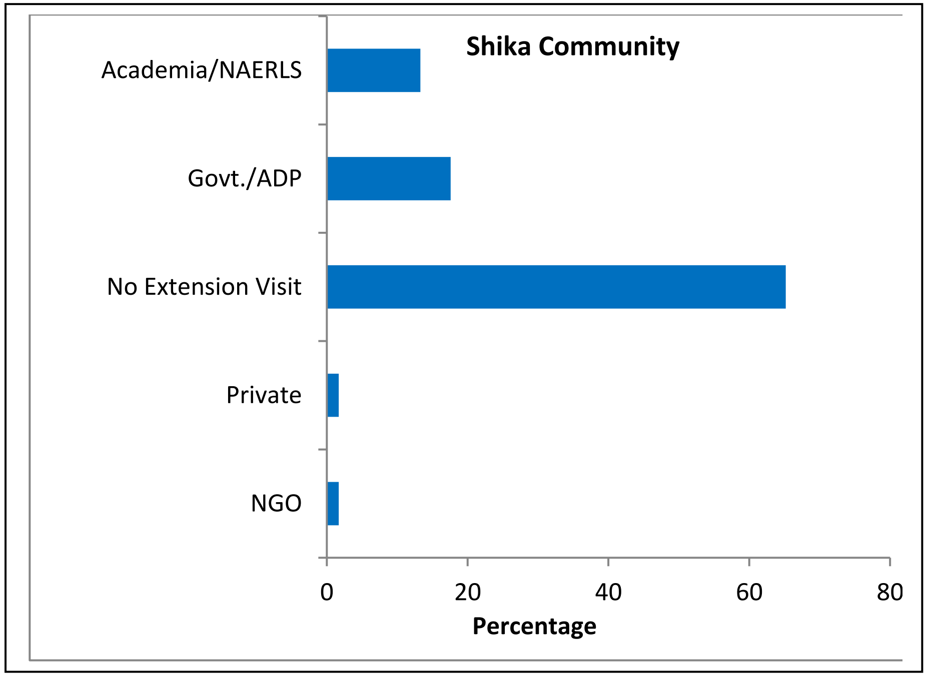


Figure 5.9a: Distribution of the respondents according to extension contact for Shika Community (Non-Adopted Village)
Source: Survey; Shika n=100 Scale: %

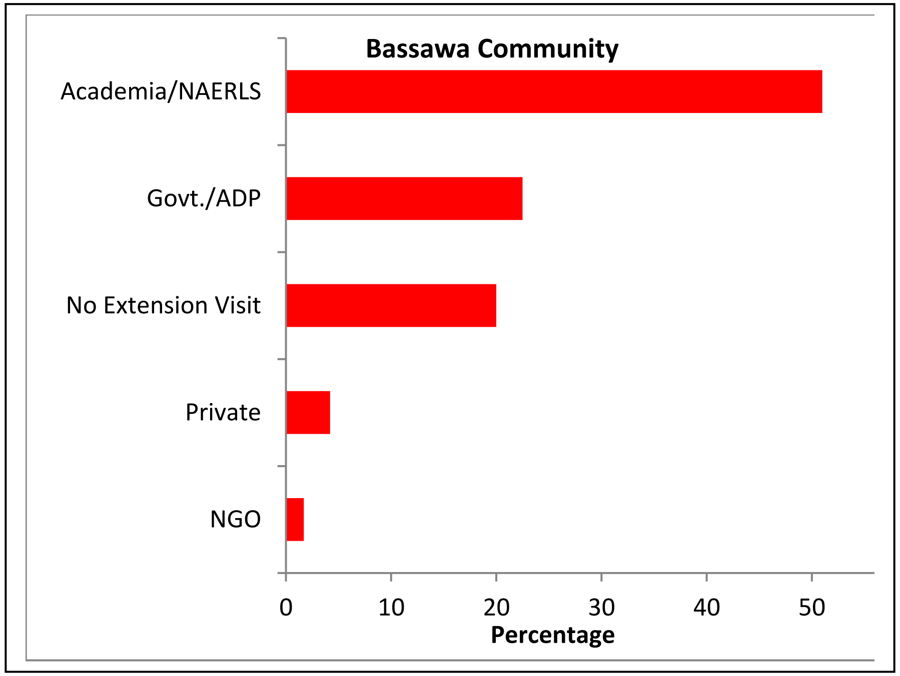


Figure 5.9b: Distribution of the respondents according to extension contact for Bassawa Community (Adopted Village by NAERLS)
Source: Survey; Bassawa n=100 Scale: %

(i). Effect of Extension Contacts and Experience

The baseline data shows that the two case study communities could be considered as fairly homogenous as chi-squared analysis found no significant difference between many of their characteristics. However, the communities can be sub-divided based on whether they experience extension through the Adopted Village programme initiated by NAERLS in 2012. The result of the chi-square analysis shows that there is statistically significant difference ($P<0.01$) between the two communities in relation to extension contacts and experience (Table 5.1).

Table 5.1: Chi-Square analysis between Shika and Bassawa in terms of extension experience

		No	Yes	Total
No	Count	31	58	89
	Expected count	28.5	60.5	89.0
Yes	Count	1	10	11
	Expected count	3.5	7.5	11.0
Total	Count	32	68	100
	Expected count	32.0	68.0	100

Chi-square Tests

	Value	df	Sig. (p-value)
Do you benefit from the Adopted Village Concept initiated by NAERLS	2.981	1	0.001

Source: Evaluation survey 2016; X^2 = Chi-square; $P < 0.01$ is significant

This shows that Bassawa community is still showing a greater perceived benefit of extension support in that just over half (51%) of the respondents from the adopted village (Bassawa) received extension contact/visits regularly from NAERLS, while 22.5% received extension visits from the ADP/Government agents only at the commencement of farming season. The results also show that 4.2% and 1.7% of the respondents had extension visits from the private sector and NGO's respectively. This implies that the overwhelming percentage of the farmers that received extension contacts could be attributed to the project initiated by the NAERLS, as part of its extension services delivery to farmers in the geo-political zone of Nigeria. Only 20% of the farmers in Bassawa indicated that they do not receive any form of extension visits.

From figure 5.9a, the findings of the respondents according to extension contact from Shika community (Non-adopted village) reveals that an overwhelming majority (65.2%) of the farmers had no contact with extension personnel. While only one third (30.9%) of the non-adopted village respondents reported that they had contact with extension personnel from the ADP/Government and academia but not as frequent as it ought to be. Only two sample respondents form the non-adopted village reported that they received visits from the private sector and NGO's. The non-adopted village (Shika) received far fewer extension visits in comparison to the adopted village (Bassawa). In summary, the distribution of the respondents according to extension contacts from the case study clearly differentiated the two communities based on the adopted and non-adopted status.

5.2 Demographic Characteristics of the Extension Workers

As discussed in Chapter four (section 4.8.1), the demographic characteristics of the extension workers who participated in the focus groups are reported here. The 20 extensionists were selected and the foremost rationale was based on those who volunteered from academia *(*NAERLS*);* government (ADP); Non-Governmental Organizations (NGOs) and the private sector. A breakdown of the sample and where they are working is provided in Table 5.2 below.

Table 5.2: Sample size of extension workers according to the organisation

Organizations	Working with Bassawa	Working with Shika	Total	The type of focus group discussion
Academia (NAERLS)	5	0	5	Extension in Nigeria.
Government (ADP)	3	2	5	How to improve it.
NGOs	2	3	5	Motivating extension workers.
Private sector	2	3	5	Summary of discussion
			20	

Source: Field survey 2016

The majority (16) of them were between 30-49 years old. Most (17) of the participants were males, while 3 were females. The study results show that 18 extension workers were married and 13 were from the household size of 10 or fewer members. Most (11) of the participants had Higher National Diploma Certificate (HND), followed by those (4) who had Ordinary National Diploma (OND) and (3) of them who had B.Sc. certificates, all in agriculture related subjects and signifying that they are literate.

On secondary occupation, 14 of the extension workers were involved in farming as outside income-generating activities to supplement their extension work, while 4 were involved in trading as a secondary occupation. The study results suggest that the majority of extension specialists have outside work to support their families. During the focus group discussion, extension workers reported that there is a considerable economic pressure on agricultural extensionists as on other government employees in Nigeria, this situation forces them to diversify and supplement their incomes with other activities. However, it seems that such pressure, or the opportunity for outside employment, is greater for the extension workers in Kaduna state as 18 out of 20 extension workers are involved in alternative/secondary occupations.

Also, four in-depth interviews were conducted with senior extension managers from the four extension sectors. Three of the senior extension managers had more than 25-years' experience, while one had 33 years of experience and he reiterated that "*I am currently preparing for my retirement" (Extension manager no.1 - in-depth interview).* All the four participants were male.

5.3 Current Extension Service Delivery in the District/State

As previously described in Chapter Four (section 4.6.2), the senior extension managers (one from each sector: i.e. academia, ADP, NGO and the private sector) were selected from the focus group participants to participate in in-depth interviews designed to explore and identify why the traditional extension models are not working in Nigeria.

A number of key themes emerged from the analysis of the focus group discussions as well as the qualitative interviews with both the senior extension managers and the extension workers focus group discussions. These are presented in order of the frequency of occurrence in the data:

1. The actors involved in extension work in Nigeria.
2. The effectiveness of traditional extension models in Nigeria.
3. The perceptions of farmers regarding extension agents' performance.

This section is framed around these three key themes. The qualitative findings are supported by quantitative findings from the evaluation survey of participating 200 smallholder farmers who also participated in the baseline livelihood survey. Where quotes are provided from the qualitative data, to protect the confidentiality of the participants, each participant is identified by a number.

5.3.1 Actors involved and key problems facing extension work in Nigeria

In Nigeria, there are key actors involved in rural development and extension service delivery to smallholders to enhance their agricultural productivity and standard of living of the farmers. During the focus group, extension workers emphasised that extension services are provided by a diversity of organisations ranging from the public, academia, commercial and voluntary sectors. It was agreed that the primary objectives of the four sectors are directed to influencing farmers' decisions and practices of the farming household. The current extension services and actors involved in Nigeria were summed up by the extension manager no.2 during the interview in his office, the exact question was: who are the actors involved in extension services in Nigeria? The manager summarised as follow:

"Nigeria has perhaps the largest research and extension institution in Sub-Saharan Africa, comprises of 17 commodity-based research institutes and a specialised national extension institute, three specialised University of agriculture and 18 Faculties of agriculture in regular universities, we also have one International Institute of Tropical Agriculture (IITA). He pointed out *that all the aforementioned institutions altogether and independently provides agricultural innovation not only to the public but also the private extension service providers. Agricultural Development Programmes (ADPs) have been at the frontline of extension system in Nigeria. This suggests that extension is largely public. However, the system was presumed to be ineffective due to some factors militating against the sector" (Extension manager no 2- in-depth interview).*

The researcher asked the manager to elaborate further on what he meant by saying that the system was presumed to be ineffective. The ADP manager went on to state: -

"What I'm saying is that there are prevailing challenges facing Nigeria's extension services, including inadequate and untimely funding, you will agree with me that successful implementation of agricultural extension activities is strongly dependent on adequate funding from government; a very weak Research-Extension-Farmer-Inputs Linkages system; poorly motivated staff; ineffective top-down approach; lack of relevant technology; poor leadership and coordination" (Extension manager no 2- in-depth interview)

Similarly, in the interview with another zonal manager, the actors involved in agricultural extension delivery services and failure of the traditional extension emerged most notably as apprehensions about the system. When asked about his view of the government in the context of extension services in Nigeria, the director appeared frustrated by the lack of action taken by the Nigerian government and he went further to explain the underlying problem influencing the extension services in Nigeria:

"*We all know the traditional extension services were doing very fine in Nigeria during World Bank-ADP approach and were extremely effective. It could be recalled that the ADP performed a significant role in the extension and advisory services, particularly in the dissemination of agricultural technologies to our smallholder farmers, link research and farmers. The obvious reason was because agricultural extension activities were three-sided funded by World Bank, the Federal government and State government. However, the final withdrawal of World Bank assisted funding had severe consequences on the performance of our agricultural extension services. It may interest you to know that fifteen years after the World Bank's support ceased (mid-1970s) the Nigeria agricultural extension activities have been suffering from lack of funding from the governments and even the present administration is finding it extremely difficult to tackle the challenges in the agricultural sector. The government is expected to be able to solve the current challenges in agricultural extension even without the World Bank's support". (Extension manager no 1- in-depth interview).* A similar view was held by another senior extension manager in relation to the current agricultural extension services in Nigeria:

"I think the current situation of agricultural extension service in Nigeria needs urgent attention because the system is not effective to the need of our resource-poor farmers who are the bedrock of food production. Of course, the problems had been in existence for several years. The poor performance of the traditional extension services has been attributed to insufficient funding; poor logistic support and inadequate staffing; poor agricultural policies, low

competencies of extension agents and corruption just to mention but a few. It is also important for me to let you understand that the withdrawal of World Bank sponsorship of ADP in Nigeria and the sharp decline in both funding and the performance of extension activities had posed a great challenge regarding the effective means of funding extension services in Nigeria. However, the government needs to be committed to the agricultural sector in order to restore its lost glory. We are making effort as NGO nevertheless; our exertion cannot be fully recognised without adequate support from the Federal government". (Extension manager no 3 - in-depth interview)

Taking the above findings together, it can be argued that, the current challenges in agricultural extension services in Nigeria is as a result of poor agricultural policies, poor enabling environment coupled with high-level corruption which has become the order of the day in every organization in the country. Another problem was dependency on external funding instead of the Nigerian government developing its own service using external funding as a “start-up” phase. In addition, it could also be argued that with such negative perceptions mentioned by the extension professionals of their own services and staff, it is in all probability no wonder that the smallholders’ farmers have little or no confidence in extension services and delivery.

5.3.2 The Effectiveness of Traditional Extension Models in Nigeria

Relevant here are the views/comments of the participants (focus group discussion with extension workers and farmers surveys) towards the effectiveness of the traditional extension models and communication in Nigeria. Focus group participants were asked what is working within the extension system, what is not, and why?

The agricultural productivity of smallholder farmers depends predominantly on the effectiveness of extension service delivery in terms of knowledge and timely information, to help several rural producers improve their production and living standards (Wambura *et al.* 2012). It is therefore expected that smallholder farmers should benefit consistently from scientific research, through diligent knowledge transfer and timely information from the extension workers, to show significant improvements in agricultural production. These benefits could be achieved by offering effective training on best agronomic practices, using appropriate and up-to-date information.

However, the evaluation survey results showed that the majority (87%) of the smallholder (Shika) respondents had negative perceptions of the effectiveness of the extension services in the area (Figure 5.10). While, 95% of the respondents from Shika community reported that they had no contact with extension workers in the last one year (Table 5.3). The chi-square analysis revealed that there is statistically significant difference between Shika and Bassawa communities in terms of extension experience and support. However, although farmers in the Bassawa community had higher levels of contacts with extension workers, it is interesting to note that the majority of farmers in the community still rated extension as ineffective.

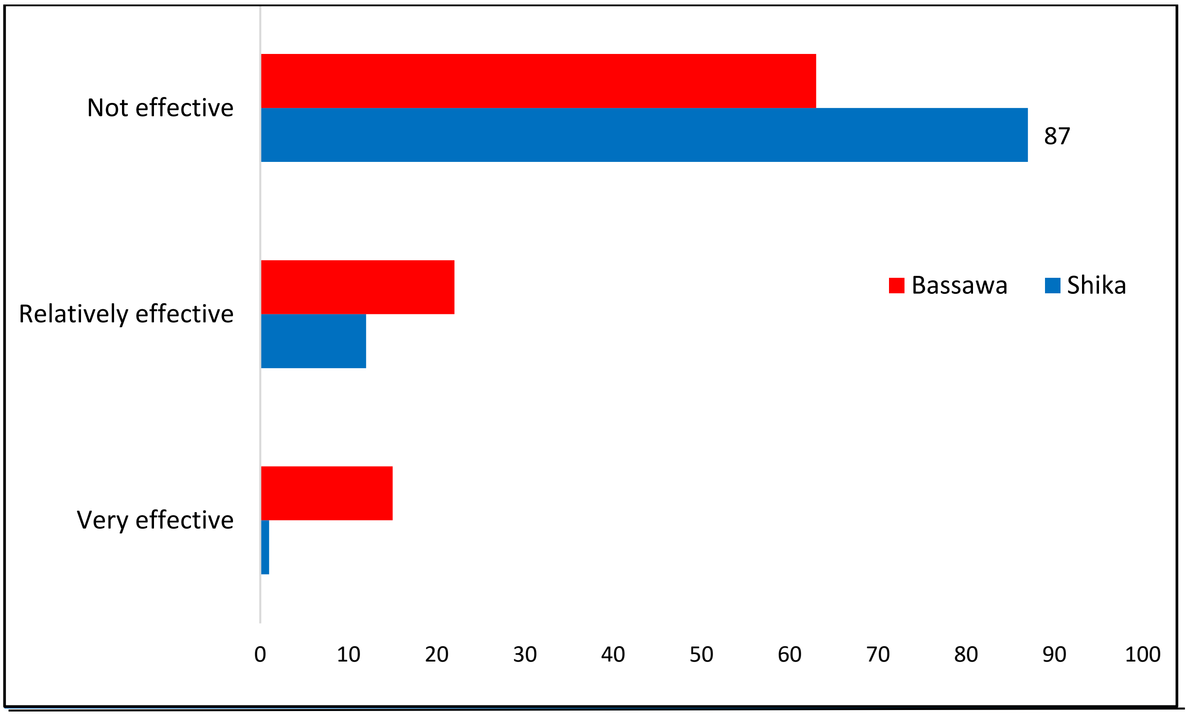


Figure 5.10: Distribution of in relation to the effectiveness of extension service delivery. Source: Survey; Shika n=100, Bassawa n=100 Scale: %

Table 5.3: Chi-squared analysis Distribution of respondents in relation to the effectiveness of traditional extension models

How effective is extension services delivery in your area?		Not effective	Fairly effective	Effective	Very effective	**Total**
Total	Observed count	0	31	49	12	100
	Expected count	8.0	31.0	49.0	12.0	100.0

Chi-square Tests

	Chi-squared	**df**	**Sig. (p-value)**	**Shika**	**Bassawa**
How effective is extension services delivery in your area?				95%	28%
	93.520[a]	9	0.000**	5	72

Source: Evaluation survey 2016; Shika n= 100, Bassawa n=100, P < 0.01 is significant

The focus group discussion allowed for a more in-depth discussion of extension. Extension workers were asked how effective traditional models of extension and communication in Nigeria are. What is working within the system, what is not and why?

According to one respondent:

"Well, from my own perspective the traditional extension models including: training and visit extension (T&V), farmer field and public extension system is not effective in Nigeria. Also, there are several challenges militating against our agricultural sector such as; poor funding, low incentives or poor salary for extension workers, ineffective agricultural research-extension linkages, insufficient and inappropriate agricultural technologies for our resource-poor farmers. The government needs to find an urgent solution to the problems of agriculture in Nigeria" (Agricultural Extension professional no. 5 - focus group).

Similarly, another respondent commented:

"It is very clear that extension services in our country are not effective, could you imagine that the extension agent ratio to farmers is now over 1:3000, but we are hoping for a rapid change

from this new government to help us employ more graduates into the system" (Agricultural Extension professional no. 2 - focus group).

Again, another participant remarked:

"Basically, the traditional extension models have been neglected by the Government and they are not working effectively to support our small-scale farmers, I think something should be done to bring the lost glory of agriculture back to our country. The Nigerian government now focuses on revenue from the oil and gas sector and neglects the agricultural sector totally" (Agricultural Extension professional no.6 - focus group).

In general, evidence from the focus group respondents revealed that a large proportion of the extension workers agree that traditional extension models are not working effectively in Nigeria because the majority affirmed by nodding their heads when their colleagues were offering comments to the discussions as a sign of agreement.

However, not all respondents agree. For example:

"…….I agreed that traditional extension approaches are not working effectively across the nation particularly if we consider the agent and farm families' ratio, however, I think extension services are fairly effective especially in our institution here in National Agricultural Extension and Research Liaison Services (NAERLS), Ahmadu Bello University, because the institute had initiated various projects and programmes to assist small-scale farmers, for instance; the Adopted Village project and secondary schools project; and Sasakawa programme were judiciously implemented in our institute. All these efforts were geared toward assisting small-scale farmers. Also, I need to mention it here that ABU radio station is disseminating information and technical advice to small-scale farmers in a local dialect and is working effectively because farmers usually call us through to the mobile phone number broadcast on the radio programme." (Agricultural Extension professional no. 1 - focus group).

Interestingly, Extension professional no. 2 quoted the extension-farmers ratio and explained his own opinion on the subject matter as well as how his places of work the NAERLS and ABU radio are reaching out to resource-poor farmers in rural areas with diverse initiatives to improve their agricultural productivity and livelihoods. From the context of the field study, type of information broadcast by the ABU radio station include; *From our markets to you; Let's go farming; Modern Agricultural; Rich man of the dry season and Programme for nomads.*

5.4 Factors Influencing the Effectiveness of Traditional Extension Service in Nigeria

The extension workers focus group participants were asked to mention the factors influencing the effectiveness of traditional extension service. The respondents (extension workers) gave a number of factors that influence the effectiveness of traditional extension. These factors have been grouped and are reported in Figure 5.11. These issues influencing extension services will be discussed more fully in chapter 7.

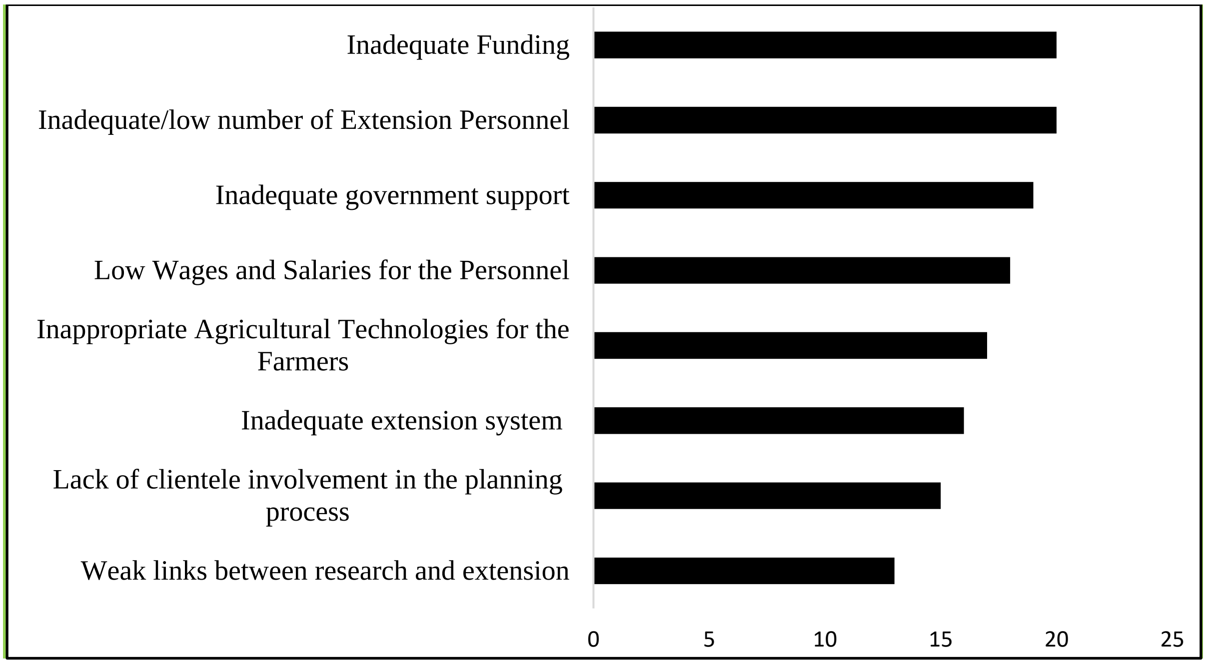


Figure 5.11: Factors influencing the effectiveness of traditional extension service (n = 20) Scale: 20 Extension workers

Omotayo (2010) stated that Nigeria is currently suffering from low agricultural productivity due to a number of factors influencing the sector including inadequate extension systems, ineffective dissemination of improved technologies, the poor linkage between extension and research and climatic change. The evidence from the responses above implies that the ineptitude of agricultural extension system in Nigeria as revealed by the majority of professionals may be associated with poor government support and neglect of the sector.

Furthermore, another respondent highlighted some reasons why the extension system is not working and suggested the role of the government.

"I work with ADP, this is my 24th year of experience as an extension worker but the system is not as effective as it ought to be. The use of radio, mobile phones and field demonstration are working especially with the advent of ICT in Nigeria. Nevertheless, the government should assist to resuscitate the agricultural sector and extension services by providing all the necessary logistics and invest in agriculture (Agricultural Extension professional no. 3 - focus group).

Again another participant added:

"To me, I strongly believe that if the three systems of government can invest in ICT, extension services for small-scale farmers would be more effective. We can reach more farmers in rural areas at the same time with ICT. We really need the government of Nigeria to intervene, especially the Federal Ministry of Agriculture and Rural Development" (Agricultural Extension professional no.7 - focus group).

From the information gathered, findings revealed that a vast majority of the participants agreed that application of ICT into extension services would make a significant difference and assist them to reach a greater number of small-scale farmers. The results from the survey also show that the majority of the smallholder farmers use radio (90%) and mobile phones (85.8%). This finding is in line with previous studies such as Aker and Mbiti (2011), Habiba *et al.* (2012) and Mwangi and Kariuki (2015).

Other respondents made similar comments:

"The use of ICT to disseminate agricultural information to our smallholders is working in Nigeria especially radio, mobile phones, print media, television and so forth. For instance, we have received many testimonies/calls from farmers about ABU radio. Farmers in Kaduna State and its environment do listen to our agricultural programme on the radio, twice in a week in the local dialect. However, the government should endeavour to increase our salaries and provide incentives in order to boost the morale of extension personnel." (Agricultural Extension professional no. 4 - focus group).

"There is no doubt that ICT are working in extension systems in Nigeria. In fact, I remember the programme initiated by Dr Akinwunmi Adesina, the former Minister of Agriculture, called the Growth Enhancement Support Scheme (GESS), in which (e-wallet) mobile phones were used to disseminate agricultural information to small-scale farmers in rural areas on specific places to redeem their farm inputs. Indeed, ICT are making waves in the Nigerian agricultural system" (Agricultural Extension professional no. 9 - focus group).

In the farmer in-depth interviews carried out for this study, participants also suggested that the integration of ICT would contribute considerably to the effectiveness of agricultural extension services in Nigeria. Information is a valuable resource to small-scale farmers and almost all the rural farmers surveyed have mobile transistor radios (90%) they carry around. This implies that information and knowledge are increasingly becoming critical factors for efficient and effective agricultural decision-making among smallholders. The farmers tended to absolutely value the modern ICT extension services delivery compared to the old system of extension in obtaining agricultural information as the majority were active users of ICT; radio (90%) and mobile phones (85.8%). Although, farmers used mobile phones technology for diverse purposes in the study area, a breakdown of the uses of mobile phones in the study would be fully discuss in chapter 6.

Again another participant added:

"I think the role of ICT cannot be underestimated in our extension work for effective and efficient delivery to smallholders because ICT serves as additional tools and we find them very useful especially radio and mobile phones. They really support our extension work to farmers. However, I want to appeal to the government to make modern ICT available for us such as computers, internet and projectors so that we can upgrade ourselves and be able to communicate skills and knowledge to our rural farmers. (Agricultural Extension professional no. 11 - focus group).

Another extension worker commented:

"I can say it emphatically that in Nigeria more than 80% of our small-scale farmers have access to a mobile phone either directly or otherwise, perhaps because the cell phones are relatively cheap and affordable. As field agents, the farmers usually contact us with their mobile phones to ask for useful information or make some clarification based on the information" (Agricultural Extension professional no.12 - focus group).

*Agai*n, two respondents highlighted:

"........Despite the fact that our small-scale farmers have access to mobile technology, there are yet some factors that pose great difficulties to effective communication; the first one is the socio-demographic characteristics, farmers' knowledge of ICT, language barrier, especially to some of us who cannot communicate in the local dialect fluently, as well as bad roads, as the distance from the villages discourages extension workers from visiting farmers.(Agricultural Extension professional no. 13- focus group)

From the above study findings, it implies that the value of ICT cannot be underrated. The findings reveal that smallholder farmers preferred traditional ICT, mainly radio (90%) as their main source of accessing agricultural information followed by mobile phones (85.8%). Hence, radio and mobile phones can be utilized to the break the barrier of bad roads and distance from villages and still deliver timely and relevant GAP technology and market information to rural farmers which help them make informed decisions on technologies adoption and subsequently where to sell their produce. It can therefore be argued that ICT tools can bridge the gap between agricultural extension workers and distance from remote villages. Similarly, extension workers do not need to risk their lives travelling through bad roads to the rural communities, because some of the rural road becomes almost impassable during raining season. As a result, radio and mobile phones could be strategically used to ameliorate the problem and also serve as an additional tool supporting the face to face extension visits, particularly in the modern day extension delivery system (Miittal and Mehar 2012, Sanga *et al.* 2013, Ganesan *et al.* 2015, Fu and Akter 2016).

5.4.1 Factors that hinder effective communication

The findings also revealed that extension workers were constrained by a number of factors that hindered effective communication as identified during the focus group discussions and evaluation survey. These include: language barriers; poor roads network; excessive distance from the village, farmers' knowledge of ICT; farmers' sources of information, among others (Figure 5.12). The above-mentioned concerns made it extremely difficult for extensionists to disseminate information and to effectively communicate extension programmes to rural farmers.

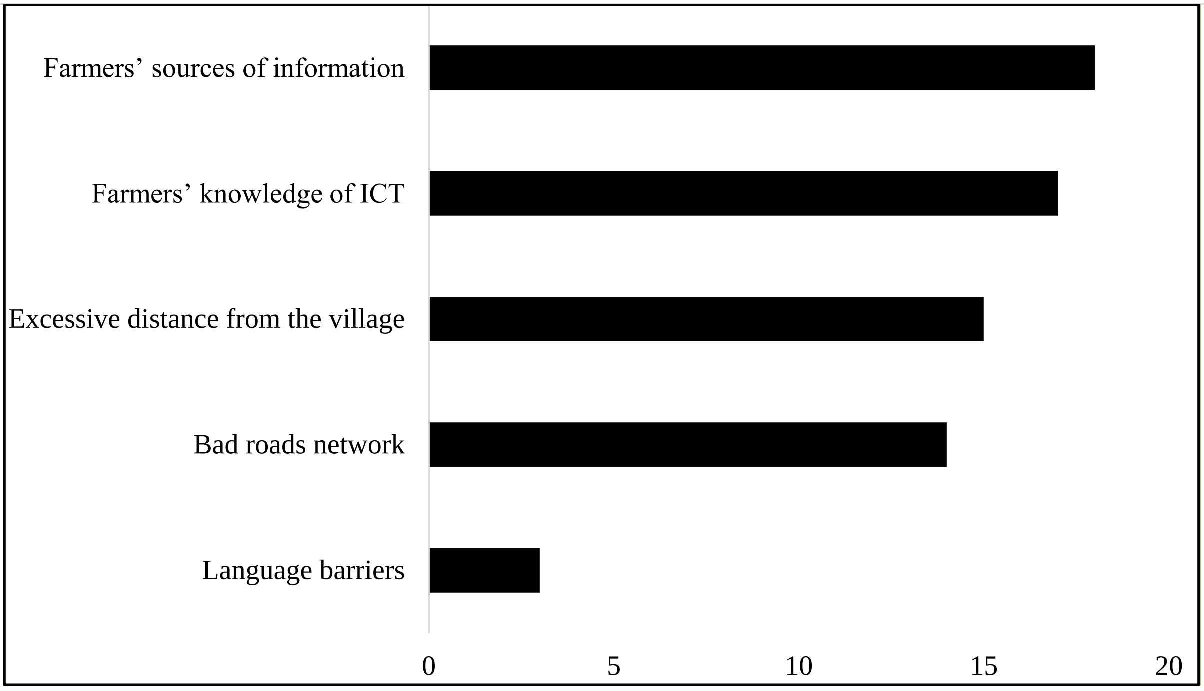


Figure 5.12: Factors that hinder effective communication in the study area as cited by extension staff (N= 20)
Scale: 20 Extension workers

The table shows the Spearman rank correlation between various *factors that hinder effective communication and contact with extension agents.* The Spearman rank correlation is non-parametric which was used to identify and test the strength of the relationship between two set of data that are categorical in nature but drawn from a bivariate normal population (Field 2009). Spearman's correlation works by calculating Pearson's correlation on the ranked values of the data. Ranking (from low to high) was achieved by assigning a rank of 1 to the lowest value, 2 to the next lowest and so on (Wiafe and Yona 2016). On whether farmers had contact with extension agents, the extension workers indicated yes or no. The answer was on scale or rank of 1 to 5. Table 5.4 gives the summary of the estimated results.

