

INNOVATION: ICT ADOPTION AND CROP PRODUCTION IN NIGERIA

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Abstract

The use of Information and Communication Technology (ICT) in crop production is still relatively new in Nigeria. An observation of the statistics on ICT adoption and crop production with the exploration of the application of the theoretical prescriptions of the Diffusion model (in terms of innovation) to crop production suggests a strong positive association. This study empirically examines the degree of association between crop production and ICT adoption in Nigeria using Pairwise correlation methodology. The results showed that mobile cell subscription and internet usage indicated a high positive degree of association with crop production while fixed telephone lines indicated a weak but positive correlation with crop production. The study postulates that Crop production can be achieved by increasing the utilisation of ICTs in the Crop production value-chain process and the recommendation from the study was to encourage the use of ICTs through government and private sector investment in the agric sector development to reduce the cost of acquisition of ICTs by crop producers and farmers.

Key Words: ICT adoption, Crop production, Correlation Analysis

INTRODUCTION

Smart Agriculture/ E-agriculture comprise of the use and development of ICT for agriculture purposes. E-Agriculture started in developed economies, and is now being closely followed by developing economies but is growing at a slow rate (Goyal & González-Velosa, 2012). E – agriculture has been proven to increase agricultural output by improving product quality, providing full information for product pricing, enabling the collection of agricultural data more

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efficiently, improving soil testing techniques, improving marketing (e-commerce), easy sorting and record keeping, and so on. The argument for developing countries to globalize is important and is designed to enhance access to foreign capital, improved technology in order to enhance the prospect for larger markets (Alege & Osabuohien, 2013). The continued increase in globalization and integration of food markets has intensified competition and efficacy in the agriculture sector, and has brought unique opportunities to include more smallholders into supply chains.

Goal two of the Sustainable Development Goals (SDG) which was enacted in 2015 is to end hunger, achieve food security, improved nutrition and promote sustainable agriculture in the world. To achieve this goal, strategies would have to be put in place by countries especially in the developing part of the world to meet up the 2030 deadline. To achieve sustainable agriculture in this modern age, the application of Information and Communication Technology (ICT) cannot be under-utilized. Agriculture plays a significant role in economic and social development in most less-developed and developing countries. Agriculture faces a range of modern and serious challenges, particularly in developing countries exposed to price shocks, climate change, and continued deficiencies in infrastructure in rural areas. Adequate dissemination of detailed information is a necessary condition for improvement of all areas of agriculture (Zhang, Wang & Duan, 2016). Theory also suggests that ICT has a positive impact on the development of any nation.

Despite the fact that studies have shown e-agriculture increases total agriculture output in developed countries and the fact that Nigeria has the required labour to carry out such great agriculture exploit coupled with one of the highest arable fertile land for growing crops, Nigeria still relies partly on the importation of some agricultural products to combat food insecurity. Hence, this study, based on the gap found in literature intends to determine the degree of association between ICT adoption and agricultural productivity (Crop Production) in Nigeria. Consequently, the immediate research questions include: is ICT adoption associated with crop production in Nigeria? What should be the immediate policy agenda for Nigeria in implementing the use of ICT in agriculture? The main objectives of this paper are to provide statistical analysis of ICT adoption and crop production variables in Nigeria, determine the degree of association of ICT adoption (in terms of mobile cell subscription, internet usage and fixed telephone lines) and crop production in Nigeria.

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The outline of the study is as follows; Section 2 contains the insights from literature, section 3 comprises of the method of analysis, section 4 contains the discussion of results while section 5 contains the conclusion and recommendations of the study.

INSIGHTS FROM LITERATURE

ICT adoption is now raising much interest among economists. Literature is starting to witness a large body of theoretical and empirical debate on ICT and Economic growth (Ghosh, 2016; Imbert & Papp, 2015; Muralidharan, Niehans & Sukthankar, 2014; Jack & Suri, 2011), Inclusive growth (Ejemeyovwi & Osabuohien, 2017). Some researchers investigated ICT penetration on specific subsectors and sectors like the banking sector (Osabuohien, 2008), How Institutions matter in terms of Technological Utilisation in Africa (Efobi & Osabuohien, 2015), The challenges and opportunities in Technological Diffusion and Economic Progress in Africa (Osabuohien & Efobi., 2012), ICT and Productivity (Ark et al, 2002; Daveri, 2002; Jorgenson 2003), ICT and Agriculture in different countries (Aker & Fafchamps, 2010; Armstrong. & Gandhi, 2012; Asenso-Okyere and Mekonnen, 2012; Sangbuapuan, 2012; Chavula, 2013; Salamasis, & Theodoridis, 2013; Vosough *et al*, 2015; Zhang, *et al*, 2016). The use of ICT in agriculture can bring changes to the poor and needy areas in an economy such as food security (Kumar & Sankarakumar, 2012).

