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Smallholder Farmers and Mobile Phone Technology in Sub-Sahara Agriculture

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Abstract

One of the major constraints in Sub-Sahara agriculture is inefficiency and; improving it in agricultural value chain is important to increasing productivity and reducing poverty. One of the ways to improve the efficiency in the agriculture supply chain is the adoption and use of mobile phone. Mobile phone ownership and usage for social and agricultural purposes have received attention with an indication that it is growing in Sub-Sahara Africa. It provides different avenues for the transfer of knowledge and information among stakeholders of Agribusiness. This study investigates how much farmers have applied this technology and the benefits derived from it. Considering these objectives, a quantitative data derived through multi-stage sampling procedure was collected through a process of questionnaire administration that yielded 328 smallholder farmer respondents. The data was analysed using Stata 12 software. The results indicate that more young farmers use mobile phones and more than 82% of the farmers possess at least secondary school certificate. The farmers spend more (mobile phone bill) seeking market information than any other agricultural activities and obtaining weather information was one area in which they have not received reasonable benefits. One country information limits generalisation of the study and caution should be taken when using the data.

Keywords: Agricultural development; Accessing market information; Improving farming efficiency; Mobile phone; Small-holder; Sub-Sahara Africa

Introduction

Smallholder farmers produce about 80 percent of the developing world's food. These women and men are key contributors to global food security, custodians of vital natural resources and biodiversity, and central to climate change mitigation and adaptation (International Fund for Agricultural Development -IFAD 2014). Developing and improving agriculture have taken many approaches. The rural development strategies which include formation of cooperative organisations, provision of access to credit and technical information amongst others have been worthwhile approaches (Ogbeide 2014). Framing these approaches into functional units involves three main players – the provider of inputs, the converter of inputs and the users of the output (Timmer et al., 1983).

The providers of inputs into agriculture are diverse and often time distantly located away from the converters. Farm input providers such as the financial institutions, Agribusiness/farm management organisations, technical services, chemical and planting materials suppliers are often situated in the cities or local government headquarters (Karamagi & Nalumansi 2009). The input converters are the farmers. Farmers particularly in the developing countries are small-scaled with limited contact to exchange and share crucial information, knowledge and skills needed for production, processing and marketing (Alleman et al., 2002 and FAO, 2005). Consequently, yields are low, and incomes from agriculture leave little for the farmer to turn over. Access to crucial inputs is poor or denied due to difficulty in information flow either from the provider of inputs or the users of output (FAO 2005).

The users of outputs include manufacturers that represent the secondary inputs providers and the final consumers of farm produce. The users of agricultural outputs in like manner to the input converters are most times geographically located far away from the farmers. The result of these slack relationships is high production cost, inefficiency, non-competitiveness and corruption. For example fertilizer distribution to farmers in Nigeria was hijacked by middle men with no farming interest; who either divert them to unintended markets or resell to the farmers at exorbitant price (Allafrica 2013). The diversion results in farmers not getting the fertilizer at all or on time and in most cases at a higher price. The delay in getting the inputs, the corruption in the process and the increase in cost creates inefficiency in the supply chain and causes production to be uncompetitive (Chorn, Sisco & Pruzan-Jorgensen 2010).

Increasing the efficiencies in an agriculture value chain is important to increasing productivity and reducing poverty. Creating a more efficient value chain involves productive engagement of the functional units in the value chain and how the information around these units is managed. One of the ways to improve the efficiency in the agricultural supply chain is the use of mobile phone technology (Halewood & Surya 2012). Mobile phone technology application in diverse business situations is growing in Sub-Sahara Africa and many other developing countries; it provides different opportunities to transfer knowledge and information among players in the Agribusiness value or supply chain including the government. The use of mobile phones was initially mainly for urban residence but has found social and economic usefulness for the rural populace to obtain information on weather, market and other related issues (Aker and Mbiti, 2010).

The support for mobile phone technology for agricultural purpose has been boosted with manufacturers and software designers either aligning their products to suit agricultural

use or create specific products for agricultural use. In Nigeria for example, Nokia since 2010 focused on providing mobile learning (mLearning) applications for the transfer of basic skills state-of-the-art technologies, and production skills for crops, livestock and fisheries. Also the national governments have worked assiduously towards comprehensive internet platforms that provide access to all relevant information (Syngenta Foundation 2011).

Mobile phone applications usage in the Sub-Sahara Africa has increased tremendously particularly in countries like Cote d'Ivoire, Ghana, Nigeria, Mali, Rwanda, Tanzania, Zambia, Kenya, Mozambique, Uganda, Malawi, Mozambique, Madagascar (Qiang, Kuek, Dymond & Esselaar 2011). The potential benefits to farmers in these and other countries using mobile phone technology to connect with diverse stakeholders in the agricultural value chain cannot be overestimated with some studies pointing to huge success (Qiang, Kuek, Dymond & Esselaar 2011; Martin & Abbott 2011).