Table 5.4: Spearman rank correlation between factors that hinder effective communication and contact with extension agents (N=20)

Factors that Hinder Effective Communication	Contact with extension agents	Spearman correlation	*P*-value
Language barrier	2.5	0.635	0.001**
Bad roads network	1	0.772	0.000**
Excessive Distance from the villages	24	0.852	0.001**
Age of the farmers	71	0.585	0.156
Farmers' knowledge of ICT	0	0.376	0.174

Source: Evaluation survey 2016; P < 0.05 is significant

To shed further light on the factors that hinder effective communication to rural farmers as pointed out by the extension workers, survey data provides some useful insights. A correlation was conducted to explore the relationship between the variables and effective communication. As shown in Table 5.5, the results of the variables reveal that there was a positive and statistically significant relationship between language barriers, bad roads network and excessive distance from the villages with ineffective communication of agricultural information (Table 5.5). This suggests that language is important for effective communication to take place and has a significant impact. Communication methodologies and tools can help to overcome this language barrier, thus making the work of extension agents more productive and effective. Also, insight from the interviews with the extension workers suggests that a good communication strategy can establish a dialogue with rural farmers by involving them in the planning and development process and by conveying knowledge in a participatory way for improved farming activities.

5.4.2 Frequency of Contact with Extension Agents

Figure 5.13 indicates that the majority (79.5%) of the evaluation survey respondents had no contact with extension agents in the last six months from Shika community, while 72% had no extension contact from Bassawa community. This suggests that after the project in year 2012 Bassawa community had reverted back to no regular contact with extension agents. Only 17% and 24% of the farmers from Shika and Bassawa respectively were contacted within the last two months, while only 2.5% of the farmers from Shika reported being visited fortnightly which is the T&V system of extension's recommendation. The findings of the study indicate farmers' communication with extension agents is extremely poor in the study area. Farmers interviewed also claimed that extension workers did not visit their villages regularly. The most significant themes were:

"We are local people, we do not have access to vital agricultural information that could help us increase to achieve maximum yields increase. We need assistance from the government." (Farmer no 4 - Interview).

"In the past we used to receive extension advice from NARELS, particularly during the adopted village project, however since then hardly can you see extension workers to visit our village/communities. We do not really know our transgression". (Farmer no 2 - Interview)

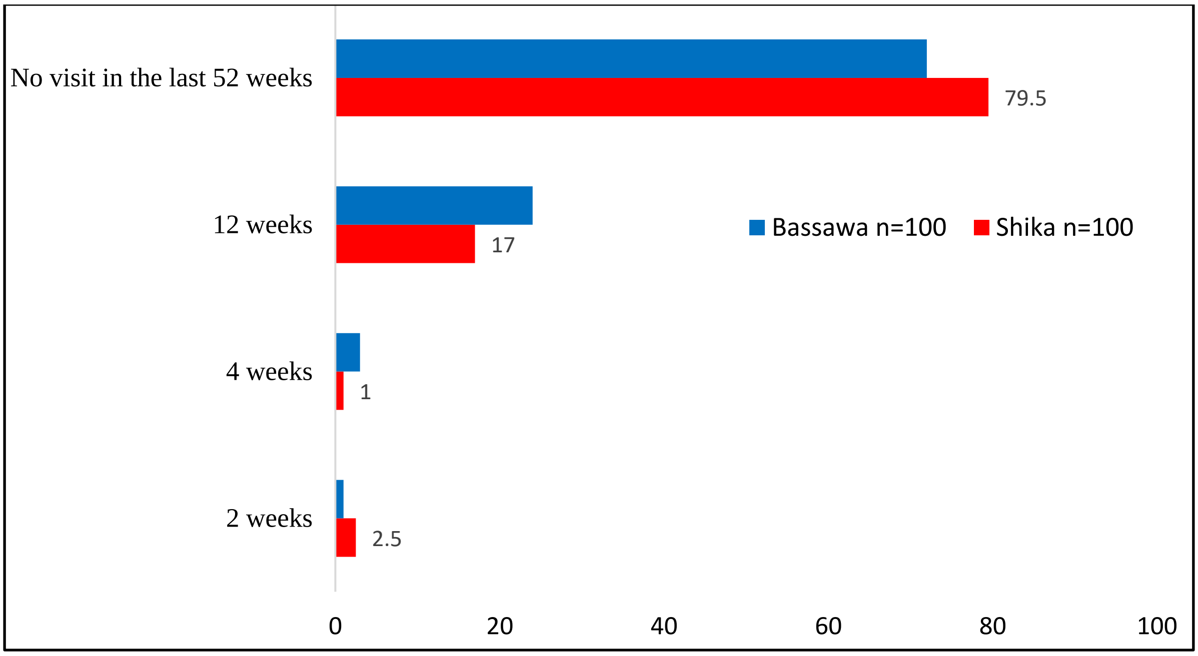


Figure 5.13: Distribution of Respondent's Frequency of contact with extension agents
Source: Survey; Shika n=100, Bassawa n=100 Scale: 100%

These qualitative findings were consistent with the quantitative evaluation survey which indicates that 79.5% of the smallholder farmers do not have access to extension contacts in Shika, while 20.5% of the respondents received agricultural information through media, mainly through agricultural radio programs and telephone calls/SMS text messaging in which extension agents made available through various agricultural education activities (Figure 5.13). According to the findings from the focus group and in-depth interview, the results of this study may be due to insufficient funding for logistics from the government, poor salaries and inadequate staffing, among others as reported by the extension professionals during the focus group and in-depth interviews. These findings are consistent with what has been observed in most previous studies in Nigeria and Sub-Saharan Africa regarding the low frequency of extension mirrors the limited number of extension workers (1:3000 farmers) in the study area which makes it extremely difficult to reach all farmers.

5.4.3 Farmers' Perceptions Regarding Extension Agents' Performance

As part of the evaluation survey, five point-Likert scales were used to elicit information on farmers' perceptions regarding extension agents' effectiveness to the respondents in the study area. The scale was: *strongly agree = 5, agree = 4, indifferent = 3, disagree = 2 and strongly disagree= 1.* Figure 5.14 revealed that 89% of the farmers in Bassawa perceived lack of regular contacts with extension officers a challenge, while 82% in Shika reported likewise (Figure 5.14).

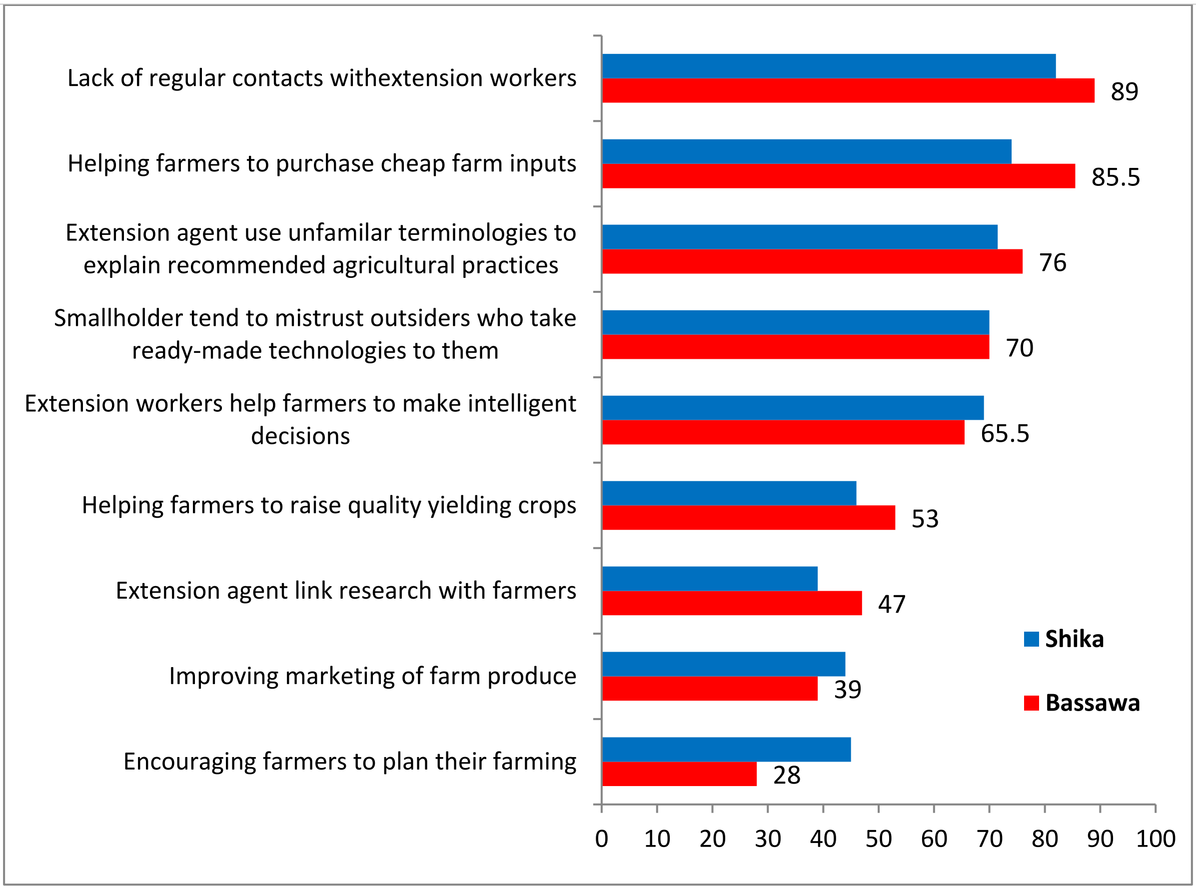


Figure 5.14: Perceptions of Shika and Bassawa communities regarding extension agents' performance before the intervention
Source: Survey 2016; Shika n=100; Bassawa n= 100 Scale: %

Results in Table 5.5 revealed that the majority (86%) of farmers from Shika community reported that extension services were not effective, while 75% of the farmers from Bassawa reported likewise. The results also show that 67% and 73% of the smallholders surveyed disagreed with the statement 'extension workers play a role in helping rural farmers to increase crop production', whereas 25.5% and 24% from Shika and Bassawa respectively agreed with the statement and the remaining 7.5% and 3% responded that they didn't know. Further investigation reveals that the majority of those who disagreed with the statement explained that extension workers did not visit them and most of the time they source advice from their fellow farmers in the village or telephone the NEARLS staff. As depicted in Table 5.5, Chi-square analysis was used to test significant relationship between farmers' perception regarding the role of extension services and increase in crop production. The results revealed that there is no statistical significant relationship between extension services and increase in crop production. This may be because of the ineffectiveness of the extension services in the study area.

Table 5.5: Chi-Square analysis of relationship between Farmers' perceptions regarding extension agents' role in helping rural farmers to increase crop production

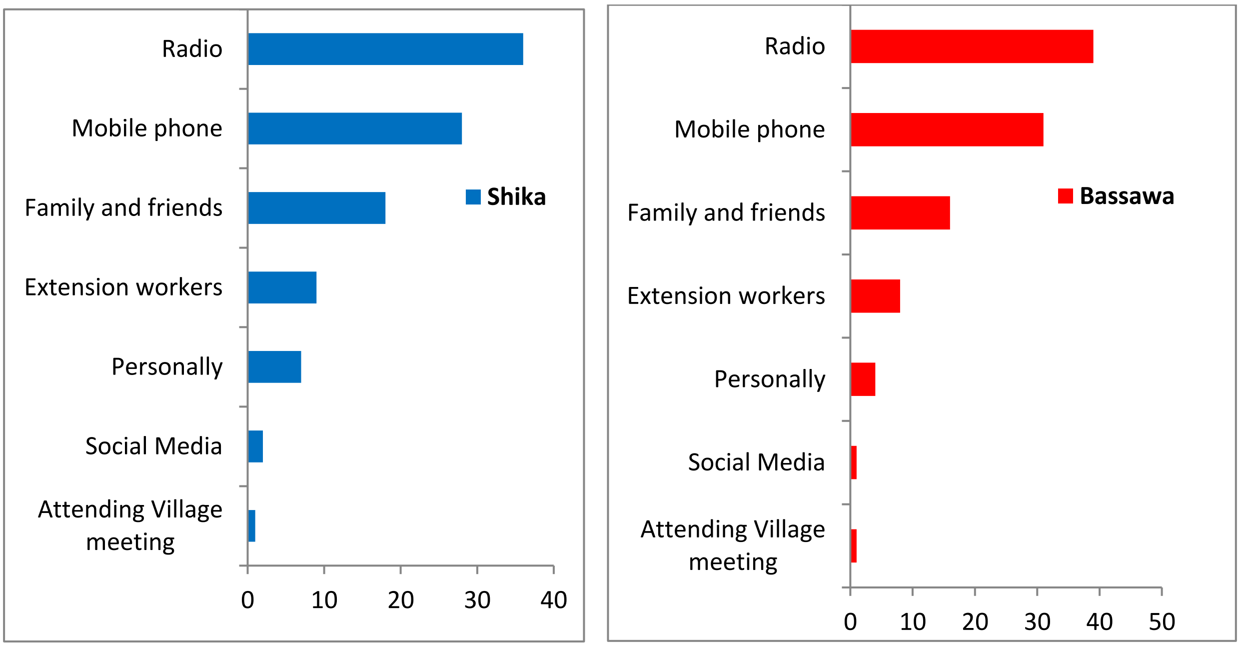
Do you believe that extension workers play a role in helping rural farmers to increase crop production	Shika n=100	Bassawa n=100	Chi-Square	df	p-value
Yes	25.5	24	12.84	1	0.14
No	67	73			
I don't know	7.5	3			
Do you think extension services is effective your area?					
Effective	9	23	22.29	1	0.16
Not effective	86	75			
I don't know	5	2			

X^2 = Chi-square; P< 0.001 is significant
Source: Survey; Shika n=100, Bassawa n=100

5.4.4 Preferred Sources of Agricultural Information among Smallholder Farmers

Information has become a critical factor to increase smallholders' production and productivity. As a result, the most preferred sources of information by smallholder farmers were investigated and respondents were requested to rank the sources of agricultural information used. As presented in figure 5.15a-b, the findings reveal that smallholder farmers preferred traditional ICT, mainly radio (36%) as their main source of accessing agricultural information followed by mobile phones (28%) for Shika community, while 39% and 31% of smallholder farmers from Bassawa community indicated that they prefer radio and mobile phone respectively.

The study results further indicate that agricultural extension agents, personal sources and social media were not considered as significance in obtaining agricultural information by the respondents. The findings of the study show that radio and mobile phones were relevant agricultural information which help farmers to make informed decisions about what crops to plant and where to purchase affordable farm inputs and which market to sell their produce. In this regard, the need and choice of the sources of information on improved agricultural technology, and how timely and relevant information is disseminated to the targeted smallholder farmers should be of paramount concern to both agricultural development practitioners and agricultural extension workers. However, the chi-square test shows that there was no statistically significant differences between the farmer's present sources of agricultural information.



Source: Survey; Shika n=100% Bassawa n=100 Scale: %
Figure: 5.15a-b Present sources of agricultural information among smallholder farmers

5.5 Current Problems Affecting Agricultural Extension Services in the Study Area

During the focus group discussions, extension workers were asked to highlight and rank the current problems affecting extension organisations in the study area. As shown in Table 5.16, of the ten problems mentioned, all of them seem to be affecting agricultural extension services in the area. However, the most significant of these problems ranked by the extension workers was the exceptionally low number of extension workers in the area, while inadequate ICT amenities and lack of incentives for field personnel were among the least important problems (Figure 5.16). Of course, this study acknowledge that ICT are not a panacea to social and economic development problem of the rural communities in Nigeria. In the same way, ICT do not eliminate all of the burdens facing rural farmers and they could not automatically solve all the pastoral development difficulties. Nevertheless, they have potential to help the smallholder farmers to leap some of the traditional obstacles to development by improving access to appropriate and timely information. Therefore, ICT can be used to support traditional extension models. Further investigation revealed that extension workers particularly the staff of ADP-Government have no access to computer and internet. *"I can tell you categorically that 70% of extension workers in ADP cannot operate computer. I do not have one and many of my colleagues" (Agricultural Extension professional no.6 - focus group).*

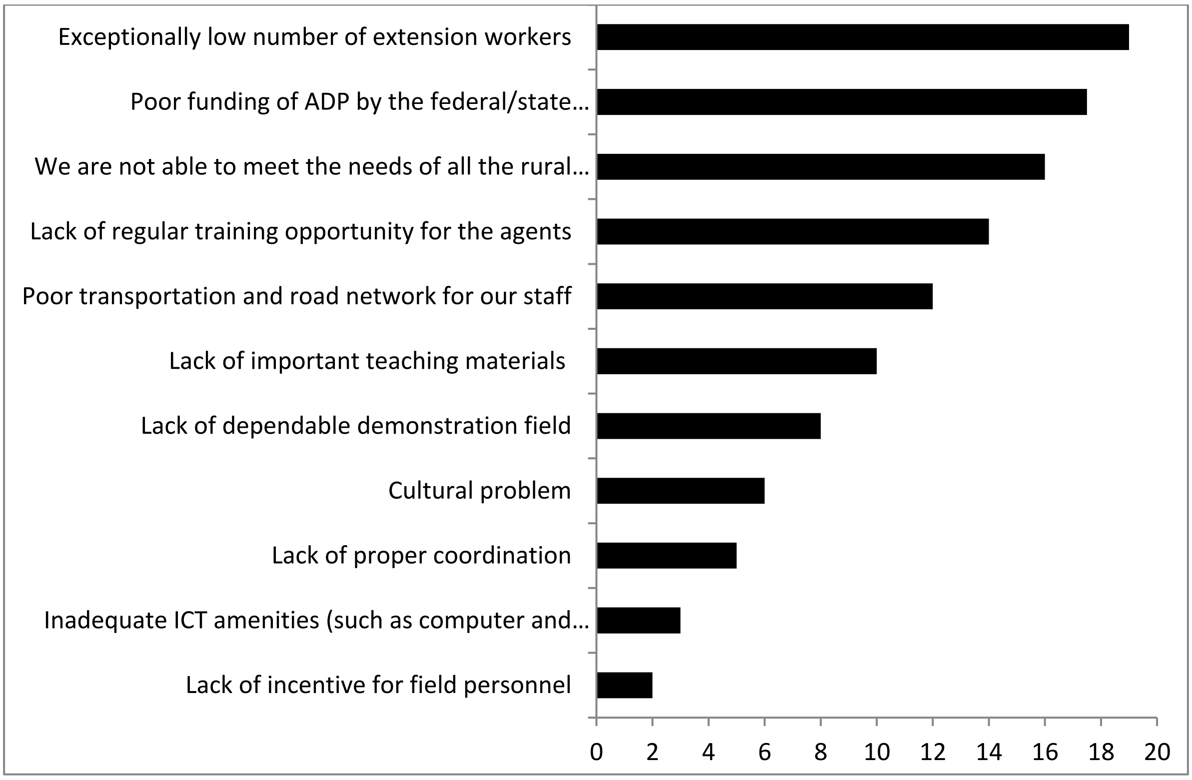


Figure 5.16: Problem affecting agricultural extension services in the study area
Source: Survey; Extension workers n=20 Scale: 20 Extension workers

5.5.1 Potential Solutions to Improve Extension Services in Nigeria

Focus group participants were requested to suggest some potential solution to the aforementioned problems militating against agricultural extension in the area. These are some of the suggestions:

1). The federal and state ministry of Agriculture should recruit more agricultural graduates' youths and train them. More extension workers need to be hired in order to significantly reduce the problem of the extension workers to farm families' ratio which is currently 1:3000 in the Kaduna State (Omotayo 2010).

2). The government should endeavour to provide additional funding support to ADP for effective extension services delivery to the rural farmers.

3). Regular technical training should be given to village extension agents and government should provide mobility system (vehicles and motorcycle) to be able to reach the rural communities.

4). The government can also improve the quality of extension services by conducting need assessment programme.

5). Village extension agents working in the study area require to be assisted through the provision of field teaching materials and incentives.

6). The government should support the development of other partners that are involved in extension delivery to rural farmers such as NGOs, private sectors and farmer cooperative societies.

5.5.2 Level of Adoption of GAP Technologies by the Survey Respondents

The previous sections have outlined the various limitations of current extension services in the study area. To provide further insight, and to give a baseline for the study, this section provides a summary of current levels of awareness of GAP technologies among survey respondents. Data in Figure 5.17a-b reveal the level of adoption of GAP technologies by the surveyed farmers before and after (i.e. pre and post) workshop on GAP technologies. Oladele and Adekoya (2006) opined that the awareness of GAP technologies is relatively low in rural Nigeria. The GAPs selected as appropriate for the training in the communities includes; improved seeds, soil management, spraying of herbicide, pesticide control, improved planting spacing of crops, use of crop residue to feed livestock, cover crops, striga control, water management, crop rotation, improved storage, compost and green manure, zero tillage, spacing and mulching.

Prior to the GAP training, a total of 200 questionnaires were used to elicit information from the respondents, farmers were requested to indicate their level of awareness and level of adoption of improved technologies by using a three-point Likert rating scale. The scale was as follows: *High = 3, Medium = 2 and Low = 1*. The level of adoption was determined using Spearman rank correlation. Figure 5.17a-b gives the summary of the estimated results.

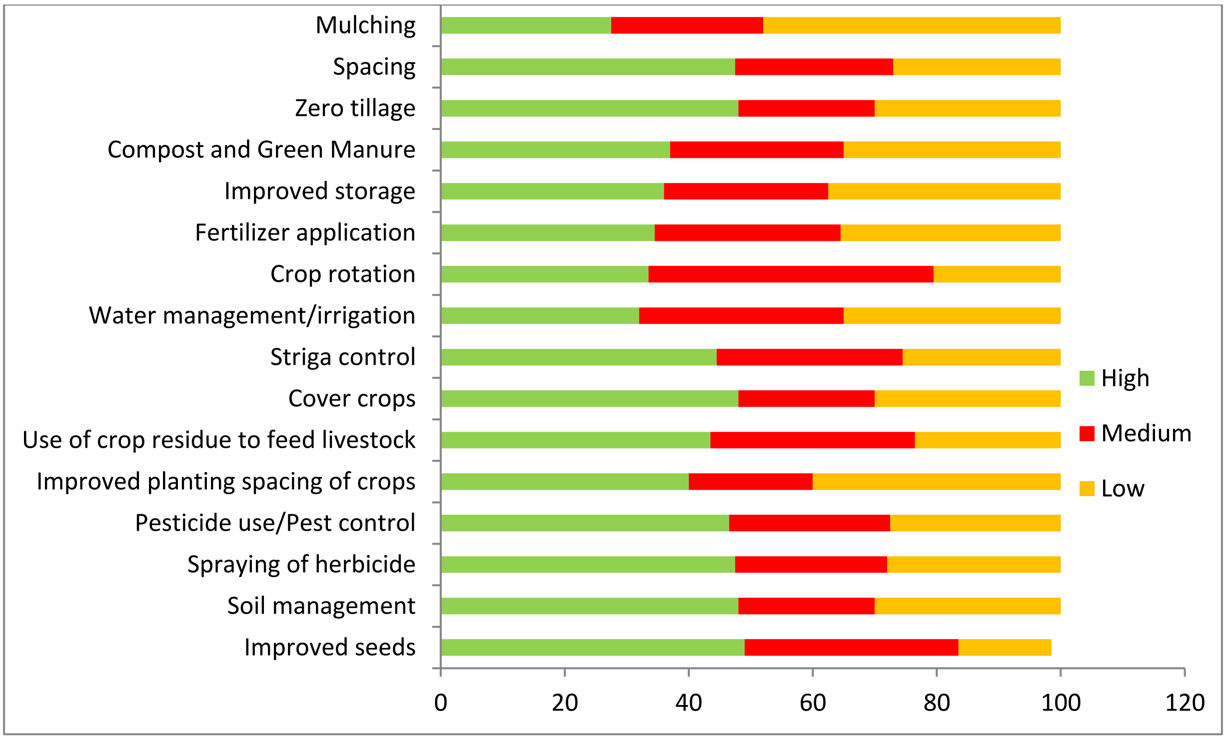


Figure 5.17a: Level of adoption Before GAP training by the survey respondents (N =200) Scale: %

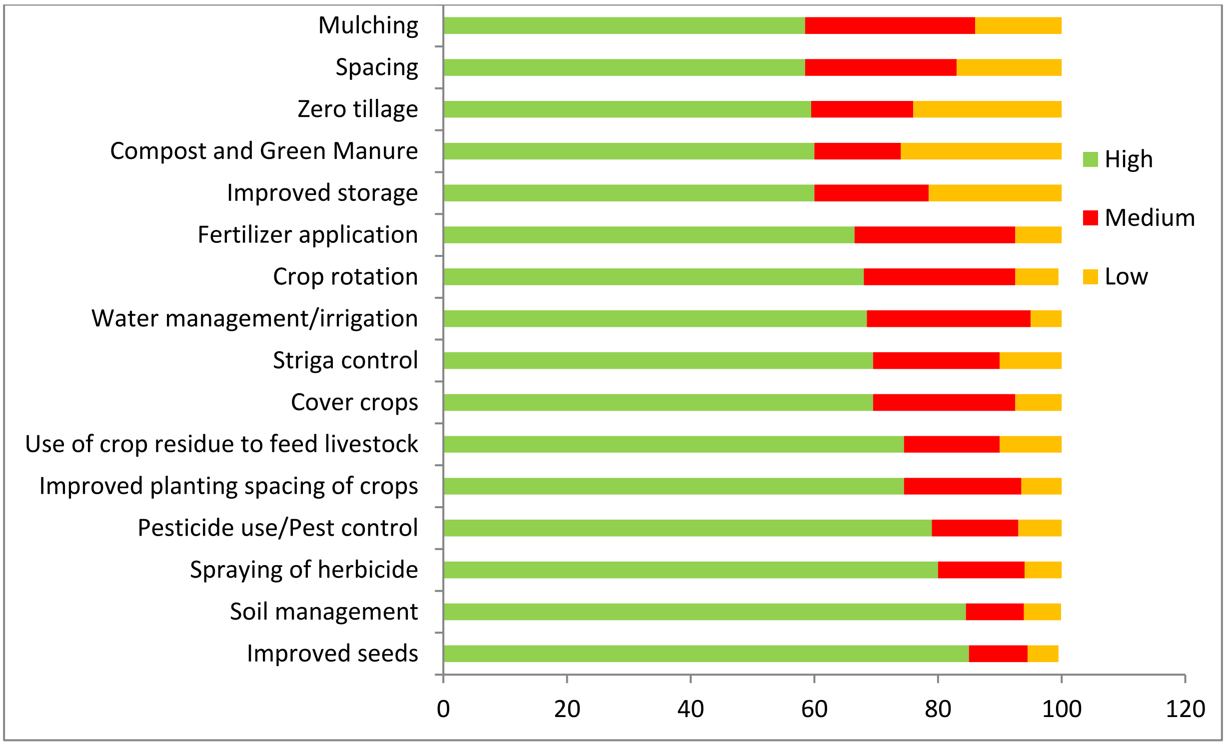


Figure 5.17b: Level of adoption After GAP training by the survey respondents (N= 200) Scale: %

The table shows that all the GAP technologies show various degrees of adoption level post training. The Chi-square test revealed that 13 GAP technologies were statistically significant at P <0.05 level indicating high level of adoption and acceptance of the GAP technologies by smallholder farmers. They are: **improved seeds, soil management, spraying of herbicide, pesticide control, improved planting spacing of crops, use of crop residue to feed livestock, cover crops, striga control, water management, crop rotation, improved storage and compost and green manure.** Generally, eleven out of the 16 GAP technologies developed together with the farmers and trained in a participatory approach have been classified as high adoption while two of the GAP technologies were regarded as medium and the rest (3) of the GAP technologies fell under low adoption. These results thus suggesting that farmers rated GAP technologies high after the workshop/training in terms of technology transfers.

5.5.3 Barriers to Adoption of GAP Technologies in the Study Area

As presented in Figure 5.17a-b, farmers from Shika and Bassawa were requested to state the reasons why they do not adopt GAP technologies. Farmers highlighted the barriers to adoption and also ranked them in the order of importance. They unanimously ranked financial constraints as the major barrier to implementation, followed by high costs of fertilisers and extreme poverty level in the study area. High illiteracy levels of members, very poor government policy in agriculture and the high cost of labour, herbicides and improved seeds, and addiction to the traditional method of farming were ranked 4th, 5th, 6th, 7th and 8th respectively (Figure 5.17a-b). Other barriers cited by smallholders included adulteration of farm input in the markets, inadequate farmlands, lack of farm machinery to assist members, low awareness level, farmers no longer trusting extension agents and fear of failure of improved technology were also noted. However, during the focus group discussion with extensionists, poor implementation of government policy and high costs of fertiliser due to the economic recession in the country, were raised as major barriers. One farmer from Shika community explained that the Federal Ministry of Agriculture and Rural Development announced that smallholder farmers in the country should open bank accounts for soft loans. According to him, they all left their villages in a group and went to a particular bank in the metropolitan to open bank accounts. Moreover, as shown in Table 5.6a-b, the Chi-squares analysis revealed that there exists a statistical significant difference between the communities in relation to extension experience and government policy on agriculture. The two factors were statistically significant at <0.001 level. However, other factors were not statistically significant. This shows that Bassawa community is more open to extension services and more influenced by the project.

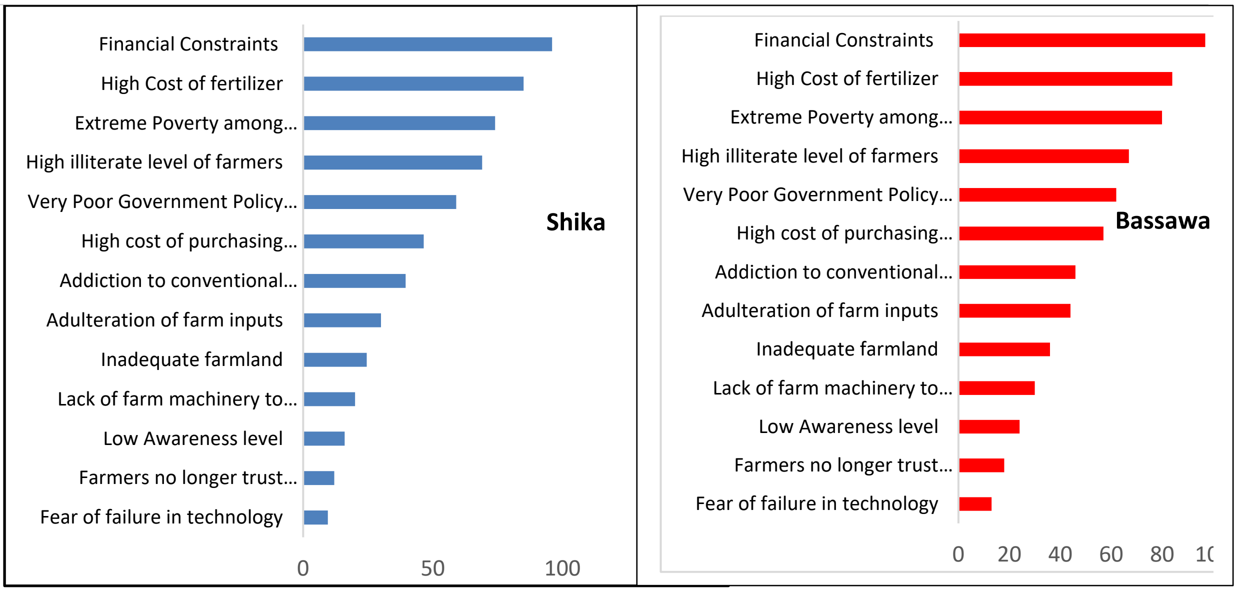


Figure 5.18a-b: Barriers to adoption of GAP technologies by farmers in the study Area
Source: Survey; Shika n=100, Bassawa n=100 Scale: 100%

Table 5.6: Chi-squared analysis between the communities in relation to extension and government policy on agriculture

	Shika		Bassawa		Chi-squared	Df	P-value
	Yes	No	Yes	No			
Very Poor Government Policy on Agriculture	89	11	78	22	46.39	5	0.000**

Source: Survey; Shika n=100, Bassawa n=100
P < 0.001 is significant

5.5.4 Farmer Participatory Extension Approach

As outlined in the Methodology in the previous chapter, in order to address a number of the limitations of current extension approached and barriers to GAP adoption outlined above, during the second visit (May-June 2016) to the study area, the researcher, assisted by two extension professionals from academia (NAERLS) who communicate effectively in local dialect (Hausa language) and are also familiar with the targeted study area, undertook a farmer participatory training programme on GAP technologies. The farmer participatory training was strategically designed by the researcher as a farmer-centred process of purposeful and creative collaboration between the researcher and smallholder farmers. During the in-depth interviews and focus group discussions with the extensionists, the farmer participatory approach received several invaluable suggestions from the extensionists. The most significant ones were:

"I think the farmer training participatory approach is a better idea to improve technology adoption among rural farmers. The approach would also increase the beneficiaries farming knowledge and skills which perhaps influence participants decision positively". (Extension manager no 3 - in-depth interview)

"Participatory training approach is the best strategy when rural development researchers and field extension agents wanted rural farmers to adopt improve technology. Without a doubt, with regards to the adoption of new agricultural technologies, the likelihood that farmers will adopt a new technology is dependent on the related training available to them". (Agricultural Extension professional no. 3 - focus group).

