
**IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTS) ON
AGRICULTURAL PRODUCTIVITY AMONG SMALLHOLDER FARMERS:
EVIDENCE FROM SUB-SAHARAN AFRICAN COMMUNITIES**

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ABSTRACT: *The study was carried out to assess the impact of Information and Communication Technologies (ICTs) among smallholder farmers in Northern Nigeria during October 2015 and September 2016 cropping season. Data were collected with structured questionnaires distributed to 200 smallholder farmers. The study used a multiple stage random sampling procedure to select farming household. Likert type scales were used to analyze the data. The main aim of the study was to find out the impact of ICTs on the agricultural productivity and welfare of the respondents. The t-test result revealed that ICT Services Short Message (SMS text reminders) had positive and significant impact ($P < 0.001^{**}$) on the agricultural productivity of smallholder farmers. The findings showed that 52% of the respondents experienced rapid increases in their crops productivity; and improved standard of living of the farmer as a result of the ICT Services Short Message (SMS text reminders). In addition, a large proportion (92%) of the respondents revealed that ICT Services Short Message (SMS text reminders) are beneficial to them. The results also revealed that radio, mobile phone and television among others were the most available ICT devices to the smallholder farmers in the area. However, the results obtained showed that radio and mobile phone were the most readily available ICT device with 97% and 85.8% respectively. The study however recommended that the Federal Government should create an enabling environment towards improved rural infrastructure and access to internet and other mobile communication technologies for rural people which would improve the overall use of ICT facilities. In addition, the Nigerian Government should establish ICT training centers in all the rural areas and educate farmers on the benefits of ICTs. Lastly, the study also suggested that there is a need for the development of ICT skills among agricultural extension workers and farmers in rural Nigeria.*

KEYWORDS: SMS text reminder, smallholders, productivity, mobile phone, radio.

INTRODUCTION

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 (Ajani, 2014; Irungu, *et al.* 2015; Gayi and Tsowou, 2016, Francis, 2016, Sennuga, 2019). Over the last two decades, Sub-Saharan Africa has witnessed a significant explosion in the use of ICT (Conger 2015). However, Chikaire, *et al.* (2017) 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. 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, 2012; Hassan *et al.* 2011, Sennuga, 2019). 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.

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 (Sennuga, 2019). Agricultural extension has been the key driver in the agricultural sector aimed at bringing economic growth to several developing countries. In Nigeria for example, 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.* 2015). 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 2010; Annor-Frempong *et al.* 2015, Sennuga, *et al.* 2020).

The strong drivers for the use of ICT in agricultural extension services are due to their features that have the potential to influence extension services. Colle and Roman (2016) 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, and as a result, the extent to which farmers progress, depends mainly upon their access to the most up-to-date and relevant information (Lucky and Achebe, 2013; Sennuga, 2019). ICT have been invaluable in much rural development efforts to bridge the information gap (Bhatnagar and Schwere, 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 (Balogun, *et al.* 2016).

Similarly, Wyche and Steinfield (2015) 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 2012); 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 (2012) 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 (2013) findings show a number of obstacles limiting the adoption of ICT ranging from finance; community ownership and relevance; technology; organization and management. This study focuses specifically on ICT (SMS text reminder) using mobile phone technology and crop production. Almost half of the world's population make use of (SMS text) 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, Francis, 2016). Undeniably, mobile services have transformed every sphere of human endeavor, 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; all have 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.

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, Nwagwu and Opeyemi, 2015, Chikairem, *et al.* 2017).

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.* 2013). 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 2011). 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)

Source: Survey, 2016

Figure 1: Radio- Farmer programme in the study area

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, 2011). 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.

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. Information has become a valuable commodity both in developed and developing countries (Onwuebele 2011). Consequently, many developing countries that have acquired the necessary mobile phone technology infrastructure have experienced terrific and rapid growth and are moving rapidly into the post-industrial information-based economy (Alleman 2005; Onwuebele 2011). ICT are making a significant impact as a major catalyst for information and knowledge which creates 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; Onwuebele 2011).

