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IMPACT OF MOBILE TELEPHONY ON TECHNICAL EFFICIENCY OF FARMERS IN NIGERIA

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ABSTRACT

This study assessed impact of mobile telephony on technical efficiencyof farmers in Nigeria. The study stemmed from the need to achieve sustainable agricultural production through meeting the presnet food needs of Nigerians without compising the ability of the future generations to meet their own needs. Specifically, the research examined the socio-economic charateristics of the farmers, prevalence of use of the technology by farmers, technical efficiency of the farmers as well as the relationship between the use of mobile telecommunications services and technical efficiency of the farmers. Primary data obtained from 170 farmers were used for the study. The tools of analysis used were the descriptive statistics, Krusckal-Wallis One-way ANOVA, the stochastic frontier model and correlation analysis. The study reveals a positive relationship between mobile telephony and the farmers' technical efficiency. However, majority of the farmers were not members of any agricultural association and had no access to extension services through which they could be trained on the inherent benefits of using the technology for farm activities. Therefore, the study recommends massive building of stable mobile network in the study area, enlightenment of the farmers on the use of the mobile telephony for agricultural activities and formation of viable association by the farmers.

Keywords: mobile telephony, farmers, technical efficiency, relationship, prevalence

INTRODUCTION

The agricultural sector is essential in the economic development and poverty alleviation drive of many countries. The importance of the sector is more pronounced in the developing countries where it is the main thrust of national survival (Adebayo and Okuneye, 2005). About 70% of the populace in Nigeria, for instance, are involved in agriculture (NBS/CBN, 2006). Agricultural production is carried out largely by small-scale farmers who have little or no contact with the exchange and sharing of 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.

It has been highlighted that a strong linkage complemented by flawless information flow enhanced by the use of Information and Communication Technologies (ICTs) will significantly boost agricultural production in developing countries (Arokoyo, 2005; Futch and McIntosh, 2009). One of the most exciting forms of these ICTs is the mobile telephony, particularly in the context of developing nations. It has the potential to allow countries leapfrog older technologies and begin converging with the rest of the world in terms of economic performance. Perhaps most importantly, mobile phones require lower levels of skills to operate than do computers or the Internet, and the socio-economic barriers are also smaller because of the lower up-front expenditure required (Kenny, 2002). In most developing nations with low-skilled and low-income labour forces, these factors make mobile telecommunications an enticing prospect. Mobile telecommunications can also more easily overcome the geographic hurdles that have prevented remote areas from receiving modern communication in the past. The oft-used example is that of the rural farmer who, with access to prompt information regarding market prices, weather patterns and best practices for the first time on his mobile phone, can better optimize his incomes and improve his efficiency (Houghton, 2009).

In order to enhance wide access to exchange of information through telecommunications services, the Federal Government of Nigeria promulgated Decree 75 of 1992. The decree established the Nigerian Communications Commission (NCC) as the National Regulatory Authority for Telecommunications in Nigeria. The decree also liberalised the telecommunications industry in Nigeria, opening it to private participation (Nnama, 1999). Thus, deregulation of the telecommunications sector has led to the introduction of major Global System of Mobile Communications (GSM) and mobile phone providers such as MTN Nigeria, Globacom, Zain Nigeria, Etisalat, Cisco, Intercellular, Visafone, multilinks, Mtel, Rainbownet, Reltel, Starcomms, VGC Communications, among others.

There has also been a lot of investments in telecommunications services in Nigeria by both the public and private sectors. In 2010, a GSM operator in the country, MTN Nigeria, obtained a funding worth N318 billion from a consortium of 15 Nigerian banks and two foreign banks. The fund was said to be used for expanding network infrastructure so as to improve quality of services in the country (Daily Champion, 2010).