"I strongly believe that farmer participatory will work better than our usual training and visit extension approach, which was regarded as top down approach. From my experience when we involve farmers in any technologies development process they tend to adopt more because there is tendency for them to trust in the technology". (Agricultural Extension professional no. 5 - focus group).

"I think this is a very good approach, experience had revealed that smallholder farmers have a propensity to adopt more improved technologies when they have better understating through direct training". (Extension manager no 3 - in-depth interview)

Eight extension workers also participated in the workshop. The main purpose of this collaboration was to develop GAP technologies that would meet the local environmental conditions of the farmers via exchange of experiences with the farmers and to actively involve the end-user in the development process. Rather than developing and releasing "perfected" technology packages which may eventually not meet the farming and living conditions of the farmers (a typical top-down approach), the GAP participatory training commenced in the study area on Monday, 4th May 2016. The session was designed to allow the researcher and farmers to effectively work together to develop 16 GAP technologies and an Action Plan to implement the technologies. The detailed procedure was as follows:

1. Prior to the training session, GAP technologies that are relevant to the study locations were reviewed from the literature (see annex 1) to determine scientific reasons whether they could improve farming in this type of farming system and farmers were asked whether they were aware of GAP technologies. An overwhelming majority (81%) of the farmers reported that they were aware. Drawing from their experiences, one farmer explained that they do not recognise them as GAP, they called them agronomic practices. Another farmer stated further that extension workers from NAERLS came to their village in 2012 during Adopted Village Project to introduce agronomic practices to the villagers.

Similarly, another farmer emphasised that: *"Extension staff from NAERLS came to Shika village and its environs to introduce Sasakawa Global 2000 (SG 2000) programme and discussed some agricultural improved technologies with the villagers. Since then they did not visit our village regularly".* The findings suggest that farmers in the study area are aware of GAP technologies.

2. Farmers were requested to list all the agronomic practices (GAP) they were aware of.

3. The researcher helped them to organise and capture the list on the flipchart.

4. Following the list mentioned by the trainees, the research assistant discussed extensively the merit and demerit of each technology listed by the participants and also showed them the pictures of the improved technologies on the slide presentation.

5. Following the discussion, the researcher pointed out major conclusions and, together with the participants, 16 GAP technologies were defined.

Since farmers were part of the decision-making and development process, it was hoped that response to the uptake of the GAP technologies would increase significantly.

5.5.5 Effectiveness of the Training among Smallholder Farmers

Training is assumed to have a strong influence on the adoption decisions of smallholders since it creates awareness about new improved technologies. During the focus group discussions with extensionists and semi-structured interviews with farmers, several issues relating to the effectiveness of extension delivery in the area and GAP training were discussed. Specifically, participants were asked to mention benefits of agricultural extension services, particularly those derived from the farmer participatory training on GAP technologies either directly from the researcher or from lead farmers to the trainees. A number of key factors emerged. The benefits listed by farmers include:

1. Providing farmers with new skills and information.
2. Easy to understand because we are familiar with/trust the lead farmers.
3. Providing intensive support.
4. Ability to work together as a community.
5. Increased quantity of crops this farming season.
6. Improved family welfare.
7. Adoption of more GAP technologies.
8. Increased household income and standard of living.
9. Acquisition of additional farmland.
10. Enhanced education and level of farmers' socialisation with others.

5.6 Summary

This chapter has presented the findings of the data obtained from the baseline livelihood survey that was conducted in the first phase of the research in order to lay a solid foundation for the study. The survey was based on a sample of 200 households and the results show the two case study communities were similar in every aspect except on the bases on the extension experiences. However, Shika community emphasised that the current extension services in the study area are grossly ineffective and inefficient to meet the needs of rural farmers. Moreover, 69.5% of the survey farmers indicated that they had no visit/contact with extension agents in the last year, ABU radio (and other radio stations) and mobile phone technology were the principal sources of extension advice.

The chapter has also presented findings from the focus group discussions and in-depth interviews from farmers and extension workers. The research further identified that almost all the extension worker participants unanimously reported that after the withdrawal of World Bank funding to ADP, the Federal Government of Nigeria finds it extremely difficult to independently fund the extension and advisory services in Nigeria. Exceptionally low numbers of extension workers and poor funding were ranked as the fundamental challenges confronting extension services in the area.

The results reported in this chapter highlight a number of issues in relation to the adoption of GAP technologies and use of ICT among smallholder farmers. The use of SMS text reminders, participatory GAP training, trust, and other factors have been shown to influence farmers' decisions to adopt technologies. The significance and implication of these findings will be considered further in the discussion chapter that follows and a new model for using mobile phones to improve extension services to smallholder farmers in order to improve their productivity and livelihood Nigeria will also be given priority.

The chapter has also described the effectiveness of traditional extension services in the study area. The following key findings have been discussed:

The current extension services in the study area are ineffective and inefficient to meet the needs of rural farmers. Almost all the extension worker participants unanimously reported that after the withdrawal of World Bank funding to ADP, the Federal Government of Nigeria finds it extremely difficult to independently fund the extension and advisory services in Nigeria. 69.5% of the survey farmers indicated that they had no visit/contact with extension agents in the last year, while 86% reported that extension service delivery was not effective in the area. ABU radio (and other radio stations) and mobile phone technology were the principal sources of extension advice. Exceptionally low numbers of extension workers and poor funding were ranked as the fundamental challenges confronting extension services in the area.

Chapter Six. Impact of GAP Training Intervention and SMS on GAP Adoption among Farmers

This chapter presents the findings of the research based on the statistical analysis of data obtained from the evaluation survey conducted in the third phase of the study after the GAP training and SMS intervention had been carried out. The chapter is structured as follows:

- Farmers' perceptions regarding effectiveness of the overall training programme.
- Effectiveness GAPs training by lead farmers.
- Trainee farmers' perception regarding the training.
- With SMS and without SMS farmers.

6.1 Farmers' Perceptions Regarding Effectiveness of the Overall Training Programme (n = 200)

As presented in Figure 6.1, it was revealed that the majority (70.5%) of the respondents indicated that the overall training on GAP technologies intervention programme was very effective in providing them with knowledge and skills, while 27% of the respondents stated that the training was relatively effective and a negligible proportion (2.5%) expressed that they did not find the training effective. The findings show that the overall GAP training programme was effective for a great majority (97.5%) of the respondents. The findings agree with Ajayi (2014) who stated that smallholder farmers in developing countries would adopt new innovation if adequate technical supports and resources were made available to them.

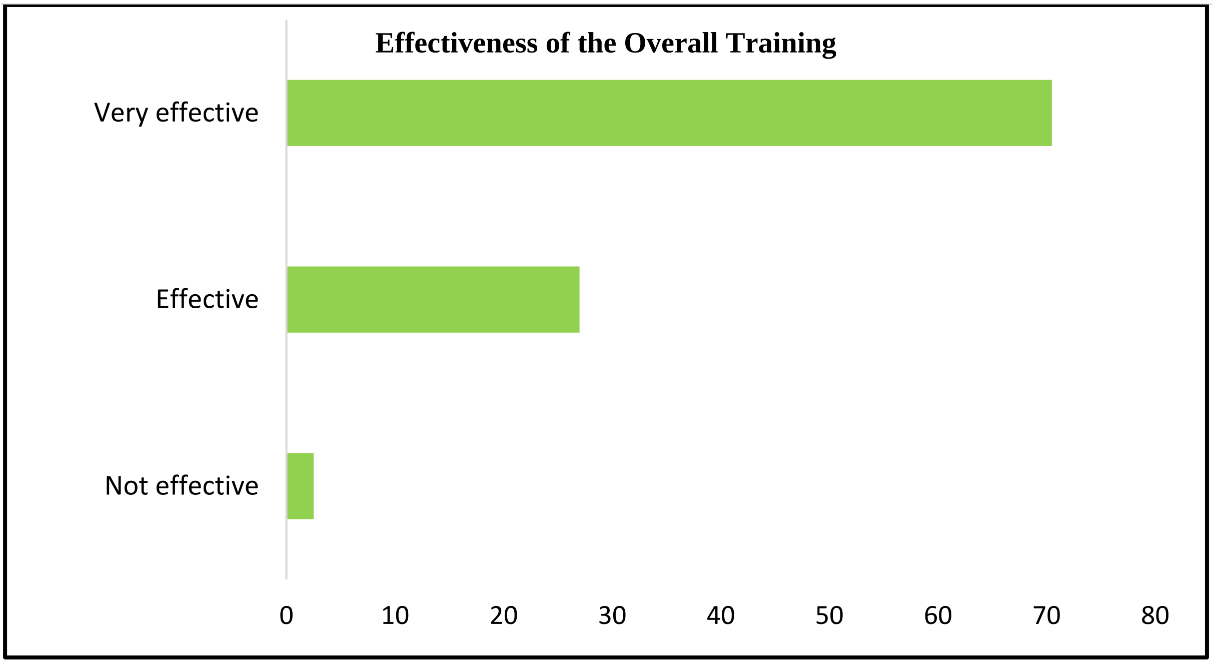


Figure 6.1: Farmers' Perceptions Regarding Effectiveness of the Overall Training Programme (n = 200) **Scale: 100%**
Source: Survey 2016; Smallholder farmers (n=200)

6.1.1 Effectiveness of the Training Programme Delivered by the Researcher among the Lead Farmers and Adoption of GAP

Lead farmers were asked to rank the effectiveness of the training provided by the researcher. The exact question was "How would you rate the effect of the GAP training sessions provided to you by the researcher?" A 3-point Likert scale was used to record these responses, (1= less effective, 2= effective and very effective = 3). The study results revealed that the majority of the lead farmers 95% found training very effective. The results also revealed the existence of a significant and positive correlation between the effectiveness of the training and GAP adoption among the lead farmers (Table 6.1). The study results show that adoption of improved seeds (r = 0.34**), soil management (r = 0.47**) and spraying of herbicide (r = 0.45**) significantly and positively correlated (Spearman Rank) with the level of perceived effectiveness of the training (Table 6.1). Similarly, nine GAP technologies are significantly and positively correlated among the trainee farmers these included improved seeds (r = 0.59**), soil management (r = 0.33**), spraying of herbicide (r = 0.25**), fertilizer application (r =

0.55**). This implies that the GAP training had positive effect on recommended GAP adoption.

Table 6.1: Spearman rank correlation between Adopted Lead farmers and Trainee farmers (Lead farmers n =50; Trainee farmer n=150)

GAP Technologies	Lead farmers (Trainer)	P-value	Trainee farmers	P-value
Improved seeds	0.34**	.000	0.59**	.001
Soil management	0.47**	.000	0.33**	.002
Spraying of herbicide	0.45**	.000	0.25**	.000
Pesticide use/Pest control	0.36**	.001	0.49**	.001
Improved planting spacing of crops	0.63**	.002	0.62**	.002
Use of crop residue to feed livestock	0.33**	.000	0.38**	.000
Fertilizer application	0.26**	.000	0.55**	.001
Striga control	0.35**	.001	0.33**	.000
Water management/irrigation	0.85**	.002	0.25**	.000
Crop rotation	0.63**	.000	0.859^{NS}	0.377
Cover crops	0.75**	.001	0.077^{NS}	0.564
Improved storage	0.39**	.002	0.098^{NS}	0.732
Compost and Green Manure	0.32**	.000	0.086^{NS}	0.312
Zero tillage	0.098^{NS}	0.531	0.079^{NS}	0.472
Spacing	0.037^{NS}	0.426	0.098^{NS}	0.381
Mulching	0.055^{NS}	0.735	0.095^{NS}	0.426

Source*:* Survey 2016; Lead farmers n =50; Trainee farmer n=150

6.1.2 Trainee Farmers' Perceptions on the Effectiveness of the Training Delivered by the Lead Farmers to their Peers (N= 150)

Figure 6.2 reports data on the participants' perceptions of the effectiveness of the training delivered by the lead farmers to their peers (trainee farmers). As shown in figure 6.2, the majority of the trainee farmers surveyed (98%) indicated that the training was effective and increased their level of agricultural production especially in this recession period in Nigeria. The findings show that participants were happy with the training delivered to them by the lead farmers. This result revealed that lead farmer extension approach is an effective model because farmers trust their fellow farmers (85%) even more than extension workers in the area. This result concurs with the FAO (2013) which strongly recommends the use of the lead farmer model in passing knowledge to smallholder farmers.

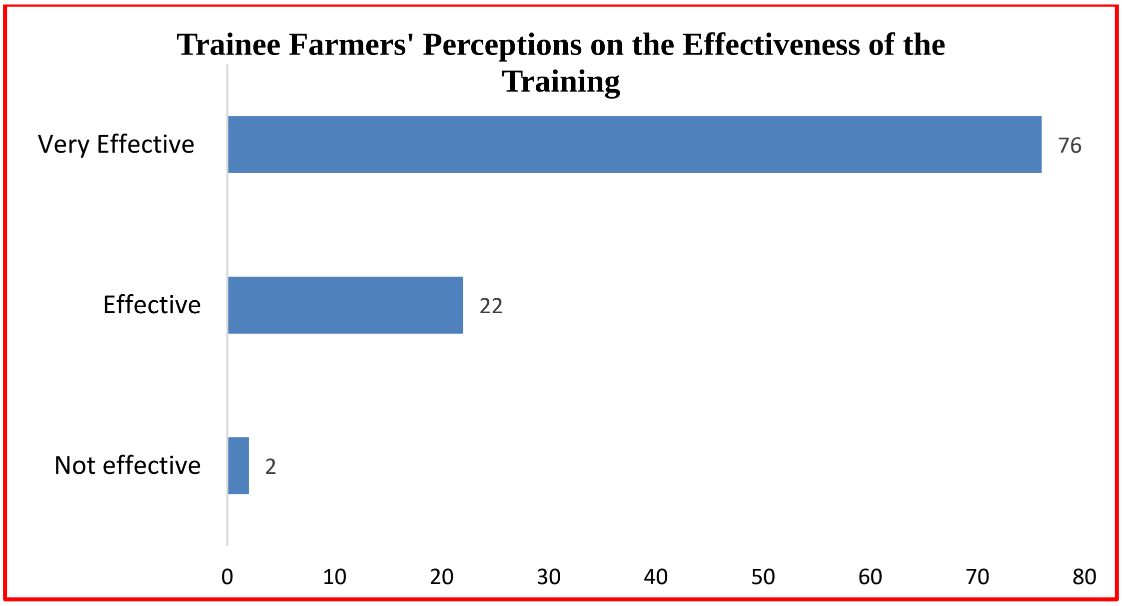


Figure 6.2: Trainee Farmers' Perceptions on the Effectiveness of the Training Delivered by the Lead Farmers to their Peers (N= 150) Scale: 100%
Source: Survey 2016; Smallholder farmers (n=200)

6.1.3 Comparison between the 25 Lead Farmers With-SMS (Bassawa) and 25 Lead Farmers Without-SMS (Shika) in Relation to the Effectiveness of the Training (N = 50)

To know whether there is a significant difference between the 25 lead farmers with extension visits and SMS reminders and 25 lead farmers' without with regards to GAP adoption, an independent sample Mann-whitney test was conducted (Table 6.2). The results of the Mann-whitney test revealed that there was a statistically significant mean difference between the 25 lead farmers with-SMS and 25 lead farmers without-SMS at 5% significance level as indicated in Table 6.2 (Mann-whitney= -3.823, p= 0.000**). The results show that extension visits and SMS text reminders received fortnightly by the former significantly influenced adoption of improved agricultural technology. As shown in Figure 6.3, the mean responses revealed that

With-SMS farmers perceived the training very effective and encouraged the adoption of GAP technologies. These findings corroborate with Aker (2011) who recommended ICT as an effective tool to reach more farmers in developing countries.

Table 6.2: Mann-whitney test between the 25 farmers lead farmers' with-SMS and 25 farmers lead farmers' without-SMS

Category	N	Mean Rank	Exact Sig.	Sig. (2-tailed)
With SMS **(Bassawa)**	25	1.921	-3.823	0.000**
Without-SMS **(Shika)**	25	0.841	-2.686	

Source*:* Survey 2016; Lead farmers n =25; Trainee farmers n=25

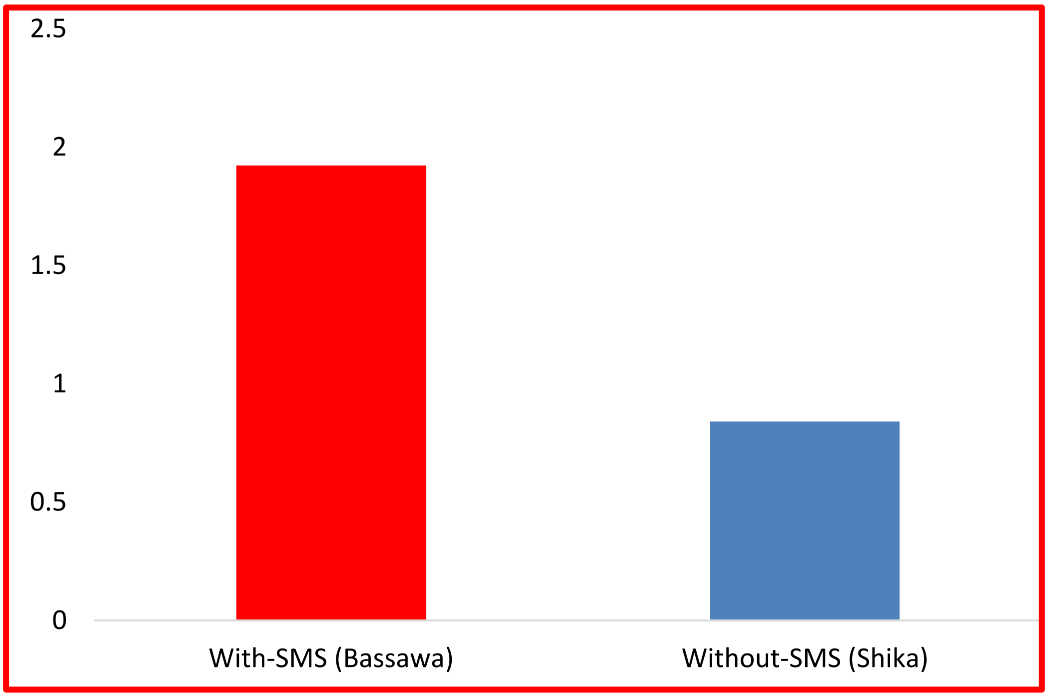


Figure 6.3: Mean score/responses of the 25 lead farmers' with-SMS and 25 lead farmers' without-SMS

6.1.4 Comparison between the 25 Lead Farmers' Without-SMS and 75 Trainee Farmers' Without-SMS in Relation to the Effectiveness of the Training

To determine whether there is a significant difference between the mean of variables regarding the two farmer categories (i.e. 25 lead farmers without-SMS and 75 trainee farmers' without-

SMS), in relation to the effectiveness of the training, an independent sample t-test was conducted. The survey results show a significant mean difference (t= 0.215, p=.000**) between the 25 lead farmers and 75 trainee farmers' with-SMS in relation to the effectiveness of the training at 5% significance level which shows is more effective (Table 6.3).

Table 6.3: T-test Analysis between the 25 lead farmers' without-SMS and 75 trainee farmers' without-SMS in relation to the effectiveness of the training

Category	N	Mean Score	df	Std. E	t-test	P-value
25 lead farmers' with-SMS	25	2.45	24	.035	0.215	.000**
75 trainee farmers' with-SMS	75	2.09	74	.071		

Source*:* Survey 2016; Lead farmers' with SMS n =25; Trainee farmers' with-SMS n=75; ** Significant at the 0.05 level

This shows that Bassawa community is still showing a greater perceived benefit of extension support. Table 6.3 shows that there is a statistical significant between the lead farmers and the trainee farmers, which implies that both the 25 lead farmers' without-SMS and 75 trainee farmers' without-SMS strongly agreed that the training was effective (57%). This suggests that there is likelihood that the effectiveness of the training influenced the adoption level of the beneficiaries.

6.2 Impact of GAP Training and Action Plan on Adoption by Smallholder Farmers

As discussed in the Methodology chapter, this study aimed to assess the impact of GAP training and a lead-farmer extension model, together with the use of SMS reminders on the level of GAP adoption by smallholder farmers, as shown in Table 6.4, the non-parametric Spearman rank test was used to predict the impact of the GAP training on the adoption of the sixteen GAP technologies recommended to lead farmers and then communicated to trainee farmers (200 farmers in total). The results indicated that the coefficient of thirteen GAP recommended technologies was positive and statistically significant among the farmers, showing increased adoption post-training (see Table 6.4). What emerges from this analysis of findings suggests that the impact of the participatory GAP training intervention provided to the farmers has been positive and effective which resulted in technology adoption.

Table 6.4: Spearman rank test between GAP technologies and adoption using n=200

GAP Technologies	Adoption Level	Spearman Rank	P-value
Improved seeds	85.0	15.0	0.000**
Soil management	84.5	30.0	0.000**
Spraying of herbicide	80.0	28.0	0.001**
Pesticide use/Pest control	79.0	27.5	0.000**
Improved planting spacing of crops	74.5	40.0	0.000**
Use of crop residue to feed livestock	69.5	23.5	0.000**
Cover crops	69.5	30.0	0.000**
Striga control	68.5	25.5	0.001**
Water management/irrigation	68.0	35.0	0.000**
Crop rotation	66.5	20.5	0.002**
Fertilizer application	60.0	35.5	0.000**
Improved storage	60.0	37.5	0.057**
Compost and Green Manure	59.5	35.0	0.036**
Zero tillage	58.5	30.0	0.123NS
Spacing	58.5	27.0	0.570NS
Mulching	69.5	48.0	0.327NS

Source: Survey 2016; P < 0.05 is significant

The results presented in Table 6.5 show the farmers responded positively when asked whether they had benefited from the participatory GAP training sessions. The results reveal that 83% indicated that it was beneficial, while 91% reported that they acquired information, skills and knowledge and increased agricultural production and productivity (79%) as a result of taking part in the participatory GAP training (both lead and trainee farmers). This shows that the GAP training was successful and beneficial to the vast majority of the participants.

The results of the evaluation survey further found that 83% of the farmers indicated that the GAP participatory training sessions had a positive impact on their crop productivity this cropping season (Table 6.5). This shows that the farmers actually benefited from the GAP training sessions they attended whether delivered by the research team or by the lead farmers and the information and skills acquired enabled the majority of them to practice them.

Table 6.5: Distribution of GAP Adoption and Action Plan on crops productivity (n = 200*)*

Impact of GAP Adoption and Action Plan	%
Do you think the GAP participatory training sessions was beneficial?	
Yes	83
No	17
Were you able to apply the Information gather, knowledge and skills gained from the training?	
Yes	91
No	07
I don't know	02
Do you think the GAP participatory training sessions had a positive impact in your crops productivity?	
Yes	79
No	21
Adoption of GAP among with-SMS farmers	
Fully Adopted	73
Partially Adopted	20
Not Adopted	7

Source: Survey 2016

When probed on the impact of the action plan on adoption, analysis of findings indicated that the majority of the farmers (80%) said that they were able to work much faster and easier on their farmland since they knew the next activities to perform through the action plan developed during the GAP training. This implies that the respondents were able to save more time and become more productive. At this juncture, it could be concluded that without attending these participatory GAP training sessions (both direct to the lead farmers and in-direct to trainee farmers), the smallholder farmers would not have been able to adopt the same level of recommended GAP technologies and subsequently would not have improved their crop productivity to the same extent.

6.2.1 Impact of Extension Visit and SMS Text Reminders on Agricultural Productivity

As mentioned previously in the methodology chapter, during the second visit to the study area, with-SMS farmers (100 in Bassawa village) received one visit from the researcher and his team (2 extension workers). In order to establish whether the extension visits and SMSs sent to farmers had benefits in addition to the GAP training, analysis was undertaken between farmers who had received the training only and those who had received the training but also had received an extension visit and SMS reminders. The positively significant rank of extension visits made to the farms of the with-SMS group by the researcher and his team as reported in the methodology chapter also had a positive impact. This suggested that extension visits conducted after the training to the farmland of the farmers had positive and significant impact. The findings imply that regular visit of extension workers may enhance the rate of adoption by smallholder farmers. According to the findings in Table 6.6, all aspect of the intervention had positive and significant impact on agricultural production (GAP training, action plan, SMS reminders and extension visit) triggered the adoption among the smallholder farmers. The findings implies that no single intervention could successfully influence GAP adoption in the study area.

Table 6.6: Spearman rank test of the Impact of Extension Visit and SMS Text Reminders on Agricultural Productivity (Bassawa Community n= 100)

Variables	Spearman Rank	P-value
Education level	0.453**	0.011
Age	0.302**	0.005
Farm size	0.389	0.063^{NS}
GAP participatory training	0.053**	0.000
SMS Text Reminders	0.379**	0.000
One Extension visit	0.369**	0.001

Source: Survey 2016; P < 0.05 is significant

The intervention encouraged the adoption of the GAP technologies via extension services by providing quality, complementary, adequate and appropriate extension services immediately after training which enabled farmers to adopt and implement the recommended technologies. It is unfortunate however that the majority of the smallholders in rural areas of Nigeria had not been able to obtain technological information previously perhaps due to poor extension service delivery, lack of social amenities, lack of technical know-how and access to communication medias. The findings imply that regular visit of extension workers may enhance the rate of adoption of GAP technologies by smallholder farmers. In this study, the researcher encouraged the adoption of the GAP technologies by providing quality, complementary, adequate and appropriate extension services immediately after training which enabled farmers to adopt and implement the recommended technologies more easily.

In order to measure the impact of extension visits on crop production amongst with-SMS farmers, the evaluation survey employed some parameter estimates to measure the impact. These include; education, the age of the household head, farm size, road network and participation in the GAP training. Table 6.6 reports the analysis of the findings on the impact of access to extension visits on with-SMS farmers on levels of agricultural production. The results of the spearman rank test revealed that the estimated parameters were statistically significant in terms of having an impact on production levels. This finding suggests that receiving only one extension visits could influence farmers positively and improve technologies adoption and crop productivity.

Using the formula provided by Halvorsen and Palmquist (1980), the study found that access to agricultural extension services of at least one visit during growing season raised the value of crop production by 42% of the with-SMS farmers, all of who received a visit. Second, this positive impact of extension is found for both maize and non-maize production cultivated by the adopters. Third, the effect of these results revealed that with-SMS farmers who received extension visits during the cropping season and SMS text reminders followed technical and extension advice, adopted more than 70% of the recommended GAP technologies. This result is consistent with what was found regarding the impact of GAP training on adoption (Table 6.7).

6.2.2 Impact of SMS Text Reminders on GAP Adoption by With-SMS Farmers

In addition to extension visits, this study sought to determine the influence of SMS text reminders on the adoption of GAP technologies and its impact on the agricultural productivity by comparing adoption levels among without-SMS and with-SMS farmers. Spearman rank analyses were used to assess the relationship between SMS text reminders and GAP adoption. Results of the analyses can be seen in Table 6.7 which shows the summarized details of without-SMS and with-SMS farmers in terms of the adoption of GAP technologies included in the survey.

The result in Table 6.7 show that there was a statistically significant mean difference between the with-SMS farmers and the without-SMS farmers (at $P \leq 0.05$ level) in relation to GAP adoption. As reported earlier, 73% of the with-SMS farmers in the study area fully adopted recommended technologies. This implies that SMS text reminders seems to influence the adoption of GAP technologies among the group, although, not all the GAP were adopted by with-SMS farmers. Moreover, as mentioned earlier other factors such as GAP training, action plan, extension visit contributed to the decision making of the farmers to rapidly adopt GAP technologies. Similarly, the finding of this study may also suggest the greater the adoption rate of GAP technologies by with-SMS farmers the higher the crops yields and productivity and the income capacity of such farmer (70%). Adoption of GAP could help the farmers to sustainably boost crop productivity as well as improve their standard of living. Results of this study are consistent with the findings of the earlier studies who observed that adoption of improved agricultural technologies helped in increasing the agricultural productivity of farmers (Awotide *et al.* 2012; Adofu *et al.* 2014).

It is therefore, evident from these findings that the use of SMS significantly influenced the adoption of GAP technologies among with-SMS farmers (Table 6.7). The probable determinant drivers that facilitated this may be associated with the technical support in terms of the participatory training programme on GAP technologies and SMS text reminders sent to with-SMS farmers by the researcher every two weeks, before and during the growing season.

Table 6.7: Chi-squared Test of GAP Adoption: Comparing SMS farmers to Non-SMS farmers

GAP Technologies	SMS Farmers Adoption Level	Non-SMS Farmers Adoption Level	Chi-squared Test	p-value
Soil management	85.0	59	.247**	.000
Water management	84.5	58.5	.368**	.000
Fertilizer application	80.0	58	.365**	.000
Crop rotation	79.0	46.5	.437**	.000
Compost and Green Manure	74.5	46	.278**	.000
Cover crops	69.5	46	.168*	.001
Improved storage	69.5	45	.329**	.000
Use of crop residue to feed livestock	68.5	44	.269*	.000
Striga control	68.0	43	.400**	.000
Spraying of herbicide	66.5	43	.217**	.002
Improved planting spacing of crops	60.0	41	.358**	.000
Pesticide use/Pest control	60.0	39	.231**	.000
Improved seeds	59.5	35	.220**	.002
Mulching	58.5	27	.199	.105 NS
Spacing	58.5	25	-.071	.318 NS
Zero tillage	69.5	25	-.032	.650NS

Source: Survey 2016; P < 0.05 is significant

Moreover, the farm input supports in terms of improved seeds given to all the participants as an incentive also influence them to adoption. To the researcher's knowledge, so far there is no large survey data-based evidence on the influence of SMS text messages on the adoption of GAP technologies among smallholder farmers in the academic literature in Nigeria. This research study's main strength stems from its originality. Although previous studies have focused on the impact of text messages on market prices and efficiency, price or weather information, and the influence on farmers' decisions in terms of where to sell crops (Jensen 2007; Fafchamps and Minten 2012; Urquieta and Alwang 2012; Cole and Fernando 2012; Nakasone 2013; Duruiheoma 2015; Agwu *et al.* 2015; Larochelle *et al.* 2016), this is the first empirical study to reveal findings that show that SMS text reminders to rural farmers and intensive training may influence adoption of GAP technologies. The use of information and participatory training offered to the participants was largely an educational process which they converted into useable knowledge. Parsa *et al.* (2014) stated that effective training provides a person with the ability to recognize opportunities, become endowed with knowledge, self-esteem and the skills to act on them. Moreover, Ahmed *et al.* (2011) emphasised that better-trained smallholder farmers are known to make greater use of information, advice and the training, and are more diligent and proactive in adjusting to agricultural changes and adopt new improved technologies.

However, the fundamental role of agricultural extension services is to provide smallholder farmers with new knowledge on agricultural practices through education advisory services and facilitation. In fact, farmers need new skills and knowledge which they could easily acquire through effective and productive extension services. Parsa *et al.* (2014) blame insufficient training and technical support as a basic cause of limited adoption of new agricultural technologies in rural Africa. The food insecurity in Africa is largely a result of low agricultural productivity perhaps because the extension services that should train smallholders who are the major producers of crops food are not effective. Degnet and Belay (2001) observed that frequent contact with extension workers positively and significantly influenced farmers' adoption decisions. Also, Yinhak (2005), in his study on determinants of adoption of improved technologies found that farmer's' participation in farm demonstrations and training had a positive and significant relationship with the adoption of technologies.

The results of this study have revealed the importance of information (through extension services and SMS text reminders) and participatory training sessions among smallholder farmers as a veritable tool for improving adoption and subsequently increase the crop yields of smallholders. The studies conducted on the importance of training programmes on the adoption of improved technologies by Van den Berg and Jiggins (2007) and David *et al.* (2012) reported that farmer field school programs (participatory approach) were found significantly positive in Kenya, Tanzania and Uganda, and had very widely good impacts on productivity and the incomes of the participants. In the same vein, Farmer Field Schools (FFS) and Training and Visit (T&V) programs were found to significantly increase pesticide knowledge and use among farmers and raised yields in Burkina Faso and India and had increased the value of production per hectare in Zimbabwe (Owens, Hoddinott and Kinsey 2003; Godtland *et al.* 2004).

Additionally, a recent study on the evaluation of the impact of the training and visits (T&V model) by Larsen and Lilleør (2014) reported that T&V programmes in Tanzania were significantly positive regarding yields and food security, but provided no evidence of reduction of income poverty. Participatory training is a key booster of adoption among smallholder farmers and goes a long way in ensuring acquisition of relevant skills and knowledge needed (Ndirangu and Bwisa 2016). Farmers services and training needs to be more hand-on and practical (Ndirangu and Bwisa 2016). On the other hand, the SMS text reminders sent to farmers served two specific purposes; (1) provide appropriate information on the recommended GAP technologies, and (2) reminded smallholders to adopt the GAP technologies and use them. A similar study by (Jensen 2007; Urquieta and Alwang 2012; Larochelle *et al.* 2016) provided evidence that text messages affected outcomes such as choice of market, rice dispersion and market efficiency and assisted farmers to obtain cheap farm inputs. Additionally, Fafchamps and Minten (2012) found that the receipt of text messages influenced a smallholder farmer's decision of where to sell his crop produce, they concluded that although differences in the prices received between control and treatment groups is not always statistically significant.