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). 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).

Relevant Good Agricultural Practices' (GAP) to the Study Area

After a careful consideration of farm household in making improved decision about ICT and technologies adoption the following factors were put into consideration in selecting 16 Good Agricultural Practices (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 study area: 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. The impact of ICTs (SMS text) on agricultural productivity among smallholder farmers is yet to be established and this is why this study was conducted. Therefore, the main objective of this study is to assess the impact of Information and Communication Technologies (ICTs) on agricultural productivity among smallholder farmers in Northern Nigeria. The specific objectives of this study are to:

- i. examine the socio-economic characteristics of the farmers in the study area;
- ii. identify ICT devices available to the smallholder farmers;
- iii. determine the impact of ICTs (SMS Text reminders) on farmers' agricultural productivity;
- iv. identify constraints facing the smallholder farmer' use of ICT devices.

METHODOLOGY

The study was conducted in two zones of Kaduna State Agricultural Development Project (KADP). Kaduna State is located between latitudes $9^{\circ} 03^1$ and $11^{\circ} 32^1$ North of the equator and longitude $6^{\circ} 05^1$ and $8^{\circ} 38^1$ East of the Greenwich Meridian (Kaduna State Ministry of Agriculture 2014). Specifically, the study was carried out in two randomly selected rural communities (Shika and Bassawa) in Giwa and Sabon-gari Local Government Areas respectively. The two rural communities were purposely selected out of 22 villages because of their age-long agricultural practice and presence of adoption practices noted there (Sennuga, et al. 2020). Multiple stage random sampling procedure were used to select 200 farming households 100 from each village (Basswa and Shika village) that participated in the study. Farmers were trained on 16 Good Agricultural Practice (GAP) technologies. In addition, ICT (SMS text reminders) were sent to farmers fortnightly. The rainy season (May-October) is extremely heavy in the southern part of Kaduna state with an average of over 1,524 mm, which is higher than in the northern part which has an average of 1,016mm (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°C and 32° (Kaduna State Ministry of Agriculture 2014). The major food crops grown are yam, maize, millet, groundnut, rice, beans, melon, sweet potato, cassava, guinea corn and vegetables such as pepper, tomato and carrot. The study made use of both

primary and secondary data. The primary data were collected from field survey using structured questionnaires and face-to-face interview schedule. Secondary data sources were utilized to provide background information and other necessary to achieve some objectives of the study. Such secondary data includes peer review journals, textbooks, publications and proceedings. Enumerators were given adequate training. A baseline livelihood surveys was conducted in the study area (Bassawa and Shika communities), and the questionnaire was pre-tested with three farmers working with Ahmadu Bello University (ABU), Zaria. Basically, data were analyzed using descriptive and inferential statistics. This was used to analyze the objectives. A four (4) point Likert type scale of Strongly Agreed (SA), Agreed (A), Disagreed (D) and Strongly Disagreed (SD) assigned values of 4, 3, 2 and 1. The software SPSS version 24 was used and included frequency, mean, percentage and t-test analysis.

RESULTS AND DISCUSSIONS

Socio-economic Characteristics of Smallholder Farmers

The socio-economic characteristics of the respondents investigated in the study included: age, gender (sex), marital status, household size, level of education, family education, major crops cultivated, household assets, household economics assets and income level. The age of the farmers in the households ranged from 20 to 70 years. 59.2% of them fell within the middle age of 31-50 years in both communities. This suggests that the majority of the respondents were within their economic active age and this enhances their productivity and usage of ICT devices for relevant agricultural information that will enhance their agricultural production (Table 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. However, it is generally assumed that younger people tended to be more productive than their older counterparts. Results in Table 1 below showed that all the respondents were males; this is because the cultural traditions of the study area do not allow females to be actively involved in farming activities (Sennuga, *et al.* 2020).