This study therefore sets out to investigate how much the farmers have taken advantage of this technology and the benefits derived from it. Considering these objectives, the study must also provide answers to such questions as do farmers practically use mobile phone for agricultural purposes? Does mobile phone usage drive improvement in productivity? What benefits do the farmers derive using mobile phone? This study is important; it helps to capture and evaluate the progress of mobile phone adoption and uses and also identify, assess and make judgment on benefits the smallholder farmers obtain with the device. It is critical that the success or otherwise of the use of this device be studied; for improvement and adaptation purposes. This study put no emphasis on any particular crop/livestock or quantitative unit of output but looked at agriculture in general terms in relation to smallholders using farmers' psychological response measure to assess the benefits of the technology. However, the study area is renowned in the production of cassava, maize, cattle, sheep, goat, pig, poultry, fisheries, oil palm, rubber, vegetables among others.

The conceptual theory that underpins this study is the diffusion of innovation. The theory of diffusion of innovation defined how innovation is adopted by a social group with the result that the innovation becomes part of the existing social system. Rogers (1983) in his first publication of the theory in 1962 argued that diffusion is the process by which an idea, object or practice perceived as new is communicated to members of a social system through well-defined channels over a period of time. This new idea, object or practice is refer to as innovation. For diffusion to take place, the idea, object or practice must be actionable with relative advantage over the existing one or provide multiplier benefit to an existing one over a period of time. The time frame dimension is to allow for evaluation of the benefit of the innovation to the adopters and also creates a window of observation for the would-be adopters to make adoption decision. Therefore, adoption of a new technology does not happen instantaneously in a social system; rather it is a process whereby some individuals are quick to adopt the technology than others. However, innovation must have the capacity to improve and create better social economic conditions for the adopters while leveraging on ability of the target group to apply it from an assumed or learned standpoint (Robinson 2009).

Literature review

Mobile phone technology and agricultural usage

The theory of diffusion of innovations is central to the adoption, use and the attendant benefits of mobile phone technology application in agriculture particularly by smallholders (Martin & Abbott 2011). Robinson (2009) noted that when an innovation is introduced into any settings, it offers three valuable intuitions into the process of social change. Such

intuitions include what quality attributes make an innovation to spread, understanding the needs of the different user groups and the role played by peer networks in ensuring the spread of the adoption. According to Avgerou (2010), understanding the use of mobile phones to aid agricultural development requires an adequate knowledge of the technology and the perceived impacts it has, as well as an assessment of the opportunities and barriers reinforced by the local social structure of the user communities.

Aker and Mbiti (2010) and Aminuzzaman, et al. (2003) argued that mobile phone adoption by farmers is predicated on the perception that it is better than most other communication means, as it is convenient to handle, provides economic advantages and enhances social status of users. The use of mobile phone sits within the core value of communities communicating within and between groups for social or economic interactions. It enhances past experiences of communication by removing the cumbersomeness associated with other communication methods (Qiang, Kuek, Dymond & Esselaar 2011; Martin & Abbott 2011). This perceived relative advantage of mobile phone arguably increases rate and possibly the growth in mobile phone ownership amongst community members and farmers in particular.

Benefits of the mobile phone

Agriculture as a business or at least as a means of earning income involves a lot of interactions. It can be in terms of hiring labour, gathering market and price intelligence, procurement of farm inputs, seeking technical assistance from the extension or expert agents or obtaining weather information (Okello et al., 2012). However, the location of the parties in the interaction, travel distances, ineffective and costly transportation, all encumbrances the ability of the farmers to improve productivity and improve the family and community wellbeing (Okello et al., 2012; GSMA 2013). Important to these interactions is the need for them to be done in a manner that is timely, effective and efficient. Farmers must adopt a means by which they are able to gain access to required information and inputs at the appropriate time in a cost effective manner.

In Kenya, mobile phones were used for the identification and management of livestock diseases, and for coordinating greater attendance and participation in organisations' meetings (FARM-Africa, 2007; Martin & Abbott 2011). Karamagi and Nalumansi (2009) noted that in Central Uganda, farmers adopting the use of mobile phones were able to connect to FoodNet - a service that supplies current price information of agricultural commodities, as well as contact details for interested buyers via SMS. This mobile phone service reduced the 121 kilometre travels farmers in the Bugerere District in central Uganda make to the main market in the state capital, Kampala in search of buyers. This process often left the farmers with thousands of litres of unsold milk that become worthless due to spoilage (Karamagi & Nalumansi 2009).

Mobile phones have been found to help improve the productivity of individua ls and organizations within resource-constrained environments due to increased efficiency, effectiveness, and reach (Qiang, Kuek, Dymond & Esselaar 2011; Hudson, 2006). The rapid uptake and popularity of mobile phone applications by rural farmers have led to development of unique and innovative approaches to using these applications in solving some salient issues faced by farmers. Several studies have revealed some innovative examples; it has been reported that farmers use mobile phones to coordinate access to agricultural inputs (Martin & Abbott 2011; Ansari & Pandey 2013; Syngenta Foundation 2011; Das, Basu & Goswami 2012); accessing market information (Odhiambo 2014; Das, Basu & Goswami 2012; Martin & Abbott 2011); for financial transactions (Qiang, Kuek, Dymond & Esselaar 2011; Martin

& Abbott 2011; Kirui, Okello, & Nyikal 2010) and; to seek agriculture emergency assistance and expert advice (Qiang, Kuek, Dymond & Esselaar 2011; Martin & Abbott 2011; Churi, Mlozi1, Tumbo & Casmir 2012).