In Bolivia, Urquieta and Alwang (2012) found that women farmers used mobile phones to gather potato price information from different markets and they thus received significantly higher prices for some crops. In India, Jensen (2007) stated that mobile phones are effective in gathering price information from spatially separated fish markets. It is however, evident from the results of this study that mobile phone and participatory training are the powerful tools that can change farmers' behaviour to make an informed decision.

6.2.3 Drivers for GAP Technologies Adoption amongst With-SMS Farmers

As presented previously, of the 16 GAP technologies recommended for uptake, 13 were fully adopted and implemented by the majority of the with-SMS farmers. The level of uptake of these 13 GAP technologies was statistically significantly different between the with-SMS and the without-SMS groups, while the difference in levels uptake of only 3 GAP technologies was non-significant. Based on the findings of these results, the with-SMS farmers were requested to comment on the drivers/reasons behind their decisions to adopt. The respondents gave a wide range of reasons that led to their decision to adopt the GAP technologies. However, it is really interesting to note that farmer's ranked GAP participatory training, SMS text reminders, extension visit and trust in lead farmers as the most significant drivers/reasons for GAP adoption (Figure 6.4).

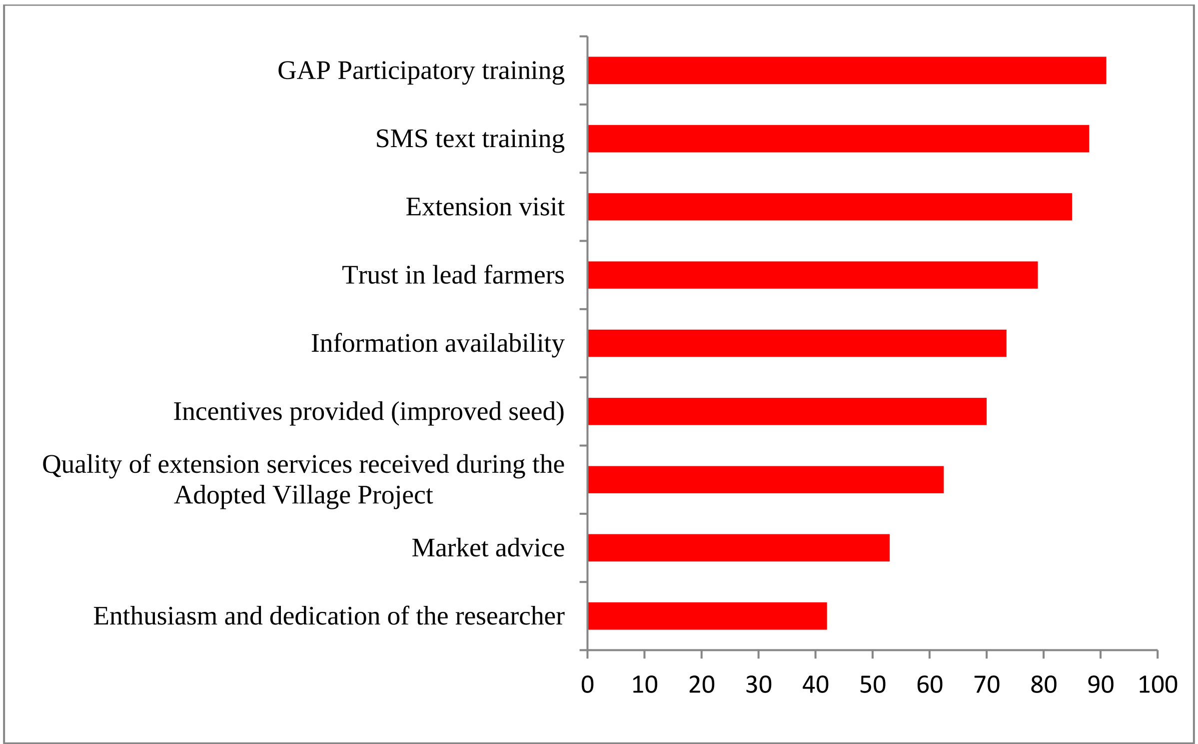


Figure 6.4: Drivers for GAP technologies adoption (N=100) **Scale: %**
Source: Survey 2016; n=100

In order to gather additional information that was not captured during focus group discussions and interviews on the impacts of GAP training and Action plan (Figure 6.5), the evaluation survey requested the respondents to list the impact of the participatory GAP training and action plan on adoption and crop productivity this growing season. The responses to this question were consistent with the findings of the survey. The impacts listed by farmers include:

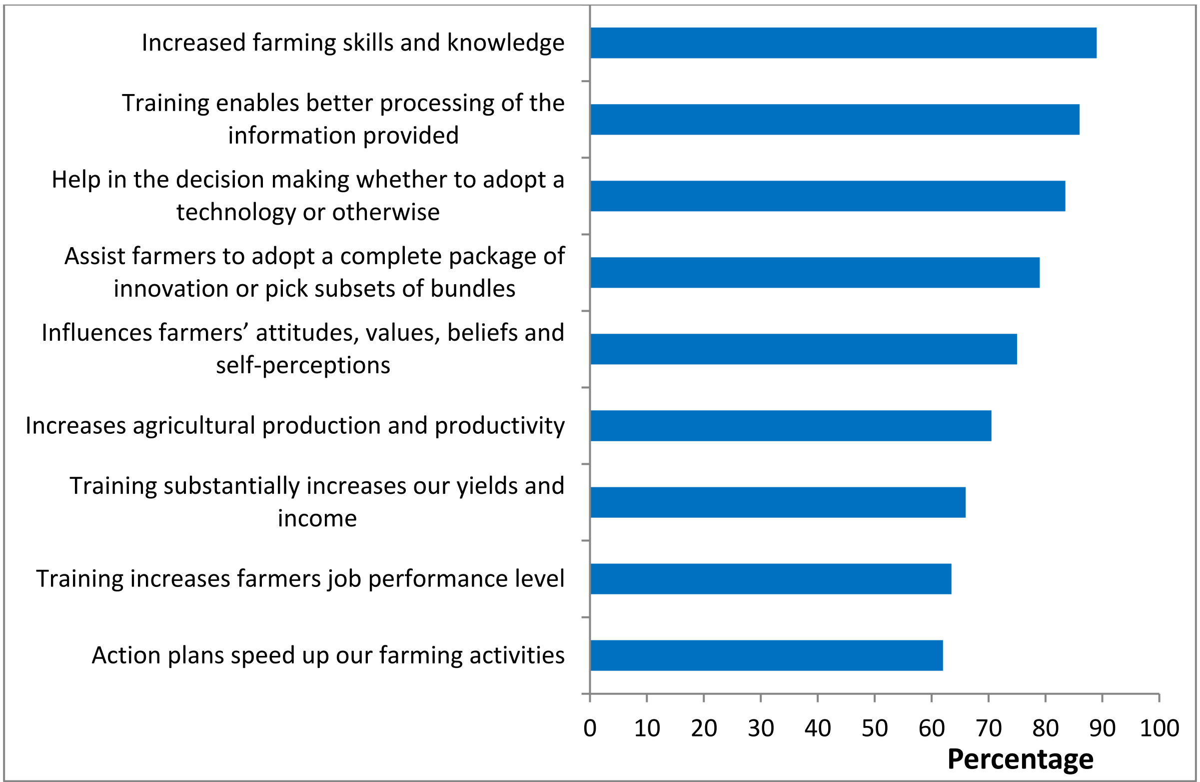


Figure 6.5: Impact of the participatory GAP training **Scale:%**
Source: Survey 2016; n=100%

6.2.4 Factors Influencing Adoption of GAP Technologies among Without-SMS Farmers

As mentioned previously, 13 GAP technologies were fully adopted by the majority of the with-SMS farmers, while only 6 were adopted by the majority of without-SMS farmers. Only three of the reasons provided in the evaluation survey were considered to greatly influence without-SMS farmers for non-adoption of GAP technologies. Moreover, the evaluation survey conducted among the without-SMS farmers requested the farmers to list and rank the perceived barriers to GAP adoption. Generally, the level of illiteracy was not the main reason preventing rural farmers from adopting GAP technologies. Poor information and lack of capital were rated as the most significant barrier to GAP adoption (Figure 6.6). The factors posing the greatest barriers perhaps deserve particular attention when planning and implementing improved agricultural technologies development for the rural communities. This suggests that farmers were not able to follow the action plan, thus resulting to non-adoption of GAP technologies.

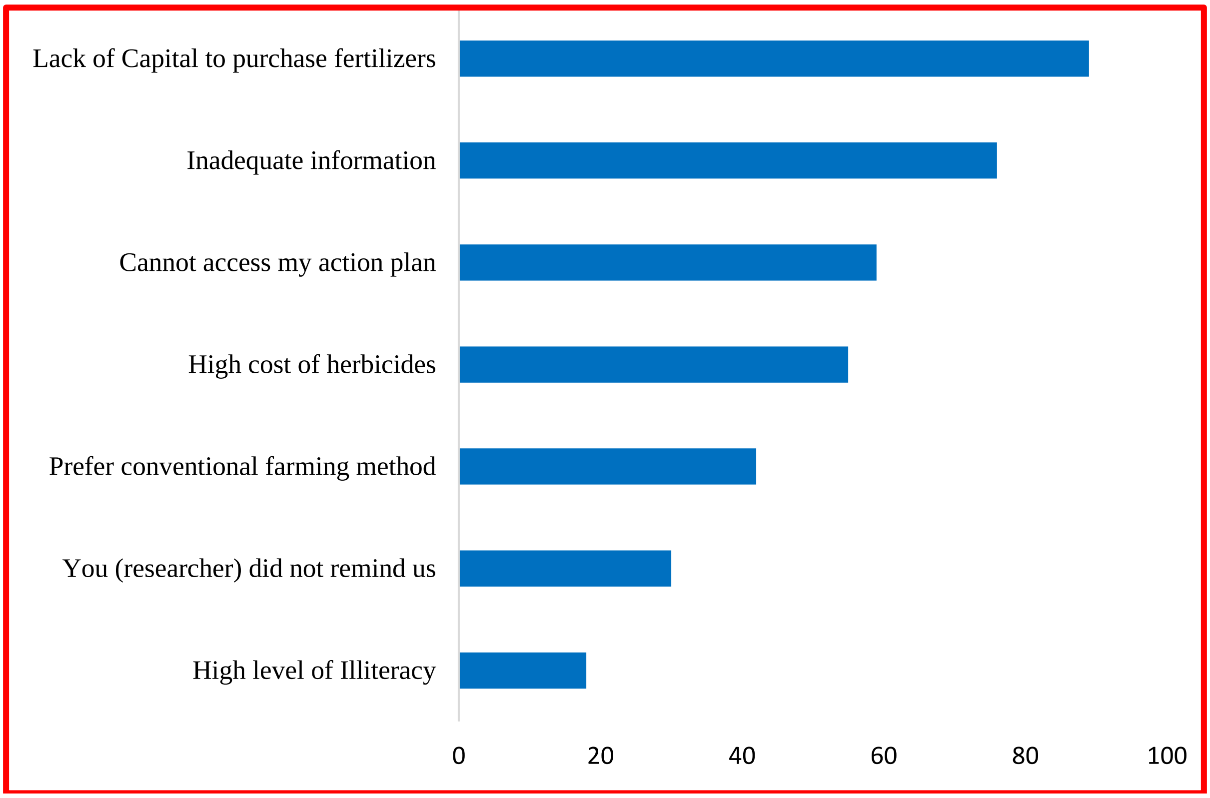


Figure 6.6: Factors influencing adoption of GAP technologies among without-SMS farmers Scale: %
Source: Survey 2016; n=100%

6.2.5 Difference Between Shika and Bassawa Communities in term of Extension Intervention

This section presents a t-test of mean difference between Shika (without-SMS) and Bassawa (with-SMS) Communities in relation to the extension supports received. The with SMS farmers (Bassawa) received extension GAP training and extension visits conducted by the researcher and also benefited from the Adopted Village Project initiated by the NAERLS in 2012. However, without-SMS farmers (Shika) received only GAP training.

Table 6.8: T-test result between Shika and Bassawa Communities in term of Extension Intervention Shika n=100, Bassawa n=100

	t	df	Mean	Sig. (2-tailed)	Std. Error
Extension Intervention Equal variances assumed	-2.344	9	-53.45	.005	.141
Equal variance assumed	-3.413	9	-51.63	.002	.097

Source: Survey 2016; P < 0.05 is significant

The independent sample t-test result (Table 6.8) shows the difference between the Shika and Bassawa communities in terms of extension support/intervention. The result of the analysis revealed that Bassawa community was statistically significantly different, with community members receiving double the level of extension intervention from NAERLS and extension visit by the researcher.

6.2.6 Impact of SMS Technology on Agricultural Productivity of With-SMS Farmers

The difference in agricultural productivity of with-SMS farmers between 2015 (pre-intervention) and the 2016 cropping season (post-intervention) was explored. Findings reveal that the whole intervention had a positive and significant impact (P<0.000**) on the agricultural productivity of with-SMS farmers (Table 6.9). In the same light, the results presented in figure 6.3 indicated that a large proportion (89.5%) of the with-SMS farmers reported that the SMS text reminders prompted them to adopt and implement the recommended GAP technologies which can substantially increase yields. The results of the evaluation survey show that the majority of with-SMS farmers indicated they experienced an increase in yields due to the availability of credible information through SMS text reminders received fortnightly. Findings from this study show 42% of with-SMS farmers experienced an increase in the productivity of the crops as a result of the extension visit, text reminders and subsequent adoption of 13 GAP technologies. This implies that improved extension services and provision of reliable information through SMS reminders may increase the crop productivity of smallholder farmers. The findings revealed that the role of timely and appropriate information cannot be underrated.

Difference in Agricultural Productivity between 2015 and 2016 cropping season among the with SMS farmers

The evaluation survey included a question that recorded the income and profits on agricultural production of respondents in year 2015 (before intervention) and profits realised in year 2016 cropping season after the GAP intervention. The question asked respondents to write the profit realised in 2015 and 2016 respectively as a result of GAP intervention. Table 6.9 presents the means and standard deviations, t-test results for the outcome variables.

Table 6.9: Means results result between 2015 and 2016 cropping season among the with SMS farmers and without-SMS; (N=200)

Impact of the intervention on agricultural productivity of with-SMS farmers

Outcome indicator	Mean	Std. Dev
Quantity harvested The Year 2015 (Kg)	3219.00	1445.78
Quantity harvested The Year 2016 (Kg)	4901.50	1926.48

Source: Survey 2016; P < 0.05 is significant

T-test result of the difference between With-SMS and Without SMS Farmers

	t	df	Mean	Sig. (2-tailed)	Std. Error
Extension Intervention Equal variances assumed	-5.320	6	-46.72	.001	.130
Equal variance assumed	-6.012	6	-48.51	.000	.082

The results also revealed that access to mobile phones (SMS) had a positive and significant influence ($P<0.001^{**}$) on the yield increase of the smallholder farmers. So far there is no large survey data-based evidence on the influence of SMS text reminders on the adoption of GAP technologies among smallholder farmers in the academic literature in Africa. This research study's main strength stems from its originality.

6.2.7 Impact of GAP Intervention on Agricultural Productivity/Income of Sample Farmers

As mentioned previously, this is presents more detail on the impact of GAP intervention project on smallholder farmers' mean income, reported in Table 6.10, shows that the with-SMS farmers enjoyed an increase of 42% in their income (₦332, 989 - ₦167, 079) from the 2015 growing season (pre-intervention) to the 2016 growing season (post-intervention), resulting in a difference of income of ₦165,360 which is positive and significant at 1%. The without-SMS farmers had an increase of 13.6% (₦265, 210 - ₦163, 004) but not as high as that of with-SMS farmers in their income. The impact of the GAP intervention further proved the fact that the increase in the income realised by the with-SMS farmers was attributed to the adoption of the recommended GAP technologies and subsequent increase in crop yields. This is based on the positive mean income value obtained which was significant at 1% level of probability. Overall, what surfaces from this analysis of findings suggests that generally, the GAP intervention provided to the sample farmers had a positive impact both on their agricultural productivity and income. However, other factors that contributed to the success of the intervention are discussed in the next section.

Table 6.10: Estimate profits of the farmers after GAP intervention on agricultural productivity/income; Shika =100; Bassawa n=100

Category	Year 2015 Pre-GAP Intervention (₦)	Year 2016 Post-GAP Intervention (₦)	Difference (2016-2015) (%)
With-SMS farmers (Bassawa)	167,079	332,989	42.2
Without-SMS farmers (Shika)	163,004	265,210	10.7
Difference between groups	4,075	59,079	

Source: Survey 2016; P < 0.05 is significant

Farmers reported that the intervention had contributed immensely to their agricultural productivity and livelihoods. The smallholders reiterated that the GAP participatory training and SMS text reminders were impactful.

A farmer from the with-SMS group stated that *"my household would never forget the impact of this research and I wish you could come around next year during raining season with this intervention"*.

6.2.9 Other Factors Influencing Adoption of GAP Technologies

Various factors relating to the adoption of GAP technologies and farmer characteristics were also tested using t-test of independence. Table 6.11 below reveals a significant relationship between GAP adoption and socio-demographic variables. The results reveal that age, gender, education attainment and farming experience had a positive and significant ($P<0.05$) influence on the adoption of GAP technologies by the respondents. The findings of the study are in line with most adoption studies such as Mignouna *et al.* (2011); Keelan *et al.* (2014); and Mwangi and Kariuki (2015) who found that farmers' socio-economic characteristics had an influence on the adoption of technologies. However, the present study found that farmers' marital status, household size, indigenous knowledge and farm size were not significant. These factors are discussed in more detail in the following sub-sections.

Table 6.11: Spearman rank correlation between factors influencing adoption of GAP technologies among farmers

Variable	Spearman rank	P-value
Age	0.641	0.001**
Gender	0.502	0.000**
Marital status	0.740	0.081
Social participation	0.342	0.000**
Cultural/Religious	0.497	0.001**
Education level	0.690	0.000**
Farming experiences (Year)	0.081	0.002**
Weather condition	-0.226	0.620
Pest and disease control	0.529	0.110
GAP participatory training	0.650	0.000**
Indigenous knowledge	-0.407	0.328

Source: Survey 2016; P < 0.05 is significant

i. Impact of Age on Adoption of Technologies

The findings reveal a positive and statistically significant (0.05%) relationship between age (0.001) and technology adoption (Table 6.11). This result reveals that the majority (65%) of farmers who participated in the survey belong to the active age group and still have strength to cultivate more farmland and explore new agricultural innovations. Age has been considered to be a major underlying characteristic in the adoption decisions made by smallholders (Adesina and Baidu-Forson 1995). Age was also found to positively influence the adoption of Integrated Pest Management (IPM) on peanuts in Georgia (McNamara *et al.* 1991) and sorghum in Burkina Faso (Adesina and Baidu-Forson 1995) among older farmers. However, there is a debate on the direction of the effect of age in adoption, the older farmers find it extremely difficult to take the risks which may result in low technology uptake (Caswell *et al*. 2001).

The results of this study are supported by Mwangi and Kariuki (2015) who found that the active age group are characteristically less risk-averse and are keener to try new technologies than older farmers. Furthermore, younger farmers still have the potency to take a risk, grow more crops and search for new agricultural innovations. For instance, in India, Alexander and Van Mellor (2005) established that the adoption of genetically modified maize increased with age for the active age group farmers as they gained experience and increased their stock of human capital, but declined with age for older farmers closer to retirement.

ii. The Role of Gender in the Adoption of Technologies

The study results revealed that the gender of the respondents had positive and statistically significant (0.05%) level influence on the adoption of GAP technologies. This implies that male farmers are more likely to adopt modern agricultural technologies than their female counterparts. The reason for this is that men are the people in the study area who make the production decisions and also control the productive resources such as land, labour and capital which are critical for the adoption of new technology. However, gender issues in agricultural production and technology adoption have been investigated for a long time and most studies have reported mixed evidence regarding the different roles men and women play in technology adoption (Bonabana-Wabbi 2002).

However, the present study results disagree with Morris and Doss (1999) who found no significant association between gender and the adoption of improved maize technology in Ghana. The study concluded that agricultural technology adoption decisions depend largely on access to resources only, rather than gender. They explained further that if adoption of improved maize depends on access to land, labour, or other resources, and if in a particular context men tend to have better access to these resources than women, then, they are more likely to adopt new technologies than women. In comparison, Lavison (2013) indicated that male farmers were more likely to adopt organic fertiliser than their female counterparts. This finding corroborates with that of Mwangi and Kariuki (2015) who found that male-led households are more likely to embrace agricultural technology, because of their leading role; facilitating the planning and operation of the farm to improve productivity and maintain the well-being of the family. In Nigeria, a survey conducted by Obisesan (2014) found that male farmers had a significant and positive influence on the adoption of improved cassava production techniques. Accordingly, men are more likely to seek and adopt new knowledge and technologies due to their access to resources (Asfaw and Admassie 2004; Buyinza and Wambede 2008). This is consistent with the results of the present study, which found that male-led households adopted almost all the recommended GAP technologies.

iii. Impact of Cultural/Religious on the Adoption of Technologies

The results of spearman rank correlation revealed in Table 6.11 show a significant correlation between cultural/religious and adoption of GAP technologies in the study area. Cultural norms and value, religion and tribal background may influence adoption of agricultural technology. The belief, habits and rituals attached to religion and culture are so deeply rooted and many influence how smallholder farmers embrace improved technology. For instance, due to the religion affiliations in the study area no single farmer keep/rear pigs. Consequently, the cultural/religion affect the ownership of certain type of livestock by the households and may also play a significant role in the adoption process.

iii. Impact of Education and Training on the Adoption of Technologies

The study results presented in Table 6.11 illustrate a significant relationship between level of education and the adoption of GAP technologies. According to the literature, it is expected that more knowledgeable farmers will adopt more improved practices than those less knowledgeable. This relationship has been established by previous studies (Rogers 1983, Caswell *et al*. 2001, Mwangi and Kariuki 2015). According to Deressa *et al.* (2011), involvement of the educated population in farming activities is thought to create a favourable mental attitude towards the acceptance of new agricultural technologies especially of information and management-intensive practices.

Additionally, Croppenstedt *et al*. (2003) reported that more highly educated farmers (a minimum of primary level) and those from large households were more likely to adopt new technologies than the less educated and those from smaller families due to their greater exposure to new knowledge and technologies, and having more labour resources to carry out farming activities. Therefore, the effect of the educational level was found to increase the probability of a smallholders' adoption of new practices. Moreover, Doss and Morris (2001) and Daku (2002) found that education positively affected the adoption of Integrated Pest Management (IPM) technologies among smallholder farmers in Kenya and Nepal. This implies that the level of education is a powerful tool in the hands of smallholder farmers enabling them to read the labels on fertilizer bags, for example, or follow directions on the operation of machines, tools and other items.

Educational levels increase the ability to obtain, process and use information relevant to the adoption of a new technology (Mignouna *et al*. 2011; Lavison 2013; Namara *et al*. 2013). For example, in a recent study by Mwangi and Kariuki (2015) on the adoption of new technologies by fish farmers, and Keelan *et al*. (2014) on the adoption of organic fertilisers, it was found that education levels had a positive and statistically significant influence on the adoption of the related technology. The reason for this is that higher education levels influence respondents' attitudes, making farmers more open, rational and able to analyse the benefits of the new technology (Waller *et al*. 1998). Other studies that have also reported a positive relationship between education and technology adoption as cited by Mwangi and Kariuki (2015) include; Goodwin and Schroeder (1994) on forward pricing methods, Huffman and Mercier (1991); Putler and Zilberman (1988) on the adoption of microcomputers in agriculture, Mishra and Park (2005); Mishra *et al.* (2009) on the use of the internet, Rahm and Huffman (1984) on reduced tillage, Roberts *et al.* (2004) on precision farming and Traoreb *et al*. (1998) on the on-farm adoption of conservation tillage.

iv. The Role of Farming Experience in the Adoption of Technologies

As reported in Table 6.11, the level of farming experience is a significant factor influencing the adoption of GAP technologies in the study area. According to Petros (2010), longer farming experience implies accumulated farming knowledge and technical know-how and skills, all of which contribute to technology adoption. In a study by Melaku (2005), farming experience was found to be positively and significantly related to adoption. Similarly, Yishak (2005) found the difference between the mean level of farming experience of adopters and the non-adopters was statistically significant.

v. Impact of Household Size in the Adoption of Technologies

The findings reveal a positive and significant relationship between household size and technology adoption. Household size is simply used as a measure of labour availability for farmers with large families (Mwangi and Kariuki 2015). It determines the adoption process in that, larger households have the capacity to relax labour constraints during the introduction of new technologies (Mignouna *et al*. 2011). This implies that farmers with large families will certainly generate more income through large-scale production of improved technologies using family labour. Hence, the bigger the family size, the more economically stable the family (Mwangi and Kariuki 2015).

vi. Impact of Farm Size on the Adoption of Technologies

As noted from Table 6.11, farm size had a negative significant influence on technology adoption. These results show that farm size does not have an effect on the GAP adoption. The reason may be because the respondents are small-scale farmers who operate on small farmlands. A similar finding was reported by Parvan (2011) who established that farm size does not always affect adoption; rather the literature finds that the effects of farm size vary depending on the type of technology being introduced, and the institutional setting of the rural community. However, in a study undertaken by Akudugu *et al.* (2012), farm size was found to have a positive relationship with the probability of adoption of modern agricultural production technologies among commercial farmers. This finding is consistent with previous studies that have found that large-scale farmers are more likely to adopt new technologies than small scale farmers (McNamara *et al.* 1991; Abara and Singh 1993 and Kasenge 1998).

In analysing the diffusion of conservation tillage practices, integrated pest management (IPM) activities and soil fertiliser testing among American farmers, Fuglie and Kascak (2003) began with the traditional explanatory factors, including farm size (Moser and Barrett 2008; Parvan 2011). They reported that larger farms were more likely to adopt the technology bundles sooner than small farmers (Parvan 2011).

This presents a serious challenge to policy makers and the government of Nigeria in promoting the adoption of modern agricultural production technologies in the study area. This is because an overwhelming majority of farmers in the Kaduna state and Nigeria as a whole operate on a small scale with the average farm sizes hardly exceeding four hectares.

6.3 Summary

This chapter has presented the findings of the data obtained from the evaluation survey and some interview data that was conducted in the third phase of the research in order to understand and identify the impact of the participatory GAP training and intervention to the study area. The survey was based on a sample of 200 smallholder farmers and the results show that the participatory GAP training sessions and intervention delivered were positive and had a significant impact on the technology adoption and agricultural productivity of the respondents.

For example, 13 GAP technologies were fully adopted as a result of the training, with 89.5% of farmers stating that information was gathered and knowledge and skills gained from the training were implemented and 79% reported that the GAP intervention had a positive impact on their crop productivity.

In the same vein, the results obtained from the with-SMS farmers reveal that SMS text reminders delivered to them had a positive and significant impact on their income, with a 42% increase in their income (₦332, 989 - ₦167, 079), resulting in a difference of income of ₦165,360, while the without-SMS farmers had an increase of 13.6% (₦265,210 - ₦163,004) in their income. Nevertheless, a number of barriers to technology adoption were identified by the without-SMS farmers. Barriers identified by this study include; poor information, lack of capital, the high cost of herbicides and preference for conventional farming methods.

The findings also identified that the majority of farmers use their mobile phones to call extension workers from ADP and NAERLS for advice, as well as people like traders and other farmers who are in possession of agricultural related information. The chapter has also presented the findings from the semi-structured interviews conducted in the third phase of the study which were used in conjunction with the survey to aid better interpretation of the results. The interviews identified some impacts of the GAP training and action plan amongst the sample farmers as well as some impacts associated with the SMS text reminders. The research further identified drivers/reasons behind with-SMS farmers' decision to adopt GAP technologies and highlighted some constraints facing smallholder farmers' access to markets in the study area.

There was a rapid increase (85%) in the level of adopted of improved technologies after the farmer participatory training among the respondents compared to pre-training (49.5%). There was a strong positive correlation (r = 0.001**, p<0.05) between participatory training sessions and adoption of GAP. The results reported in this chapter highlight a number of issues in relation to the adoption of GAP technologies and use of ICT among smallholder farmers. The use of SMS text reminders, participatory GAP training, trust, and other factors have been shown to influence farmers' decisions to take up recommended GAP technologies. The significance and implication of these findings will be considered further in the discussion chapter that follows and a new model for using mobile phones to improve extension services to smallholder farmers in order to improve their productivity and livelihood Nigeria will also be given priority.

Chapter Seven. Constraints Facing Smallholder Farmers Access to Market

This chapter presents the findings from the perspective of smallholder farmers' access to market in the study area. Markets provide smallholder farmers with the opportunity to generate income, contributing to a reduction in abject poverty and hunger in the rural communities. Indeed, market access for smallholder farmers means the ability to acquire farm inputs and farm services, and the capacity to deliver agricultural produce to buyers. However, smallholder farmers often face a number of constraints and challenges to accessing the available markets and addressing these constraints may create enabling conditions that would encourage smallholders to access markets for their produce and participate more effectively, thus boosting productivity, increasing incomes and reducing poverty and hunger in the rural areas.

In order to address these challenges, the farmer survey respondents were asked what challenges/constraints they face in accessing the markets and to choose their answers from a checklist. Their responses are presented in Figure 7.1 below, showing that the major constraints facing farmers in accessing the markets were lack of access to resources (96.5%); cost of transport to market places (85%); poor infrastructure (79%) and poor farmer support services (76.5%).

