The potential impact of mobile phone application in agroecological transitioning in southeast Nigeria

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Abstract: *Farmers' transition to agro-ecology is an ambitious challenge requiring a concerted effort to upscale adoption. Information communication technology (ICT) plays a significant role in improving smallholder farmer's livelihoods by linking them to markets, access to weather forecasts, agricultural techniques and other essential services. Hence, application of ICT such as mobile phone in agro-ecology could address the challenges in agro-ecological transition. Nigeria is amongst the sub-Saharan countries where agro-ecology is yet to gain a foothold. Mobile phone companies have invested extensively in Nigeria taking advantage of the huge population which was estimated at 191 million in 2017, resulting in improved access to mobile and internet facilities. Hence, Nigeria appears set for a pioneering revolution in ICT application for agro-ecology transition. In a six month pilot, a mobile phone-enabled platform known as SmartAgroecology was developed with 30 farmers and 20 extension personnel purposively selected for the study. Using a focus group discussion, the participants' perception of agro-ecology and the information delivery through the platform was assessed and the limitation to the application's wider use evaluated. Although there were socio-economic barriers to the application's wider use, access to information about agro-ecology practices improved and farmers are willing to adopt the practices using the platform irrespective of their circumstances and information sources. The application enhanced farmers and extension personnel training through information exchange. The study recommends unified efforts by all stakeholders in promoting initiatives that promote agro-ecology, whilst emphasising on efficiency and sustainability of such initiatives.*

Keywords*: Mobile phone-enabled application, Agro-ecology transitioning, Nigeria*

Introduction

Agro-ecology offers a solution to Africa's agricultural problems as it provides means of achieving food productivity without compromising on the integrity of the environment and polluting ecosystems. It is evident that agro-ecological techniques can increase health and livelihoods, yield or productivity and protect ecosystems at low cost (Altieri 2017). Agro-ecology provides approaches to enhance resilience and sustainability of food systems as well as a means of achieving the United Nations development goals and the principles of the right to adequate food (De Schutter, 2010). Agro-ecology is suitable for Africa as agro-ecological approaches can easily be adapted to local conditions and in the sustainable management of small land holds whilst protecting the environment and avoiding water pollution at a reduced cost (De Schutter, 2010). Additionally, agro-ecology improves and sustains on-farm fertility production, which in turn reduces farmers' reliance on external inputs and government subsidies, in addition to making vulnerable smallholder farmers less dependent on loans and retailing. This; has been experimented by growing green manure such as *Faidherbia albida* (a nitrogen-fixing plant species), other leguminous-cover crops or by applying livestock manure on the farm (Badgley et al., 2007). Agro-ecology is described as "*deeply rooted in the ecological rationale of traditional small-scale agriculture, representing long established examples of successful agricultural systems characterised by a tremendous diversity of domesticated crop and animal species maintained and enhanced by ingenuous soil, water and biodiversity management regimes, nourished by complex traditional knowledge systems*" (Altieri 2017). Although agro-ecological methods can be

labour intensive especially during the early implementation stage, because of the complexity of managing different plants and animals, and other farm activities such as recycling of farm waste. Ajayi et al., (2009) concluded that the higher labour-intensity of agro-ecological practice is a reality especially in short term, however, it creates job opportunities in return. Agro-ecology also contributes to nutritional diversity as a result of the diversified plant and animal species managed under agro-ecological principles on farms (DeClerck et al., 2011). Furthermore, agro-ecological practice can significantly mediate the negative effects of climate change by increasing carbon sinks in the soil organic matter and avoiding carbon dioxide through reduced use of direct and indirect energy (Mijatovic et al*.,* 2010; Hoffman, 2011; Aguilera et al., 2013). The impact of agro-ecological practices is illustrated in Figure 1. Despite these potentials, agro-ecological techniques have not been widely adopted in African countries such as Nigeria.