Mobile phones assist in mining information. According to FAO (1997), efficient market information provision has positive benefits for farmers, traders and policymakers. Up-to-date, or current, market information is easier obtained and enables farmers to negotiate with traders from a position of greater strength. It also facilitates spatial distribution of products from rural areas to urban areas and between urban markets by sending clear price signals from urban consumers to rural producers regarding quantities and varieties required.

Studies have been conducted on ways and which system application best suit the rural dwellers for social and business communication. Martin and Abbott (2011); Okello et al. (2012) and GSMA (2013) argued that the mobile phone is best suited for the rural people including the farmers. Interactions with mobile phones are cost effective ways for smallholder farmers to stay connected with other stakeholders and also provide them with a sense of security and social status.

Factors that influence mobile phone technology application by smallholder farmers

In the review of relevant literature, a number of factors were noted to affect the use the mobile phone by farmers for both social and agriculture related purposes. Mobile phone ownership in developing countries is still low despite the increase in the past several years. However, gender plays a role in mobile phone ownership and use. In short a woman is still 21% less likely to own a mobile phone than a man and this figure increases to 23% if she lives in Africa (GSMA 2013). Closing this gender gap would bring the benefits of mobile phones to an additional 300 million women and by extending the benefits of mobile phone ownership to more women, a host of social and economic goals can be advanced (GSMA 2013).

Age of the adopter plays an important role in influencing mobile phone usage. According to Okello, Kirui, Njirani and Gitonga (2012), young persons are more servile with technology irrespective of their locality and; that young people have a positive correlation with the use of the mobile phone. Therefore it is expected that young farmers will be inclined to use this technology for most of the day-to-day transactions.

Kirui et al. (2010) noted that smallholder farmers' educational level is low; the implication is that it creates challenges to adoption and use of modern technology such as mobile phone. Feder and Umali (1993) suggested that farmers require the necessary knowledge and information to use technologies and that the level of knowledge correlates positively with the adoption of new technologies by farmers. The works of CIMMYT (1993) and Kirui et al. (2010) corroborated Okello et al. (2009) that the literacy level of the farmers is 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. Therefore the literacy level of farmers affects mobile phone use differently and can influence the level of adoption across the various Sub-Sahara African communities.

Halewood and Surya (2012) argued that one of the factors that influence mobile phone usage is to improve efficiencies in the agricultural value chain. It is important to increasing productivity and reducing poverty. Mobile phone use by smallholder farmers creates a more efficient value chain that maximises time usage, reduce transportation time and cost and

improve productive interactive engagement among the functional units in the value chain (Qiang, Kuek, Dymond & Esselaar 2011; Martin & Abbott 2011; Halewood & Surya 2012).

The high usage of mobile phone by adopter farmers buttressed its capability to also act as a tool for education and gaining knowledge as well as spreading viewpoints and communication with family members and the larger social community (Okello et al., 2012). Baumüller (2012) assessing the factors that influence technology adoption noted that the adopter must have (1) knowledge of the existence of the technology, the ability to assess its suitability for the farming system as well as potential risk, and the ability to obtain and finance the technologies; (2) be able to use technologies; farmers need to have the necessary knowledge of how to use them, the ability to use them and the ability to manage any associated risk and (3) be able to improve productivity, efficiency and generate additional income.

Theoretical Framework

The essence of adopting an innovation such as mobile phone technology application for agricultural purposes hinges on its ability to transform an existing way of doing things into a better and more efficient one. The ultimate result is to provide increased and quality output to the market, guaranteed income for farmers and a dynamic and prosperous community.

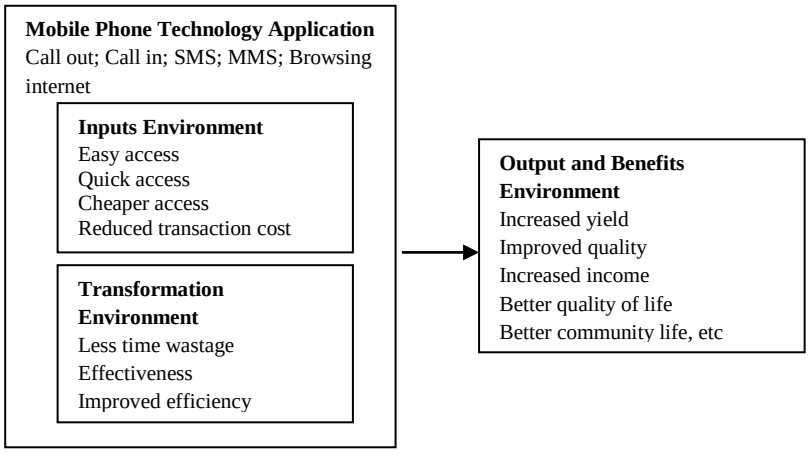

Figure 1 Theoretical Framework: Small Farmers and Mobile Phone Technology

The mobile phone use by farmers is well known as an exemplary case of a technology enabling bottom-up empowerment through information access, driven by agribusiness and end-user innovation (GSMA 2013; Sherry n.d.). The major mobile phone functionalities applicable are the voice call, short message service (SMS), multi media service (MMS) and internet browsing. The use of these functionalities is impacted by users' level of literacy generally and the specific knowledge of the technology available to the consumers.