Empirical evidence shows that ICT has a positive impact on Agricultural output. Most of the works used primary data which involves the use of questionnaires for data collection (Ogbomo & Ogbomo, 2008; Hassan *et al.*, 2011; Chukwunonso *et al*, 2012; Ramli *et al.*, 2013; Okwusi *et al.*, 2009). Nwabueze & Ozioko (2011) put forward that ICT has been proven to be the engine of growth in the 21st century. It has found its place in many sectors in West African economies and its importance cannot be over emphasized. ICTs have inclusive advantage accumulation, information storage and dissemination; makes things easier and faster (Chisita, 2010). ICT adoption in terms of mobile technology, internet facilities and so on could be used to overcome problems related to physical distance and mobility of people, allowing them to enlarge areas of practices and maintain connections outside the immediate space of their homes, work, other local areas and increase access to timely and relevant information (Brown *et al.*, 2001; Katz, 2003; Ling & Pedersen, 2005; Asongu *et al.*, 2016).

ICT could be used to carry out agricultural financial transactions. The e-wallet innovation in Nigeria is a way of using SMS to order and pay for seeds and fertilizers. Financial transactions

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are even made cheaper with the use of ICT as discount rates are given. This makes agricultural transactions timely, effective and easier. A study carried out revealed that ICT is a veritable tool and requirement for agricultural and rural transformation even though it is not widely accessed by farmers in these communities. It was recommended that information and communication technology facilities be made available in most rural localities in the state such as internet facilities, overhead projector, and the Agricultural extension staff should be properly trained in this area to be able to train farmers using ICT facilities (Ugboh & Tibi, 2008). Labour, as well as capital and technology have a direct relationship with total agricultural output. From the results in the analysis done on the role of ICT on Agriculture in West Africa; labour and capital were elastic. This implies that, for any change in Labour and Capital, agricultural output increases more than proportionately. These results were statistically significant (Akimuda, 2014).

The effect of utilization of ICT for agricultural transformation on socio-economic characteristics of farmers in south-eastern Nigeria was carried out. Structured interview was administered on 270 respondents in the study area. Data analysis was by the use of multiple regressions. Findings revealed that Age, education, marital status and income significantly influenced utilization of ICT for agricultural information by farmers. It was recommended that efforts should be made by Federal, State and Local Governments to provide adequate ICT resources in both urban and rural areas (Okwusi *et al.*, 2009).

ICT helps to provide pricing information, production and agriculture extension and demand information through knowledge availability (Awuor, *et al.*, 2013). Pricing Information here refer to Information on selling such as market availability, retention price, selling price, dealers, ware house; production and agriculture extension information include funding, credit, awareness about crops, pollution control, pest and disease control, new farming techniques, quality enhancement. Demand information consists of crop variety, land use, soil health, soil nutrients, requirement, irrigation, Weather report. Knowledge availability includes dedicated website, emails, SMS, Voice calls/customer care agents, tele-center, E-learning/training. Some other ways in which ICT can help tackle key challenges in agricultural value chain development, are Pricing and weather information systems, applications to help buyers manage transactions with the thousands of small – scale farmers who supply to them, Mobile banking and apps that facilitate quick payments, Initiatives to expand the reach of farm extension services through phones, radio, internet, personal computers, or text messaging (SMS) campaign for enabling environment.

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Wide ICT adoption leads to improved value chain interaction, financial Inclusion, increased research and development for increased productivity. The value chain consists of the various users from development/production stage to the distribution stage to the consumption stage. The problem of frictions (imperfect information) between the various components of the value chain will be reduced drastically. ICT serves as a platform for the instantaneous interaction across wide distances without any physical barrier. ICT empowers the value chain members with nearer and safe access to finance, credit facilities, on-the-spot transaction, and so on. ICT assists in delivering research and development by connecting experts on food production, on-the-spot sharing of information of latest world practices on crop production. However, ICT has its limitations in a country like Nigeria. Some of the limitations are high cost of adoption of internet facilities, internet enabled smart phones; high level of illiteracy and language disparity, relatively low ICT investment and infrastructure, relatively, inconsistent electricity and energy availability, the creation of room for organised criminal activities such as hacking and Cybercrime activities, fear of loss of huge amount of money due to online fraudulent activities (Johnson, 2016).