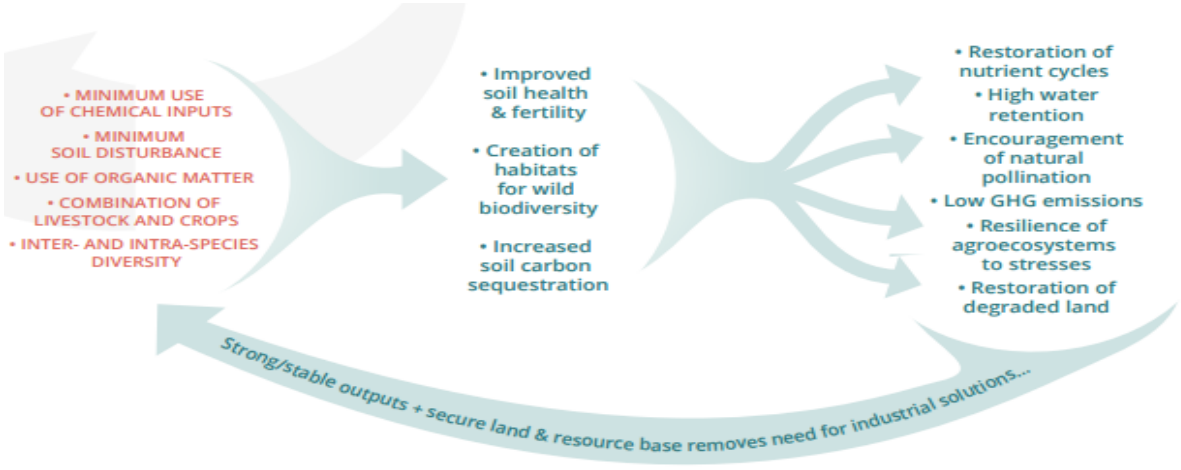

Fig. 1: The Circles of a Healthy Ecosystem in Diversified Agro-ecological System (Frison, 2016).

Nigeria is currently faced with food security crises with her growing population becoming increasingly dependent on imported processed foods (Okafor, 2011), in addition to the gradual marginalisation of the subsistence-oriented farm system, and insecure land tenure (Nwajiuba, 2011). The country is among the African countries that embraced the Green Revolution (GR) strategy which although improved cereal production but at considerable cost to human and the ecosystem. The GR approach influenced the intensification of land production area by reducing the fallow periods, increased mono-cropping and use of agro-chemicals (Akinwumi, 2014; Enete et al., 2011; Oguamanam, 2015; Pingali, 2013). Such agricultural activities have harmed the environment, affected human health, exacerbated climate change, increased the distortion of ecosystems, polluted the natural water systems, and rendered many soils infertile (Adomako and Ampadu 2015; Wallinga, 2009). Also, agriculture in Nigeria is faced with the rising temperature, desertification, rise in sea levels, and changes in rainfall patterns (Nwaiwu et al., 2013). Nwajiuba (2012) reported that agricultural activities in the region are less impressive. Aikhionbare (2015) further noted that agricultural activities in Nigeria are posing a devastating continuous effect on the farming system. The agricultural activities and the highlighted issues draw a significant attention to agro-ecology transitioning as it can no longer be comforting to claim that Nigeria's agricultural activities are ecologically sustainable.

Farmers' transition to agro-ecology is a challenge because agro-ecology farming systems are known to be knowledge-intensive and require concerted efforts to upscale adoption. Poor adoption of agricultural innovations especially in Nigeria has been blamed on poor agricultural information delivery systems. Obiora (2013) observed that organisational issues

such as poor funding and stretched extension to farmer ratio are impeding extension services for effective agricultural information delivery. Also, poor or non-existent extension services impact negatively on farmers motivation to adopt sustainable agricultural practices (Ma et al., 2009). Also, unavailability and inadequacy of extension services hamper farmers' training and programmes designed to enhance adoption of agricultural initiatives (FAO nd). On the other hand, Okeke et al., (2015) noted that effective agricultural information communication to farmers is vital in attaining efficient agricultural extension practices in Nigeria. Hence, the need to establish effective agricultural information delivery approaches that can boost interactive process amongst farmers, extension personnel and all stakeholders that are involved in enhancing agricultural innovation and adoption.

Information Communication Technologies (ICTs) enhances agricultural development and processes. ICTs generally consist of technologies used to aid information and communication, which include hardware (computers, telephone/mobile phone, radio, television, video, and digital camera), software, networks, and media for information collection, storage, processing, transmission, and presentation of voice, data, text, images, and related services (Asenso-Okyere and Mekonnen 2012). The role of effective agricultural information system aided by the use of Information Communication Technologies (ICTs) in agricultural development and the positive impact in the enhancement of adoption of agricultural innovations is established in the literature (Baloch and Thapa, 2016; George et al., 2011; Kuehne et al., 2017; OECD, 2001). Accordingly, the Food and Agriculture Organisation of the United Nations (FAO) and International Telecommunications Union (ITU) highlighted some of the diverse and significant roles of ICTs in agricultural development and processes (see Figure 2).