In terms of the marital status of the respondents, overwhelming majorities (96.7%) of the respondents were married with half of these households having 10 or more members; the remainder had larger families of 21 plus members reflecting polygamy within the communities. The result is not surprising because large family sizes are the norm in Northern Nigeria and large families provide accessible workforces. Furthermore, the cultural tradition and religion 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. In the same vein, large household may also help to access more agricultural information.

Educationally, 44% of the respondents had acquired primary education, while 17% had secondary education. Only 7.5% of the respondents possessed higher education (Table 1). This suggests that the respondents in the study area obtained the basic education required for better understanding and usage of ICT devices that will make it possible for them to increase crop production. In addition, it is generally thought that the level of education enhances the ability to comprehend and also adopt relevant agricultural information. Indeed, according to Olumba and Rahji (2014) and Kalungu and

Filho (2016), highly educated farmers tend to adopt relevant agricultural innovation better than less educated ones. In terms of household assets, 58% of the households keep poultry, a greater proportion (61.7%) keep sheep and goats. A sizeable proportion of the respondents (42%) also indicated that they rear cattle and only 6.5% specified that they keep other livestock such as camel, duck, turkey etc. The baseline livelihood survey shows that no single household keeps pigs in the study area. This was attributed to the religion (Muslims) of the respondents. It was revealed during the interview that the Muslim faithful do not rear pigs (Sennuga, *et al.* 2020).

In relation to family income, greater proportion (58.7%) were in the income range of ₦301, 000 - ₦400, 999 (equivalent to \$860 - 1,145USD) followed by 25.5% who were in the range of ₦121, 000 - ₦300, 999 (i.e. \$347 - 859 USD). This is less than \$1.5 per day poverty line i.e. income divided by number of adults. This implies that a greater proportion of the respondents would be able to train their children in schools.

Table 1: Demographic representation of the socio-economic Characteristics of the smallholder farmers (n= 200)

<i>Variables</i>	<i>Percentage</i>
Age (years)	
20-30	15.8
31-40	31.7
41-50	27.5
51-60	17.5
61-70	6.7
> 70	.8
Gender (Sex)	
Male	100
Female	0
Marital status	
Single	3.3
Married	96.7
Household size	
≤10	50.8
11-20	36.4
21-30	12.1
>31	.7
Level of education	
No education	30.8
Primary	44.3
Secondary	17.0
Tertiary	7.5
Family education	
No education	3.3
Primary	55.0
Secondary	35.8
Tertiary	2.5
No Children yet	3.3
Household Asset	
Poultry	58.0
Sheep and goats	61.7
Cattle	42.8
Other livestock	6.5
Pig	0

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 97.0% owned radios respectively (Figure 2a-b). Evidence from the field study shows that on weekly basis smallholders actively listen to agricultural 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 (See Box 1)*. Mobile phones and radios play a major role in diffusing agricultural information in rural communities (Aldosari *et al.* 2017, Sennuga, *et al.* 2020). This implies that mobile phones and radios could help farmers make well informed decisions on adoption of Good Agricultural Practices and influence farmer's agricultural productivity positively. A chi-square test shows that there were no statistically significant differences between the two communities.