In sum, few studies in relation to information and communication technology on agricultural productivity have been conducted in Nigeria, and non (to the best of the researcher's knowledge) of them has attempted to provide a comprehensive analysis of the degree of association between ICT adoption and crop production at the macro level in Nigeria using quantitative secondary time series data.

THEORETICAL FRAMEWORK AND METHOD OF ESTIMATION

The Theories underpinning this paper are the diffusion theory of innovation (Rogers, 1962) and search theory. The diffusion theory of innovation was proposed by Everett Rogers (1962). The theory proposes that four factors are responsible for the spread of a new idea: the innovation, communication channels, time and a social system. This theory applies to this research on ICT adoption and crop production because innovation has been established as a criterion for increase in productivity overtime as propounded by Schumpeter in the Schumpeterian growth theory. Innovation could be in terms of ICT or non-ICT. Communication channel is also proposed by the diffusion theory, which emphasises the importance of ICT in Crop production – in bridging the gap between the raw material (seed, fertilizers, and so on) suppliers, producers (farmers), researchers (experts on seed production), distributors, consumer through means like mobile phone applications, real time mobile communication overtime through the internet. The social

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system being referred to is a receptive environment that is willing to receive and open to new ideas.

Search theory is also known as “Matching theory”. The theory was propounded by George Stigler. Search theory analyses the search-frictions as a result of the imperfect information that exist between the various components of the value chain such as the demand and supply, producer and supply of raw materials. ICT could help to reduce these search frictions. The method of estimation used for this research is the Pairwise correlation method to determine the degree of association existing between the two variables involved in the research (Gujarati, 2009) -ICT adoption and Crop Production in Nigeria.

Due to the nature of the study, the implicit model for the empirical analysis of this paper is specified thus;

$$Y = f(\text{LAB}, \text{GFCF}, \text{MCS}, \text{NOIU}, \text{FXTL}) \quad (1)$$

Given the nature of the data, analysis, the production function adopted is the Cobb Douglas production function which is given as:

$$Y_{(t)} = A_{(t)} K_{(t)}^{\alpha} L^{1-\alpha}_{(t)} \quad (2)$$

To convert the model to linear form, the explicit form of the model is therefore transformed by taking the log of the values, we have:

$$\ln Y = \beta_0 + \beta_1 \ln \text{LAB}_t + \beta_2 \ln \text{LGfcf}_t + \beta_3 \ln \text{LNoiu}_t + \beta_4 \ln \text{LMcst}_t + \beta_5 \ln \text{LFxtlt}_t + \mu_t \quad (3)$$

Where:

β_0 is the intercept and $\beta_1, \beta_2, \beta_3$ and β_4 are the parameters to be estimated; subscript ‘t’ is the time period. Y is total crop production in Nigeria during the years of analysis; LAB is labour – total number of people in the population included in the production process; GFCF is capital employed in Nigeria; MCS is number of mobile phone users in Nigeria; NOIU is number of internet users in Nigeria; FXTL is the number of fixed telephone lines in Nigeria.

The Apriori expectations are the facts which should be a confirmation of the exogenous growth model which propounds that productivity increases with more investment in technology. The Exogenous theory implies that there is a direct relationship between agricultural output and ICT. Labour is expected to have a direct positive relationship with total agricultural output hence; the

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coefficient carries a positive sign, $\beta_1 > 0$. Capital is expected to have a direct positive relationship with total agricultural output. The coefficient carries a positive sign. $B_2 > 0$. Number of internet users' apriori expected coefficient here has a positive sign meaning an increase in number of internet users brings about an increase in total agricultural output and vice versa. This means that, the coefficient would be $\beta_3 > 0$. Number of mobile phone users' apriori expected coefficient is to have a positive sign. Meaning that, an increase in number of phone users brings about an increase in total agricultural output hence, $\beta_4 > 0$. The stochastic term, μ , cannot be estimated because it is expected to be normally distributed with mean of zero and also has a constant variance. Therefore, $\beta_1, \beta_2, \beta_3, \beta_4, > 0$

The data used for this research is secondary time-series data for Nigeria (1985 – 2014; 30 years).