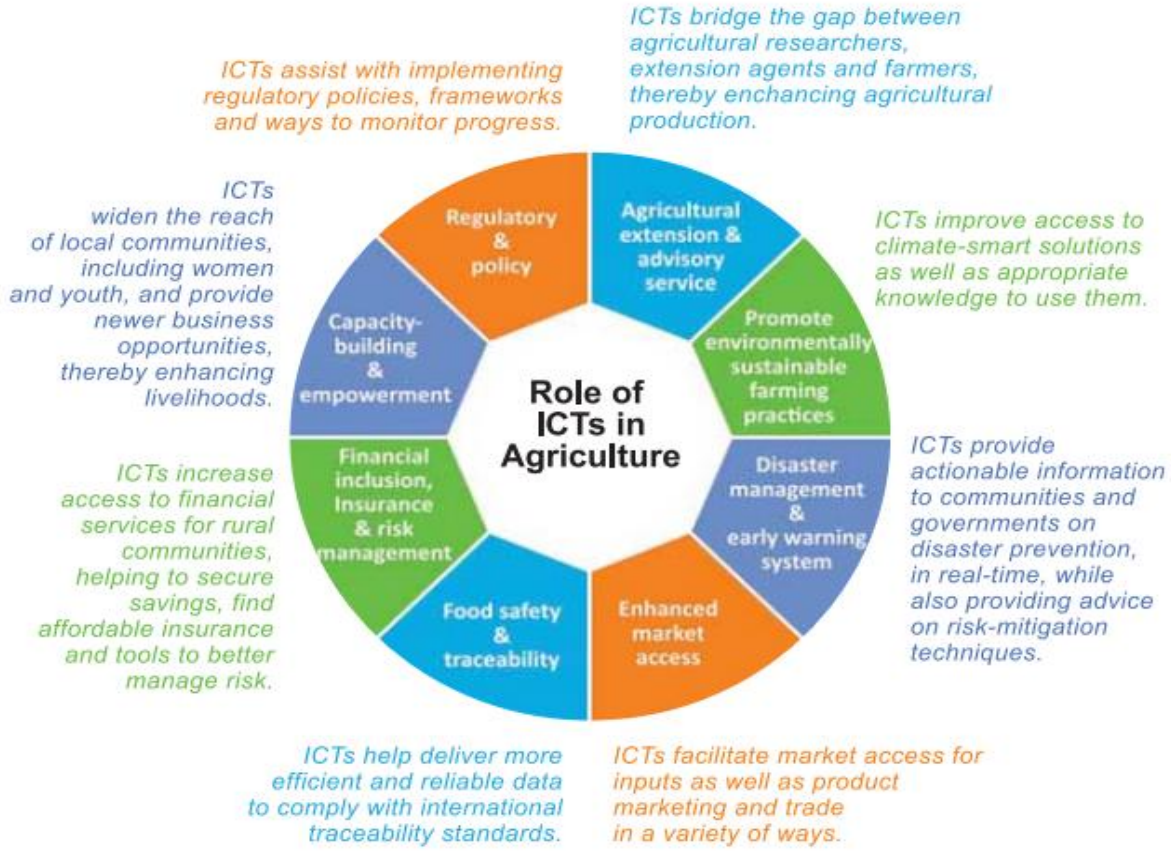

Fig. 2: The Role of ICTs in Agricultural Development (FAO and ITU 2016)

ICTs could serve as means of stimulating farmers' interest in new ideas and practices as well as provide useful information that could enhance farmers' decision making including adoption of farming methods that improve farmers' livelihoods and promote rural development (Ani et al., 1997; FAO 2012; Lwoga, 2010; Masuki et al., 2010; Nazari and Hassan 2011; Omotayo, 2011).