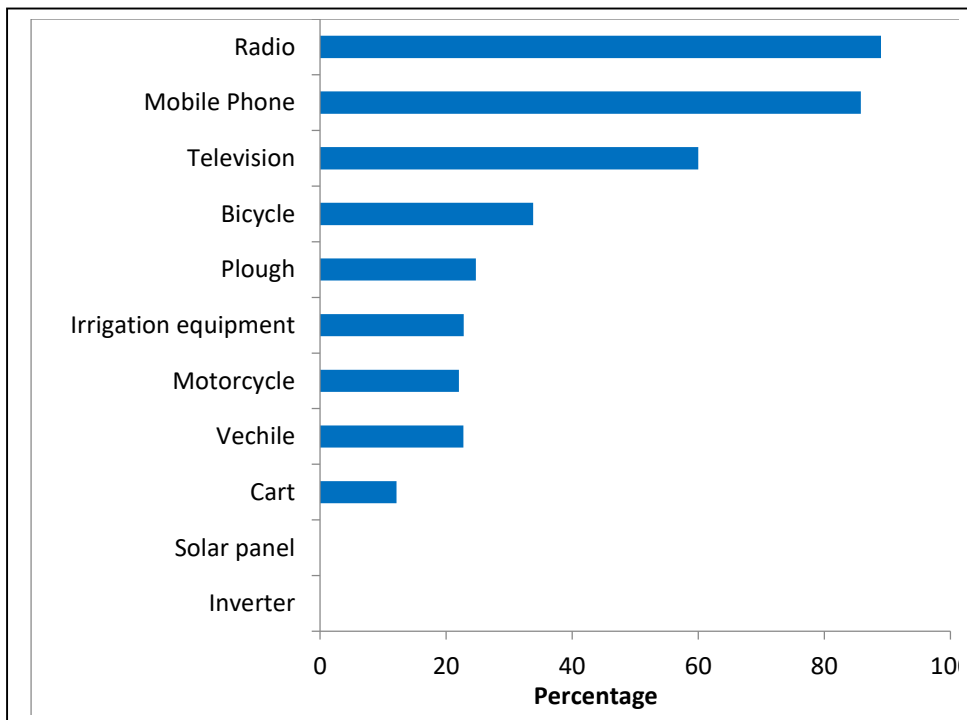


Figure 2a: Distribution of the respondents by household Assets
 Source: Field Survey Data; Shika n=100 Scale: %

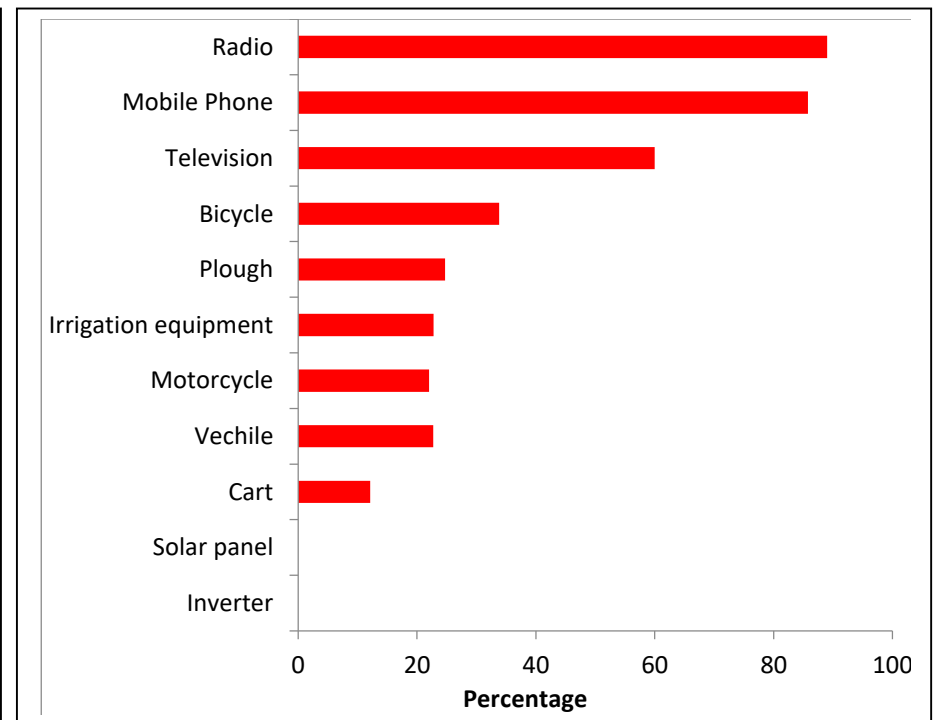


Figure 2b: Distribution of the respondents by household Assets
 Source: Field Survey Data; Bassawa n=100 Scale: %