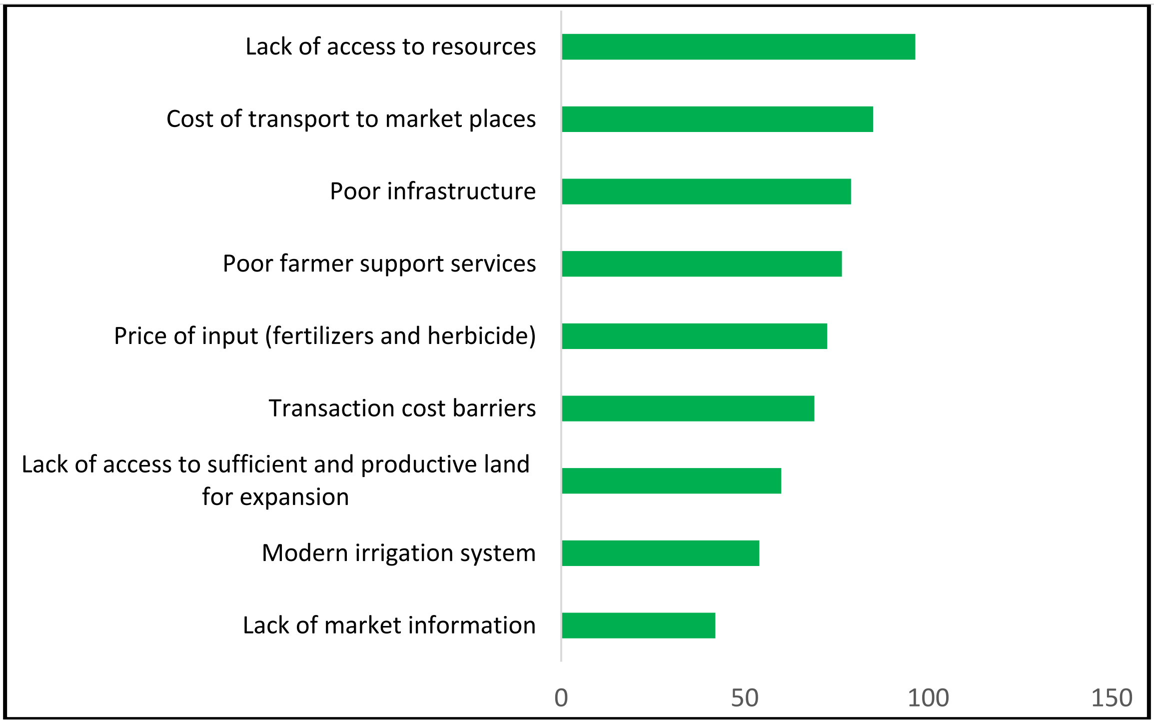


Figure 7.1: Distribution of constraints facing smallholder farmer's access to market
Source: Survey 2016; n=200 **Scale: %**

7.1 Distance from Market

Agricultural market are very important to smallholder farmers in the study area. The distance is gathered from farmer's information taken and across checking the kilometre from the major market in the area, Sabo market. From sampled respondents, 98% of farmers reported that it took them 6 to 16km to transport their agricultural produce to market, while only 2% reported that it took them less than 5km (Figure 7.2)

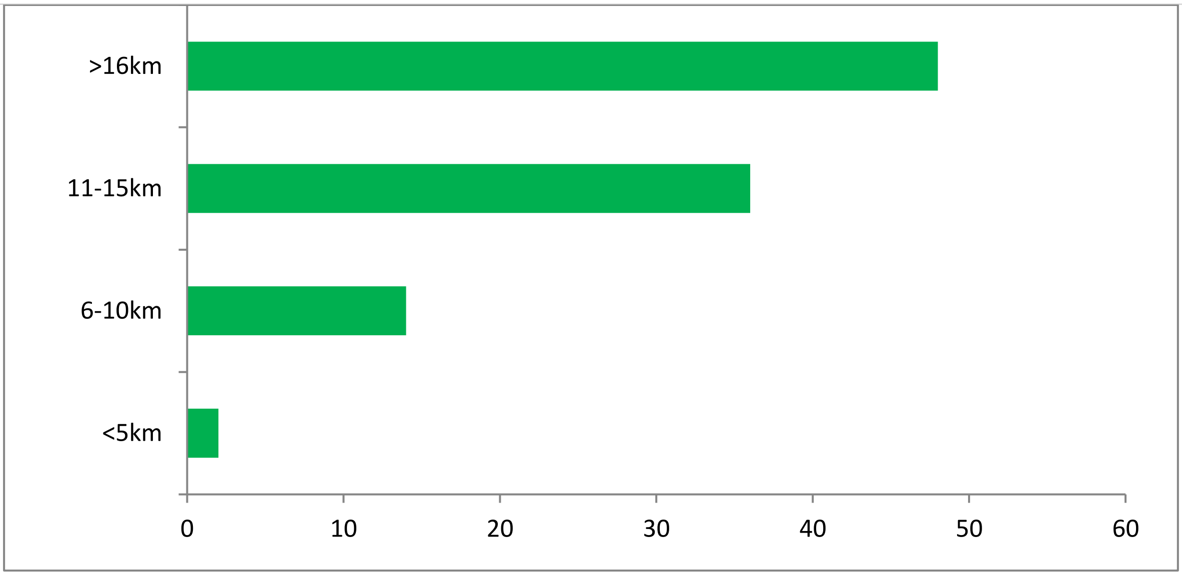


Figure 7.2: Distribution of Distance from Market **Scale: %**
Source: Survey 2016; n=200

7.1.1 Frequency of Market Visit

Visiting market is one way of finding market information and cross-checking mechanism of pre-gathered information with the existing price. From the sampled respondents, 96% of the farmers visit market to purchase and sell their farm produce. Meanwhile, 65% of the farmers reported that they use mobile phone to find out market price before sending their produce to market for sale, while only 4% stated that they visit market once in a week (Figure 7.3). During the focus group discussion, farmers reported that usually visit markets primarily to purchase and sale farm produce, and to find out market price information

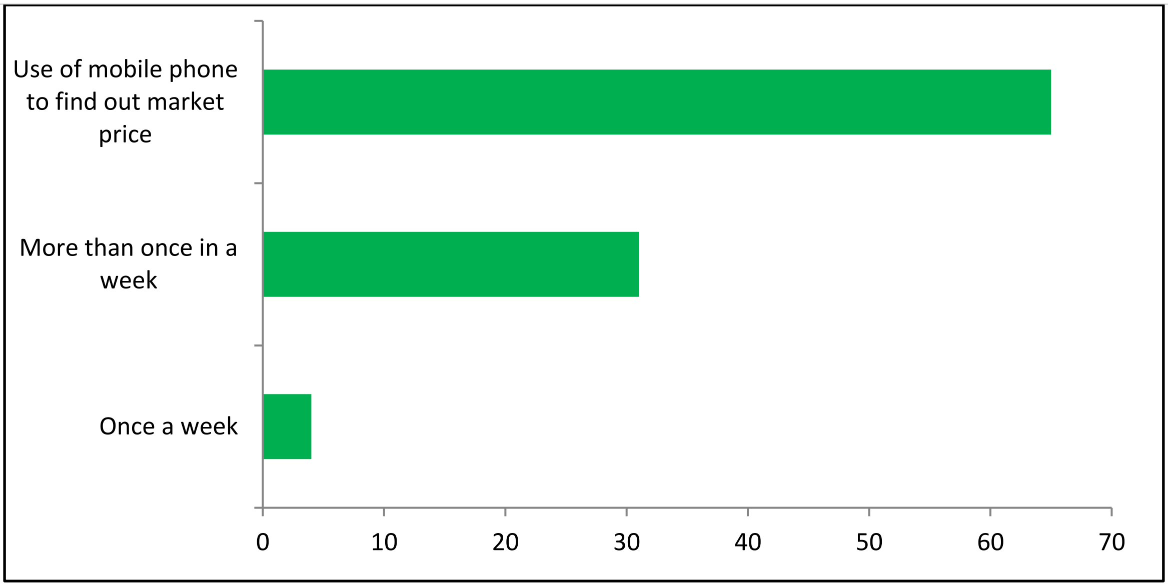


Figure 7.3: Distribution of Frequency of market visit **Scale: %**
Source: Survey 2016; n=200

7.1.2 Smallholder Access to Market Information by ICT

Farmer with more access to market information have a better chance of marketing his surplus product and gain higher value of sale. Among the respondents, 75% of the farmers acquire market information through ABU radio broadcast programme and mobile phone calls to markets, while 16.6% get market information from their neighbour and market visit (Figure 7.4).

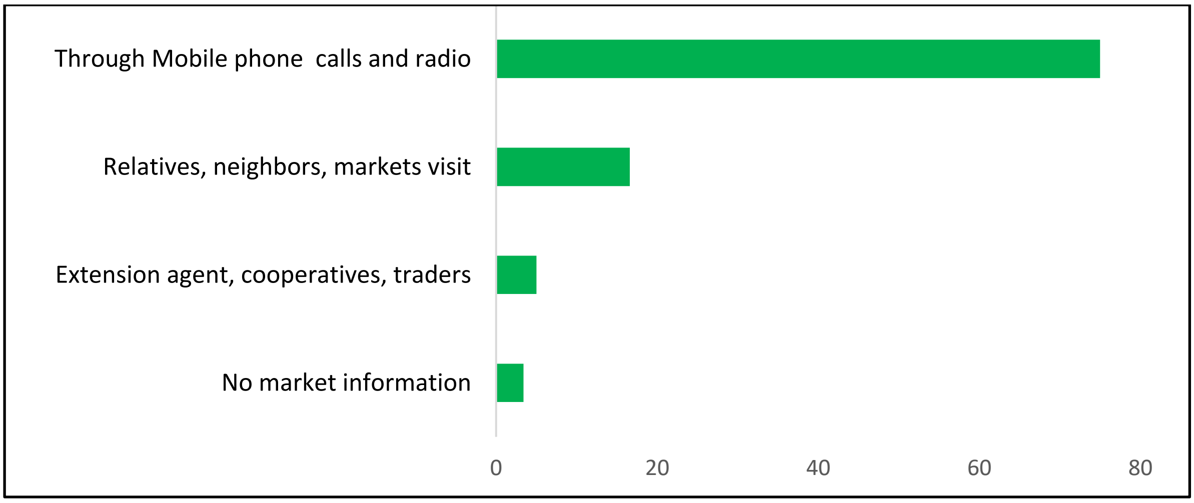


Figure 7.4: Distribution of Household access to market information
Source: Survey 2016; n=200 **Scale: %**

7.1.3 Agricultural Commodities Traded in the Market

As shown in figure 7.5, traders in the study area ventured into diverse agricultural commodities and utilized diversified mechanism to attract and retain their customers. As the respondents' response, 35% of them were trading rice, followed by maize (17%) and cowpea (12%) respectively (Figure 7.5). The respondents were asked about mechanism used to attract and retain their customers. Among the mechanism relaying on were market price reduction and using inherited family customers.

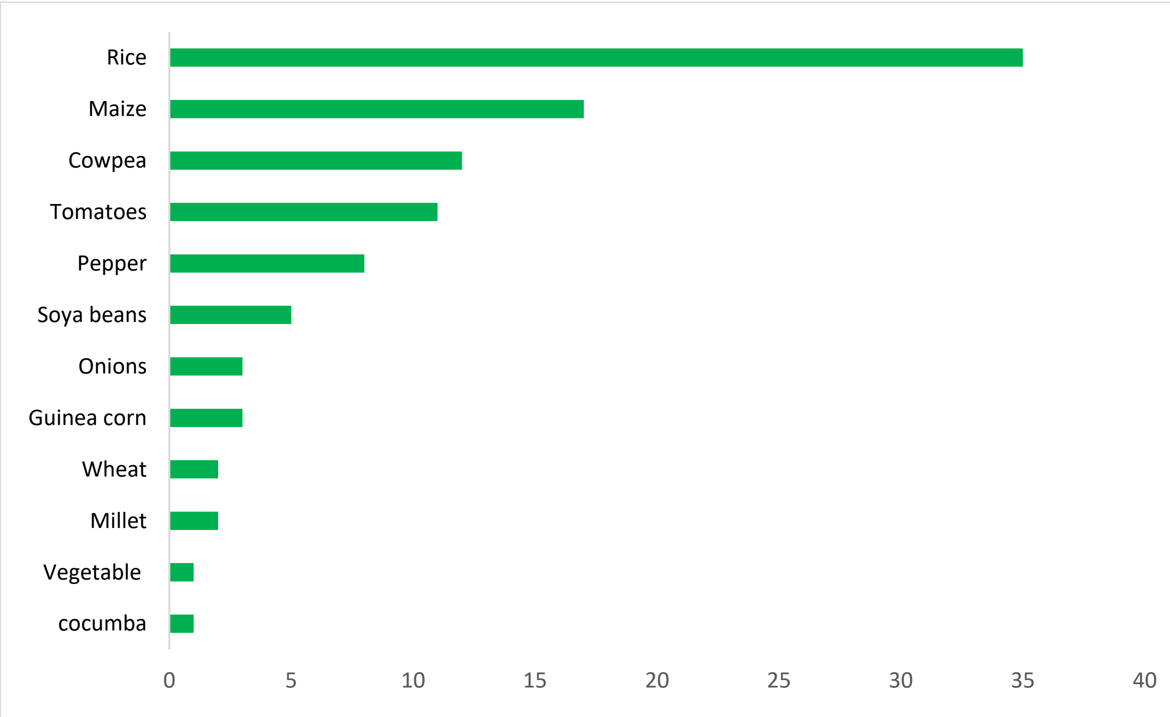


Figure 7.5: Distribution of Agricultural Commodities traded in the market
Source: Survey 2016; n=200 Scale: %

7.1.4 Use of Mobile Phones by Farmers in Relation to Market and Trading

The findings illustrated in Figure 7.6 summarize the usage of mobile phones among smallholder farmers for marketing information and trading. According to the respondents' interview and key informants responses, it was found that an overwhelming majority of the participants used their mobile phones to seek information related to the market prices of farm inputs including the cost of seeds, fertilizers, herbicides and insecticides. The farmers reported that using mobile phones enabled them to access current market prices on agricultural inputs. This implies that usage of the mobile phones in the study area increases the transparency of market prices for farm inputs by providing up-to-date market information and specific places to purchase the needed inputs at those prices. The finding also suggests that having this information at their disposal enables farmers to make purchasing decisions and to negotiate more effectively. Ultimately, this information improves bargaining power and thus increases incomes. The study results are similar to Zoltner and Steffen (2013), Chhachhar and Hassan (2013) and Magesa (2015) who reported that mobile phones significantly reduced communication information costs and asymmetry for smallholder farmers.

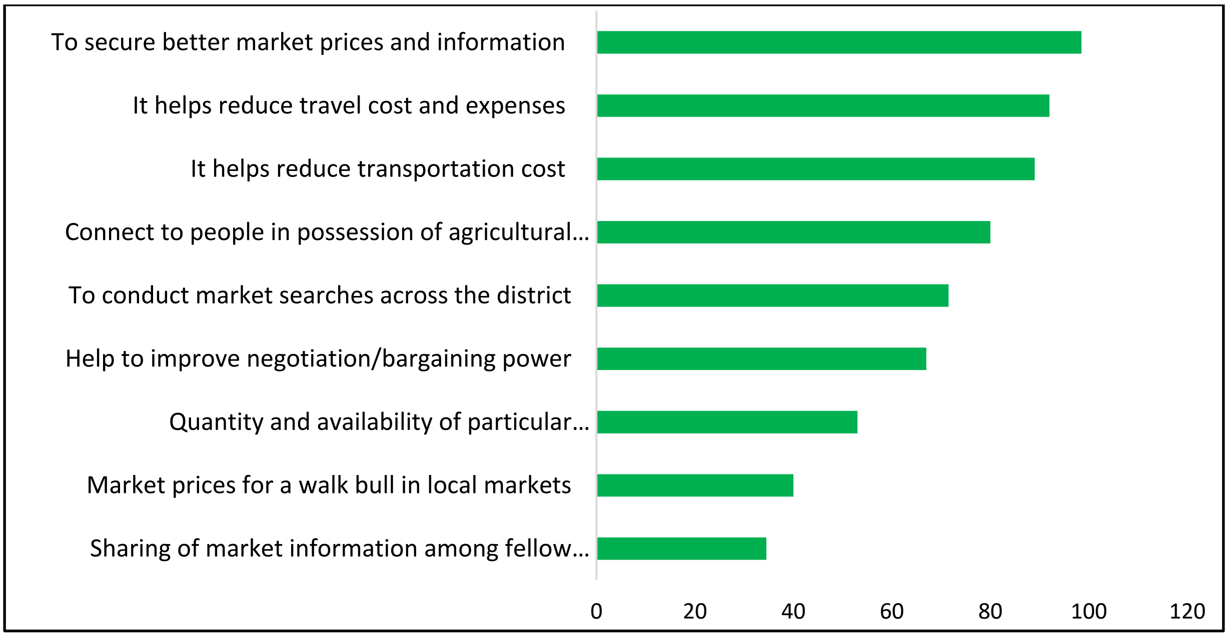


Figure 7.6: Distribution of Contribution of mobile phones in relation to market and trading

Source: Survey 2016; n=200 **Scale: 100%**

As presented in Figure 7.6, findings revealed that the majority of farmers used mobile phones to source information related to market prices for agricultural commodities (98.5%) and quantity and availability of particular products/produce in the market (53.5%). Such prior information enables farmers to have a good understanding of community prices before transporting produce to market, and also where best to sell for high returns. Mobile phones also enable producers to communicate directly with traders rather than intermediaries and thus avoid being cheated. This is supported by interviews with a lead farmer in the study area who reported that:

"*Cheating of market price is very rampant and has become a normal tradition for middlemen because they want to make as big a profit as possible from the farmers, but now they find it extremely difficult to cheat us because we have mobile power"*

This implies that farmers in the study area recognize the importance of seeking market information prior to selling their agricultural commodities, however, lack of consistent and trustworthy formal sources of market information constrains smallholder farmers. This finding is consistent with Chhachhar and Hassan (2013) who reported that farmers directly contacted market brokers in nearby cities to sell their products. In Nigeria, access to recent and up to date market information is low and inadequate, perhaps due to high illiteracy levels, a lack of regular and reliable information and relatively high costs in terms of the time and resources needed (Magesa 2015).

In addition, the smallholder farmers reported that they used mobile phones to seek market prices for a walking bull in different local markets in Kaduna state, as well as sharing market information and experience among fellow farmers in order to increase profits (Figure 7.6). This implies that farmers used their mobiles to search for relevant information to meet their needs and to circulate that information very rapidly. This also suggests that the use of mobile phones promotes the expansion of local markets in Nigeria. It could be concluded therefore that a mobile phone is a powerful tool in the marketing system. As shown in figure 7.6, smallholder farmers listed mobile phones usage in relation to market and trading.

7.1.5 Access to Agricultural Market by Smallholder Farmers

As part of the post-intervention evaluation survey, farmers were asked to state the status of accessing agricultural markets. As shown in Table 7.1 the majority of with-SMS farmers (85.5%) easily access markets by physically transporting their produce to the marketplaces using hired buses and trucks, compared to only 74% of without-SMS farmers. Also, 79% of with-SMS reported that they sold their agricultural produce to the buyer at the farm gate compared to 63% of without-SMS farmers. These results suggest that increasing access to information may improve market accessibility and bargaining power of the smallholder farmers.

Table 7.1: Distribution of Access to Agricultural Market by smallholder farmers

Variable	With-SMS (**Bassawa**)	Without-SMS (**Shika**)
Hired buses/truck to transport the produce to market	85.5	74
Sold at farm gate	79	63

Source: Survey 2016

These issues will be addressed more fully in the discussion chapter that follows. In addition, a high proportion of the farmers (81.5%) reported that they also use mobile phone to connect with people like traders and other farmers who are in possession of agricultural related information. When the impact of mobile phones and SMS text reminders delivered to the farmers fortnightly in the course of this research was investigated further, one young and educated farmer from the with-SMS group (Bassawa village) stated that "*to me, access to mobile phones is beneficial in several ways, it has improved my information bank, increased my access to markets, price information and expanded my marketing options and bargaining power*". Another active age group farmer reported that he could conveniently sit at home while using a mobile phone to access information, such as market prices and input availability. On further investigation, survey farmers listed the following most frequently sought information: These issues will be addressed more fully in the discussion chapter that follows.

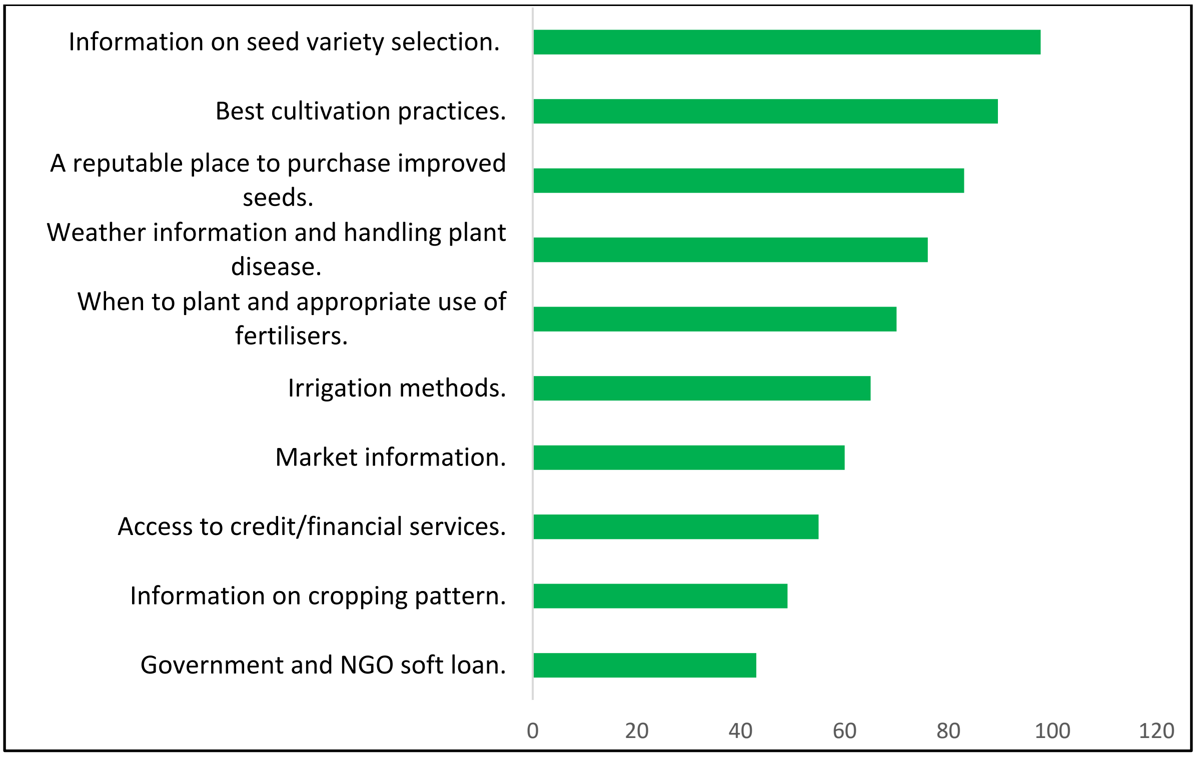


Figure 7.7: Most frequently sought information by smallholders
Source: Survey 2016; n=200 **Scale: %**

7.2 Use of Mobile Phones among Extension Workers for Market Information

Figure 7.8 shows the results of focus group discussions and the interviews conducted with extension workers to ascertain their use of mobile phones for the dissemination of information to farmers; specifically to find out the types of information they share with clientele. According to Figure 7.8, extensions workers were most concerned about sharing market information with smallholders, followed by information on fertilizer and agrochemical availability in the local markets and information relating to best agricultural practices. The extension service providers reported that staff from NEARLS adopted village unit usually travel to a local market in the district/state to make an enquiry about the most recent markets prices for all agricultural commodities. The information is then broadcast on ABU radio every Monday in local dialects.

Extension workers further reported any farmer could call using their mobile phone and ask for the information. Extension workers were least interested in communicating information to farmers relating to agro-meteorological information and pests and diseases. The reason for this could be that the nature of the role of extension workers means that they are not so involved with technology dissemination on climate change and weather conditions.

The result reported here imply that integrating ICT devices into agricultural extension services could adequately provide farmers with the most relevant market information thereby enhancing their earning capacity.

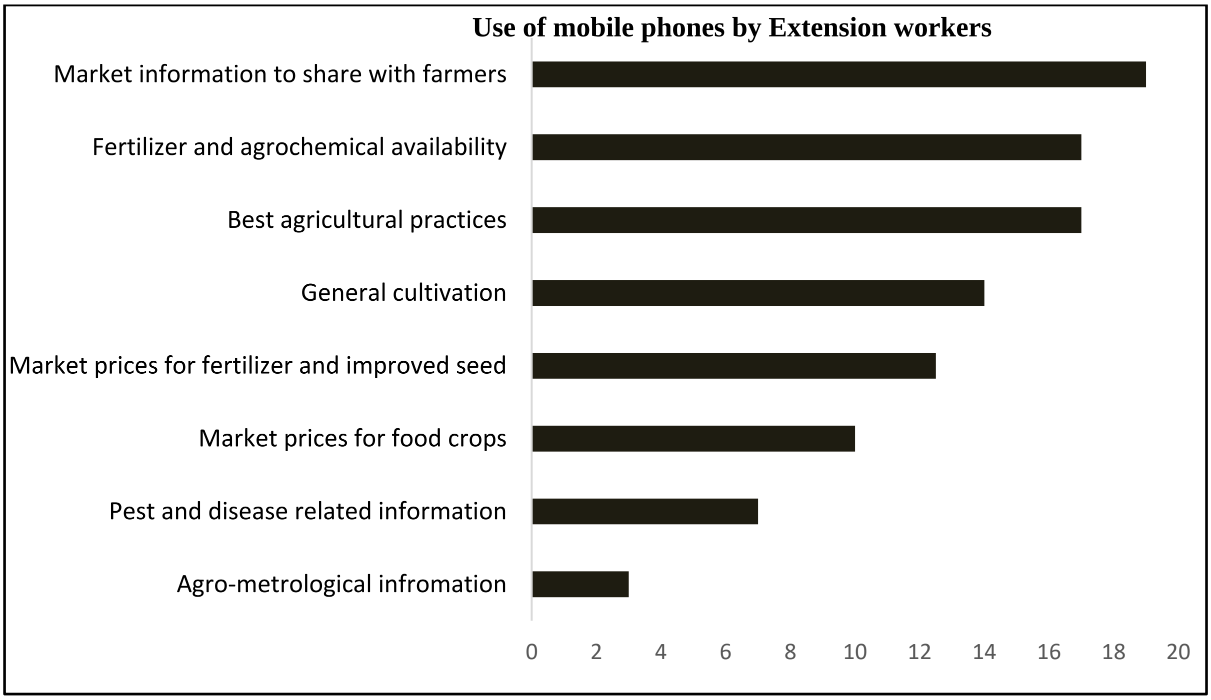


Figure 7.8: Extension workers' perceived Information shared with farmers through mobile Source: Survey 2016; n=20 Scale: %

Chapter Eight. Discussion

8.0 Introduction

Results from this study were presented in the previous two chapters. In this chapter, all the findings are brought together in an integrated discussion and the key emergent themes related to GAP technology adoption are explored relative to existing adoption studies and theory of Technology Acceptance Model as introduced in section 2.2.6. In addition, insights from the mixed methods approach adopted for this study have assisted in providing a robust view on issues associated with the subject under consideration. The chapter forms a narrative of the entire thesis incorporating ideas that have emerged over the course of the research and, whenever possible, the results are compared with previous findings. The research findings for each of the five research objectives are summarized and explained within the context of current academic knowledge and the chapter concludes with a proposed model of mobile phone technology supporting traditional extension models in order to improve traditional extension services to smallholder farmers in Nigeria. The chapter is structured in five sections based on the study's five research questions, in the order presented below:

1. How effective are traditional models of extension and communication in Nigeria from smallholders' and extension workers' perspectives?

2. What are the barriers to and opportunities for the adoption of improved technologies in the agricultural development process in Nigeria?

3. How do farmers and extension workers use mobile technology in relation to market access and trading?

4. How has the use of mobile technology influenced adoption of GAP technologies and what is the impact of mobile technology on agricultural productivity of smallholder farmers?

5. Can a new model using mobile phone technology as a communication tool be developed to improve extension services to smallholder farmers' in order to improve their productivity and livelihoods in Nigeria?

8.1 Factors influencing the Effectiveness of Traditional Extension Models and Communication in Nigeria

The following sections present the identified factors limiting the effectiveness of traditional extension models in Nigeria in relation to agricultural extension theories, particularly the Technology Acceptance Model (TAM). A total of six key factors have been identified from the current study, as discussed below:

8.1.1 Inadequate funding

Insights gained from the investigation suggest that poor funding is among the numerous challenges facing agricultural extension system in Nigeria. The study further revealed that the main source of funding for extension activities in Nigeria was from the Federal and State government, and the system has been starved after the withdrawal of World Bank assisted funds. Consequently, the sector cannot deliver effectively in the face of this death in funding. The focus group discussion interviews have shown that the funding level of agricultural extension activities in the country has been extremely poor and this has contributed to the inconsistency in extension services and low adoption which brings about low productivity in subsistence farming. Moreover, lack of funding could prevent village extension workers from visiting farmers, in order to conduct farm demonstrations and training to sensitize farmers. The findings from this study are supported by the surveys conducted by Auta and Dafwang (2010), Donye *et al.* (2014) and Imoloame and Olanrewaju (2014) who emphasised that grossly inadequate funding, training and technical advice are the key factors that contribute to the ineffective delivery of services by the extension workers in Nigeria. Inadequate funding and lack of credit facilities have led to the collapse of agricultural extension system in Nigeria

(Ogunremi and Olatunji 2013). Likewise, Adopted Village Concept faced similar challenges such as; input support for participants, inadequate logistics for facilitators and inadequate land for demonstrations. (Doyen *et al*. 2013).

8.1.2 Inadequate/Low Number of Extension Personnel

The findings of this study have revealed that there is a need for an increased number of extension officers in order to reach more smallholder farmers. This is consistent with the Technology Acceptance Model (TAM) in order to improve the adoption level of new innovation by smallholders and help in dealing with behavioural intention and usage by farmers. The majority of extension workers from the different organizations that participated in the focus group discussions and qualitative in-depth interviews identified that if the government could employ more graduates and train them, that gesture would transform and improve extension delivery in Nigeria. They reiterated that the low number of extension workers in Nigeria was a big challenge to the system. When probed further, it was revealed by the concerns voiced by the interviewees who suggested that recruiting about 3,000 to 4,000 agricultural related graduates with the minimum wage of ₦50,000.00 would solve the problem of the grossly insufficient number of extension workers and help address unemployment currently facing Nigeria. In the same vein, farmers spoke about the lack of extension visits and concluded that traditional extension services are not effective. The insight gained from the investigation also revealed that in the study area, the extension worker ratio to farm families is standing at a ratio of one extension worker to 3,000 farmers. This finding clearly suggests that inadequate staffing of extension workers is one of the major constraints to the ineffective extension sector in Nigeria and other developing countries.

Extension workers recognized the significance of mobile phones as a unique technology not previously available to them and the farmers. However, with the manifold increase and widespread penetration of mobile phones in Nigeria, a number of farmers can be reached with the dissemination of appropriate and timely information - instantaneously and at the same time. The focus group data reveal that mobile phones and radio can be used tactically to enhance the effectiveness of extension services to improve farmer communication and address high farmer number per extension worker. The extension workers responses to mobile phone usage and its effectiveness indicated that ICT, especially radio and mobile phones play an important role in providing up-to-date information regarding the adoption of GAP technologies and marketing to rural farmers in the study area and Nigeria at large.

"ICT are powerful tools, our ABU radio assists rural farmers a lot because they listen to radio every time and anywhere, therefore we use that avenue to transfer knowledge, information about farm inputs, extension advice and educate farmers about new technology and best agricultural practices. We also provide current market price information through ABU radio because we know farmers require adequate information to improve their farming and standard of living. It may interest you to know that some of them even telephone us using mobile phone to ask for more clarification after the radio programme. However, this platform cannot be used to adequately address the high farmers' number per extension officer. The government still need to recruit more extension workers to make the system more effective and efficient". (Extension profession 3 - focus group discussion)

"........without ICT farmers cannot get any reliable information because we do not have an adequate number of extension workers to visit remote villages, and besides all our rural areas in Nigeria lack social amenities and infrastructure that will motivate village extension agents to even contact them. Basically, we use radio and mobile phones to disseminate agricultural and market information to smallholder farmers". (Extension profession 6 - focus group discussion).

Assessing the effectiveness of mobile phones technology amongst farmers, the study results have shown that 88% of the smallholders used their mobile phones to contact extension workers for agricultural information and related guidance, while 79% indicated that they use mobile phones to connect to markets and traders. The findings of this study have shown clearly that ICT especially mobile phones are very useful in agricultural knowledge to enhance farmer's communication linkages between extension services and rural communities. Moreover the results of this study have shown that in the modern extension service delivery ICT could serve as an additional tool and help to adequately address high farmer's numbers per extension officer. As a result, the government should recruit more extension workers and deploy them to remote villages in Nigeria. Numerous studies on extension delivery services in Nigeria have established that inadequate numbers of extension officers and lack of equipment poses major challenges to the sector (Koyenikan 2008, Farinde and Atteh 2009, Adekunle 2013, Nsikak-Abasi and Kesit 2015), while some extension officers are also poorly trained (Babasanya *et al.* 2013).

8.1.3 Inadequate Government Support

Evidence from the current study has shown that the Nigeria agricultural extension services are suffering because of inadequate government support and lack of a consistent approach to the sector. Extension professionals expressed their concerns about the challenges confronting the extension service delivery in Nigeria and emphasized that inadequate government support had been a major concern after the withdrawal of World Bank assisted support. They reiterated that the government has flinched from its responsibility as clearly documented in the Nigeria agricultural policy; which stated provisions of training facilities and rural infrastructure, the establishment of effective communication channel for the researcher, extension workers and the smallholder farmers, and the establishment of demonstration farms for effective technology transfer. The findings of the in-depth qualitative interviews provide some illumination on this issue. For example, a respondent pointed out that the Nigerian government has neglected the agricultural sector and concentrated on crude oil due to its quick revenue at the detriment of agriculture. Additionally, another professional stated that there is likely to be paradigm shift in the sector "*the government state that it is time to go back to agriculture as oil revenue shrinks and present administration would also cut short the long bureaucratic processes that Nigerian farmers had to go through to get any form of assistance from government"*.

Insight from the investigations also reveal that extension workers' and farmers' views concurred that there was a lack of government support to meet the transport cost for visiting farmers in the remote villages. A farmer affirmed that "*we hardly receive extension visits and you know we are local people, we need support from the government"*. This problem has been noted in the literature (Obiora and Emodi 2013, Dimelu *et al.* 2014, Okeke *et al.* 2015, Akinnagbe and Olaolu 2016) which emphasises that inadequate government support for extension services and poor government policies and programmes in agriculture are major barriers to the sector.

8.1.4 Low Wages and Salaries for the Personnel

The findings from the study have shown that low wages and salaries are among the factors militating against the effectiveness of agricultural extension and advisory services in Nigeria. Like many other civil servants in Nigeria, extension professionals revealed that the wages are not only extremely low, but are not paid when due. They revealed that poor wages are a constant source of frustration. This study identified that due to seven months lack of salaries or unpaid arrears, the majority of the officers effectively engaged themselves in secondary occupations to ameliorate their suffering. Indeed, lack of wages or unpaid salaries is adversely affecting the effectiveness and efficiency of extension service delivery in the study area. The findings of this study are supported by the studies of Ogunremi and Olatunji (2013), Otu *et al.* (2014), and Okwoche *et al.* (2015) on the determinant of job satisfaction among extension workers and officers, who concluded that poor remuneration, irregular salaries and allowances for the field extension agents and officers are some of the barriers to the effectiveness of agricultural extension in Nigeria.