The farmers often time would originate communication but are generally in the middle of the communication chain transforming the information and inputs they source into products for the market. In this model the inputs environment relates to where farmers are able to access inputs critical to production. Inputs such as weather information, insurance, localised geospatial and real time information, technical knowledge, stock and machineries are not only required but must be acquired in a quick, easy and cheap manner (Szilagyi & Herdon 2006; Lio & ChunLiu 2006). This creates efficiency leading to decreased cost of doing business, improved revenue and better market knowledge.

The farmers apply the inputs they obtain from the different input providers and transform them into output. With mobile phone, farmers and other stakeholders in the value chain can make a call; send SMS or MMS to each other. In this regard, inputs and inputs information are obtained faster with little or no travel time involved (Qiang, Kuek, Dymond & Esselaar 2011; Martin & Abbott 2011). Farmers are able to convert the inputs on time; plant the seeds at the right time, get weather warnings before disaster happens and are able to communicate to the technical expert of any anomalies observed in their farms for quick intervention. Market information obtained on time helps the farmers to determine the cropping pattern, estimate inputs price, plan what to sell and at what price (Qiang, Kuek, Dymond & Esselaar 2011).

Obtaining and utilising of inputs at the appropriate time is crucial to the success of any farm enterprises particularly the ones that can be influenced adversely by weather. Mobile phone enables farmers to get quickly information that impacts on inputs transformation thus causing them to act on time. The result is that all things being equal, maximum and quality yield can be reasonably guaranteed. The farmer can take advantage of the best market price leading to increased income, better social and community life (Odhiambo 2014; Das, Basu & Goswami 2012; Ansari & Pandey 2013).

Methodology

The study involved a quantitative analysis of data collected through a meticulous process of questionnaire administration that yielded 328 smallholder farmer respondents. The study was conducted in Cross River State of Nigeria which politically has 18 Local Government Areas (LGAs). Agriculturally Cross River State is divided into three: the Calabar, Ikom and Ogoja zones. A multi-stage sampling procedure was adopted to select the respondents for the study.

Figure 2. Map of survey area: Cross River State of Nigeria

In the design of the questionnaire, the intent was to solicit response from all the different crop/livestock producers hence the study did not specify any particular crop/livestock. The quantitative unit of output was not solicited in the questionnaire considering the assumed level of education of the target respondent; more so the study was

unable to provide a guide for the farmers to follow. Therefore the study relied on farmers' response to the psychological questions to assess the benefits of the technology.

Choosing the sample respondents was done in multi-stage, firstly a random sampling of the LGAs yielded two LGAs from each of the agricultural zones giving a total of six LGAs (Akpabuyo, Calabar Municipal, Abi, Yakurr, Bekwarra and Ogoja LGAs). The second stage comprised purposive sampling of five communities from each LGA. These communities are among those connected to the various mobile phone networks. From the purposive sampling, 30 communities were identified. The stage 3 also involved purposive selection of 12 farmer respondents from the communities based on ownership of mobile phones and engagement in agricultural production. The list of respondents from each community was compiled by the community leaders. A total of 360 respondents were targeted. Face to face questionnaire administration was conducted in one month; ending 11 November 2014. Data analysis included sample descriptive statistics and regression model analyses; all conducted using Stata 12 software.

Results and discussion

Of the targeted 360 respondents, only 328 of them were surveyed due to time and financial constraints and were used for data analysis. The results presented in the study comprised the descriptive statistics of the surveyed farmers, their mobile phone ownership status and the associated operating cost and its structure. Others include an analysis of the benefits of using mobile phone and a regression analysis and the factors that influence mobile phone usage by smallholder farmers. The constraints to mobile phone usage were also considered. The result and discussion begin with the sample descriptive statistics.

Descriptive analysis of respondents

Table 1. Descriptive analysis of respondents. Sample size = 328

Variable	Variable characteristics	Frequency	Percentage of respondents
Gender	Male	248	75.610
	Female	80	24.390
Age Group	18 - 29 years	3	0.910
	30 - 39 years	112	34.150
	40 - 49 years	45	13.720
	50 - 59 years	45	13.720
	60 years and over	123	37.500
Educational qualification	First School leaving certificate	57	17.380
	Secondary School certificate	118	35.980
	OND/NCE	24	7.320
	Bachelor's degree/HND	114	34.760
	Higher degrees	12	3.660
	Others (Please specify)	3	0.910
Marital Status	Single	51	15.550
	Married	277	84.450

Note: OND/NCE = Ordinary National Diploma/National Certificate of Education; HND = Higher National Diploma

This study found that there is active involvement of people across the age groups particularly the younger farmers using mobile phone for agricultural purposes and despite majority of them being married, are educated. It is not uncommon that farmers within the combined age group of 18 – 49 will generally be mobile phone servile as they are young and would take advantage to apply the skill and technology in any situations. This is consistent with the finding of Okello, Kirui, Njirani and Gitonga (2012). As more young people go into agriculture it is expected that mobile phone use for its related activities will continue to increase. More and new applications will be utilised by farmers making them take advantage of the ever increasing technology offerings available. Young farmers (people) are more socially active and can share knowledge faster; creating learning environment for themselves and the older farmers. Under this circumstance, the older farmers can break away from their traditional or conservative ways of interaction. The older groups of farmers are more driven by the need to be more efficient in doing business and will apply every measure including mobile phone technology to improve efficiency.