The impact of the role of ICTs in agricultural development and information delivery is undeniably felt in Nigeria. ICTs have aided and improved the dissemination and access to agricultural information among farmers, researchers and extension personnel (Oladele, 2011; Okeke et al., 2015). Agu (2013) also concluded that ICT could help to meet the requirements of Nigerian women farmers by delivering basic education, information on food security, markets, improved farming techniques and food conservation. Although there are other communication channels used for agricultural information dissemination in accordance with the national policy on agriculture (Ariyo et al., 2013). Such channels include newsletters, radio, newspapers, farm magazine, television, leaflets, and many others (Dare, 1990). Arguably, radio and television were perceived as the most preferred means of communication as they are capable of reaching a large audience and message can be transmitted in receivers' own language (Omenesa, 1997; Nwuzor, 2000; Ariyo et al. 2013). Both though share common features of the one-way mode of information transmission but do not support feedback or in-depth training (Mittal and Tripathy 2009). However, mobile phone and its enabled application have made a remarkable increase in the rapid exchange of information amongst farmers and extension agents (Tali, 2016), thus, creating opportunities for knowledge sharing and feedback. Smartphones and basic-feature phones with internet connection capability and touchscreen interface are now widely used globally (Dehnen-Schmutz et al., 2016). The usefulness of mobile phone in enhancing farmers' livelihood, agricultural extension services and agricultural development in Nigeria has been established in the literature (Asa and Uwem 2017; Egbule et al., 2013; Haruna et al., 2013; Ogbeide and Ele 2017; Ogunniyi and Ojebuyi 2016). Oyesola and Obabire (2011) observed that mobile phones are farmers' most preferred source of agricultural information. Furthermore, Bolarinwa and Oyeyinka (2011) noted increased farmers' access to extension services by the use of mobile phones. Banmeke et al. (2017) also observed that extension agents in Nigeria consider mobile phones as a capable means of dissemination of information to farmers, whilst, Fasola and Adewumi (2011) noted farmers' use of mobile phones in their farm operations as high.

Most significantly, mobile phone industries are increasingly playing major roles in developing the socio-economic situation of Nigerian populace as well as making the mobile connectivity more accessible. The industries have invested extensively in Nigeria taking advantage of the huge population which was estimated at 191 million in 2017 (Worldometers.info, 2018), resulting in improved access to mobile and internet facilities and people making a living with mobile business. In a report by Jumia Mobile Report Nigeria (2018), mobile connectivity has become the major driver of innovation and contributes to economic growth. The report noted that the penetration of mobile phone in Nigeria is increasing as the number of subscribers grew exceedingly, estimating at 84% penetration in 2017. The major mobile network operators in Nigeria are MTN, Glo, Airtel and Etisalat with fixed line and network equipment supply offering 2G, 3G and 4G services, although 4G is still new (GSMA 2015). Also, users have access to mobile applications that require less data (Jumia Mobile Report 2018). Furthermore, mobile operators and innovators are already using mobile applications and short message services to deliver information such as health advice, education, agriculture and government services (GSMA 2015). Presently, there are fewer agricultural ICT-based products and/or services developed in view of promoting farmers' access to agricultural information in Nigeria as highlighted in Table 1 below compared with other sub-Saharan African countries. Qiang et al. (2011) also revealed that Kenya and Uganda ranked the highest in pioneering agricultural development using mobile application services. However, none has been developed for agro-ecological techniques and principles.

Table 1: Mobile phone services for enhancing access to agricultural information in Nigeria (Adapted from the web pages (2018))

Mobile Services	**Inventor/Founders**	**Description**	**Platform**
Growth Enhancement Support Scheme	Federal ministry of agriculture and rural development, Nigeria	The scheme was designed to provide access to information about fertilizer and seed availability to farmers through their mobile devices (NADS report 2011)	Short message service (SMS), push notification and voice calls
Hello tractor	Business entrepreneurs	Provides access to low-cost tractors that farmers can buy or rent using their mobile phones	SMS
Verdant	Nasir Yammama	Provides farmers' access to agricultural information, market and financial information, via mobile phone	Web
Nokia Life	Nokia	Provides access to agricultural information, crop tips, weather forecast and market prices via mobile phone	SMS
Orgfarmob	Agricultural experts at the Federal University of Agriculture, Abeokuta, Nigeria	Provides information on organic training materials	Web
Zenvus	Ndubuisi Ekekwe	Measures and analyses soil nutrients and temperature to assist farmers to apply the fertilizers and irrigate their farms rightly.	Web