8.1.5 Insufficient and Inappropriate Agricultural Technologies for Farmers

Insights from the study have revealed that inadequate research, limited extension and farmer linkages to assist demand-driven research and enhance the use of best agricultural practices technologies continue to restrain efforts to increase farmers' agricultural productivity. As a result, smallholders continue to use insufficient and inappropriate agricultural technologies which contribute to low agricultural productivity. This explicitly explains the role of TAM and shared belief in the benefits of an appropriate technology that influence new technology adoption among smallholders. The findings suggest that there is a need for extension services that can easily facilitate and link research to rural farmers. This result corroborates with the findings from the literature reported in chapter two of the current study. In addition, Taye *et al*. (2013) and Ibrahim (2014) emphasized the provision of relevant and appropriate agricultural technologies that would contribute significantly to the problem of low yields among the smallholder farmers.

8.1.6 Lack of Farmer Involvement in the Planning Process

The findings of this study have identified the need for farmers' participation in the planning and technology development processes as mentioned by the extension workers. It was also revealed during the qualitative in-depth interviews that smallholders' decision not to adopt improved technology was a result of a lack of trust in the technology. The research findings suggest that a top-down extension approach is not the best way to disseminate agricultural technology to rural farmers. Farmers' views concurred with the aforementioned finding in which the majority (92%) of the with-SMS farmers declared that the GAP participatory training intervention contributed to their rapid adoption of GAP technologies. This suggests that farmers should participate in the planning and development process of any viable rural intervention. The findings of this study are supported by the study conducted by Bello and Obinne (2012) and Ragasa *et al.* (2016) who stated that a participatory approach is the best strategy in any technology adoption study target toward smallholder farmers.

8.2 Factors that Hinder Effective Communication in Nigeria

8.2.1 Language Barriers

The findings from this investigation have shown that language barriers are one of the major factors affecting communication among rural farmers in the study area. This underpinning the theory of TAM and two widely recognized technology implementation success factor (training and communication) on the perceived usefulness and perceived share of use during technology implementation. Insights gained from the study revealed that some of the extension workers cannot communicate effectively in the local language, consequently they find it extremely difficult to disseminate improved technology to rural farmers who cannot speak the English language. It was further revealed that extension workers who are not proficient in the local dialect (Hausa language) reported that they would prefer to disseminate agricultural information to literate farmers through mobile phones. One extension worker suggested that for farmers to have access to timely and appropriate agricultural information, government should provide mobile phones for farmers as it was proposed by the former Minister of Agriculture and Rural Development, Dr. Akinwunmi Adesina. Communication is indispensable and plays a fundamental role in the adoption of GAP technologies among smallholder farmers. Hence, the findings suggest that there is a need for effective communication between extension workers and smallholders in order for farmers to make informed decisions to adopt improved technologies. Extension professionals interviewed also suggested that the government should endeavour to establish information centres in all rural areas where local dialect would be the primary source of communication for effective dissemination of agricultural information, taking into account the high illiteracy level amongst rural dwellers. This shows that mobile technology also has its limitation and could only be used as additional tool and cannot replace face to face communication completely (Apantaku *et al.* 2016). During the interview, one farmer complained about poor radio and mobile phone signal in their village. This suggests urgent needs for rural infrastructure in villages. This finding is supported by the studies of Ajayi and Gunn (2009) and Ajani (2014), who recommended that the government should provide rural infrastructure that will assist rural farmers' access to agricultural information for effective communication and optimal crop production. In a study conducted by Apantaku *et al.* (2016) on farmers' and extension workers' views on the limitations of effective extension delivery in Nigeria, it was stressed that farmers ranked language barriers as the second most important barrier.

8.2.2 Poor Road Network

The poor road network in rural areas has been identified in this study as a major constraint to regular visits by extension workers. Indeed, many rural communities in Nigeria lack access to motorable roads which discourages extension workers from taking agricultural technology to those communities. As shown in Chapter Five, one extension professional claimed simply, "*there are no good roads in all our village"*. In Bassawa community, farmers complained that during the rainy season their roads become almost impassable. This suggests that a lack of good and motorable roads may prevent rural farmers from getting extension contact. They reported that the poor condition of the roads leads to high transport fees charged by the truck and bus drivers. Consequently, a large proportion of perishable agricultural food crops are trapped on the farm, leading to substantial losses, particularly during post-harvest. The findings of this study are supported by Fabiyi and Hamidu (2011) and Sani *et al*. (2015), who emphasized that participants in their studies identified poor roads and substantial losses of perishable agricultural produce as a major problem.

8.2.3 Excessive Distance from the Village

This study has shown that excessive distance from the city centre to the remote communities is one of the contributing factors preventing extension workers from visiting smallholder farmers in their villages. During the focus group discussions, extension workers revealed that they cannot travel long distances for field visits and risk their lives because they wanted to disseminate agricultural technology to rural farmers in the extremely remote villages. Considering the lack of government support, low wages and salaries, lack of basic infrastructural facilities in rural areas and many other factors, extension workers would prefer to visit the rural areas that are not too far from the urban centres where transport and communication systems function better. This finding revealed the fundamental reason behind the selection of Bassawa community as a beneficiary village in the adopted project initiated by NAERLS.

8.3 Barriers and Opportunities to the Adoption of GAP Technologies

The findings of the evaluation survey revealed some critical barriers to the uptake of GAP technologies, in particular among the without-SMS farmers. A total of seven factors have been identified from the results of the survey as barriers to the adoption of GAP in the study area as discussed below.

8.3.1 Financial Constraints

Results of this study have identified lack of access to credit facilities or finance as the most important barrier constraining the uptake of GAP technologies among the smallholder farmers. Findings revealed that the majority of the farmers are income poor - thus highly constrained of both operating capital and investment in their farming businesses. Farmer interviews also revealed that the majority of smallholders cannot access credit/soft loans from the micro-finance banks in the area due to lack of collateral security or high-interest rates charged by the financial institutions. Farmer interviewees argued that the cost of agricultural inputs (fertilizers, improved seeds and pesticides) are still very expensive when compared to the indigenous farming practices, and the high cost of inputs creates the most important barrier to the adoption of new improved technologies in the area. Finance is a big challenge to rural dwellers and a barrier to technology adoption. Corroborating this finding, a number of studies on technology adoption among smallholder farmers have emphasised a lack of access to credit/financial constraints as a key determinant of the adoption of new technology by resource-poor farmers (Ayoade and Akintonde, 2012; and Awotide 2015), and the high cost of technology and labour are a hindrance to adoption (Onasanya *et al.* 2006, Anka 2014).

8.3.2 Inadequate Information

The study's key finding is that inadequate information was the second most important barrier to GAP technology adoption by the without-SMS farmers. The results of the evaluation survey show that without-SMS farmers did not adopt GAP technologies to the same extent as there with-SMS counterpart who fully adopted 13 GAP technologies. The results of qualitative interviews with the without-SMS farmers revealed that the lack of SMS text reminders/information and extension visit may be a significant factor influencing why farmers did not adopt the GAP technologies. For example, one of without-SMS farmers claimed simply: "*The researcher did not remind them, he gave us incomplete information*". This finding suggests that information through SMS reminders had a positive impact on GAP adoption amongst with-SMS farmers and participants found it very effective. This finding has shown that the role of accurate and timely information cannot be underestimated. Information is knowledge and power. It is therefore imperative to ensure that the information is reliable, appropriate and consistent. Davis (2003) Technology Acceptance Model discussed in chapter Two provides a useful framework to consider farmers' responses to inadequate information to improve adoption level. A number of previous studies on improved technology adoption have noted that lack of information/knowledge and effective communication can be a barrier to the uptake of improved technologies (Kolade and Harpham 2014, Mwangi and Kariuki 2015, Aremu *et al.* 2015, Nallusamy *et al.* 2015, Adio *et al*. 2016 and Awotide *et al*. 2016).

8.3.3 Inability to Access Action Plan

The third most important barrier to smallholder farmers was the inability to access the action plan provided to them by the researcher after the GAP training. Analysis of the survey data found that the majority of the without-SMS farmers could not access the list of farming activities developed together to make their work easier. This was further explored in the qualitative interviews, in which farmers were questioned about why they could not access the action plan, 84% of the farmers responded that they did not remember to follow the action plan, while very few farmers (<5%) said that they pasted the action plan at the back of their doors as instructed during the GAP training but they completely forgot to adopt it. During the focus group discussion, one farmer complained that they were given *"less information while the other group was given full information"*. The findings of this study align with Kabir and Rainis (2015), who found inadequate information and lack of knowledge as a barrier to the uptake of Integrated Pest Management (IPM) among paddy farmers in Iran. Ajani (2014), also suggests that rural farmers lack appropriate information to help them make sound decisions.

8.3.4 Poor Implementation of Government Policies on Agriculture

Insights from the investigation have revealed that poor implementation of government policies on agriculture is predominant among the major barriers to the adoption of GAP technologies in the study area. As shown in Chapter Two, a number of agricultural policies have been implemented in Nigeria in order to improve agricultural productivity of rural dwellers and boost food production and livelihoods. However, many of these policies have failed as a result of poor implementation and coordination of the programmes, as well as corruption and embezzlement of funds meant for the programmes. Indeed, planning of agricultural policies is not a challenge in Nigeria but poor execution and implementation are. Insights from the qualitative interviews further support the findings. During the interviews, poor implementation of government policies and high costs of fertilizers due to the economic recession in the country were raised. One farmer explained that prior to the growing season, the Federal Ministry of Agriculture and Rural Development announced that smallholder farmers in the country should open bank accounts for soft loans. According to him, they all left their villages in a group and went to a particular bank in the metropolitan to open bank accounts. Unfortunately, after two weeks the government announced that the bank account should be from a specific bank designated for the programme. The finding of this study is supported by the studies of Ugwu and Kanu (2012), Agber *et al.* (2013), and Maku and Kigbu (2016) who emphasized that poor coordination and mismanagement of policy instruments constitute major impediments to the achievement of goals and objectives of past agricultural policies and programmes in Nigeria. Akinbamowo (2013) identified poor translation and articulation of policy prescription into implemented programmes.

8.3.5 High Cost of Fertilizers and Herbicides

Enhancing the adoption of GAP technologies, fertilizer application and herbicides are important inputs for increasing agricultural productivity and combating poverty amongst smallholder farmers. The result from the qualitative interviews show that the high cost of fertilizers and herbicides may hinder farmers from adopting improved GAP technologies. The market intelligence survey further revealed that a 25kg bag of fertilizer during the economic recession in Nigeria (during the third phase of the research) was sold at between ₦10, 000.00 and ₦10, 700.00. One farmer complained bitterly that fertilizer was expensive *"I sold my mobile phone and television to purchase a bag of fertilizer because I could not afford to leave my crops unattended".* This finding supports the studies of Hailu *et al*. (2014) and Perey (2016) who stated that lack of access to agricultural inputs and play a fundamental role in the limited uptake of new improved technologies.

8.3.6 Preference for Indigenous and Traditional Farming Methods

This study has revealed that the without-SMS farmers indicated that they would prefer to use indigenous and traditional knowledge of farming rather than the suggested GAP technologies. Farmer interviews showed that the smallholders choose to continue practicing traditional method as a result of the challenges they perceived constraining them such as financial constraints, lack of timely and up-to-date information, inadequate government support**,** the high cost of fertilizers and herbicides, poor tools and limited storage facilities. When probed further, a respondent mentioned that they would appreciate adopting most of the GAP technologies but they lacked further reminders and advice after the GAP training. In the same light, another farmer revealed that he was motivated to practice seven GAP technologies because of the knowledge and skills received during the participatory GAP training as well as the trust he had in the lead farmers who delivered the training. The findings from this research are supportive of the works of Nobuhito *et al.* (2015) and Kiptot and Franzel (2015) who emphasized the significant of timely information and informal training amongst farmers in order to enhance technology adoption rates and improve agricultural productivity.

8.4 Opportunities derived from GAP Technologies Adoption

This section explores the opportunities that have been identified by this study to increase GAP technology adoption among smallholder farmers in Nigeria. This section also puts forward the potential advantages of the intervention which was implemented in this study and the underlying role of TAM in adoption of improved technologies among smallholders. The opportunities identified from the study investigation can be conveniently grouped into four main categories as discussed in the following sub-sections:

8.4.1 Increased Farming Knowledge and Skills

Insights gained from the investigation suggest that the participatory extension approach resulted in a positive impact by increasing farmers' knowledge and skills as well as having a positive impact on technology adoption. The current study has shown that the GAP workshop favourably increased respondents' skills and knowledge, which invariably influenced adoption of the recommended GAP technologies. This certainly shows the significance of training in transferring knowledge and skills about best agricultural practices to rural farmers. This research has shown that smallholder farmers require being trained to improve their knowledge, skills and attitudes on good farming practices in order to increase agricultural productivity and standards of living. Beyond the GAP training workshop, there are a number of ways of imparting knowledge and skills of agricultural practices to rural farmers. These include, but are not limited to, farmer field schools (FFS) (Ngin *et al.* 2016), lecture method (Jasim and Norsida 2016), television, radio, extension services and demonstration. Whatsoever method of knowledge transmission is adopted, it is essential to make sure that farmers are actively involved in the process. The intensity of participation during training increases the probability of smallholders' adoption of GAP technologies. Hence, by being involved, smallholders are expected to get a better understanding of the GAP technologies, how to use the technologies maximally and the potential benefits of GAP adoption.

Table 8.1: Distribution of the Respondents' Operational Cost of Production before and after GAPs Adoption (Bassawa Community n =100)

Selected Input/operations	Cost per Hectare (₦)	Cost per Hectare (₦)
	Before GAPs adoption	After GAPs adoption
Fertilizer Application	4500	10000
Land clearing	5000	4500
Cultivation	6000	4000
Planting	2000	2000
Weeding	4000	4000
Harvesting	3000	2000
Processing	2800	2800
Total	27,300	29,300

Source: Field Survey, 2016

Table 8.1; shows the cost of production before and after adoption of the GAP technology where it was observed that the smallholders spent less on crop production before adopting the GAP technology. The result also revealed that smallholders invested more resources in crop production after implementation of technological improvement than before then.

The analysis done on the income/profits of the respondents before and after the adoption of the GAP technology shows that income of farmers after the adoption of GAPs are better off than income generated before adoption by ₦294,600 on the average per smallholder. This is shown as Net income in Table 8.2 (see appendix). In the course of this study, certain features were identified of the smallholder farmers in Bassawa community. Some of the features are family size of the respondents, improved varieties used, types of farm tools/implements use by respondents, cost of production before and after the adoption of GAPs technology.

8.4.2 Increased Agricultural Production and Productivity

Insights from the analysis have revealed that the GAP participatory training and SMS text reminders facilitated an increase in crop production among the with-SMS farmers, with a 42% increase in income compared to the immediate past year, prior to the intervention. It was also found that 79% of the adopters indicated that the GAP intervention had a positive impact on their agricultural productivity and livelihoods. A positive and statistically significant relationship was found amongst SMS text reminders ($p = 0.001$**), GAP training ($p = 0.000$**) and GAP technologies adoption. The findings from this research are supported by a study conducted by Ainembabazi and Mugisha (2014) who concluded that a significant relationship was found between ICT and farm productivity of small-scale farmers in Kenya. The results are further supported by Dontsop Nguezet *et al.* (2012) and Kalungu and Filho (2016) who added that awareness was found to have a positive and significant correlation with the benefit of using ICT in agriculture to achieve high yields and increase productivity among small-scale farmers.

Table 8.2: Income/Profits of the respondents before and after adoption of GAPs technology (Bassawa Community n =100)

Operations	Income before Adoption (₦)	After GAP Adoption (₦)	Net revenue
Cost of production	17,400	25,700	Income before adoption
Yield of Maize per hectare	7.6 tones	14.86	294,600
Price per tone	40,000	40,000	Income after adoption of GAPs
Gross Revenue	40,000 X 7.8	40,000 X 14.86	568,700
Total	312,000	594,400	Difference 568,700 – 294,600
Net revenue	312,000 – 17,400	594,400– 25,700	274,100
Total	294,600	568,700	₦274,100

Source: Field Survey, 2016

Table 8.3: Chi-square Tests of the Impact of GAPs Technology on Agricultural Productivity of the Respondents (Bassawa Community n =100)

FO	FE= RT X CT/N	FO – FE	$(FO - FE)^2$	$(FO - FE)^2/FE$
25	35.4	- 10.4	108.16	3.055
18	12.6	6.6	43.56	3.457
50	45	5	25	0.555
15	20	- 5	25	1.250
30	28	2	4	0.142
8	14	-6	36	2.571
28	34.6	- 6.6	43.56	1.258
12	16.5	- 4.5	20.25	1.227
10	14.2	- 4.2	17.64	1.242
8	4.6	3.4	11.56	2.513
				$x^2c = 17.270$

DF = (r - I), (c -1), = (4 - 1), (2-1) = 3, Alfa = 0.05 $x^2t = 5.342$

Chi-square calculated =17.270 and Chi-square tabulated =5.342, since the Chi-square tabulated is less than the calculated i.e. x^2t (5.342) < x^2c (17.270), the study therefore conclude that there is a significant impact of GAPs technology on agricultural productivity of the respondents.

8.4.3 Information Availability through SMS Messages

Information availability emerged as the second positive impact of GAP participatory approach on adoption amongst the with-SMS farmers. There is a need for constant access to appropriate and timely information through farmer training and agricultural education in order to motivate and influence farmers' decisions to adopt GAP technologies and increase production. Fundamentally, information is paramount to adoption on new technology and this is consistent to the role of TAM theory. This finding is consistent with that of Jain *et al*. (2015) and Mittal and Mehar (2016) who emphasised that information through radio, extension guidance and informal training can play a critical role in the transformation of rural communities, assist farmers in problem-solving and enable them to become more actively ingrained in the agricultural knowledge and information. Other information needs emerging from this study related as stated by farmers was access to market information, weather forecasts, information on storage facilities and information on crop and livestock diseases and general advice related to agriculture (Mwombe *et al.* 2014 and Kenia-Rosa 2017).

8.4.4 Decision Making whether or Not to Adopt a Technology

As mentioned above, providing information via participatory training and extension services to smallholder farmers about good practices in farming, timely access to market information can facilitate sound decision making about whether to adopt a technology or otherwise. Farmer training had consistently been a significant element in the development of rural communities and has shaped over a long period of time the way farmers think and respond to studies related to technology adoption (Roberta *et al.* 2016). Farmer training also opens opportunities to share experiences, best practice, incentives and new market information to farmers which enables them to make informed decisions regarding technology adoption. This finding corroborates with Shu and Ching-Horng (2015) who stated that access to information is a vital tool for empowering smallholders to make informed decision and managing their lives successfully.

8.5 Use of Mobile Phones by Farmers in Relation to Market Access and Trading

Although this study has focussed on the impact of SMS reminders on the uptake of GAP technology, the findings of the research reveal a range of other benefits of mobile technology. A high level of usage of mobile phones by the respondents in relation to market and trading was recorded in the study area. The qualitative interviews showed that smallholder farmers were using their mobile phones in diverse ways. These included: accessing market information on farm inputs (fertilizers, pesticides, improved seeds etc.), current market prices of agricultural commodities, and direct contact with traders and buyers, finding out quantity and availability of a particular product in the markets, and sharing market information and experiences with fellow farmers in the village to achieve a better income. These results signify a general proactive use of mobile phones by the respondents which helps them to conduct market searches over a wider number of markets and participate effectively. It is therefore evident that mobile phones are valuable and could make significant contributions to market access and the trading capacity of the farmers.

Additionally, respondents mentioned and ranked the contributions of mobile phones in relation to markets and trading. The results show that farmers used their mobile phones to secure better market and prices (98.5% of farmers who own a mobile phone), to reduce travel time and expenses (92%), to reduce transportation costs (89%), to conduct markets searches across the district (87.5%), and helps to improve negotiation/bargaining power and broaden networks. The findings suggest that mobile phones present greater markets access opportunities for smallholder farmers. The findings corroborated with Fang *et al.* (2014) and Wyche and Steinfield (2016) who reported that mobile phones are widely used in rural areas and enable farmers to secure reliable and timely market information, and share experiences in order to develop better means of increasing incomes. Moreover, farmers have easier access to advisory services and non-market information by using mobile phones (Aker 2008, Aker and Mbiti 2010).

8.6 Impact of SMS Technology on GAP Adoption and Agricultural Productivity

The findings of this study have identified major significant impacts of SMS technology on GAP adoption and agricultural productivity of the with-SMS respondents and the underlying theory of technology acceptance and utilization among users. The identified impacts include; improving the uptake of GAP technologies, increased crop production, improved access to prompt and timely information, increased communication, increased awareness, higher incomes and increased trust and confidence in the GAP technologies.

8.6.1 Improve the Uptake/Adoption of GAP Technologies

Evidence from this study has shown the effectiveness of appropriate extension intervention as a valuable and powerful tool to facilitate the uptake of GAP technologies among smallholder farmers, especially among the with-SMS farmers. This is consistent to the theory of TAM which argued that the perceived usefulness and perceived ease of new technology enhances adoption among users (Davis 1998).

Smallholders need to have access to agricultural information in order to make sound and meaningful decisions. The findings of the study suggest that the role of effective communication cannot be underestimated, because effective communication provides the critical links between the farmers and the researcher. Apulu (2012) stated that communication is the flow of information between two or more people but also a process of creating, shaping and maintaining the relationship in order to achieve a common goal. The need for effective communication with rural farmers cannot be underestimated as this can motivate and encourage them to adopt the GAP technologies. The finding is consistent with that of Jain *et al.* (2015), and Wyche and Steinfield (2016), who emphasized that providing mobile phones SMS text messaging to smallholder farmers improved the uptake of improved agricultural technology in Kenya and India.

8.6.2 Increased Agricultural Productivity

The findings of this study have identified that mobile SMS text reminders provide a helpful tool to encourage GAP adoption and subsequently increase agricultural production and improve the standard of living of smallholder farmers. Assessing the impacts of SMS text reminders initiative, the evaluation survey found that mobile SMS text reminders contributed towards the increase in agricultural productivity of the smallholder farmers, with a large proportion (86%) indicated that mobile SMS reminder enhanced their agricultural productivity and household income. It was also found that the majority indicated that adoption of GAP had improved their income and assisted towards achieving food security. The farmers also reported that SMS text reminders play an important role in providing information regarding implementing the action plan, which subsequently increase agricultural productivity.

"Without SMS text reminders, I would not have remembered to follow my action plan. That would have prevented me from the benefits I enjoyed from this GAP intervention project". (Farmer no. 4).

".........without SMS text reminders, many of us would not have adopted GAP technologies, but because we received SMS fortnightly it kept on ringing in our ears and I could recall vividly that some lead-farmers also forwarded the text messages to the group members to remind them. Without a doubt, provision of SMS text reminders was a life changing experience in our community because it was first of its kind, we never had it before. Many of us also had a significant increase in our crop production this farming season, when compared to what we produced last year". (Farmer no. 2)

The findings of this study are supported by Islam and Gronlund (2011) who asserted that mobile phones and radio are useful technologies for delivering the most up-to-date information on farm inputs and market information to the rural communities (Aker 2011, Mittal and Mehar 2015 and Aonngernthayakorn and Pongquan 2017) and agronomic practices in order to increase agriculture productivity and improving farmers' livelihoods via the adoption of new improved technologies (Mittal 2012).

8.6.3 Increase Farmer's Household Income

This finding suggests that the right information provided through extension visits and timely SMS text reminders in general had a positive impact on farmers' household incomes and livelihoods. The market survey study also revealed that the with-SMS farmers sold a larger proportion of their harvest in the Sabon-gari market in the study area. It is noteworthy to emphasize that empowering smallholder farmers with agronomic advice and market information can greatly increase farm household's income.

Based on the findings, the study have put forward that access to appropriate information via GAP participatory training, extension visits and mobile SMS text reminders, and trust in lead-farmers approach can have a significant impact on the adoption of GAP technologies. The study also found that the probability of the active age group to adopt GAP technologies is higher because they are considered to be more educated and enlightened, and thus susceptible to behavioural change than the old generation in the study area.

8.7 The Model for Mobile Technology (ICT) Supporting Traditional Extension Approaches to Improve access to Effective Communication by Smallholder Farmers in Nigeria

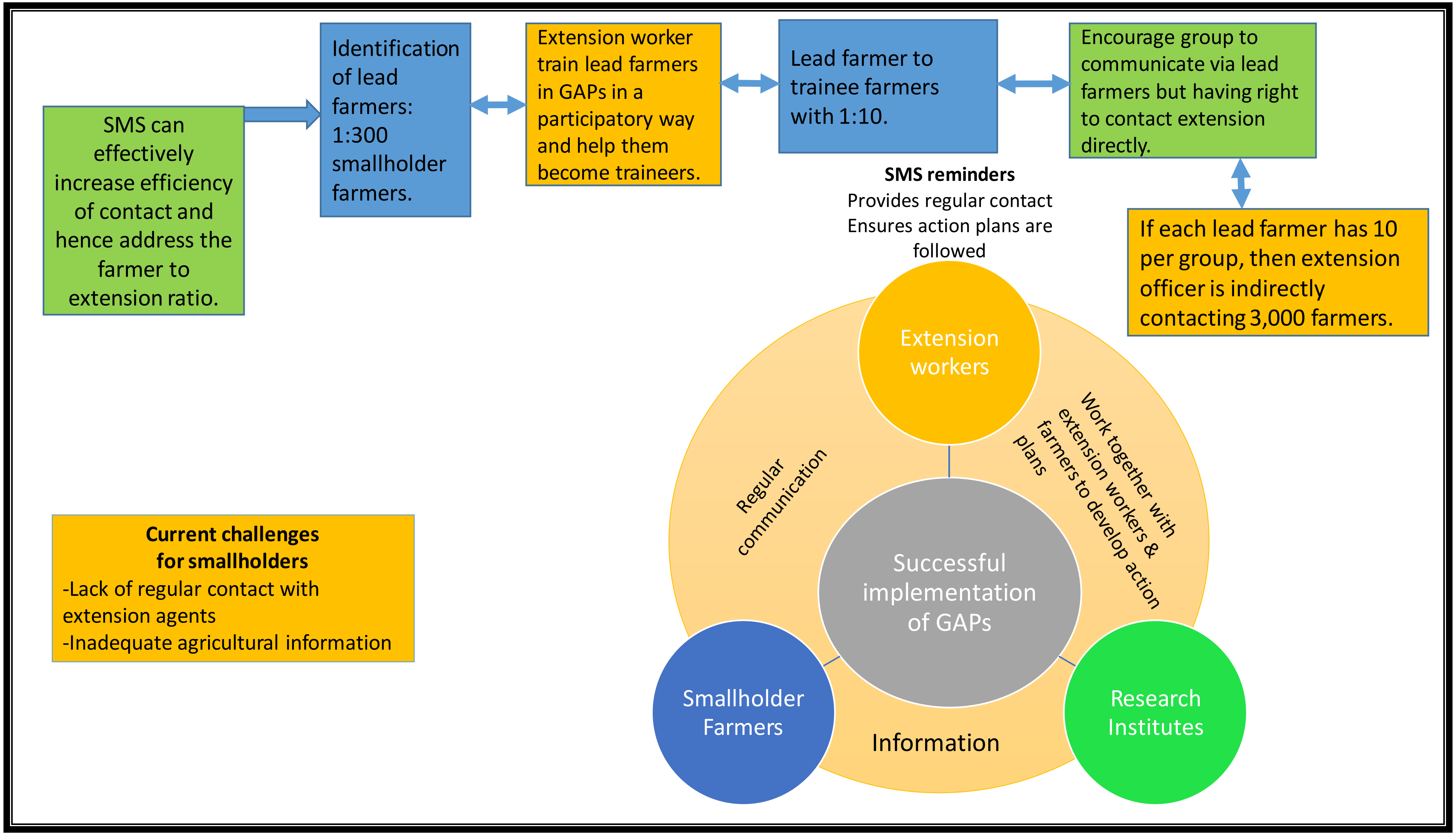
Evidence from the discussion has shown that although various ICTs were being used in the study area to communicate with rural farmers, radio and mobile phones were the most predominant used by the extension workers and farmers. Okeke *et al.* (2015) pointed out that ICT plays a very important role in extension service delivery to farmers, such as improving information flow and connecting people within rural areas, as well as answering questions relating to farming challenges and agronomic problems; giving farmers the opportunity of getting timely feedback and acquiring market price information. Karubanga *et al.* (2016) stated that ICT such as televisions, videos radios and mobile phones can greatly enhance access to information and stimulate adoption among small-scale farmers. Mobile phones save time and costs of transportation. In addition, Aker 2011 cited by Fu and Akter (2016) reiterated that mobile phones can meet most of the basic information needs of the smallholder farmers and allow for two-way communication between farmers and extension workers.

The key element in the model presented below is that SMS text messaging can effectively increase efficiency of contact and hence address the farmer to extension worker ratio (see figure

8.1). Based on the findings of the current study and the literature in chapter 3, the model however revealed some prevailing challenges and gap between smallholder farmers and extension workers including; lack of regular contact with extension agents, inadequate agricultural information, inadequate funding, low number of extension personnel, grossly inadequate support from the government, lack of human and finances, excessive distance to the rural area, bad road networks etc. The model also suggests a potential way to address the current challenges through participatory approaches based on the research findings. Similarly, the model emphasises the benefits of participatory approaches among the stakeholder (Reed 2008). The model suggests triple-helix collaboration whereby research institutes, agricultural extension workers and smallholder farmers work closely together to promote effective communication and combine efforts to agree on future action (as shown in the circle of the model, see figure 8.1). The key methods employed in this study in addressing the identified challenges were (1) GAP participatory training (2) Lead-farmer-trainee farmer approach, and (3) SMS text reminders. All these worked together to achieve the desired outcome - successful implementation of GAP. The model aims to serve as a guide as to how SMS text reminders as well as other approaches (i.e. participatory approach and lead farmer approach could help increase GAP implementation by smallholders, in addition to resolve the issues militating against effective communication between extension delivery and smallholder farmers in Nigeria, as identified by this study. The model is shown in Figure 8.1 below:

The model suggests that SMS text reminder can be effectively utilized to support the lead farmer trainee farmer approach and assist the smallholders to get improved access to extension professionals, improved access to markets and agricultural inputs and prompt feedback from research through extension agents.

Figure 8.1: The Model for Mobile Technology (ICT) Supporting Traditional Extension Approaches to Improve access to effective communication by Smallholder Farmers in Nigeria



The model for mobile technology supporting traditional extension approach was developed to address the present farm families' extension ratio. Currently, the extension officer farmer ratio is 3000: 1 and ideally, we could have 300: 1, however, if each extension worker has a portfolio of 300 lead farmers working with them and each lead farmer has 10 trainee farmers locally, then extension officer is directly communicating with 300 farmers and indirectly contacting 3000 smallholder farmers. Moreover, if the extension officer then have the ability to communicate with these smallholder farmers through Mobile phone as supposed to travelling to villages by car or motorcycle considering the restriction of bad roads. Then he can remind farmers on what to do through contact of the lead farmers through SMS text. It actually means instantaneously all the farmers would get the message at the right time. Meanwhile, extension visit to smallholder farmers in the villages would take the officer more than two weeks. As a result, extension delivery is more timely and cheaper with the use of Mobile phone. Therefore, Mobile phone technology does two things: (1). It lowers the cost of communication. (2) It allows instantaneous timely communication reminder, particularly if there is a well develop action plan for farmer to farmer extension.

Similarly, the study found that 85.5% of the households actively used their mobile phones for getting agricultural information on a regular basis from extension officers. When the farmers were asked about their most frequently seeking agricultural information through mobile phones, they reported that information about land preparation, cultivation methods, weather information, the appropriate time to plant, seeds variation information, fertilizer prices and availability are most frequently asked information (Section 5.6.5). Mobile technology bridges the gap between extension agents and smallholder farmers thereby enhancing effective communication and allowing for interaction on a regular basis. Moreover, communication through mobile technology is considered very significant in enhancing farmers' understanding of the agricultural market situation. It is important to employ SMS reminders alongside with other approaches (i.e. participatory approach and lead farmer approach) because they could help increase GAP implementation among smallholders. Although, these approaches are not panacea on their own but they are maximising on the fact that so many farmers already use mobile phones and they are incorporated into a wider approach of enhancing relationships, cooperation and communication between farmers, extension workers and research institutes.

As depicted in the model, the current challenges are presented on the left hand side as revealed in the study. Drawing from the findings, it is evident that various aspects of the model works, for example, 98% of the farmers indicated that participatory meeting helped them in decision making to adopt the GAP technologies and was very effective (Section 6.1.2). Similarly, the lead-trainee farmer approach was helpful as the majority of the farmers surveyed (70.5%) indicated that the approach was very effective and increased their level of agricultural production especially in this recession period in Nigeria.

Farmers can communicate and receive information in the local dialect (Hausa language) about various agricultural subject matter. As illustrated in the model, this important technology can provide a new approach to smallholder farmers, allowing them to communicate directly with researchers and agricultural extension officers. Through this important technology, farmers also have the opportunity to communicate directly with market brokers and customers to sell their product at a good price.