TABLE 1: Table showing the Variables and their corresponding definitions

Variables	Definitions	Data Sources
Total Crop Production (Y). (dependent variable)	This is the total number of crops produced (value added) in Nigerian (Tonnes).	Nigerian Bureau of Statistics and Central Bank of Nigeria(CBN)
Internet Users (NOIU) (β_1)	This is the total number of people that utilise internet in Nigeria	World Development Indicators (WDI)
Mobile Cell Phone Users (MCS) (β_2)	This is the total number of mobile cell phone Subscription in Nigeria.	World Development Indicators (WDI)
Capital (GFCF) (β_3)	This is the total amount of investment in the economy in terms of fixed and variable	World Development Indicators (WDI)

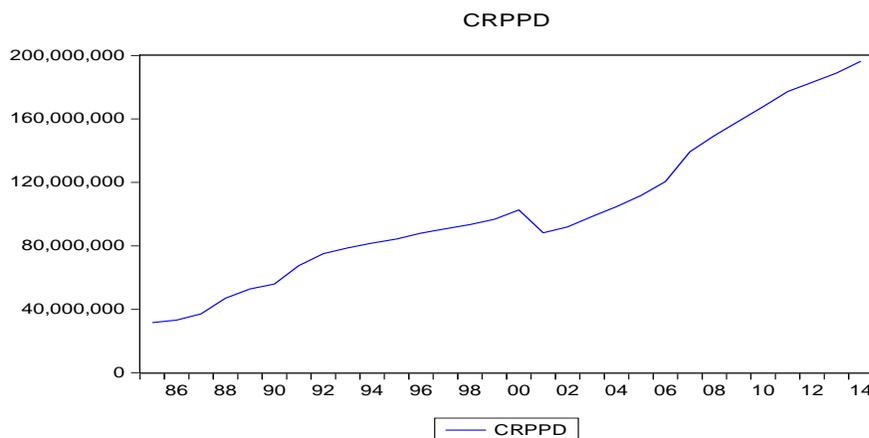
RESULTS AND DISCUSSION

Patterns of ICT adoption and Crop production in Nigeria

Crop production in Nigeria consists of staples such as maize, millet, sorghum/guinea corn, rice, wheat, acha, beans/cowpea, cassava, potatoes, yam, cocoyam, plantain, vegetables; other crops which comprise of groundnut/peanut, bennis seed / sesame, soya bean, cotton, palm oil, cocoa, rubber, sugarcane, kola nut, ginger, cashew, pineapple, and palm produce. Table 1.0 below shows the trend of Crop production and ICT adoption in Nigeria (1985 to 2014). Crop production capacity (tonnes) in Nigeria has been experiencing increase within the period of 1985 and 2014, although, there was a slight reduction at 2000 and 2001. The maximum crop produced

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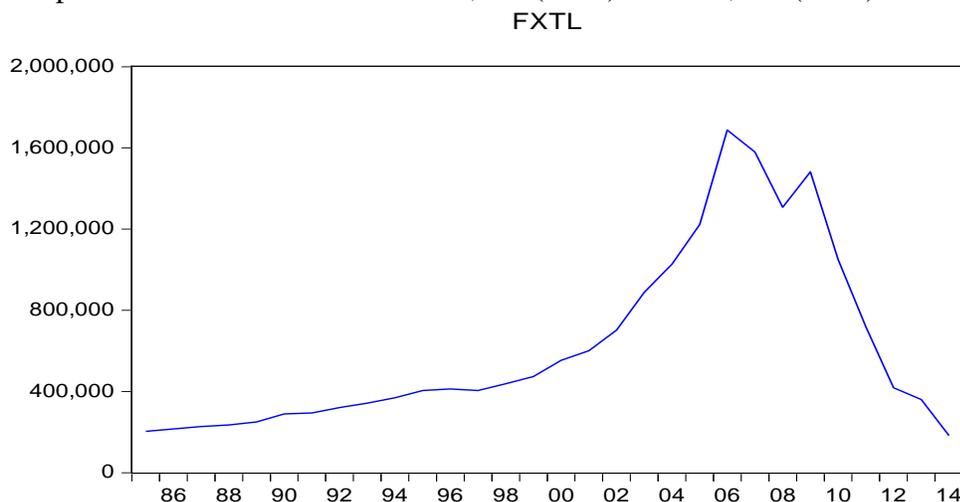
in tonnes was in year 2014 with 196 million tonnes while the minimum was seen in 1985 with 31.6 million tonnes.