ICT Devices Available to the Smallholder Farmers in the Area

Table 2 revealed that different ICT devices were readily available for respondents in the study area. The table showed that radio, mobile phone and television are the most widely used ICT devices in the area with percentages of 97.0%, 85.8% and 48.3% respectively. This result suggests that these devices are the most reliable sources of agricultural information and innovation to the smallholders. This result is in line with a study conducted in Kilosa District, Tanzania on contribution of ICT in improving access to market information among smallholder farmers, where Njelekela and Sanga (2015) revealed that the respondents indicated that they received relevant agricultural information through radios, mobile phones and televisions. Similarly, 38.7% indicates that newspapers are also readily available for use and contains relevant good agricultural information. Whatsapp and magazine had a very close average percentages of 29.5 and 28.7 respectively, this also indicates that agricultural information can be received and sourced for through them, however they are not actively available because few smallholders owned and had access to smart phones (android/ios phones). In the same vein, computer and internet users are 15.2% and 13.3% respectively, which as well shows that they are not readily available but, still serve as a medium of getting relevant agricultural information. This could be attributed to the high cost of purchasing a desktop or laptop computer which is relatively expensive in Nigeria. Also, the high cost of internet subscription or poor network coverage may be prohibitive for respondents. E-mail, Digital camera and I-Pad have the least percentages of 6.7, 4.1 and 3.1 respectively. This confirms that they are the least available ICT devices through which smallholders' source relevant agricultural information in the study area. Altogether, the results revealed that radio is the most readily available ICT device for the respondents in the area. For example, during the face-to-face interviews, a farmer revealed that Ahmadu Bello University (ABU) Zaria Radio station is the most widely listen to by the farmers in the area due to its strategy of broadcasting fascinating programmes.

Table 2. Distribution of available ICT devices to the Smallholder Farmers

Available ICT Devices	Percentage (%)
Radio	97.0
Mobile Phone	85.8
Television	48.3
Newspaper	38.7
WhasApp	29.5
Magazine	28.2
Computer	15.2
Internet	13.3
E-mail	6.7
Digital Camera	4.1
I-Pad	3.1
Compact Disk (CD-ROM)	3.0

**Multiple Reponses

Source: Field survey 2016

Table 3: Distribution of ICT (SMS Test Reminders) on Agricultural Productivity (n = 200)

Impact of ICT (SMS Test Reminders) on Agricultural Productivity	%
Do you think the ICT (SMS Test Reminders) was beneficial?	
Yes	92.0
No	8.0
Do you think the ICT (SMS Test Reminders) had a positive impact on your Agricultural productivity?	
Yes	89.0
No	11.0

Source: Field Survey 2016

Impact of ICT (SMS Text reminders) on Farmers' Agricultural Productivity

The difference in agricultural productivity of smallholder farmers between 2015 (pre-intervention) and the 2016 cropping season (post-intervention) was explored. Findings reveal that ICT (SMS text reminders) had a positive and significant impact ($P < 0.000^{**}$) on the agricultural productivity of smallholder farmers (Table 4). In the same light, the results presented in Table 3 indicated that a large proportion (92%) of the respondents reported that the ICT (SMS text reminders) were beneficial and prompted them to adopt and implement the recommended GAP technologies, which could be attributed to substantially increase yields. The results of the survey showed that the majority (89%) of smallholder farmers indicated they experienced an increase in crop yields due to the availability of credible information through SMS text reminders received fortnightly. Findings from this study show that 52% of smallholder farmers experienced an increase in the productivity of their crops as a result of the ICT (SMS text reminders) received fortnightly and the subsequent adoption of 13 GAP technologies. This result implies that provision of reliable information through SMS text reminders may increase the agricultural productivity of smallholder farmers. Also, the findings revealed that the role of timely and appropriate information cannot be over-emphasized.