During the second phase of the study, a mobile phone workshop was organised in the communities, demonstrating the uses of mobile SMS text messaging among smallholders and testing the proposed mobile technology model to unlock markets and also obtain agricultural information from the extension officers. Farmers, particularly the younger and active aged group, were motivated to use SMS text messaging regularly to access market information and share agricultural information. However, this model will particularly help the policymakers integrate mobile SMS text messaging in agricultural extension. As shown in the model, improving extension services to smallholder farmers in Nigeria has the potential to increase agricultural productivity and transform the sector, lift millions of people out of poverty, especially rural farmers, turning agriculture into successful business opportunities all across the country to create wealth for Nigerian farmers. The approach outlined in this model could go some way in addressing the challenges identified with current extension approaches and help encourage smallholders to undertake particular actions to improve agricultural productivity.

8.8 Summary

The findings of this study support the assertion made by Aker and Mbiti (2010) that ICT could be incorporated into extension services in order to reach more rural farmers instantaneously and deliver up-to-date agricultural information that would enhance agricultural productivity, income, and standards of the living. Smallholders are very important to the agricultural economy in Nigeria, especially at this period when revenue from crude oil has fallen drastically. Therefore, the government, policy makers and rural developers should intensify efforts to assist rural communities with the provision of ICT infrastructure and data based websites to make information available to farmers promptly.

This chapter has presented a model that can facilitate the adoption of mobile technology supporting traditional extension approaches in order to improve extension services to smallholder farmers in Nigeria. The chapter also examined the contextual factors that limit the effectiveness of the traditional models of extension and communication in Nigeria from the extension workers and smallholders' perspectives. This study have contributed to literature and the body of knowledge by exploring the adoption of GAP technologies among smallholder farm households using mobile SMS text reminders in Northern Nigeria, which has never been done previously.

The identified challenges, if completely addressed by the Nigerian government would enable the traditional extension services to be more effective and efficient to the rural communities. This will not only assist the agricultural productivity of the smallholder farmers but also improve the economy of the country and bring the lost glory of agriculture back as one of the best agricultural producers across the globe prior to the oil boom. Nigerian smallholder farmers would benefit significantly from the effective utilization of mobile technology provided that the government implements appropriate initiatives required to enable the use of mobile phone by extension workers and farmers. Smallholder farmers should be encouraged by the government to access and utilise mobile phones by supporting them financially with low-interest rates and long-term loans. In the same light, more awareness creation and informal training for both extension workers and farmers should be intensified by the government.

Chapter Nine. Conclusions

9.1 Introduction

This final chapter of this thesis summarises the key findings that have emerged from this study. In light of the research findings, a number of considerations for the integration of mobile phone technology have emerged to improve traditional extension services as an additional tool for effective service delivery to smallholders. The chapter also explores some of the methodological considerations and limitations of the study, including the usefulness of the mixed methods research approach in studying the underlying significance of ICT and its impact on technology adoption among smallholder farmers. Possible directions for future research and the significant contributions of the study to knowledge are also presented.

9.2 Key Findings

This study has explored the use of ICT among smallholder farmers and extension workers and their relevance in encouraging the implementation of sustainable GAP in Nigeria. After positioning the study within the wider academic literature, five research questions were developed in order to guide the data collection and analysis, a number of key findings have been identified.

Traditional agricultural extension models were found to be perceived by the majority of smallholder farmers and extension workers as ineffective. Various challenges associated with the ineffectiveness of agricultural extension models were noted, including; inadequate funding, inadequate number of extension personnel, inadequate government support, low wages for the extension personnel, and inappropriate use of agricultural technologies by smallholder farmers.

In relation to the second research question, a number of barriers and opportunities to the adoption of GAP technologies were noted by the smallholder farmer participants. The barriers noted included: financial constraints, inadequate information, poor implementation of government policies on agriculture, high cost of fertilizer and herbicides and preference to indigenous and traditional farming method. The study found that through successful extension delivery and follow up communication through SMS reminders, many of these barriers could be addressed through the provision of accurate and timely production and market information.

In answer to the third research question, this study has shown that a large majority of the smallholder farmers used mobile phones to seek market information about a range of issues including: market prices for agricultural inputs such as fertilizer; seeds varieties and herbicides; and the latest market prices of agricultural commodities. Smallholders also used mobile phones to share market experiences among themselves in order to assist members to get better incomes for their farm produce. These findings demonstrated that farmers could have direct access to market information through the use of their mobile phones, reducing their reliance on middlemen who often take advantage and try to exploit them. Mobile phone technology provides them with required services as well as appropriate and accurate market information.

Further investigation revealed that by using mobile technology, farmers do not need to transport themselves to local markets before obtaining market information, especially during the rainy season when most of the roads in the study area become literally impassable.

In response to the final research question, the use of mobile SMS text reminders technology influenced the adoption of GAP technologies and its impact on the agricultural productivity of smallholders, this study has shown that mobile SMS technology significantly influenced the adoption of GAP technologies among the farmers of the with-SMS group, whilst the without-SMS farmers demonstrated a far lower level of uptake of recommended GAP technologies. The findings of this study reveal that access to appropriate information via mobile SMS text reminders, together with the GAP participatory training, extension visits and trust in lead-farmers approach play a significant role in the adoption of GAP technologies. The research has revealed the value and importance of mobile technology as a tool that is capable of delivering timely and reliable information to smallholder farmers. The with-SMS farmers in this study indicated that access to information via SMS text reminders sent to them fortnightly influenced them to make informed decisions and to adopt most of the GAP technologies that were suggested to them as part of their action plan. Moreover, this study has revealed that the use of mobile technology had a significant impact on the agricultural productivity and household income of the with-SMS farmers who experienced an average increase of 42% in productivity compared to previous farming season. While this study has shown that the crop yields and incomes of the without-SMS farmers also increased in this farming season directly after the intervention, it was far lower than the with-SMS group. In addition to the SMS reminders, further investigation revealed that the participatory GAP training and lead farmer approaches contributed significantly to the increase in their output this farming season.

9.3 Methodological Considerations

The use of interdependent data collection methods in the form of baseline livelihoods survey, qualitative in-depth interviews and focus group discussions, followed by a quantitative evaluation survey has established the potential benefits of adopting a mixed method research approach. During research phase 1, the baseline livelihood survey was designed to create a baseline for the study and to inform the development of the focus group discussions and in-depth interviews conducted in the second phase, they were equally employed to investigate and explore the effectiveness of traditional extension models and how ICT could be better used to improve the adoption of GAP technologies. These data were then used to inform the development of the participatory training and extension intervention. In the third phase of the study, the quantitative evaluation survey was used to establish the impact of the GAP training on adoption and the influence of SMS text reminders and extension visits. It was also used to evaluate barriers to the adoption of GAP technologies among the respondents.

Based on the findings of the three research phases a new model of using mobile technology as an additional communication tool to improve extension services delivery to smallholder farmers was developed. Without the complementary qualitative research phase, the development of the contextually suitable evaluation quantitative survey that was used in the third phase of this research would have been impossible. The mixed methodology approach adopted for this study proved very effective, comprehensively addressing the research questions posed by this thesis. Also, the study participants offered maximum support and engaged well in all three phases of the research; baseline livelihood survey, workshop/GAP training, in-depth interviews and focus group discussions and the evaluation survey, providing high quality and substantial datasets. The data collected during the three phases was collectively strengthening, which allows for the triangulation of the findings.

9.4 Study Strengths and Limitations of the Study

As mentioned in chapter 8, this research is the largest study and the first in Nigeria, to date, to comprehensively investigate specifically how SMS reminders could be better used to improve the adoption of GAP technologies among smallholder farmers in order to increase their farming productivity and livelihoods. Indeed, the main strength of this research emanates largely from it originality and the utilization of a broad collection of data to address a multiple phenomenon in a natural setting. As a result, this study offers additional standardized evidence which perhaps might better guide practice, the government, policy makers and further empirical research.

This research has increased our understanding of the impact of SMS text reminders on the adoption of GAP technologies amongst smallholder farmers. Although, this study has achieved its aim and objectives, and has justified the research questions outlined in chapter one of this thesis, caution must be exercised and consideration given to the mixed methods employed and the study design. First and foremost in relation to the qualitative aspect of the study, Benton

(2000) reiterates that qualitative methods have been criticized on the grounds of disregarding issues of validity and reliability and for being unscientific and untrustworthy. To address this, the reliability of this study was enhanced by mixed methods triangulation and participants checking of the research findings and study results. The main strength and weakness of both qualitative and quantitative methods were carefully considered and strategies to minimize any threat to the credibility of this study were implemented (see Methodology chapter section 4:8).

The main weakness of the study as previously acknowledged was the study design where the researcher should have had half of Bassawa and half of Shika lead farmers using SMS compared to remainder not having SMS. This is because loading all farmers with SMS on Bassawa confounded observation which earlier adopt a village programme by NAERLS. The researcher acknowledged this and that a better design have been half of Bassawa plus of Shika should have had with SMS and rest without. That would have then spread the effect of adopt a village across the two groups. This study design would be adopted for postdoctoral fellowship.

The small sample size of the qualitative research phase of this study is another limiting factor. Only 4 focus group discussions (with the same 20 participants at each) and 4 qualitative in-depth interviews were conducted due to limited time available and cost constraints imposed upon the study as well as the limited availability of the extension worker participants. As a result, it is not possible to generalise the qualitative findings to the wider population. Nonetheless, when coupled with the quantitative findings of the study, the results provide comprehensive and important insights into the views of extension workers. The quantitative evaluation survey was designed to compensate for the limitations in order to adequately address the aim and objectives of the study. However, due to the aforementioned limitations this study could not cover the whole country and therefore does not provide a fully representative picture of the impact of mobile phones on adoption of improved technologies among smallholder farmers across Nigeria. It is therefore important for further research to be carried out in order to build on and complement the findings reported in the thesis. Another limitation of this study is that it is difficult to ascertain the exact impact of the SMS reminders as the with-SMS farmers (Bassawa) also had additional extension visits. This could be improved in further study by providing SMS text reminders to half of Bassawa and Shika respectively after the initial GAP training in order to test the impact of the SMS mobile technology in the study area.

From the aspect of the geographical dimension, this study was primarily limited to the North-west agro-ecological zone of Nigeria. Therefore, it may not be appropriate to generalise and apply these research findings to other agro-ecological zones and other African countries. Further research is therefore needed in order to have a comprehensive understanding of the topic across agro-ecological conditions.

Another important limitation relates to the inaccessibility of female farmers in the study area (Northern Nigeria) by the researcher, due the cultural practices in the area which prevented this study from providing a representative sample with a balance of the participants. The majority of women working in agriculture in the study area could not be reached to actually investigate how they utilize mobile technology in their farming activities and the marketing of their agricultural produce. While this limitation should be taken into account when considering the research findings, it is unlikely to be similarly problematic for researchers in other agro-climatic zones of Nigeria as female farmers could easily be accessed in the South-West and Southern Nigeria due to different social practices.

While the new ICT model of using mobile technology as an additional tool in extension services delivery provides an interesting insight into the relationship between farmers, extension workers and research institutes, it is imperative to note that the development of the model was an exploratory process, necessitating subjective decisions about the data gathered by the researcher.

9.4.1 Personal Reflection

The 36 months of the PhD research has been an intense learning period coupled with different but challenging experiences which has changed my attitude and personal life. As I reflect over the months invested in doing this research work, there was so much to do in a short time and it seemed to be a task that would never end. Doing PhD research work has taught me how to conduct independent study and I have gained invaluable knowledge and skills, and effective time management. With the support of my supervisors, I now have a good understanding of the research process, making coherent arguments, and writing scholarly reports. Indeed, this research journey has also developed my intellectual capacity. However, I would like to acknowledge that the field work trail was flawed in that half of Shika community and half of Bassawa community supposed to receive SMS text reminders not all Bassawa village.

9.5 Research Contributions

This section of the chapter presents the significant contributions of this research. Firstly, contributions to knowledge are considered, followed by practical contributions.

9.5.1 Original Contributions to Knowledge

Drawing from the evidence presented in this thesis, this research has contributed significantly to the body of knowledge within the field of sustainable agricultural extension and ICT by providing original confirmation that the use of mobile technology in the form of SMS text reminders, GAP participatory training and lead farmer approaches contributed to adoption of GAP technologies among smallholder farmers and subsequently increased crop yields and the incomes of the participants. This research has identified that mobile phone usage can improve farmers' ability to make informed decisions on the adoption of improved technologies (also see appendices 6). The original contributions of this research also stem from the ability of this study to prove that the use of lead farmer approach is a unique strategy to encourage other farmers in the community to adopt improved technology. Similarly, the original contributions of this research also emanate from its ability to empirically identify that only one approach or strategy can never guarantee high adoption rate among smallholder farmers. However, this research proved that there are motivating factors or determinant factors to adoption, these include; access to appropriate information via mobile SMS text reminders, GAP participatory training, extension visits and trust in lead-farmers, each of which plays an essential role towards the adoption of GAP technologies.

In the same way, the original contributions of this research study also stems from its ability to empirically pinpoint key barriers affecting the adoption of GAP recommended technologies. These include: financial constraints in purchasing farm inputs; lack of knowledge and low levels of awareness; poor information/communication; unavailability of extension agents for advice; lack of improved seeds varieties and lack of government credit facilities. The study has also contributed to the discourse in the academic literature and the field of agricultural extension and information technology in agriculture by identifying the limitations of previous studies in extension services delivery to smallholder farmers in developing countries, especially from the Nigerian context.

No previous research in Nigeria has empirically investigated how SMS reminders could enhance the adoption of improved technologies by smallholder farmers in Nigeria. This is the first study research to do that. Scholarly articles on the influence of SMS text reminders - and their utilisation to prompt farmers on GAP in Nigeria and the other developing countries. Thus, this thesis has added to the current body of literature and has made original contributions to the field of mobile phone technology in agriculture and extension services.

Considering previous studies on the topic, it was noticed that no attempt has been made to put forward a strategic plan for using mobile technology to improve extension services delivery to smallholders in order to improve adoption of technologies and increase agricultural productivity in Nigeria. This research has developed a new ICT model in extension services that can assist stakeholders, policy makers and the Nigerian government in their efforts to increase agricultural productivity in Nigeria. Generally, the new ICT model demonstrates a dynamic perception of the factors that can enhance the adoption of improved technologies and improve crop yields by smallholders.

The new model that has been developed in this study can be applied and tested by other researchers. In addition, evidence from the model would not only assist agricultural extension workers in Nigeria but also help other developing countries. The new ICT model in extension services will generally help policy makers to strategically set achievable plans for the overall attainment of sustainable agricultural and food security in Nigeria.

This research has made an original contribution to the importance of participatory training sessions and the involvement of smallholder farmers in technology development and adoption before introducing new innovations to rural communities. Relatively few studies have recognized the significant role of participatory training programmes for smallholders. Participatory training sessions will not only influence the smallholder farmers' decisions regarding the uptake of recommended technologies but will also build trust and encourage them to take risks. The benefits of participatory training presented in this research can offer additional insight for researchers and stakeholders who are considering introducing new improved technologies to rural communities. Therefore, the scholarly findings from this research can supplement previously accumulated insight on the benefits of farmer participatory or involvement in technologies development process and planning.

9.5.2 Practical Contributions of the Study

This study has contributed to agricultural policy and theory by supplying sufficient information about traditional extension models/approaches and new thinking in extension services, as well as the impact the use of ICT can have in. Correspondingly, the research provides insight into

ICT in extension service delivery with respect to the use of mobile phones (SMS text reminders) in the adoption of improved technologies. As a result of this research, participating farmers were offered free participatory training on GAP and an action plan. Half the participants also received an extension visit and SMS reminders. These farmers fully adopted thirteen of the GAP technologies which rapidly increased their crop yields and incomes (see appendix 5). As a result of this study, farmers were given improved maize seeds as an incentive to compensate for their time and fertilisers from NGO were sold to the participant at subsidized prices. The with-SMS farmers also received free mobile phone training sessions on how to unlock markets using the potential of mobile technology as well as free SMS text reminders every two weeks. This study has proffered suggestions on how the Nigerian government and policymakers can support ICT in agricultural extension service delivery to facilitate adoption of GAP technologies by smallholder farmers, which can assist to boost the country's economy.

Indeed, the contributions of this research are well-timed, as the Nigerian Minister of Agriculture and Rural Development recently initiated GAP into the agriculture sector and requested all the State Ministry of Agriculture across the nation to educate their field extension workers on the importance of GAP technologies and train them during their fortnightly meetings. The field extension agents will in turn educate rural farmers and encourage then to embrace and adopt the GAP technologies in order to improve their agricultural productivity. The promotion of the GAP technologies and the use of mobile phones, and particularly SMS text reminders by the federal government could accelerate adoption especially if the smallholders could be supported with informal training, credit facilities and improved farm inputs.

9.6 Recommendations for Further Research

The findings of this research and the research limitations have culminated in the identification of a number of potential areas for future research directions which are worthy of further investigation. The recommendations for further research as a result of this study are outlined below.

As this thesis has shown, more empirical investigation is required to further validate the findings, in order to increase the generalization of the study results in various agro-ecological zones within Nigeria and other regions in Africa and the developing world. A replication of this research in another geographic location or vegetation zone within Nigeria especially in the Southern part would help to provide data comparison and determine whether the research findings have a similar impact in other regions.

Although quite a number of research studies have been conducted in the area ICT utilization among farmers, the area related to the use of SMS text reminders to smallholder farmers in order to improve the adoption of GAP is still very new. Thus, future research could build on these findings which can be conducted in other climatic regions within Nigeria as well as other Sub-Saharan countries. Future investigations should endeavour to expand the understanding of the impact of SMS text reminders on the adoption of GAP technologies and their effective usage, which was outside the scope of the current research.

The mobile technology model in extension services delivery to farmers should be tested and validated in different locations to establish its generalisability. Similarly, future research could build on this model as new factors could emerge by examining the impact of ICT or mobile technology on the productivity of smallholder farmers in Nigeria. A comparative analysis of this study could also be conducted in other Africa countries, for example Burkina Faso or Kenya to determine differences in the context of Sub-Sahara Africa countries. For instance, in UK and US researchers have compared ICT adoption policies between the two developed countries.

9.7 Final Concluding Remarks

This research examined the use of ICT among smallholder farmers and extension workers and its relevance to sustainable GAP in Nigeria. In sum, the research finds that SMS text reminders supported by extension visits improved the adoption of GAP technologies which led to subsequent increases in crop yields and enhanced smallholder farmers' food security and incomes. The study found that SMS text reminders had a positive significant impact on the adoption of most of the recommended GAP technologies by farmers. This study has shown that investment in mobile technology and appropriate training programmes, as well as the activities that accompany the introduction of improved technologies to rural villages, can significantly contribute to improving agricultural production, productivity and the livelihoods of smallholder farmers in Nigeria.

This research also shows that traditional agricultural extension models are often ineffective and are constrained by several challenges. The study has emphasised the potential opportunities brought about through incorporating mobile technology into agricultural extension services in order to make the system more effective and efficient, and reaching the currently unreached rural farmers.

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Appendix 1: Ethical Approval Certificate

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Appendix 2: Letter of introduction from my Director of Research: Dr Richard Baines

Royal Agricultural University Cirencester

14th June, 2015

Dear

Re: Royal Agricultural University Research in Nigeria

I would like to introduce Samson to you as one of three Nigerian PhD students carrying out participatory research with smallholder farmers in Nigeria under my mentorship as their Director of Studies. All three studies seek to engage communities in improving their farming practices to improve livelihoods while protecting natural resources and adapting to the likely challenges of climate change. In all cases local extension staff will also be engaged in the study.

First of all, can I assure you that all researchers will be asking permission of communities and will treat all information in strictest confidence; however, the research is developmental allowing the communities and extension staff to jointly benefit from the findings of the studies. We also hope that our work will positively contribute more widely to rural and agricultural development. Secondly, we are happy to share this research with key State and National institutions where the work links to existing policies and plans. I will leave Samson to describe his study plan and programme to you and I hope you may be able to assist in some way.

The second reason for writing is to share with you the interest the RAU has in Africa's development and some of the initiatives we are involved with.

- As Director of Africa Programmes, I am responsible for the 'Africa's Land and Food Fellowship' programme which was established in 2006 and has provided leadership training to over 60 Fellows from 13 sub-Saharan countries. To date two Nigerian Fellows have completed the programme and one is attending this year. Information on the Fellowship programme can be found at www.rau.ac.uk/africa and applications will be invited for the 2017 programme later this summer.
- The University has been involved in a number of contract research and consultancy developments across Africa; the following provides some examples:
    - Evaluation of soil erosion risks using the SLEMSA model and then providing farmer guidance to reduce sedimentation risks for micro-hydroelectric plant (TANZ).
    - Agricultural Education and Training Strategy for Colleges and Universities (RSA).
    - Initial appraisal of land for Foreign Direct Investment (FDI) by expatriate national (KEN).
    - Evaluation of Bio-intensive Training Centre and extension (KEN).
    - Small-scale farmer supply of vegetables to mining company (ZAM).
    - Joint venture between UK integrator and farmers (ZAM)
    - Leadership in Agricultural Development training (NIG).

- We are currently working on the development of farmer and agri-business incubation units (MOZ) and have bid to develop similar capacity building strategies (ANG & TANZ). In addition, we have signed an MOU with the rural university forum for Africa (RUFORUM) in order to explore joint capacity building.

In summary, the main areas we are interested in developing are threefold:

1. Helping smallholders move from subsistence farming to commercial agriculture though developing both capacity and the right business models to connect them to value chains.
2. Working with Agricultural Colleges and Universities to develop innovative curriculum and staff capacity to service commercial smallholder and commercial agricultural needs.
3. Leadership and high level capacity building for rural and agricultural development.

Should any of these or other areas of development be of interest, then I would welcome the opportunity to discuss these further with you; in the meantime, may I thank you for allowing Samson to study in-country.

Yours faithfully,

Dr Richard Baines
Director – Africa Programmes

Appendix 3: The Farmers Interview Questionnaire for Livelihood Survey

ROYAL AGRICULTURAL UNIVERSITY
CIRENCESTER, UNITED KINGDOM

SCHOOL OF AGRICULTURE

USE OF INFORMATION AND COMMUNICATION TECHONOLGIES (ICTs) AMONG EXTENSION WORKERS AND FARMERS AND ITS RELEVANCE TO SUSTAINABLE AGRICULTURAL DEVELOPMENT IN NIGERIA

FARMERS INTERVIEW QUESTIONNAIRE

Dear respondent,

My name is Samson Olayemi Sennuga. I am a Postgraduate student at the Royal Agricultural University, Cirencester, United Kingdom. I am currently undertaking a research study which explore how Information and Communication Technologies (ICTs) could be used to improve the adoption of good agricultural practices and to increase productivity of smallholder farmers in Nigeria using mobile telecommunication (GSM) as an extension tool supporting traditional extension approaches.

I am carrying out this livelihood survey to gather some basic information and it is important to know your views. Results from this study will yield valuable information that will increase your productivity. I am writing to request your cooperation in filling out the attached survey.

The information gathered will remain strictly confidential. It will not be passed to government or any other organization. It will be used exclusively for the purpose of this study.

Thanks for your cooperation.

Some materials have been removed from this thesis due to Third Party Copyright. Pages where material has been removed are clearly marked in the electronic version. The unabridged version of the thesis can be viewed at the Lanchester Library, Coventry University

Question No	Question	Response				
Q1	Name of Respondent					
Q2	Are you the household Head?	**Yes**		**Q3** If not what is your relationship to the HH? (e.g. wife, son, brother)		
		No				
Q4	Respondent Mobile Number					
Q5	Name of Respondent Community					
Q6	Respondent's Gender	**Male**		**Female**		
Q7	Marital Status i) Single ( ) ii) Married ( ) iii) Separated ( ) iv) Divorced ( )					
Q8	a) Respondent Age *(tick appropriate response)* b) *Family (Household) age/gender*	Respondent age	Tick	Family(Household) age	No	Gender
		Less than 20 Years		**Less than 5 yrs**		**M F**
		20 – 30 Years		**5 - 10 years**		
		31 – 40 Years		**11 – 20 years**		
		41 – 50 Years		**21 – 30 Years**		
		51 – 60 Years		**31 – 40 Years**		
		61 – 70 Years		**41 – 50 Years**		
		Above 70 Years		**Above 50 years**		
		Doesn't Know		**Doesn't know**		
Q9	a) Respondent Highest Educational Level b) *Family Education*	**a) Respondent**	Tick	b) No of family	Gender **M F**	
		Primary				
		Secondary				
		Tertiary				
		No Education				
Q10	Can you read and write? English Language Local Language (Hausa)	**Literate**		**Q11** How about other members of HH?		
		Illiterate		**Literate (number)**		
				Illiterate (number)		
Q12	a) How many meals does your household normally consume in a day? b) How many meals each day contain protein (meat, fish, beans)	**1 meal**	**2 meals**	**3 meals**	**More**	

Q13	**Household Assets** Describe the building of your house a) What type of walls? b) What type of roof? c) How many rooms d) Water supply *Take photo of house if possible*	Mud brick [ ] Brick [ ] Wood [ ] other (state) ………… Tiles [ ] Tin [ ] Wood/thatch [ ] other e.g Zink…….. State room number ….. In house [ ] Local standpipe [ ] Collect from well [ ] Collect from river/lake/stream [ ] distance ………..

Q14	Tick the assets that are owned by the household	Vehicle	Radio
		Cart	Mobile Phone
		Bicycle	Television
		Plough	Solar Panel
		Irrigation equipment	Other (state) (Inverter)

	Main Household Assets	**No**	**Yes**	**If Yes – how many?**
Q15	Do you own any cattle?			
	Do you own any goats / sheep?			
	Do you own any pigs?			
	Do you own any chickens?			
	Do you own any other livestock? (e.g Donkey, Carmel, Rabbit, Horse)			

		Crop	Rationale e.g. home consumption and % to market
Q16	**Please indicate the five most important crops to you?**	**i)**	
		ii)	
		iii)	
		iv)	
		v)	

Q17	**Labour** How many of the household members work on the farm?	Full time	**No**	Part time	**No**

Q18	Do you bring in labour or rent out family members to other farms?	Labour brought in [ ] days per month; Cost per day [ ] Labour rented out [ ] days per month; Cost per day [ ]

Q19	Respondent's Tribe		Religion / Denomination	i. Islam ( ) ii. Christianity ( )

Q20	**Land** What is the size of your total production/farmland? *(use appropriate measures community are familiar with).* *If uncertain then pace out when visiting plots*	Less than $20m^2$ (4m x 4m) Less than 0.002 hectare	
		$20m^2$ to $50m^2$ (up to 6m x 6m) 0.002 to 0.005 hectare	
		$50m^2$ to $100m^2$(up to 10m x10m) 0.005 to 0.01 hectare	
		$100m^2$ to $400m^2$(up to 20m x 20m) 0.01 to 0.04 hectare	

<table>
<tr><td></td><td></td><td>Larger – state the size</td><td colspan="4"></td></tr>
<tr><td></td><td></td><td>Is your land in 1 or several plots</td><td colspan="4">1 plot [ ] several [no …….]</td></tr>
<tr><td>Q21</td><td>Do you have title deeds for the land?</td><td colspan="5">YES [ ] NO [ ] Some with title deeds [ ]</td></tr>
<tr><td>Q22</td><td>Water
Do you have a water source for your crop production activities and livestock?</td><td>YES</td><td></td><td>NO</td><td colspan="2"></td></tr>
<tr><td>Q23</td><td>If Yes what is your source of water?</td><td>River
Stream
Borehole</td><td></td><td>Rain-fed
Dam
Well</td><td colspan="2"></td></tr>
<tr><td>Q24</td><td>Does this source provide you with sufficient water for crop production throughout the year?</td><td>YES</td><td></td><td>NO</td><td colspan="2">No of months dry [ ]</td></tr>
<tr><td>Q25</td><td>Do you have irrigation equipment for your crop production activities?</td><td>Yes</td><td></td><td colspan="3">NO (Go to Q 28)</td></tr>
<tr><td>Q26</td><td>Type of irrigation equipment</td><td>Treadle Pump
Drip</td><td></td><td>Sprinkler
Buckets</td><td colspan="2"></td></tr>
<tr><td></td><td></td><td colspan="5">Other (specify)</td></tr>
<tr><td>Q27</td><td>What is your preferred irrigation method?</td><td colspan="5"></td></tr>
<tr><td>Q28</td><td>Crop Inputs
a) Are the inputs required for crop production easily available to farmers in your community e.g. seeds, fertilizers and pesticides?
b) If no, what are the main reasons?</td><td colspan="5">Seeds Yes [ ] No [ ]
Fertilizers Yes [ ] No [ ]
Pesticides Yes [ ] No [ ]

Reasons:</td></tr>
<tr><td>Q29</td><td>What is the main challenge that you face to access crop production inputs?</td><td>Finance</td><td></td><td>quality of inputs</td><td colspan="2"></td></tr>
<tr><td></td><td></td><td>Distance from input markets</td><td></td><td colspan="3">Other (specify)</td></tr>
<tr><td>Q30</td><td>Do you have enough labour to facilitate crop and livestock production in your household</td><td>YES</td><td></td><td>NO</td><td colspan="2"></td></tr>
<tr><td>Q31</td><td>If NO, why is labor a constraint (explain)</td><td colspan="5"></td></tr>
</table>

<table>
<tr><td>Q32</td><td>Do you receive extension advice from a trained extension officer regularly?</td><td>YES</td><td></td><td>NO
go to Q35</td><td></td></tr>
<tr><td>Q33</td><td>How often do you receive visits by an extension officer for technical support linked to your vegetable production activities?</td><td>Weekly</td><td></td><td>Every two months</td><td></td></tr>
<tr><td></td><td></td><td>Monthly</td><td></td><td>Once every 5 - 6 months</td><td></td></tr>
<tr><td></td><td></td><td>Every three months</td><td></td><td>Never received a visit</td><td></td></tr>
<tr><td>Q34</td><td>The extension officers that visit you – where are they from?
(Take note of the extension officers name)</td><td>Government</td><td></td><td>Private Company</td><td></td></tr>
<tr><td></td><td></td><td>NGO</td><td></td><td colspan="2">Other (specify)</td></tr>
<tr><td>Q35</td><td>Are you satisfied by the technical support that you receive from extension officers?</td><td>YES</td><td></td><td>NO</td><td></td></tr>
</table>

Q36	If No, what is your main concern?	

Sample enterprise questions – vegetables.

V1	**Vegetables** **(if no vegetables go to Q)** What is the size of your vegetable production plot? *(tick appropriate response)*	Less than 10m^2 Less than 0.0001 hectare			
		10m^2 20m^2 (4m x 4m) 0.0001 - 0.002 hectare			
		20m^2 to 50m^2 (up to 6m x 6m) 0.002 - 0.005 hectare			
		50m^2 to 100m^2 (up to 10m x 10m) 0.005 - 0.01 hectare			
		100m^2 to 400m^2 (up to 20m x 20m) 0.01 - 0.04 hectare			
		Larger – state size			
V2	Do you grow vegetables for sale or home use at your farm?	YES for sale	No for home use	Some for sale %	
V3	Are you involved in commercial vegetable production and marketing and for how long?	Less than 1 Year		3 – 4 Years	
		1 – 2 Years		4 – 5 Years	
		2 – 3 Years		More than 5 Years	
V4	Surplus vegetables, a) Do you store vegetables b) Do you take them to market c) Do you compound as feeds to animals	No [ ] Yes [ ] if yes, type of store ………………….. No [ ] Yes [ ] if yes, which market ……………… No [ ] Yes [ ] if yes, Compost [ ] Animals [ ]			
V5	How far is this market from your production plot?	Less than 2 KMs		20 – 40kms	
		2 - 10 KMs		40 – 50kms	
		10 - 20 KMs		More than 50KMs	
V6	How long does it take you to get to this target market?	Less than 1 hour		3 – 4 hours	
		1 - 2 Hours		4 – 5 hours	
		2 – 3 Hours		More than 5 Hours	
V7	How do you get your produce to this target market?	Walk		Bicycle	
		Bus		Car	
		Other (specify)……..			
V8	How often do you supply vegetables to the market?	Daily			
		Weekly			
		Every 2 weeks			
		Once a month			
V9	How long have you been supplying vegetables to the Market?	Less than 1 Year		3 – 4 Years	
		1 – 2 Years		4 – 5 Years	

V10	Do you get any specific extension or technical advice on vegetable production?	Public Extension	Y/N	Details…
		Private extension	Y/N	Details
		Farmer Group or other	Y/N	Details

Sample enterprise questions – Livestock

L1	**Livestock** Which livestock do you keep and what area of land for each (private and communal land)	Cattle	Area (private/communal) /
		Goats	Area (private/communal) /
		Sheep	Area (private/communal) /
		Poultry	Area (private/communal) /
		Small livestock, specify Rabbit……	Area (private/communal) /
		Fish	Area (private/communal) /

L2	(a) Do you keep/rear livestock (Cattle, Goat, Sheep, Small livestock etc.) for sale or family consumption?	YES for sale (mention the species)	No for home use	Some for sale %

L3	Are you involved in commercial livestock production and marketing and for how long?	1 – 2 Years		4 – 5 Years	
		2 – 3 Years		5 – 6 Years	
		3 – 4 Years		More than 6 Years	

L4	Livestock production a) Do you have market for your livestock (Cattle, Goat, Sheep, Small livestock) b) Do you take them to market? c) Do the buyers come to farm to buy livestock?	No [ ] Yes [ ] No [ ] Yes [ ] if yes, which market …………………. No [ ] Yes [ ]

L5	How far is this market from your livestock production plot?	Less than 2 KMs		20 - 40 Kms	
		2 - 10 KMs		40 - 50 Kms	
		10 - 20 KMs		More than 50KMs	
L6	How long does it take you to get to this target market?	Less than 1 hour		3 - 4 hours	
		1 - 2 Hours		4 - 5 hours	
		2 – 3 Hours		More than 5 Hours	
L7	How do you get your livestock (Cattle, Goat, Sheep, Small livestock etc.) to this target market?	Walk		Motorcycle	
		Bus		Car	
		Other (specify) e.g Truck, Donkey……...........			