Table 1 also shows that more than 82 percent of the survey possess at least secondary school certificate; an indication that the farming population is increasingly becoming literate. This may not reflect the educational pattern across the entire Sub-Sahara Africa; however series of programs adopted by governments and other stakeholders are attracting more young people into agriculture. Therefore the use of the mobile phone will not be a difficult task to learn and adopt for all purposes including agriculture. The farmers can read, understand and apply instructions in the phone manual on how to use the various functionalities in the phone.

Mobile phone ownership and duration of ownership/usage

This study investigated the farmers' mobile phone ownership and the duration of ownership/use to determine the acceptance as an essential tool for agricultural development (see Table 2). The result shows that all the surveyed farmers have a mobile phone and more than 65 percent to the surveyed farmers have used mobile phone for more than six years. This is an indication of strong adoption of the technology and confirms Qiang, Kuek, Dymond and Esselaar (2011) finding that the adoption of information technology in agriculture is increasing in the Sub-Sahara Africa.

Table 2. Duration of mobile phone ownership/usage. n = 328

Years	Number of Respondents	Percentage
1-3 years	9	2.744
>3-6 years	104	31.707
>6-9 years	137	41.768
>9-12 Years	78	23.780
Total	328	100.0

Ownership is one of the major attempts toward the use of mobile. Ownership creates the willingness/power to explore the product and its functionalities, increases the willingness/ability to use them for diverse situations. This use process resulting from ownership increases the farmers' product knowledge. The long period of ownership/usage is also inferred to be predicated on the benefits accruable to the farmers not just in the economic sense alone but the cultural transformation of the business environment and community's communication settings. Ownership of a mobile phone also symbolises high social status in the farming communities. It is not uncommon for people in the cities and major towns to buy a mobile phone for their parents to stand out among their mates in the community. This social

symbolism of the mobile phone is consistent with the studies by Martin and Abbott (2011); Okello et al. (2012) and GSMA (2013).

Farmers' mobile phone bill and use pattern

While Table 2 showed mobile phone ownership/usage, Table 3a and 3b below show farmers mobile phone bill and the apportionment to activities consumed respectively.
More than 88% of the surveyed farmers spend a maximum ₦6,000.00 or less per month for a mobile phone bill. Despite this study not investigating the amount spent in relation to total

Table 3a. Farmers' mobile phone bill (Naira) sample size = 328

Mobile phone bill (Naira = ₦/month)	Number of Respondents	Percentage
₦1.00 - ₦3,000.00	242	73.781
>₦3,000.00 - ₦6,000.00	49	14.938
>₦6,000.00 - ₦9,000.00	29	8.842
>₦9,000.00 - ₦12,000.00	3	0.915
>₦12,000.00 - ₦15,000.00	5	1.524
Total	328	100

Note: ₦ = Naira; Nigerian currency, ₦1.00 = $0.007 USD

The farmers' phone bills structure can also be influenced by the number of inbound calls received from farm business stakeholders like input suppliers, extension agents and customers. Competitive input suppliers are more likely to initiate contacts to farmers to market their products. Such contacts reduce the amount of outbound calls the farmers make.

Table 3b. Farmers' mobile phone bill according to use pattern (percentage) n=328

Use pattern	Cumulative spend (%)	Average spend (%)
Mobile phone bill for family and community purpose	20275	61.814
Mobile phone bill for information about weather conditions	498	1.518
Mobile phone bill to obtain expert advice	2651	8.082
Mobile phone bill for financial transactions with lenders	3594	10.957
Mobile phone bill to obtain market price for agricultural products	5682	17.323
Total	32700	100

Farmers' mobile phone bill according to use pattern

As interesting as the result is in Table 3a; more importantly are the components of the bill in Table 3b. Family and community uses accounted for about 62 percent of the phone bill. This indicates a higher usage compared to the farm related use. The high domestic usage is sequel to its capability to act as a tool to educate and gain knowledge as well as spreading viewpoints and communicate with family members and the rest of the larger community. Mobile phone interactions are cost effective ways to stay connected with others and provide the user with a sense of security and social value. This is consistent with the findings of Okello et al. (2012) and GSMA (2013).