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

The survey included a question that recorded the income and profits on agricultural production of respondents in year 2015 (before intervention) and profits realized in year 2016 cropping season after the ICT (SMS text reminders) intervention. The question asked respondents was to provide the profit realized in 2015 and 2016 respectively as a result of ICT (SMS text reminders) intervention. Table 4 presents the means and standard deviations, t-test results for the outcome variables. Farmers reported that the ICT (SMS text reminders) intervention had contributed immensely to their agricultural productivity and livelihoods. The smallholders reiterated that the SMS text reminders were impactful. During face-to-face interviews, a farmer stated that *"my household would never forget the impact of this research study and I wish you could come around next year during raining season with this intervention"*.

Table 4: Estimate profits of the smallholder farmers after ICT (SMS text reminders) intervention on agricultural productivity/income; Shika =100; Bassawa n=100

Category	Year 2015	Year 2016	Difference (2016-2015) (%)
	Pre-GAP Intervention (₦)	Post-GAP Intervention (₦)	
With-SMS farmers (Bassawa)	167,079	332,989	52.2
Without-SMS farmers (Shika)	163,004	265,210	10.7
Difference between groups	4,075	59,079	

Source: Field Survey 2016; P < 0.05 is significant

Table 5: Means results between 2015 and 2016 cropping season among the with Smallholder farmers (N=200)**Impact of ICT (SMS text reminders) 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: Field 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	-5.320	6	-46.72	.001**	.130
variances assumed		-6.012	6	-48.51	.000**	.082
Equal variance assumed						

Constraints Facing Smallholder Farmers' Use of ICT Devices

Figure 3 below shows that the most noticeable constraints limiting smallholders' use of ICT devices are: language barrier (91.1%), low level of formal education (85%), unavailability of ICT devices (79.6%), high cost of ICT devices (72.9%) and extremely low income of smallholders (68.4%). Other constraints facing smallholders' use of ICT devices including; lack of ICT center (signal) in the area (65.5%), poor benefits of using ICT (57.1%), insufficient awareness of the importance of ICT in the area (49.7%) and lack of ICT training center in the area (38%). This establishes the claims of the United Nations (2018) that smallholders in rural developing countries are constrained by different factors, which prevented them from getting access to timelier and better-quality information on products and inputs as well as facilitating technology adoption among farmers. In the same vein, the least perceived constraints specified by the smallholders are; poor network coverage in the area (29.7%) and high cost of internet subscription (20.1%). These findings showed that all perceived constraints aforementioned impinge on the respondents' use of ICT devices, although some have enormous effect while others to a lesser degree. Aker and Mbiti (2010) had

earlier stated that a number of hindrances slowed down ICTs usage in developing countries, predominantly in the area of access to excellent networks and power supply.