The demand for mobile phones in Nigeria is rapidly expanding. Since the GSM launch, mobile telephony has rapidly become the most popular method of communication in Nigeria. The growth has been so rapid that Nigeria has been rightly described in various fora as “One of the fastest GSM markets in the world” (Vanguard, 2010). Stastistics from the International Telecommunications Union (ITU, 2010) reveal that at the end of 2009, there were 47.24 mobile telephone

subscribers for every 100 inhabitants in Nigeria compared with 0.92 fixed line subscribers (Table 1). All these point to the increase in subscription to mobile telecommunication services in Nigeria.

Table 1: Mobiles and Fixed Line Subscriptions in Nigeria

Year	Mobiles Per 100 Inhabitants	Fixed Lines Per 100 Inhabitants	Ratio of Mobile Cellular Subscriptions to Fixed Line Telephones
2009	47.24	0.92	51.5:1
2008	41.66	0.86	48.2:1
2007	27.35	1.07	25.6:1
2006	22.40	1.17	19.1:1
2005	13.19	0.86	15.2:1
2004	6.65	0.75	8.9:1
2003	2.35	0.66	3.5:1
2002	1.20	0.54	2.2:1

Source: ITU World Telecommunication/ICT Indicators Database

Means of exchange of adequate and relevant information is one of the key requirements to gain approaches and technical innovation which in turn will bring about increased agricultural productivity, increased income and poverty reduction among food producers in developing countries (Forestier, *et al* 2002; Dholakia and Kshetri, 2002). Aker (2008) opined that farmers' demand for means of exchanging information on agricultural activities has increased in recent years due to greater market instability and more complex production technologies, among others. Lack of timely information can prevent good quality decisions and thus lower efficiency of production decision among farmers. Farmers require means of obtaining information on agricultural production activities in order to link output markets (Adekunle, *et. al.* 2004). All these can be linked to the value that mobile telecommunications presumably bring.

In Nigeria, governments and development agencies are focusing on extending telecommunication services to rural areas where most farmers live, as they seek to encourage growth, alleviate poverty and overcome a perceived 'digital divide'. It is however important to note that very little is known about the effect of this technology on agricultural production. Considering the potentials of telecommunication services in modern agricultural production, there is a need to examine the impact of this services on agricultural activities in Nigeria. This research therefore sought to address the following questions:(1) What are the prevalent farm operations which mobile telephony is used for? (2). Does mobile telephony have any impact on the technical efficiency in production of farmers in Nigeria? (3). What is the relationship between mobile phone services and technical efficiency of farmers?

The main objective of this study is to assess the impact of mobile telephony on the agricultural production of crop farmers in Ondo State, Nigeria. The specific objectives are to describe the socio-economic charateristics of the farmers with relevance to mobile telephony; determine the prevalent activities which mobile telephony is used for by the farmers; estimate the technical efficiency of the small-scale farmers who use mobile telephony for production activities; analyze the determinants of technical inefficiency of the farmers; and determine the relationship between mobile telephony and technical efficiency of the farmers.

Assessing the influence of modern technologies, such as the mobile telephony, on agricultural production is essential in the quest for sustainable devlopment in the agricultural sector of any economy. This is with the view to determining whether the adopters of such innovations are better or worse off for using them. Mobile tephony has the potential to assist farmers on sharing relevant agricultural information that will boost their production. This is necessary in meeting the present food needs of the Nigerian population without compromising the ability of the future generations to meet their own needs. Therefore, this study will provide planners, decision makers, and implementers with practical tools for implementing effective policies on sustainable agricultural development. The study will also guide policy-makers, members of the agricultural development community, researchers, and practitioners on methods and approaches that can be used to promote the development of the use of telecommunication services in agricultural operations.

METHODOLOGY

Study Area

The study was conducted in Ondo state, Nigeria. The state is located within the south-western part of the country. The state covers an area of 14,788.723sq.km at 120 kilometres North of the ocean. It lies in-between longitude $4^0$31'and $6^0$00'East of the Greenwich Meridian and latitude $4^0$15'and $8^0$15'North of the Equator. The state is made up of eighteen Local Goverment Areas (LGAs) and has a population of 3,460,877 (National Population Commission, 2006) [See Fig. 1]. The LGAs are grouped into two zones, namely – Owo and Ondo – by the state's Agricultural Development Project (ODSADEP) based on agronomic and cultural characteristics.