The study indicated that approximately 62% of the surveyed farmers' mobile phone bills were incurred through family and other social interactions, the remaining part of the bill was incurred for sesveral agriculture related activities. The farmers spent more than 17% of the mobile phone bill seeking market information about agricultural products. This represented the largest agriculture related component of the bill. The high percentage of farmers using a mobile phone to source input and output markets is consistent with the result of Odhiambo (2014); Das, Basu and Goswami (2012); and Ansari and Pandey (2013). This is an important result, considering the capability for mobile phones to bridge the wide divide that exists between the various players in the agricultural landscape. The input and output markets can be several kilometres apart and it can be time consuming and mentally draining for the smallholder farmers to make travel trips for every transaction.

Though sourcing of inputs, outputs and markets information represented the largest single agriculture related activity for which a mobile phone was utilized, this study found that farmers' phone bill on financial transactions with lenders represented almost 11% of the total mobile phone bill. Smallholder farmers need finance to purchase inputs and were known to have financial relationships with banks particularly agricultural and community banks. Produce buyers also provide credit to smallholders to purchase inputs and to cover some operating cost in exchange for a promise to purchase the crops upon maturity or harvest. These kinds of transaction are enabled by mobile phone discussion without the farmers having to make physical presence. The almost 11% of the total mobile bill spent on agricultural finance related interaction showed the reliance of the farmers on it as an effective way of business transaction and is consistent with Qiang, Kuek, Dymond and Esselaar (2011), Martin and Abbott (2011) and Kirui, Okello, and Nyikal (2010). The percentage of mobile phone bill the smallholder farmers incur on gathering weather information represented less than two percent of the total phone bill per month. The justification for the low spending will be revealed when the discussion on benefit of the use of the mobile phone by farmers is presented.

The agricultural productivity and use of mobile phone

In determining whether mobile phone drives productivity, the study leaned on previous studies to use the variables in Table 4 to test their significant level in driving productivity. The various agricultural purposes to which smallholders use mobile phone were tested. No specific research result exists for this test in the study area; a theoretical consideration was adopted that the t-test result for each variable will be the same as the assumed (hypothesised) mean value. The t-test tests result is shown in Table 4. The result shows that for two variables - "Use of mobile phone to access market information" and "Use mobile phone for financial transactions", the p-value associated with the t-test was 0.001 which is an evidence that the mean of the two variables was different from their hypothesized value. The result indicates that the use of a mobile phone to access market information has increased and increase productivity; this emphasised how important access to market information is to farmers. Effectively and efficiently obtained market information provides benefits for smallholder farmers, input suppliers and consumers. When farmers have up-to-date market information; are better able to negotiate better terms with other stakeholders.

Relating productivity from outputs sales perspective, the increased use of the mobile phone for market information facilitates spatial distribution of products from production areas to consumer market with a clear price signals from consumers market to farmers. With this information farmers are able to adjust product quantity, quality and variety as required

according to the target markets. Furthermore farmers, because of the increasing need for market intelligence use their mobile phone more often to obtain current relevant information and well-analysed historical market information to make production decisions, such that relate to what and when to plant or breed, at what stage should harvesting be done or what market production should be directed. Considering the enormity of the effort to obtain market information across a vast geographical spread, mobile phone technology has been widely deployed by smallholder farmers in the study area to ensure they are current with market situation.

The use the mobile phone for financial transactions has also increased. Governments, financial institutions and other private lenders of fund are located often time remotely away from the smallholder farmers. In Nigeria for example some small scale farmers obtain their loan through the ministry of Agriculture and FADAMA program. They are able to use the phone to make quick calls to arrange loans or contracts that enable them to expand an existing farm enterprise, form new ones, or take advantage of opportunities to diversify, employ local workers and deal with the relevant government for example, through the remittance of income taxes.

Therefore the use of mobile phone to access market information and for financial transactions helps farmers to improve their productivity. Smallholders are able to access market information quicker and efficiently too thus saving travel transportation time and cost. The same is true when farmers use mobile phone for financial transactions and are able to obtain their financial transaction details without the need to visit the banks.

Table 4. The agricultural uses to which mobile phone is put. Sample size = 328

Variable	mean	standard deviation	t - statistics	P-Value
Use mobile phone to coordinate access to agricultural inputs	17.384	8.783	16.430	0.594
Use mobile phone to access market information	30.036	5.063	29.485	0.001
Use mobile phone for financial transactions	22.292	7.375	21.487	0.001
Use mobile phone to seek agriculture emergency assistance	14.573	6.538	13.863	1.000
Use mobile phone to obtain expert advice	17.486	8.119	16.602	0.512

For the variables – "Use mobile phone to coordinate access to agricultural inputs", "Use mobile phone to seek agriculture emergency assistance" and "Use mobile phone to obtain expert advice", the p-value associated with their t-tests were 0.594, 1.000 and 0.512 respectively. Using the decision rule, "if the p-value associated with the t-test is not small ($p > 0.05$), then the null hypothesis is not rejected", it was concluded that the mean of each of these variables is not different from the hypothesized value. These outcome though not significant are positive in driving productivity. The bottleneck that hinders the effective use of mobile phone in these variables must be addressed so as to achieve the productivity objectives in these areas. Effective use of mobile phone in providing expert advice, seeking emergency assistance and accessing agricultural inputs reduce lag time and enables farm activities to be carried out as scheduled and obtain the desired outcomes as planned.