In order to achieve sustainable advancement and/or adoption of any agricultural innovation or indigenous knowledge requires an interactive process where information and skills relevant are shared among all agriculture stakeholders. This can give the participants the opportunity to become the innovators, receivers or intermediaries. Uphoff (2013) noted the opportunities for farmers to become prime developers and evaluators of knowledge when they are actively involved, as they must make ultimate decisions concerning adoption or rejection of the initiative. More so, the approach can allow farmers to decide and participate in the development of ICT based initiatives (Barakabitze et al., 2017). Barakabitze et al. (2017) observed the effectiveness of embedding participatory approaches in developing ICT based agricultural information delivery strategies in Tanzania. Also, FAO (2009) reported that farmers' involvement in the development of ICT based agricultural solution can enhance their productivity. The call for the participatory user-centred approach in developing ICT based agricultural information dissemination initiative remains a quest for ICT for agricultural development organisations and FAO (FAO 2018; Walsham 2012). Therefore in order to enhance the transition to agro-ecology in Nigeria, farmers need support and access to agro-ecology information, as well as participate and contribute to the knowledge and design of the

initiative. This could be achieved through effective agro-ecology information dissemination channel that allows regular contact with extension, research, support and feedback. Accordingly, information should be relevant, on time, accurate, cost-effective, reliable, usable, exhaustive, and aggregate. It is envisaged that improved access to information about agro-ecology principles, techniques and practices through mobile phone applications, farmers' participation and collaboration of researchers and extension personnel would encourage agro-ecology transition.

This study investigated the farmer's and extension personnel' perception about agro-ecology and the potential for mobile phone-enabled application to enhance effective agro-ecology information delivery. Currently, the effectiveness of using participatory approach in designing mobile phone-enabled applications for enhancing agro-ecology transition in Nigeria is yet to be explored. Hence, the principal objectives are:

- To develop, test and validate a mobile application that enhances access to agro-ecology information using participatory approach.
- To evaluate whether farmers' access to agro-ecology information through the application influences agro-ecology adoption
- To assess whether the application influences the extension personnel's information delivery approach
- To evaluate the barriers to the application's wider use in Nigeria

Methodology

This study adopted the Participatory Communication (PC) strategy and recognises that farmers are knowledgeable in their indigenous practices. The study explored farmers' needs based on agro-ecology approaches and developed mobile phone-enabled application. Because this study involves knowledge inquiry, identification of the problem, action for change and solution to the identified problem using a model, situates it as a participatory action design research. "Design science research creates and evaluates information technology artefacts intended to solve identified community and/or organisational problems" (Hevner et al., 2010). Such artefacts may include models, methods, constructs, social innovations, instantiations or any design object with an embedded solution to any understood research problem (Peffers et al., 2007). Indeed, the design science research and action research are two methodological frameworks that address design-oriented research problems from a technical and socio-cultural view (Baskerville et al., 2007; Iivari and Venable 2009). Although they appear to be different, they can be integrated (Iivari and Venable 2009). Such methods ensure a relevant grounding of design science research effort in real understanding of relevant situational problems and promote naturalistic evaluation of the newly designed technology (Baskerville et al., 2007; Baskerville et al., 2009; Cole et al., 2005; Sein et al. 2011). real

Study Area

This study was carried out in the south-east, Nigeria which houses more than 70% subsistence farmers. The farmers in this region mainly cultivate crops such as cassava, cocoyams, yams, maize, okra, bananas/plantain, vegetables and rice (Nations Encyclopedia 2018). Also, one of the National Agricultural Extension and Research Liaison Services zonal offices is located in the study location, including state Agricultural Development Programme (ADP) offices located in each of the five south-eastern states namely; Abia, Anambra, Ebonyi, Enugu and Imo, thus, making the region prominent for this study. Imo state was purposively chosen as a result of the agricultural activities in the area which has been reported as less than impressive in terms of sustainable farming and food production (Nwajiuba 2012). The state lies between the latitudes 50^{o} 10' and 60^{o} 35' north of the equator, and the longitudes 60^{o} 35' and 70^{o} 31' east of the Greenwich Meridian. The total

population was estimated at 3,934,899 people, and the land area covers 5,100 sq. km with Owerri as the capital of the state (NPC 2006).