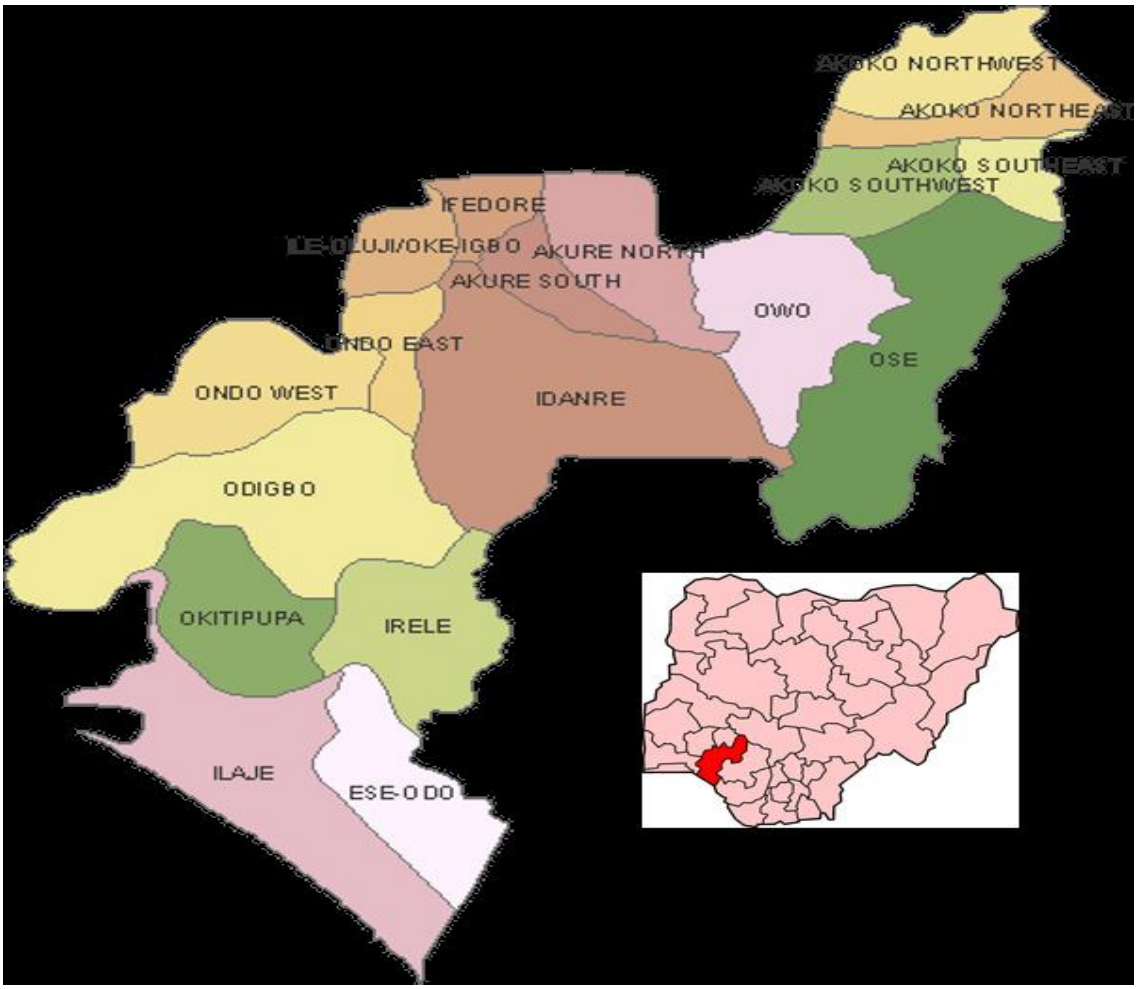

Fig. 1: Map of Nigeria indicating Ondo State its Local Government Areas

Agriculture is the mainstay of the state with majority of the farmers operating on small-scale basis (Ondo State Ministry of Information, 2009). The main food crops produced in the area are maize, cassava, yam, plantain and cocoyam while cocoa, oil palm, kola nut, cashew, rubber and timber form the major cash crops . Livestock is a minor component of agricultural system in the area. Animals found in the study area include sheep, pig, goat and chickens. They are held as a source of income and are also used to fulfill social and religious obligations (Ondo State Ministry of Information, 2009).

There is the presence of mobile telecommunications services in the state. Some the telecommunications services providers in the state are MTN Nigeria, Globacom, Airtel, Etisalat, Cisco, Intercellular, Visafone, multilinks, Rainbownet, Reltel, Starcomms, VGC Communications, among others (Ondo State Ministry of Information, 2010).

Sources of Data and Sampling Procedure

Both primary and secondary data were used for the study. Primary data were obtained from selected sample of farm households in the state. Secondary data was gathered from relevant literature and books from annual report, journals, textbooks and other grey literature.

The target population for this study were the small-scale farmers in the state. A four-stage sampling technique was used in the selection of respondents. In the first stage, a zone was selected randomly from the two ecological zones in the state. This was followed by random selection of three Local Government Areas (LGAs) from the selected zone. In the next

stage, six farm communities were randomly selected in each of the LGAs. This was followed by random selection of farm household respondents from the communities. A total of 180 respondents were selected and interviewed. The data obtained covered socio-economic characteristics, data on mobile telephony for agricultural production activities per week and agricultural production data. Though one hundred and eighty respondents were interviewed, one hundered and seventy respondents provided adequate information and were used for data analysis.