Benefits of using mobile phone by farmers

The surveyed farmers were presented with benefits options and were asked to agree or disagree with the options based on how these perceived benefits relate to them. The Table 5 shows the result; a mean value of "more than 4" indicated that more smallholders agreed that

the mobile phone provided the benefits for which investigation were made while a mean value of "less than 4" suggested otherwise.

Aside from the "Gets advance warning of weather risks" for which the surveyed farmers indicated no benefit, the farmers agreed to all other benefits. The study is not sure the reason why getting advance weather warning benefit was disagreed upon despite it been one of the main benefits in other studies - Churi, Mlozi1, Tumbo and Casmir (2012), Qiang, Kuek, Dymond and Esselaar (2011) and Martin and Abbott (2011).

Table 5. Benefits of using mobile phone by farmers

Variable	Sample size	Mean	Std. Dev.	Min	Max
Timely acquisition of price, market and farming practice information.	328	5.920	0.923	1	7
Facilitates access to technical and financial services	328	3.909	2.505	1	7
Easy to connect with other farmers for more effective collective action as producers, traders and buyers	328	5.979	1.277	1	7
Reduced cost of doing business	328	6.253	0.746	2	7
Reduced travel hours	328	6.289	0.707	1	7
Increased social networks	328	4.301	2.418	1	7
Empowers negotiations with wholesalers, traders and transport providers	328	5.526	1.786	1	7
Easier to link my products to distant markets and higher-end agricultural value chains	328	4.832	2.237	1	7
Gets advance warning of weather risks.	328	2.088	1.916	1	7
Enabled faster response to situational changes	328	5.655	1.246	1	7

However it can be inferred that in the study area, the meteorology services to farmers is still in infancy. The weather information could be available yet not accessible to the farmers due to inability to gather, harmonise and deplore the location specific information to the farmers. Effective weather services rely upon locally relevant data tailored to farmers' needs. When the meteorological services providers are under resourced, it cannot provide the services to farmer as precise and accurate to be useful for agricultural planning and operations. Another inference regarding the response to getting advance weather warning benefit is that through the ages, farmers have used local knowledge and traditional coping strategies to adapt to changes in weather conditions. For instance, they can predict the arrival of the rainy season by a change in wind patterns and imminent rain by changes in cloud colour.

Considering the responses to the indicators used to measure the benefits of mobile phones to farmers, it was obvious that smallholders have taken advantage of the flexibility in mobile phone and have avoided the difficulty and complexity of installing landline phone service that often requires huge installation fee. The flexibility of being able to go anywhere with it facilitates timely response to farmers' outbound or inbound communication. Mobile phone by its design enables smallholders to work on their farms without missing calls. Furthermore smallholders with internet connectivity can use their phone to carry out transaction anywhere with sufficient wireless coverage.

Factors that influence mobile phone usage

This study also investigated the factors that influence mobile phone usage. The education status of farmers, their gender, mobile phone ownership and usage knowledge of the farmers were tested to determine their influence on the farmers' use of the phone for agricultural purposes; see Table 6. The four predictors: mobile phone ownership, mobile phone usage knowledge, gender and the educational status of farmers were statistically significant. This result indicates that the use of a mobile phone and its functionalities by farmers has been influenced by these variables.

Table 6. Factors that influence mobile phone usage. N = 328

Variable	coefficient	P-Value
Mobile phone ownership	3.696117	0.001
Mobile phone usage knowledge	6.631437	0.001
Gender	16.40994	0.001
Educational status of farmers	5.047578	0.001

The farmers' knowledge of the use of the phone has increased enabling them to use the functionalities of the phone to meet their agricultural purpose. Therefore acquisition of knowledge of mobile phone functionalities and usage is very important as more agricultural assistance and services can now be accessed online through mobile phone. It is an efficient way to meet the farmers' needs and for the farmers to reach out to their suppliers. One of the ways farmers acquired knowledge of how to the use mobile phone is through their children. They teach their parents - particularly the less educated ones - how to make and receive calls, store and retrieve messages, send and receive SMS and MMS. Also as young educated people are getting involved in agriculture, they are able to indulge in self-learning by following the instructions on the manual of the mobile phone.

The gender of the farmer plays a part in the usage of a mobile phone for agriculture. Cultural issues, such as traditional roles of men and women in the Sub-Sahara Africa affect, delay or even prevent a woman's acquisition of mobile phones. Agriculture is still male dominated sector where the head of household oftentimes determine what goes on in the family and their means of livelihood. The relationship usually impacts women in many sphere such that Martin and Abbott (2011) concluded that women are later adopters of technology than their male counterparts. The male dominance in the use of the mobile phone also corresponds with the overall levels of economic development and a woman's role and participation in the farming environment.

The educational attainment of the farmers had an effect on their ability to read, comprehend and apply knowledge gained. The educational status of the farmers was instrumental to the adoption and use of mobile phone. As more and more educated smallholders are involved in agriculture so will the use of mobile phone technology increase. This is premised on their ability to read and understand the benefits of the phone, how to source and purchase it and the associated recharge card. Educated farmers are able to identify the network providers that will best serve their need, are able to apply the mobile phone manual and consequently make the fullest use of the functionalities for agricultural advantage.