Computed by authors; Data Source: NBS (2016); Software: Eviews9

FIG 4.1: THE TREND OF CROP PRODUCTION IN NIGERIA (1985 - 2014).

ICT adoption in this paper is measured by fixed telephone lines, Mobile cell phone subscribers (technology), Number of Internet users. During the early period of ICT adoption in Nigeria, Fixed telephone lines were the first to come into Nigeria by 1983/84 (WDI, 2016). Fixed telephone lines had the value of 203,980 (1985) and 342,287 (1993).

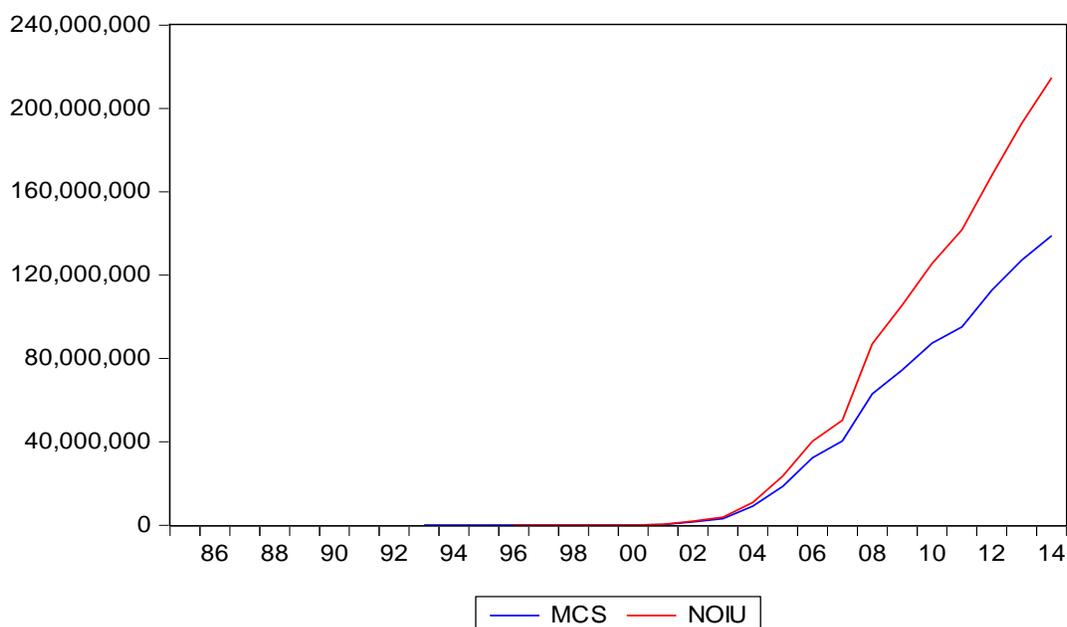


Computed by authors; Data Source: WDI (2016); Software: Eviews9

FIG 4.2: THE TREND OF FIXED TELEPHONE LINES IN NIGERIA (1985 - 2014)

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The introduction of mobile cell subscription technology brought about portability and therefore, became attractive. In Nigeria, mobile cell subscription started by 1993 with 9,049 subscribers. Nigeria witnessed internet usage in 1996 with 9,819 internet users. 2006 witnessed the highest amount of fixed telephone lines in Nigeria (1,687,972) which was followed by a fall in fixed telephone lines which was due to the introduction of the likes of mobile cell subscribers. Mobile Cell Subscribers had the highest value of 138 million subscribers at 2014 and its lowest value of 9,049 at 1993. This could be attributed to the fact that some Nigerians have multiple subscription lines from different service providers.



Computed by authors; Data source: WDI (2016); Software: Eviews9

FIG 4.3: THE TREND OF MOBILE CELLPHONE SUBSCRIPTION AND NUMBER OF INTERNET USERS IN NIGERIA (1985 - 2014)

ICTs are being referred to as General Purpose Technologies (GPTs) by economists (Atkinson, 2009). GPTs are technologies that cut across all sectors of the economy and are known to have practical usefulness in those sectors. ICTs have been found to increase productivity and output, reduce cost of transportation and many other benefits. According to World Bank Report (2009), there was a 1.3 percent growth increase with every 10 percent rise in the speed of internet connection. Rational thinkers as human beings would prefer to engage in activities that would

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yield highest levels of utility. Information and Communication Technology (ICT) found its way into Nigeria territory few decades ago. Its dominance and influence on the economy of the country cannot be overemphasized. Research has shown that ICT has the largest market in Nigeria among other African countries (Ayo *et al.*, 2010) capitalizing on her giant population. ICT is widely embraced and acceptable due to the availability and affordability of its infrastructure, which is springing up fast (Seyed & Seyed, 2012).