Analytical Techniques

The main tools of analysis used for this study are descriptive statistics, Krusckal-Wallis One-Way ANOVA, the stochastic frontier model and correlation analysis. The descriptive statistics such as mean, mode and percentage were used to analyze the relevant socio-economic characteristics of the respondents. Kruskal-Wallis One-Way ANOVA was used to examine the prevalence of the operations for which mobile telephony is used by the respondents. This involved assigning priorities to the operations undertaken by the farmers.

The equation for estimating the ranks is outlined thus:

$$K = (N-1)\frac{\sum_{i=1}^{g} n_i(\bar{r}_{i\cdot} - \bar{r})^2}{\sum_{i=1}^{g}\sum_{j=1}^{n_i}(r_{ij} - \bar{r})^2},$$

where:

n_i is the number of observations in group i

r_{ij} is the rank (among all observations) of observation j from group i

N is the total number of observations across all groups

$$\bar{r}_{i\cdot} = \frac{\sum_{j=1}^{n_i} r_{ij}}{n_i},$$

$\bar{r} = \frac{1}{2}(N+1)$, is the average of all the r_{ij}.

The stochastic frontier model by Battese and Coelli (1995) was used to estimate the technical efficiency and analyze the determinants of technical inefficiency of the respondents. The stochastic frontier production function model is specified in the implicit form as follows:

$$Yi = f(Xi, \beta) + (Vi - Ui)$$

Where: Y_i is the output of the $_i^{th}$ farm

X_i is a k x l vector of input quantities of the $_i^{th}$ farm

β is a vector of unknown parameters to be estimated

V_i are random variables which are assumed to be normally, independently and identically distributed $N(0,\delta_v^2)$. It is assumed to account for measurement error and other factors not under the control of the farmer such as weather and diseases.

A one-sided component, $U_i \leq 0$ reflects technical inefficiency relative to the stochastic frontier. Thus, U = 0 for a farm output which lies on the frontier and U < 0 for output which is below the frontier; hence, the distribution of U is half normal (Aigner *et al*., 1977).