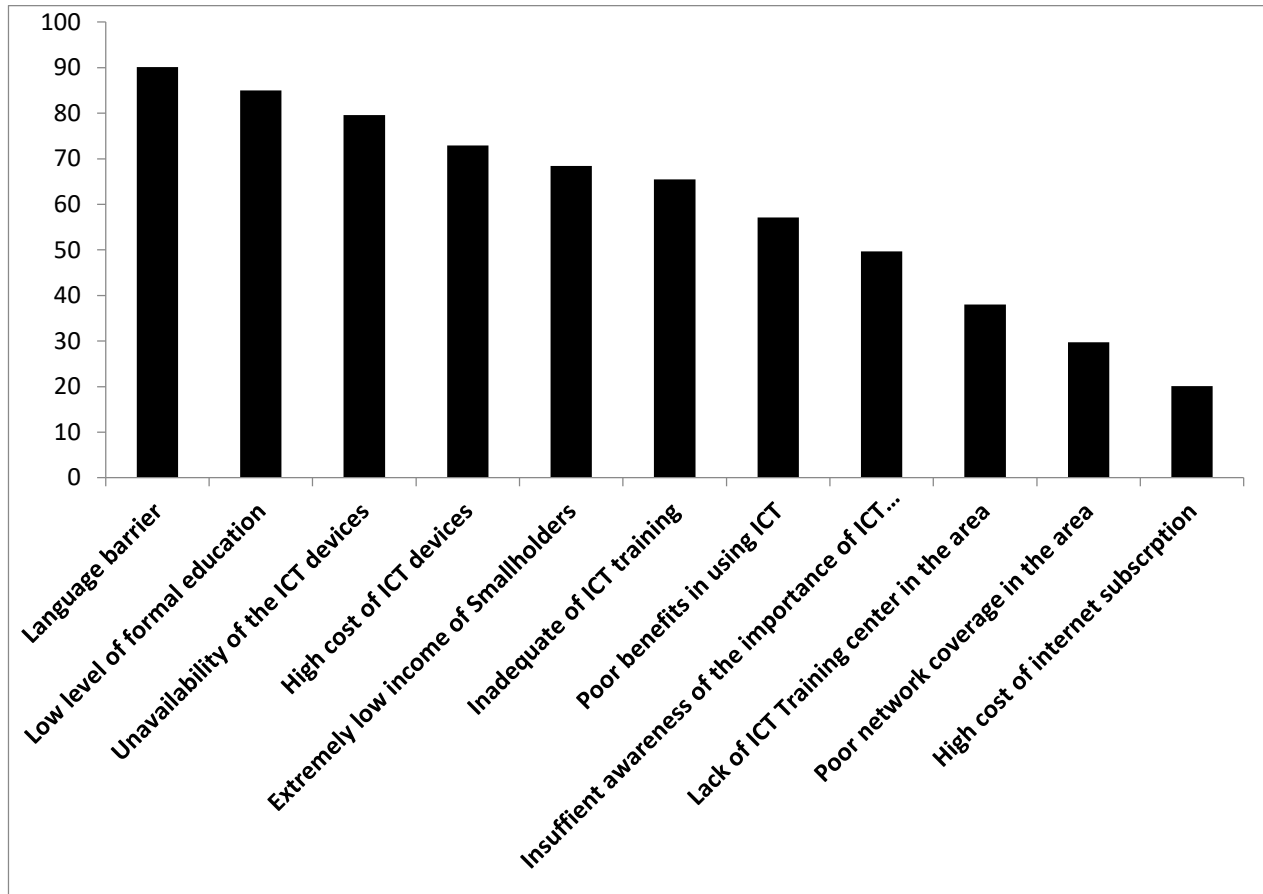


Figure 3: Distribution of Constraints Facing Smallholder Farmers' Use of ICT Devices
Source: Field Survey 2016; n=200 **Scale: 100%**

CONCLUSION

From the study, our results have shown that ICT (SMS text reminders) had great impact on the agricultural production and productivity of smallholder farmers in the study area. The results also revealed that access to ICT (SMS text reminders) had a positive and significant influence ($P < 0.001^{**}$) on the yield increase of the respondents. Our findings showed that 52% of the respondents experienced rapid increase in the productivity of the crops and improved standard of living of the farmer as a result of the ICT (SMS text reminders). Also, a large proportion (92%) of the respondents revealed that ICT (SMS text reminders) are beneficial to them. The results also showed that radio and mobile phones, followed by television were the most utilized ICTs devices among the farmers. To the best of our knowledge, there is no large survey data-based evidence on

the impact of ICT (SMS text reminders) on the agricultural productivity among smallholder farmers in the academic literature in Africa. This study's main strength stems from its originality.

RECOMMENDATIONS

The study recommends that Nigerian Government should create an enabling environment towards improved rural infrastructure and access to internet and other mobile communication technologies for poor rural people which would improve the overall use of ICT facilities. In addition the Federal Government should establish ICT training centers in all the rural area and post University graduate, especially Corp members who are on one year National Youth Service should be employed to train farmers and manage the facilities. Also, there is need to intensify the use of radio and television programmes; and mobile technology as a means to reach more farmers at the same time. Another role of Government and NGOs should be to educate smallholders on the benefits of using ICTs, including integrating such technologies for use within government extension programmes for farmers. Finally, there is need for development of ICT skills among agricultural extension workers and farmers in Nigeria.

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