Correlation results

The research was based upon the diffusion theory of innovation and search theory. This model explained growth and included labour, capital and an exogenous factor, information and communication technology as variables that can affect output. The correlation results are shown below in Table 4.1:

Table 4.1: Pairwise Correlation Coefficient

VARIABLES	LCRPD	FXTL	LMCS	LNOIU
LCRPD	1.00			
LFXTL	0.35	1.00		
LMCS	0.85	0.62	1.00	
LNOIU	0.92	0.57	0.98	1.00

A. By authors; Package: Eviews9

Correlation analysis is used to check for the degree of association that exists between two variables. This implies that if two variables are positively highly correlated, an increase in one of the variables will likely be associated with an increase in the second variable. The correlation results between information and communication technology adoption and crop production show that:

- a. Mobile cell phone subscription has a strong positive correlation (0.85) with Crop production in Nigeria. This implies that an increase in the use of Mobile cell phones is associated with an increase in crop production overtime. The use of mobile cell phone should be encouraged and furthermore, the utilization of mobile cell phones in Agriculture should be encouraged.
- b. Number of Internet users also has a strong positive correlation (0.92) with crop production in Nigeria. This implies that an increase in the number of internet users is

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associated with an increase in Crop production overtime. Furthermore, the use of the internet for the purpose of agriculture should be encouraged.

- c. The Number of Fixed Telephone Lines was seen to have a weak positive correlation (0.35) exists with crop production in Nigeria. This implies that an increase in the number of fixed telephone lines is associated with a positive but not significant increase in crop production overtime. However, the use of fixed telephones should be encouraged for agricultural use.

Information and Communication Technology could be used as a very effective medium to harness this potential as applied by many developed & developing countries. Zimbabwe (e-Hurudza phones), India (Reuters Market Light), Zambia (prepaid voucher, MRIAgro), Kenya (M-Pesa, iCow), Ghana (mFarms) have made use of ICT innovations and have had increased agricultural outputs. India for example; the Reuters Market Light (RML) has improved farmers' productivity by 14-16 percent with farmers selling even more profitably (IFPRI, 2002).

ICT adoption could lead to productivity through spontaneous information dissemination which reduces the information asymmetry (information variance) between the different users at the various sides (supply and demand) of each value chain that exists in the agriculture sector and markets (financial market – to access funds and know current financial policies; labour market – supply and demand; foreign exchange market – to be updated with the exchange rate information, and so on) in an economy. Secondly, access to ICT reduces transaction costs associated with the markets (i.e. savings in time and travel) and assist in the expansion of market boundaries (Aker and Fafchamps, 2010; Asongu *et al* 2016). M-pesa in Kenya is an example of the utilisation of ICT in agriculture. M-Pesa is a mobile phone-based money transfer, financing and micro financing service used for handling financial transactions easily with a mobile device. ICT adoption by people involved in crop production will increase productivity overtime and economic growth.

CONCLUSION

This study examined the relationship in terms of degree of association between mobile cell subscription, internet usage, fixed telephone lines and crop production in Nigeria. The results from this research show that ICT adoption has a significant degree of association with crop production process which implies that an increase in the productive utilisation of ICT adoption will be most likely strongly associated with an increase in the crop production process. More

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specifically, mobile cell subscription and internet usage indicated a high positive correlation with crop production while fixed telephone lines indicated a weak but positive correlation with crop production.

Therefore, the recommendation based on the findings is: there should be encouragement of the use of ICTs through government and private sector investment in ICT infrastructure with focus on the agricultural sector development to enable the use of ICT tools such as mobile applications, real time connection for sharing information to be utilised by crop producers and farmers. As a suggestion for further studies, it will be useful to examine the role of investment in ICT, its linkage through ICT adoption and their impact on crop production process. Other subsectors in agriculture could also be examined with respect to their relationship with ICT.

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