A Cobb-Douglas Production form of the frontier used for this study is presented as follows:

$$lnY = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + V_i - U_i \ldots\ldots\ldots(1)$$

Where: Y = Crop Output (grain equivalent)

X_1 = Farm size (ha);

X_2 = Labour (man-day);

X_3 = Fertilizer (kg);

X_4 = Agrochemical (litre);

X_5 = Seeds/seedlings (kg);

β_0, β_1, β_2, β_3, β_4, β_5 = Coefficients of various inputs with respect to output level.

The inefficiency model is represented by U_i which is defined as follows:

$$U_i = d_0 + d_1 Z_1 + d_2 Z_2 + d_3 Z_3 + d_4 Z_4 + ... + d_n Z_n \ldots\ldots\ldots\ldots(2)$$

U_i = Technical inefficiency

Z_1 = Level of education (years)

Z_2 = Membership of association (Yes = 1, No = 0)

Z_3 = Farming experience (years)

Z_4 = Household size (number);

Z_5 = Mobile telephony experience (years)

Z_6 = Usage of extension information (Yes = 1, No = 0);

d_0, d_1, d_2, d_3, d_4, d_5 and d_6 = Estimated parameters.

Since the dependent variable of the inefficiency model represents the mode of inefficiency, a positive sign of an estimated parameter implies that the associated variable has a negative effect on efficiency but positive effect on inefficiency and vice versa (Rahji, 2005).

Correlation analysis was used to measure the strength and degree of linear association between efficiency of the farmers and mobile telephony. It is defined as

$$r = \frac{\Sigma xiyi}{\sqrt{\Sigma xi^2}\sqrt{\Sigma yi^2}}$$

Where, r is a measure of relationship between the farmer's efficiency and mobile telephony and lies between -1 and +1, -1 indicating perfect negative relationship and +1 indicating perfect positive relationship. 0 indicates no relation between the variables (Koutsoyiannis, 2003).

RESULTS AND DISCUSSION

Demographic and Socio-economic Profile of the Respondents

Table 2: Demographic and Socio-economic Characteristics of the Respondents

Characteristics	Frequency	Percentage
Location Factor		
Peri-urban	47	27.6
Rural	123	72.4
Total	170	100
Age		
20 - 30	16	9.4
31 - 40	42	24.7
41 - 50	61	35.9
51 - 60	48	28.2
> 60	3	1.8
Total	170	100
Education level		
No formal education	39	22.9
Primary	58	34.1
Secondary	52	30.6
Tertiary	21	12.4
Total	170	100
Primary Occupation of the Household Head		
Farming only	126	74.1
Formal	26	15.3
Non-formal	18	10.6
Total	170	100
Farming experience		
1 - 5	36	21.2
6 -10	47	27.6
11 - 15	20	11.8
16 -20	27	15.9
> 20	40	23.5
Total	170	100
Membership of Association		
Cooperative	17	10.0
Farmers Association	56	32.9
Nil	97	57.1
Total	170	100
Access to Extension Services		
Yes	46	27.1
No	124	72.9
Total	170	100
Phone Usage for Farming Activities		
Yes	104	61.2
No	66	38.8

Total	170	100
Sources of Mobile Telephony by the Users		
Owned phone	78	75.0
Borrowed phone	4	3.8
Owned and borrowed	22	21.2
Total	104	100
Mobile telephone usage for agric (years)		
0	66	38.8
1	41	24.1
2	30	17.6
3	15	8.8
4	11	6.5
5	4	2.4
6	3	1.8
Total	170	100
Average Time Spent on Mobile Telephony/Week (minutes)		
0	66	38.8
1 – 3	59	34.7
4 – 6	38	22.4
7 - 9	7	4.1
Total	170	100
Expenditure on Mobile Telephony Per Week on Agric Operations (₦)		
0	66	38.8
10 - 50	67	39.41
60 - 100	23	15.88
110 – 150	9	5.29
160 - 200	3	1.76
> 200	2	1.18
Total	170	100

Source: Field survey, 2011

Majority (72.4%) of the respondents lived in the rural area. The modal age group of the respondents was 41 -50 years while the average was 45 years. 77.1% of them had one form of formal education or the other. This is a reflection on the use of mobile telephony for farming activities by the respondents.