Techniques used for Data Collection and Analysis

Data was generated through focus group discussions (FDGs) with 50 respondents, which allows the participants' involvement in the change process. The participants comprised of 30 farmers and 20 extension personnel purposively sampled from the Imo State Agricultural Development Programme (ADP) due to their experience and involvement in agricultural activities. The farmers rely on the field extension personnel for agricultural information and advice on access to farm inputs and other related advisory services through the state ADP. Although two mobile phone developers were involved in the study, they are not the problem owners (end users), therefore termed by this study as consultants. The study adopted Minkler (2000) strategy of the cyclical process of evidence finding, action and reflection, which lead to further inquiry and action for change. Gillis and Jackson (2002) opined that this approach allows a systematic collection of data through the generation of practical knowledge for the purpose of taking action and making a change. Furthermore, the focus group discussions facilitated the emergence of rich data through interaction and collective opinion and further exploration of the general nature of the individual's comment.

In ensuring a suitable environment for the participants, the researcher facilitated the FGDs in a public space that is familiar to the respondents, whilst also ensuring equal opportunity to each participant. However prior to the data collection, written informed consent was obtained from each participant as required for ethical approval of the study by Coventry University, United Kingdom. The participants were divided into five groups of ten participants in each group according to their individual background, respectively. The facilitators acknowledged some of the demerits of FGD approach opined by various authors (Freitas, 1998; McNiff and Whitehead, 2006) and adopted the open-ended and guided discussion approach by ensuring that the objectives of the research were explained. The themes of the discussion were worded to suit the English proficiency of the participants. The themes were predetermined to cover the knowledge inquiry from the farmers and extension personnel respectively. Three discussion sessions were arranged for each of the five groups, respectively. First was to understand the basic agricultural practices, issues encountered and to stimulate debate on the benefits of agro-ecology and the practices and preferred means of communication. Second, was to probe participants' ability in mobile phone-enabled application use and develop the application accordingly. After, the fourth month, the barriers that could affect the application's wider use was discussed. The participants used postcards in elucidating their views, whilst verbal contributions were audio recorded. Data were analysed manually using hand coding and the sources are coded to identify individual response by labelling each as Farmer 1-30 and Extension 1-20 within their representative group. The design research approach was adopted in organising the artefact to suit the need of the farmers and enhance farmer to farmer and farmer to extension personnel interaction about agro-ecology. The study adopted the six steps of design science research method which are the identification of problem and motivation; objectives of a solution; design and development; demonstration; evaluation; and communication as proposed by Peffers et al. (2008).

Results and Discussion

The platform – SmartAgroecology

The design process involved the mobile-enabled application developer who determined the desired functionality of the artefact. However, before the design and development process, all the participants' profiles were assessed to determine the suitability of the application for their needs and capability. Woodard et al., (2014) suggest the importance of assessing the capability of the end-users of a given development project in order to minimise the challenge of abandonment after the project implementation. This is ideal for an agro-ecology

development project in order to maintain sustainability. Figure 3 illustrates the design framework of the application.