L8	How often do you supply livestock (Cattle, Goat, Sheep, Small livestock etc.) to the market?	Yearly/During festive period			
		Every 2 years			
		Every 3 years			
		Other (specify)			
L9	How long have you been supplying livestock to the Market?	2 - 4 Years		8 – 10 Years	
		5 – 7 Years		Other (specify)	
L10	Do you get any specific extension or technical advice on livestock production?	Public Extension	Y/N	Details…	
		Private extension	Y/N	Details	
		Farmer Group or other	Y/N	Details	

Sample enterprise questions – Crops – Maize

C1	**Field Crops - Maize** What is the size of your maize production plot? *(tick appropriate response)*	Less than $10m^2$ Less than 0.0001 hectare			
		$10m^2$ $20m^2$ (4m x 4m) 0.0001 - 0.0002 hectare			
		$20m^2$ to $50m^2$ (up to 6m x 6m) 0.002 - 0.005 hectare			
		$50m^2$ to $100m^2$ (up to 10m x 10m) 0.005 - 0.01 hectare			
		$100m^2$ to $400m^2$ (up to 20m x 20m) 0.01 - 0.04 hectare			
		Larger – state size			
C2	Do you grow maize for sale or home use at your farm?	YES for sale	No for home use	Some for sale %	
C3	Are you involved in commercial maize production and marketing and for how long?	Less than 1 Year		3 – 4 Years	
		1 – 2 Years		4 – 5 Years	
		2 – 3 Years		More than 5 Years	
C4	Surplus maize, a) Do you store maize b) Do you take them to market c) Do you compound feeds for your animals?	 No [ ] Yes [ ] if yes, type of store ………………….. No [ ] Yes [ ] if yes, which market …………………. No [ ] Yes [ ]			
C5	How far is this market from your maize production plot?	Less than 2 KMs		20 – 40kms	
		2 - 10 KMs		40 – 50kms	
		10 - 20 KMs		More than 50KMs	
C6	How long does it take you to get to this target market?	Less than 1 hour		3 – 4 hours	
		1 - 2 Hours		4 – 5 hours	
		2 – 3 Hours		More than 5 Hours	

C7	How do you get your produce to this target market?	Walk		Bicycle	
		Bus		Car	
		Others (specify e.g Truck, Donkey)…….			
C8	How often do you supply maize to the market?	Quarterly (4 x a year)			
		2 x a year			
		Yearly			
		Every 2 years Others (Specify)			
C9	How long have you been supplying maize to the Market?	Less than 1 Year		3 – 4 Years	
		1 – 2 Years		4 – 5 Years More than 5 Years	
C10	Do you get any specific extension or technical advice on grain production?	Public Extension	Y/N	Details…	
		Private extension	Y/N	Details	
		Farmer Group or other	Y/N	Details	

Good Agricultural Practices and Extension including ICTs

			Public Extension officer Private extension Academia NGO's	
1	How often do you receive extension officer visit?	Every month		
		Every 3 months		
		Every 6 months		
		Yearly		
		Other (specify)		
2	Do you get appropriate information that meets your needs?	Yes		
		No		
3	How accessible is extension information to you?	Very accessible		
		Accessible		
		Fairly accessible		
		Not accessible		
4.	How effective is extension advisory services in terms of usefulness of information?	Very effective		
		Effective		
		Fairly effective		
		Not effective		
5	Do you have any challenges related to extension advice to improve your productivity?	Yes [ ] explain….		
		No		
6	Have you heard about good agricultural practices?	Yes		

		No		
7	If yes, where did you hear about good agricultural practices?	Extension agents		
		My neighbour		
		Radio		
		Television		
		Mobile phone		
		Printed materials		
		Other (specify)		
8	Have you ever implement advice on good agricultural practices on your farmland?	Yes [ ] which..		
		No		
9	Do you have Mobile phone?	Yes		
		No		
10	How often do you use mobile phone to get information related to your farming enterprise?	Daily		
		Weekly		
		Monthly		
		Quarterly		
		Bi-annually		
		Yearly		
11	What types of agricultural information do you get using ICT (Mobile phone)?	Market information		
		Government/NGO agricultural schemes		
		Information on cropping pattern, use of fertilizer		
		Information on new crop varieties, irrigation		
		Other (specify)		
12	Do you use mobile phone to send SMS text or receive SMS text?	Yes [ ] details...		
		No		
13	Do you make calls via your mobile phone to access appropriate information?	Yes		
		No		
14	Do you receive voice or send voice messages via your mobile phone?	Yes		
		No		
15	Have you ever received market information via ICT e.g phone etc	Yes		
		No		
16	Have you ever received information on Government and NGO's subsidies schemes via ICTs?	Yes		
		No		
17	Have you ever received market information via ICTs?	Yes		
		No		
18		Yes [ ] state the challenge		

	Do you have any challenges associated with using ICTs to access information?	No	
19	How effective is the use of ICT in meeting your information needs?	Very effective	
		Effective	
		Fairly effective	
		Not effective	
20	Between ICT and traditional extension which one really meets your timely and appropriate information needs?	Traditional Extension	
		ICTs	

Appendix 4: The interview schedule for focus group discussions with 20 Extension Workers

Engagement questions:

1. What are the traditional extension models and how effective are extension services and communication in Nigeria? (What is the focus, what is working what is not working-perhaps a flip chart to note).

2. To what extent do you use mobile phones in the service delivery to smallholder farmers? (What proportion of farmers, what types of messages timing etc).

Exploration Questions:

3. To what extent are smallholder farmers are aware of GAP (Technology adoption) through your extension services in this community?

4. What are the main opportunities and barriers to the GAP (Technology adoption) in among smallholder farmers in Nigeria?

5. What are your perceptions on the effectiveness of Mobile phones in completing traditional extension models in Nigeria?

6. How do you feel about the use of mobile phone in the adoption of GAP among farmers?

Exit question:

7. Is there anything else you would like to say about significant role mobile phones play in course of your work as an extension agent?

------Summary of key issues generated by the discussion-----------------------------

Appendix 5: In-depth Interview schedule with Four Senior Extension Managers

Interview

- Introduction
- Thank the interviewee for their time and willingness to share views.
- Briefly go over the purpose of the study and the scope of the interview.
- Start with a question that is important but not too specific.

In-depth Interview

1. To what extent are you aware of GAP, and how will you encourage farmers to adopt new technologies?

2. In your opinion, what are the factors that influenced the adoption of innovations among farmers?

3. What are your perceptions on the adoption of modern ICTs (mobile phone) compared with traditional extension in term of service delivery?

4. What are the socio-economic characteristics that influenced the adoption of modern?

5. What are the enabling factors that can improve the adoption of GAP among smallholders?

6. Is there anything else that you would like to add? Or other issues/points that I may have missed? Thank you!

------Summary of key issues generated by the discussion-----------------------------

Appendix 6: The Evaluation Survey Questionnaire with Smallholder Farmers

Royal Agricultural University Cirencester

United Kingdom

EVALUATION SURVEY QUESTIONNAIRE

The aim of the survey is to evaluate what was adopted and what was not and why? (Barriers to adoption) based in the initial workshop.

Section A:

Indicate the GAP technologies you adopted or did not adopt? Please tick

Action Plan	Adopted Yes	Partial	Not Adopted	Reason
			Why?	Why: Did it work? Or, why did it not work?
1) Soil management				
ii) Water management				
iii) Fertilizer application				
iv) Crop rotation				
v) Compost and Green Manure				
vi) Cover crops				
vii) Improved storage				
viii) Mulching				
ix) Striga control				
x) Spraying of herbicide				

xi) Improved planting spacing of crops				
xii) Pesticide use/Pest control				
xiii) Improved seeds				
xiv) Use of crop residue to feed livestock				
xv) Spacing				
xvi) Zero tillage				

Section B:

Assessment of mobile phone on the adoption of GAP technologies by smallholder farmers and the impact of ICT on agricultural productivity.

Q1. How long have you been using mobile phone?

1. 1-2yrs ☐
2. 3-4yrs ☐
3. 4-5yrs ☐
4. 6 -7yrs ☐
5. Above 8yrs ☐

Q1b. What sort of mobile phone do you have?

Basic ☐
Call and Text ☐
Smartphone ☐
Internet connectivity ☐

Q2. Do you think the use of mobile phone has improved your adoption of GAP technologies?

1. Yes ☐
2. Partially ☐
3. No ☐

Q3.How would you rate your level of adoption for the following GAP technologies using mobile phone		
1) Soil management	**1**.High ☐ 2.Average ☐ 3.Low ☐	
ii) Water management	**1**.High ☐ 2.Average ☐ 3.Low ☐	
iii) Fertilizer application	**1**.High ☐ 2.Average ☐ 3.Low ☐	
iv) Crop rotation	**1**.High ☐ 2.Average ☐ 3.Low ☐	
v) Compost and Green Manure	**1**.High ☐ 2.Average ☐ 3.Low ☐	

vi) Cover crops	**1**.High ☐ 2.Average ☐ 3.Low ☐	
vii) Improved storage	**1**.High ☐ 2.Average ☐ 3.Low ☐	
viii) Mulching	**1**.High ☐ 2.Average ☐ 3.Low ☐	
ix) Striga control	**1**.High ☐ 2.Average ☐ 3.Low ☐	
x) Spraying of herbicide	**1**.High ☐ 2.Average ☐ 3.Low ☐	
xi) Improved planting spacing of crops	**1**.High ☐ 2.Average ☐ 3.Low ☐	
xii) Pesticide use/Pest control	**1**.High ☐ 2.Average ☐ 3.Low ☐	
xiii) Improved seeds	**1**.High ☐ 2.Average ☐ 3.Low ☐	
xiv) Use of crop residue to feed livestock	**1**.High ☐ 2.Average ☐ 3.Low ☐	
xv) Spacing	**1**.High ☐ 2.Average ☐ 3.Low ☐	
xvi) Zero tillage	**1**.High ☐ 2.Average ☐ 3.Low ☐	

Q4. Do you get up to date information about agricultural productivity?

1. Yes ☐
2. No ☐

Q5. Does the information you get through mobile phone have significant impact and increase your agricultural productivity?

1. Yes ☐
2. Partially ☐
3. No ☐

Q6. Do you think the workshop/training of GAP and the use of mobile phone increase your agricultural productivity this planting season?

1. Yes ☐
2. Partially ☐
3. No ☐

Q7. Where is your preferred source of getting relevant information on agricultural productivity?

1. Friends ☐
2. Other farmers ☐
3. Extension workers ☐
4 Radio ☐
5. Mobile phone ☐
6. Other source (specify) ☐

Section C:

Evaluate the use of ICT (mobile phone technology)by farmers for market information.

Q8. Do you get market information through mobile phone?

1. Yes ☐
2. No ☐

Q8b. What sort of information do you get through your mobile phone?

1. …………………….…………………….. (2)………………………..……………………

3. …………………….................……… (4)……………………………………………..

5. ………………………………………… (6)……………………………………………..

7. ………………………………………… (8)……………………………………………..

Q9. How frequently do you use mobile phone to get market information?

1. Everyday ☐
2. Every week ☐
3. Every month ☐
4. Other (specify)……….. ☐

Q10. Do you think you get market information on time?

1. Yes ☐
2. No ☐

Q11. Do you think you the use of mobile phone increase your market information?

1. Yes ☐
2. No ☐

Q12. Where is your preferred source to get market information?

1. Friends/relatives ☐
2. Other farmers' ☐
3. Extension workers ☐
4. Radio ☐
5. Mobile phone ☐
6. Other source specify……… ☐

SECTION D: Barriers to adoption of Good Agricultural Practices

To what extent do you agree with the following factors affecting adoption of technologies?

Factors Affecting Adoption	**Strongly Agree (5)**	**Agree (4)**	**Undecided (3)**	**Strongly Disagree (2)**	**Disagree (1)**
Q13A.***Characteristicsof Technologies*** i. Cost ii. Finance/capital iii. Relative advantage iv. Technical appropriateness v. Complexity of application **vi.** Divisibility					
B. *Characteristics of Adopters* i. Technical skill ii. Attitude towards change iii. Attitude towards taking risk iv. Income level v. Farmers exposure vi. Land tenure system vii. Years of farming experience viii. Religion ix. Education level x. Labour					
C. ***Cultural Factors*** i. Belief ii. Norms iii. Taboo					
D. ***Characteristics Of Change Agents*** i. Communication Ability ii. Competency iii. Credibility iv. Confidence					
E. *Government Policy*					
F. ***Environmental Factors*** i. Weather condition					

NB: Farmers should endeavour to mention any other factor (s) aside from the aforementioned. They should be listed hereunder:

1.

2.

SECTION E: Types of Communication preferred by smallholder farmers.

Please indicate the most preferred types of communication from the list below.

Communication channel	Not at all (5)	Slightly (4)	Moderately (3)	Very Much (2)	Am Not Familiar (1)
Q14a. The value of traditional extension among smallholder farmers: **1. *Interpersonal channel :*** a. Extension agents b. Contact farmers c. Opinion leaders d. Farmer-to-farmer extension model e. Friends/neighbours					
2. *Mass media :* a. Radio b. Television c. Newspapers d. Pamphlets e. Film show f. Extension bulletins **g.** Posters/Handbills					
3. *Use of modern ICTs:* a. Mobile phone b. Internet c. Computer d. SMS messaging e. Interactive Voice Response system f. Ipad g. Email					

SECTION F: Problems in using Communication channels

Q15. Do you have problem (s) in using any of these communication channels? Please tick as appropriate and say why?

Communication channel	Yes (1)	No (0)	Q15b. If Yes, please indicate at most 2 problems you have in using any of the above listed communication channels
Q15a 1.**Interpersonal channel :** a. Extension agents b. Contact farmers c. Opinion leaders d. Farmer-to-farmer extension model e. Friends/neighbours			
2.**Mass media :** a. Radio b. Television c. Newspapers d. Pamphlets e. Film show f. Extension bulletins g. Posters/Handbills			
3.**Use of modern ICTs:** a. Mobile phone b. Internet c. Computer (Desk or Laptop) d. SMS messaging e. Interactive Voice Response system			

f. Ipad **g.** Email			

Thank you for your time.

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Appendix 7: The Market Intelligence Survey Questionnaire with Farmers and Traders

MARKET INTELLIGENCE SURVEY QUESTIONNAIRE
IN FOUR DIFFERENT MARKETS IN KADUNA STATE, NIGERIA

SECTION A: PERSONAL AND SOCIO-ECONOMIC CHARACTERISTICS OF THE TRADERS

Q1. Respondent Gender: 1□ Male 0□ Female

Q2. Respondent Age: 20-30□1 31-40□2 41-50□3 51-60□4 61-70□5 above 70□6

Q3. Marital Status: 0□Single 1□Married 2□Widowed 3□ Divorced 4□ Separated

Q4. Household Size (in Numbers): ( )

Q5. Academic Qualification (s) 0□None 1□Pry 2□Secondary 3□Tertiary

Q6. Trading Experience:………Years

Q7. Do you have your own mobile phone? □Yes (1) □No (0)

Q8a. How long have you been using mobile phone? **Q9b.** What sort of mobile phone do you have?

6. 1-2yrs	□	Basic	□
7. 3-4yrs	□	Call and Text	□
8. 4-5yrs	□	Smartphone	□
9. 6 -7yrs	□	Internet connectivity	□
10. Above 8yrs	□		

Q10. Are you a Wholesaler/Retailer? 1. Yes 0.No

Q11. Are you a Grains trader or mixture? 1. Yes 0.No

Q12. Do you purchase your commodities/grains from farmers through direct calls/texts via mobile phones? 1. Yes 0.No

SECTION B: MARKETING MAGIN INFORMATION

Q13. Commodities traded:

1. Rice ( )
2. Maize ( )
3. Cowpea ( )
4. Soya Beans ( )
5. Yam ( )
6. Maize ( )
7. Pepper ( )
8. Groundnut ( )
9. Other specify ( )

Q14. What is the producer price for 1 bag of local rice? (₦)..

Q15. What is the producer price for 1 bag of Maize? (₦)..

Q16 . What is the producer price for 1 bag of Cowpea? (₦)..

Q17. What is the producer price for 1 bag of Soya Beans? (₦)...

Q18. What is the consumers price for 1 bag of local rice? (₦)..

Q19. What is the consumers price for 1 bag of Maize? (₦)..

Q20. What is the consumers price for 1 bag of Cowpea? (₦)..

Q21. What is the consumers price for 1 bag of Soya Beans? (₦)..

Q22. How much do you pay for loading and off-loading of 100kg of maize/grain from the bulking market to the market which you trade? (₦)..

SECTION C: USEFULNESS OF MOBILE PHONE TO TRADERS IN THE STUDY AREA

Q23. Do you actively seek for market information? Yes......... No.......

Q24. Do you have any price control? Yes......... No.......

Q25. List activities and functions you use your mobile phone for.

1...

2...

3...

4...

5...

Q26. Do you agree with these statement?

I Feel Safer Because I Own a Mobile Phone	Yes.........	No.......
I Feel More Connected Because I Own a Mobile Phone	Yes.........	No.......
I Feel More Independent Because I Own a Mobile Phone	Yes.........	No.......
Mobile Phones Unlock Economic Opportunities	Yes.........	No.......
Mobile Phones Enable Women's Voices to be Heard	Yes.........	No.......

Q27. What type of information do you need to improve trading business?..
....

Q28. Do you think the use of mobile phone has improved your trading business?

3. Yes □
4. Partially □
3. No □

Q29. List 5 benefits derive from mobile phone for your trading business.

1...

2...

3...

4...

Constraints to the use of mobile phone

Q30. What problem have you been facing in using mobile phone to contact famers for supplies?

1...

2...

3...

4...

5...

Q30. How can these problems be solved?

Appendix 8: Participants' information sheet (focus group discussions with extension workers)

Focus Group Confirmation Letter

Royal Agricultural University,
Cirencester,
Gloucester,
United Kingdom.
20th February, 2016.

Dear…………………………,

Thank you for your willingness to participate in my focus group discussion. As discussed on the phone, I would like to hear your ideas and opinions about the effectiveness of traditional extension system in Nigeria and the role ICTs (especially mobile phone) can play in complementing current extension models.

You will be part of a group of 7 to 11 other extension workers from Government (ADP), NGOs, the Private sector and Academia.

The responses and discussions within the group will be kept anonymous and only referred to as extension professionals. Honorarium will be paid at the end of the focus group discussion to recognise your time and contributions. The date, time, and place are listed below. Please look for signs once you arrive directing you to the room where the focus group will be held.

May I thank you in anticipation for your insight into improving extension through ICT practices.

DATE:

TIME: 12pm

PLACE: NAERLS Complex, Ahmadu Bello University, Zaria, Nigeria.

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In anticipation, thank you very much for your help!

<table>
<tr><th colspan="3">Focus Group Participants Demographics</th></tr>
<tr><th colspan="3">Date: Time: Place:</th></tr>
<tr>
<td>Your age:
20 to 30 ☐
31 to 40 ☐
41 to 50 ☐
51 to 60 ☐</td>
<td>Gender:
Male ☐
Female ☐</td>
<td>Type of practice and years:
Academia ☐
Public (ADP) ☐
Private ☐
NGOs ☐</td>
</tr>
<tr>
<td>What is your Specialty:
Village Ext. Agent ☐
Block Ext. Supervisor ☐
Subject Matter Specialist ☐
Other specify..............</td>
<td>How long have you been in practice?
Less than 10years ☐
10 to 20years ☐
More than 20 ☐</td>
<td>How often do you use Mobile phone for service delivery to farmers?
Everyday ☐
Every week ☐
Twice a month ☐
Not at all ☐
What proportion of farmers you contact have mobile phones:..................</td>
</tr>
</table>

Focus Group Introduction

Welcome

Thanks for agreeing to be part of the focus group. We appreciate your willingness to participate

Introduction

Moderator (Samson O. Sennuga)
Assistant moderator (Peter Talabi)

Purpose of Focus group

I am conducting a PhD Research on the use of ICT (especially mobile phone) among extension workers and farmers and its relevance to sustainable agricultural practices in Nigeria. The reason we are having this focus group discussion is to get your views on the effectiveness of Extension systems in Nigeria and the significant role ICTs (mobile phone) can play in complementing extension models for efficient service delivery to farmers. To link ICT to sustainable practices I have used the adoption of GAP's relevant to this region and smallholders as the focus for communication between extension workers and farmers.

ANNEX 1

Introduction

Good Agricultural Practices Reviewed

Guidelines to improve farm practices and GAP related to soil management, water management and nutrient application

This booklet is aimed at providing support to smallholder farmers wanting to improve their farm activities in order to increase productivity and livelihood. The booklet can be used with decision support tool developed by the researcher or as an informative summary of good farm practices on soil management, water and nutrients.

This guideline are based on up-to-date knowledge on GAP, their sources and their effectiveness as commonly applied in developed countries and scientific evidences.

For further information, please contact:

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Good Agricultural Practices related to Soil, Water and Nutrient application Guidelines to improve farm practices with scientific evidence

GAP Code #	GAP	Climatic Zone	Scientific evidence	Expected outcomes	References
SM1	Soil management • Soil Organic Matter	Northern Guinea Savannah	• Higher Organic Matter holds fertility and is broken down slowly (Temp dependent). • Reduced breakdown in dry soils. • Increased breakdown in tropical and sub-tropical • High breakdown and tem can lead to loss in water.	• Increase yield • Quality • Reduced weeds, Pest & diseases. Cost saving	Aromolaran *et al.* (2001) FAO, 2003 Palm et al., 2001
SM2	• Crop rotation	Guinea Savannah	• Gradual formulations of N and split fertilizer applications can help reduce leaching and N losses. • Reduced use of pesticide • Removal of pathogen. • Maintains fertility and reduces soil erosion. • Conserves moisture. • Risk aversion.	Higher yields due to increased Nitrogen in soil.	Dimes *et al.*, 2013 FAO (2009) Dimes et al., 2013 Sharma& Singh, 2013.
SM3	• Soil Cover	Guinea Savannah	▪ Nitrogen-fixation in root nodules ▪ Increased soil microorganisms ▪ Improve soil fertility ▪ Microbial activity increased soil structure. ▪ Regulate vine growth ▪ Control soil erosion ▪ Creating compost fertilizer ▪ Reduced Nitrate leaching ▪ Improve soil structure & water holding capacity	▪ Weeds suppression ▪ Use for grazing ▪ Provide forage for pollinating insects and habitat. ▪ Reduced plant pests and diseases. ▪ Improve Soil quality ▪ Biodiversity and wildlife.	Sullivan, P. (2003) Larkin, R.P. (2011) Joyce et al. (2002) Hill et al. (2006)

SM4	• Fertilizer Application	Northern Guinea Savannah	▪ Use of NPK, NO_3 ▪ Crop growth & profitability ▪ Increase in crop yield. ▪ Quick response on the part of crops ▪ Rapid increase in productivity ▪ Improve soil fertility management ▪ Improve food security	▪ Higher yields through increased soil fertility. ▪ Incremental efficiency ▪ Soil testing ▪ Income growth ▪ Improve smallholder farm productivity ▪ Poverty reduction	Bayite-Kasule, S. (2007) Wang (2012)
SM5	• Minimizing runoff/erosion	Northern Guinea Savannah	Run-off can be prevented, through: ▪ Use of contour ploughing and wind breaks ▪ Leaving unploughed grass strips between ploughed lands. ▪ Avoiding overgrazing and the over-use of crop lands ▪ Encouraging biological diversity by planting several types of plants. ▪ Conservation of wetlands ▪ Plant cover reduces erosion ▪ It reinforces soil structure	▪ Management will minimize waste and will avoid excessive leaching and salinization. ▪ Manage ground and soil water by proper use or avoidance of drainage where required	Palm et al. 2001
SM6	• Conservation tillage	Northern Guinea Savannah	▪ Light tillage helps in increasing water absorption ▪ Higher yields in the long run in areas requiring more soil moisture.	30-40% increase in output. 55 % yield increase in soybean. 40 % yield in maize	Granatstein (1992)
WM	Water Management		• Establish a long-term plan for the sustainable management of water resources in agriculture taking into account climate change and climate variability impacts, including the increased need for protection from flood and drought risks and alteration in the seasonality and timing of precipitation.	• Contribute to raising agricultural incomes and achieving broader social equity and rural development goals. • Protect ecosystems on agricultural land or	▪ OECD 2010

			• Balance consumptive water uses across the economy with environmental needs; and •Improve water resource use efficiency, management and technologies on-farm and ensure the financing to maintain and upgrade the infrastructure supplying water to farms (and other users). ▪ Evidence in this report indicates	affected by farming activities.	
WM1	• Optimal Irrigation Practices	Northern Guinea Savannah	▪ Improve soil structure and increase soil organic matter content ▪ Apply production inputs, including waste or recycled products of organic. ▪ Maximize water infiltration and minimize unproductive efflux of surface waters. ▪ Proper use of water for irrigation as well as careful and adequate use of inputs. ▪ Timing and amount of irrigation is tailored to crop Requirements. ▪ Application techniques are appropriate to the amount of water available and selected according to local conditions. ▪ Soil water capacity is not exceeded, to minimise water waste and water pollution. ▪ Irrigation water quality is monitored and managed to avoid damaging or contaminating crops and soil. ▪ Irrigation managers, supervisors and operators are sufficiently trained ▪ Accurate records are kept.	▪ Higher yields. ▪ Enhance the functioning of the water cycle by establishing permanent cover.	FAO 2009 Knoop *et al.* 2012
WM2	• Drip irrigation		▪ Drip irrigation enables relatively small amounts of chemicals to be applied directly to plants' roots, which reduces leaching and		

		runoff and also does not raise air humidity (which encourages fungal growth). ▪ Trials experimental tomato farm in Brazil show that drip irrigation can reduce inputs of insecticide by 25% and fungicide by 50%.		
WM3	• Erosion prevention	Erosion can be strategically reduced by: ▪ Growing plants on terraces, with ridges to prevent water flow and erosion ▪ Planting crop bushes at high densities, to give a greater yield and extra soil protection. ▪ Designing drains and planning, managing and monitoring water movement to limit erosion. ▪ Digging micro catchments-small pits between freshly-planted tea bushes - to collect excess run-off. ▪ Planting oats as cover crops between newly-planted tea bushes on vulnerable slopes. ▪ Encourage riparian buffers to protect wetlands and waterways. ▪ Require proper septic system placement, design and maintenance. ▪ Require that plans include storm water management plans Encourage riparian buffers to protect wetlands and waterways. ▪ Using practices to conserve and reduce the amount of sediment reaching water bodies, overall protecting agricultural land and water quality.	▪ Using practices to conserve and reduce the amount of sediment reaching water bodies, overall protecting agricultural land and water quality. ▪ Leaving harvested plant materials on the soil surface to reduce runoff and soil erosion. ▪ Construction of ponds can make water available during dry spells in the rainy season, and for a few months after the rains cease. ▪ Enforce erosion control for logging, construction and agricultural activities.	Larkin, R.P. (2011) Joyce et al. (2002) Widomski (2014)
WM4	• Mulching	▪ Increased yields by 30% compared without mulching using white plastic mulch, yield from white yam increased by 34%.	▪ It control weeds ▪ It retains moisture ▪ Prevent moisture	

		▪ Mulching is essential to the survival of your landscape during a drought. Mulch will reduce the amount of water that evaporates from your soil, greatly reducing your need to water your plants. ▪ Mulch improves the quality of your soil by breaking up clay and allowing better water and air movement through the soil. ▪ Mulch provides nutrients to sandy soil and improves its ability to hold water. ▪ Mulch acts as an insulating layer on top of soil, keeping it cooler in the summer. ▪ Mulch keeps weeds down, and the weeds that do grow are much easier to pull. ▪ Cassava using white and black plastic mulch yield was 90% and 38.5% respectively.	▪ Maintain soil nutrient ▪ Control Pests ▪ Encourage earthworms to move in.	
WM5	• Terraces (conservation bench terraces)	▪ Terracing is an agricultural technique for collecting surface runoff water thus increasing infiltration and controlling water erosion known from an ancient history and used to transform landscape to steeped agro systems in many hilly or mountainous regions of the world (Zuazo *et al.*, 2005). ▪ Terracing is a soil conservation practice applied to prevent rainfall runoff on sloping land from accumulating and causing serious erosion. Terraces consist of ridges and channels constructed across-the-slope. ▪ Terraces provide these added benefits: ▪ The total area can be farmed, since grassed waterways are not needed;	▪ It helps in the conservation of soil and water. ▪ Terraces reduce both the amount and velocity of water moving across the soil surface, which greatly reduces soil erosion. ▪ Terracing thus permits more intensive cropping than would otherwise be possible	Wheaton and Monke, (2007) (Zuazo et al., 2005). Widomski (2014)

		▪ Elimination of grassed waterways also eliminates the inconvenience they cause when tilling or applying herbicides; ▪ Peak discharges are reduced because runoff is temporarily stored; and ▪ Sediment and other contaminants settle out behind the terrace ridge before polluting water in a receiving stream.	
WM6	Integrated Pest management	▪ Integrated Pest Management is a preventative, long-term, low toxicity means of controlling pests. ▪ Decreased use of chemical application will reduce risks to the health of staff members. ▪ Decreased use of chemical application will reduce the risk of deterioration and disfigurement of holdings. ▪ Decreased use of chemical application *may* result in a financial savings. ▪ The environmental improvements made to the facility to implement an IPM program will enhance the long-term stability of the holdings over and above protection against pests. ▪ IPM may be the *only* solution to some long-term pest problems where chemical application has not worked. ▪ IPM ultimately allows the institution to have greater control over and knowledge of pest activity in their facility. ▪ IPM is the pest management technique of choice for major institutions.	▪ Improved crop profitability due to better pest control measures and appropriate use of crop protection products. ▪ Stable, reliable and quality crop yields. ▪ Decreased severity of pest infestations. ▪ Reduced potential for problems of pest resistance or resurgence ▪ Increased consumer confidence in the safety and quality of food and fiber products.

WM7	Water conservation		▪ Properly chose crops so they are as suitable as possible with the agri-climatic conditions. ▪ Good agricultural practices as managing soil fertility and reducing land degradation can increase water efficiency. ▪ Minimise water use on the farm by reusing (where high-quality water is not needed, or even cleaned and recycled for high quality use), recycling, conserving and collecting water and/or using low demand systems. ▪ Use best available water-efficient irrigation systems. Reduce evaporation by avoiding midday irrigation and using trickle or drip irrigation techniques. ▪ Use Rainwater harvesting for irrigation, cleaning purposes. This can help to cut down on freshwater use, environmental impact and costs. Rehabilitate tanks and renovate of water harvesting structures if necessary. ▪ Storing runoff from rainy periods for use during dry spells by using tanks, ponds, cisterns, and earth dams.	▪	Granatstein (1992).
NA1	Nutrient Application • Chemical fertilizer/compost	Northern Guinea Savannah	• **Nutrient management** is using crop nutrients as efficiently as possible to improve productivity while protecting the environment. Nutrients that are not effectively utilized by crops have the potential to leach into groundwater or enter nearby surface waters via overland runoff or subsurface agricultural drainage systems.	▪ Fertilizer increase total yields. ▪ Increased soil carbon and reduced atmospheric carbon levels	Granatstein (1992). Tilman *et al.* (2002)

			• Farm productivity hinges on the nutrient availability. This depends on many factors: soil type, pH, climate, rotation and farm type so it's important to regularly test soils for key nutrients and to evaluate soil structure as well as organic matter levels • Manure organic matter contributes to improved soil structure, resulting in improved water infiltration and greater water-holding capacity leading to decreased crop water stress, soil erosion, and increased nutrient retention. • Major natural resource concerns facing cropland include: (1) erosion by wind and water, (2) maintaining and enhancing soil quality, (3) water quality from nutrient and pesticides runoff and leaching, and (4) managing the quantity of water available for irrigation. • An extensive literature review of historical soil conservation experiment station data from 70 plot years at 7 locations around the United States suggested that manure produced substantial reductions in soil erosion (13%-77%) and runoff (1%-68%).	▪ Reduced soil erosion and runoff. ▪ Reduced nitrate leaching. ▪ Reduced energy demands for natural gas-intensive nitrogen (N) fertilizers. ▪ Maintenance of optimum conditions for crop growth ▪ Protection of local and regional water resources. ▪ Enhancement of farm profitability. ▪ Both farm profitability and water quality can be improved through efficient nutrient use.	