The major occupation of an individual may determine the rate of using a particular technology for the activities involved in the occupation. About 75% of the respondents had farming as their main occupation. The few that were engaged in farming on part-time basis were mainly school teachers, bricklayers, carpenters, traders, drivers, tailors and painters. The average number of years of farming experience by the respondents was 15 years. This indicates that the respondents were likely to have acquired relevant skills in the use of mobile telecommunications services for farming activities.

Membership of association is expected to influence the use of mobile telecommunications services for agricultural activities by farmers as it can be used to pass information and share farming experiences. Over half of the farmers (57.1%) did not belong to any agricultural society. Also, about 73% of the farmers did no have access to extesion services. The implication of this is that majority of the farmers had no adequate training on the use of mobile telephony for farm operations.

About 61% of the farmers used mobile telephony for their farm operations. Also, none of the respondents used the fixed line as source of telecommunications services. Table 2 also reveals that the number of farmers that used mobile

technology increases over the years. This probably explains the rapid spread of the technology in Nigeria and the increasing awareness of its use for farming activities.

Majority (about 73%) of the respondents did not use more than 3 minutes on telephony per week. Further analysis of the findings also reveals that an average of N37.00 is spent weekly by the users of mobile technology on farming operations in the study area.

Prevalence of the Farming Operations for which Mobile Telephony is Used by the respondents

Table 3: Summary of Kruskal-Wallis Test for prevalence of the farming activities for which mobile telephony is used

Farming Activity	Mean Rank	Rank
Booking production inputs	521.41	4
Procurement of inputs	462.06	2
Sourcing market for output	501.10	3
Booking appointment with labour	618.21	6
To get access to innovation on agricultural practices	423.02	1
Sharing farming experience with colleagues	522.12	5
Chi-Square(X^2)	86.906	
Df	5	
Asymp. Sig.	.000	
1-6 Lowest to highest		

Source: Data Analysis from Field Survey, 2011.

Table 3 shows the rank of the farming activities which mobile telephony was used for in the study area. The Table shows that mobile telephony was most used for booking appointment with labour. This is followed by the need to share farming experience with colleagues and booking production inputs. The results also reveals that obtaining information on agricultural innovation is the least use to which mobile telephony is put.

Technical Efficiency of the Respondents

The results of analysis of the technical efficiency of the respondents is presented in Table 4. The estimated gamma is significant at 1% level of probability. This confirms that the technical inefficiency effects are significant in the estimated model.

From the estimated equation and in consonance with apriori expectation, the coefficients of the values of farm size, labour, herbicides and seeds/seedlings are positive and statistically significant. This indicates that the more the farmers increase area of land cultivated and the seeds/seedlings used, the more the quantity of output obtained. Also, the more labour and herbicide were used, the more the farm output was. This could be due to the fact that more farm operations would be carried out at the appropriate periods and weeds would also be controlled effectively. Farm size had the largest coefficient; this tends to suggest that the largest impact on output would be experienced if additional land is put into use.

With the inefficiency model, the coefficients of usage of extension services was positive and significant. The coefficients of membership of association, farming experience and usage of mobile telephony were, however, negative and significant.

Membership of agricultural association was positively and significantly related to technical efficiency of the farmers. This implies that being a member of association enables the farmers to have access to agricultural information, credit and other inputs as well as enhanced ability to adopt innovations, such as mobile telephony, on agricultural production.

The farming experience of the farmers was positively and significantly related to technical efficiency. This implies decreased level of technical inefficiency as the farmers spent more years in farming. The likely reason for this is that farmers acquire and develop more skills with time as long as they are in farming.