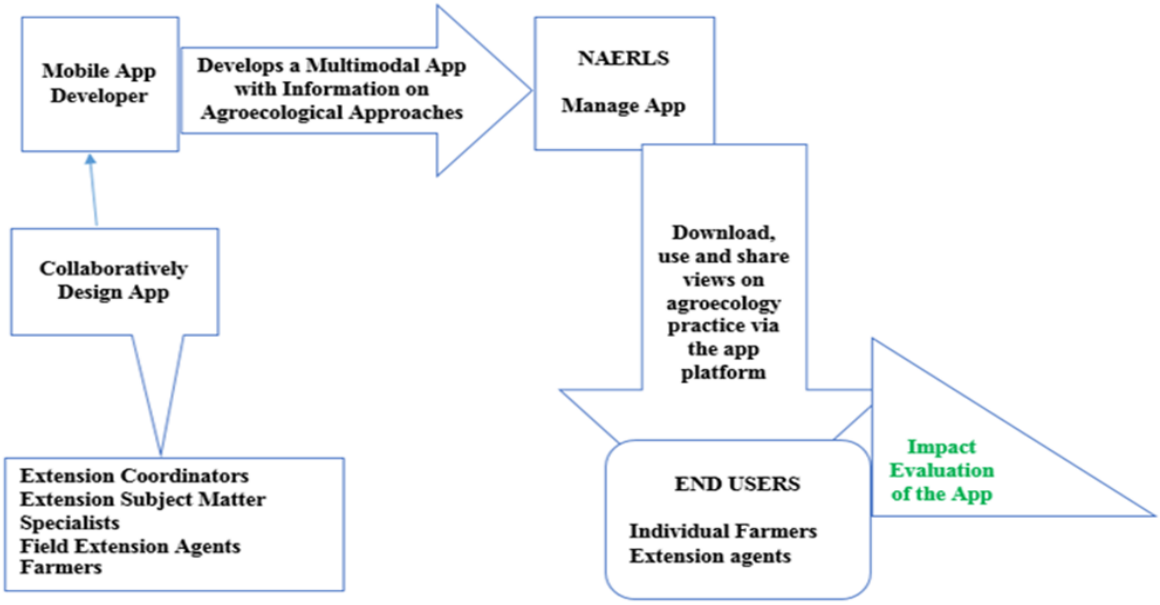

Fig. 3: The Design Framework of the Application

Farming practices

The facilitators aimed at understanding the existing farming practices and to support farmers' learning and access to agro-ecology practices. The participants' ages ranged between 30 and 69 years. All had varied years of experience in agriculture and agricultural activities. Majority of the farmers (80%) uses external farm inputs such as fertilizer, hybrid seeds and have not heard about agro-ecology approaches. This corroborates Amujoyegbe et al., (2016) that most farmers in Nigeria use agro-chemicals. When the farmers were asked the reason behind their actions, a number of the farmers explained that the practice does not require much labour. On the other hand, there were issues raised such as the agro-chemical farming inputs being expensive and sometimes not productive. One of the farmers explained, "*you see I use fertilizer and buy maize and cassava from the agriculture people, ehmm, the improve variety, but the maize does not germinate at times, and the cassava easily rotten in the soil*" (Farmer 1, Group 2). Another explained, "*I use fertilizer in my farm if stopping to use it will improve the yield, I do not mind stopping because the fertilizer and pesticides are very costly and you spend money for transportation to market to buy them*" (Farmer 7, Group 1). During the discussion, all the extension personnel explained that the basic agricultural information available to the farmers is characterised by a conventional method where the farmers are encouraged to use agro-chemicals to improve yield. One of the extension personnel explained, "*we advise farmers to use these improved crop varieties and agro-chemicals to increase their yield because most of these local varieties, especially maize, the sizes are small and yield is poor*" (Ext.personnel 16, Group 1). The extension personnel promotes farming practices that are contrary to agro-ecological principles unveiled by this study supports Ajala et al., (2013) that access to agro-chemicals is the most agricultural information available to farmers through the extension services.

Perceptions of Agro-ecology Practices

In order to determine the participants' perception of agro-ecology practices, the facilitators stimulated debates on the demerits of conventional agriculture and realised that most

participants both extension personnel and farmers have read and/or heard about the information about the negative effects of agro-chemicals on health and environment. These findings are in line with Iyagba and Ovai (2015) that farmers are aware of the environmental and health issues linked to agro-chemical inputs, but they depend on the use of agro-chemicals due to lack of information about agro-ecology practices. Building on this debate, the facilitators stimulated the discussion on the benefits of agro-ecology practices. Agro-ecology has been cited as the best agricultural practices that provide great opportunity to combat hunger and improve smallholder livelihood in Africa (Altieri 2017; De Schutter 2010). The farming system is characterised to "*fix broken food systems and repair damaged landscapes, providing abundant healthy and nutritious food sustainably while increasing incomes and improving climate resilience*" (Third World Network 2017). Furthermore, agro-ecology raises agricultural productivity and is more sustainable, affordable and profitable. Agro-ecology relies more on natural cycles rather than agro-chemical inputs and protects the environment, whilst encouraging diversity in crops and livestock production and preserving the biodiversity. Majority of the extension personnel acknowledged that agro-ecology is still new and yet to be incorporated into the Nigeria agricultural policy, although the mandate of sustainable agricultural practices still exists. However, the study revealed that the bureaucratic nature of government agricultural extension service agencies will pose a barrier to the agro-ecology adoption and integration. Also, farmers tend to respond positively to changes which could improve their productivity at a reduced cost without environmental risk. As one farmer explained "*I will prefer agro-ecology, but we need the information and follow up from the extension, I still practice crop rotation and intercropping so knowing how to control pest and diseases, improve yield, without using agro-chemical will be much better*" (Farmer 5, Group 3). Most significantly, all the farmers have genuine interest and willingness to adopt and practice agro-ecology approaches, if supported with relevant information about the principles. This finding supports Kerr (2015) who observed that farmers regularly respond to indications of climate change such as rainfall, temperature and other weather patterns and as a result, they actively seek changes in farming methods in order to adapt to these changes. However, it is evident that whilst farmers' positive perceptions towards change to farming methods in response to climate change is important, they need tools and technologies in order to respond efficiently in a practical way (Ngumbi, 2016).