Factors that limit the optimisation of mobile phone technology

The factors that affect the benefit of mobile phone technology were investigated – see Table 7. The level of the respondents' agreement to this variables were extracted. The result indicates that more than half of the sample (mean 4.98) varyingly agreed that lack of network coverage in the farming area was a big concern. Poor network coverage impacts on efficiency of the technology, it hinders the use of the technology as the need arises. Farmers have to wait until they get to where mobile phone network is available to make or receive calls. If it is an urgent call, they have to abandon what they are doing to go to where network is available. The result also indicated that respondents that had varyingly agreed to "I prefer face to face discussion" and "Lack of internet coverage hampers better use of mobile phone for agricultural purposes" represented means 3.36 and 3.19 respectively.

Table 7 Factors that limit the optimisation of mobile phone technology. Sample size = 328

Variable	Mean	Std. Dev.	Min	Max
The network coverage is poor in the farming areas	4.98	2.06	1	7
I don't know how to use mobile phone	1.45	1.26	1	7
The poor access to recharge card by rural farmers	2.71	2.16	1	7
I prefer face to face discussion	3.36	2.12	1	7
Lack of internet coverage hampers better use of mobile phone for agricultural purposes	3.19	2.54	1	7

Note: Std Dev = standard deviation; Min = minimum; max = maximum

As agriculture continue to improve, meeting farmers on one-on-one basis becomes increasingly difficult due to the number of farmers to be reached and the volume of information to be passed across to them. Conscious effort must be made to educate the farmers on the changes that must take place in the cause of improving agricultural practices. The problem of accessibility to or quality of the internet can be a worry to farmers particularly the educated ones. Internet network may frequently lose service or can be poor and this is a serious problem in rural areas where the educated farmers want to be able to independently obtain weather or market information from the web and increase their knowledge. The knowledge of how to use mobile phone and access of recharge cards were no serious issues pooling means of 1.45 and 2.71 respectively. However improvement in all these variables will help to optimise the benefits of using mobile phone by farmers.

Conclusion

This study was designed to investigate how much the farmers have taken advantage of this technology and the benefits derived from it. In view of these objectives, the study sought and provided answers to the questions raised in the objective. The study reported many benefits to smallholders that were created by mobile phone use and its unique characteristics of being handy, customised content delivery and convenience. As mobile phone providers continue to penetrate their services into the rural communities where farming is predominant, the tendency is that there will be expansion in the adoption of the mobile phone and increase use of the product to cover more aspects of agricultural activities.

The study outcome showed that many young and educated people involved in agriculture use mobile phone and that majority of them have owned the technology for more than three years. About 74% of the farmers spend no more than ₦3,000.00 monthly for recharge card and about 38% of their monthly recharge card expenses represent agricultural use. There was a strong relationship between mobile phone use and productivity and that network coverage was an issue that required serious attention. The study also found low use

of mobile phones for obtaining weather information. Weather information is an important detail upon which modern agriculture relies. Apart from providing normal agricultural weather information, it is relied upon to provide sudden extreme weather forecast that can be devastating. This study did not investigate the reason for the low mobile phone use to obtain this service, however smallholder farmers generally are conservative and would rely on tradition and local intuition to predict weather pattern. Moving forward, a review of the use of weather predicted data is necessary firstly to ascertain the availability of the data to farmers, secondly whether the farmers can access the data and finally whether the data can be made available through mobile phone applications.

Considering the benefits the farmers claimed to have obtained using a mobile phone, the realisation of the full potential of mobile phones usage can be constrained by lack of physical infrastructure. Electricity is a critical infrastructure for this service to both the providers and the farmers. The farmers rely on electricity to charge their phones and often it is not available or epileptic in supply; however farmers are excited about the benefits a mobile phone provides. The phone networks and internet services need to be improved such that farmers can use the mobile phone anywhere at any time.

Most governments in the sub-Sahara Africa are directly involved in administering extension service; it oftentimes involves the visit of the extension agents to the farmers at home or on the farm. Most, if not all, of the objects of the meetings can be conducted via mobile phone. Adoption of mobile phone for this purpose will save time and enable targeted messages to reach more farmers within the shortest possible time. The role of weather information in agriculture in modern time cannot be overestimated considering the volatility in the weather conditions due to the effects of climate change. It is important that every government should intensify effort to improve weather advice systems and to ensure the advice gets to the farmers. Government in collaboration with mobile phone producers and network providers should develop applications that can provide weather information to farmers.

The study has limitations; psychological questions were used to determine the effects of mobile phone on productivity. This made it difficult to measure the productivity in unit quantity terms. Therefore it is the recommendation of this study that further study should be carried out to evaluate in unit quantity term the effect of the use of mobile phone on agricultural productivity. Despite the similarity generally in mobile phone adoption and use across the Sub-Sahara Africa, one country information may not be sufficient to generalise hence caution should be taken when using the data. The depth of the agricultural activities for which the mobile phone is used could vary considerably in other countries within Sub-Sahara Africa.

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