Use of mobile telecommunications services was also positively and significantly related to the technical efficiency of the farmers. This signifies decreased level of technical inefficiency with

Table 4: Maximum Likelihood Estimates of the Stochastic Frontier Production Function of Respondents

Variables	Parameters	Coefficient	Standard error	t-ratio
Stochastic frontier				
Constant	b_0	869.266	6.968	124.759
Farm size	b_1	267.406*	1.473	181.487
Labour	b_2	2.112**	0.538	3.930
Fertilizer	b_3	-1.698	1.240	-1.369
Herbicide	b_4	141.453*	8.037	17.600
Seeds/seedlings	b_5	2.369**	1.281	1.849
Inefficiency Model				
Constant	d_0	1.349	1.357	0.994
Education	d_1	7.978	15.850	0.503
Membership of association	d_2	-20.527***	11.081	-1.852
Farming experience	d_3	-111.463*	13.412	-8.311
Household size	d_4	-0.941	11.521	-0.082
Mobile telephony experience	d_5	-22.612***	11.938	-1.894
Usage of extension information	d_6	327.143**	82.365	3.972
Variance parameters				
Sigma-squared (δ^2)		0.217E + 07	1.000	0.217E + 07
Gamma (γ)		0.133	0.032	4.414

* Significant at 1% level of probability; ** Significant at 5% level of probability

*** Significant at 10% level of probability;

Source:Field Survey Data, 2011

more time on mobile tephony. The likely explanation for this is that farmers that use telecommunications services are likely to have prompt access to information regarding market prices, weather patterns and best practices, with which they can better optimize their outcome and improve their productivity.

Usage of extension services was negatively and significantly related to technical efficiency. This implies that the more extension information was used the less the farmers' output. This could result from the fact that about two-third (66.20%)

of the farmers who use extension services also use other information obtained from trade associations, personal training, other farmers and literature all of which might be conflicting.

Relationship between Time Spent on Mobile Telephony and Technical Efficiency

The results of the relationship between the amount of time spent on mobile telephony and the efficiency of the farmers is shown in Table 5 . The results indicate that as the farmers spent more time on telephony, their efficiency increased, which is a positive correlation. This may be due to timely and prompt access to useful information on good farm management practices.

Table 5: Correlations between Mobile Telephony and Technical Efficiency

Variables		Telephony Time for Agric Operations	Efficiency
Telephony time for agric operations	Pearson correlation	1	.609*
	Sig. (2 – tailed)		.000
	N	170	170
Efficiency	Pearson Correlation	.609*	1
	Pearson Correlation	.000	
	Sig. (2 – tailed)	170	
	N		

* Correlation is significant at the 0.01 level (2 – tailed)

Source: Data Analysis from Field Survey, 2011.

CONCLUSION AND RECOMMENDATIONS

The study revealed positive influence of mobile telephony on agricultural production in the study area. The farmers used the technology most to book appointments with labor while accessing information on agricultural is the least activity to which mobile telecommunbications services are put. However, majority of the farmers are not members of agricultural association and have no access to extension services through which they could be trained on the use of mobile telecommunications services for farm operations. Therefore, based on these findings, the followings recommendations are suggested in order to achieve a sustainable agricultural development through the use of mobile telecommunications services:

National leaders, development agencies and network providers in Nigeria should look to promote their telecommunications industries so that more small-scale farmers can enjoy better services that will ultimately improve their productivity. There should be substantial government intervention in buiding mobile network in the rural area where this group of farmers are mostly found. Measures to improve service quality plans for the operators in the country should be put in place. In the same vein, telecommunications providers should make these services available to their subscribers, including farmers, at affordable rates. This will help in increasing the rate of using the services for agricultural production by farmers.

Besides, agricultural extension services should be improved upon in the study area. This is with the view to enlightening farmers on how mobile telephony can help increase their productivity. Training should be given to farmers on how they

can use the mobile phone to get access to latest information on agricultural production. In the same vein, farmers should also form/join viable associations to facilitate such training programmes.

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