Perceptions of agro-ecology information delivery using mobile phone-enabled application and barriers to the wider use

The participants' perceptions of the mobile phone-enabled application were generally positive with the expression of interest on the potential benefits of the application in agro-ecology information delivery. Also, the extension personnel seemed to be interested in innovations that would make their work easier and reduce the cost of operations and travel. The debate was stimulated based on the following highlights:

- Mobile phone-enabled application can raise the awareness of agro-ecological practices, helping improve farmers' livelihood
- The application will enable collaboration among farmers, researchers and relevant actors in the agriculture value chain.
- The application can facilitate access to community learning, training and demonstration.
- The application can facilitate researchers ability in understanding farmers' needs.
- The application can facilitate the practically oriented adoption of agro-ecological practices.

The participants' perception of the advantages and importance of the information delivery through the "*smartagroecology*" application was the key motivation for the use of the concept. However, there were factors that are considered to be socioeconomic barriers. A number of the participants reaffirmed that some of the rural communities still have limited electricity supply which could limit the use of the application and are of the opinion that there

should be agricultural information technology training hubs for farmers and extension personnel. This finding corroborates the opinion that some of the issues that limit mobile phone usage by farmers in developing and low-income nations include; irregular or non-existent power supply, poverty and poor ICT skills (Akpabio et al., 2007; Otene et al., 2017; Rimi and Chudi, 2017). Also, most of the farmers noted lack of regular monitoring of farmers' activities by the extension personnel and most times information about sustainable agricultural practices are limited or non-existent. The findings reconfirm the notion that lack of funding and organisational irregularities affects the effectiveness of the extension services in Nigeria (Obiora, 2013). Furthermore, the application supports farmers' self-efficiency and ability to succeed in learning new practices both individually and collectively. Farmers' having the opportunity to share knowledge and access necessary information with the confidence that extension personnel are always available on the platform to attend to their information needs, promoted their confidence. Accordingly, Bandura, (1997) noted that observing peers promotes individual capabilities. Also, the integration of the mobile phone-enabled application opens up more innovation within agro-ecology farming system.

Conclusions

The study explored the farmers' and extension personnel perception of agro-ecology and the potential of mobile phone-enabled application to enhance the transitioning to agro-ecology. The study elucidated the importance of embedding participatory communication in the development of agricultural information enhancement initiatives and maintained that the process will encourage collaboration amongst farmers and all actors in agriculture value chain. Instead of depending on the conventional extension service delivery being practised in Nigeria, farmers' learning needs to be embedded within the learning environment and/or communities that are sustainable alongside other experts in agriculture. The study observed that the farmers are willing to adopt agro-ecological practices that are sustainable and capable of ameliorating climate change and other agricultural induced environmental issues. The study suggests that mobile-enabled application has the potential to enhance agro-ecological practices in Nigeria and also could impact positively on agricultural policy in the region for the benefit of farmers and the countries economy. Agro-ecological transition in Nigeria requires a 'push factor' to hasten adoption and one of the key factors that can deliver the required push is ICT application especially mobile phone-enabled application in agricultural information management in the country. Nigeria is well positioned to pioneer revolutionary agricultural development based on agro-ecological techniques which would improve productivity, improve farmers' livelihoods and economy of rural households as well as care for the environment. The mobile phone-enabled application would provide direct access to agro-ecological information to farmers thereby removing the limitation of dependency on government-run extension services and institutions which are prone to bureaucracy, politics, poor funding, lack of sufficient manpower, and may be propagating agro-ecological policies. Also, this study is calling for a unified effort amongst all the agricultural value chain stakeholders in the development of ICT sustainable agricultural information based initiative and awakening the movement of agro-ecology in the region and reminding farmers of their autonomy.

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