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Uduji, Joseph I.; Okolo-Obasi, Elda N.; Asongu, Simplice

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The impact of e-wallet on informal farm entrepreneurship development in rural Nigeria

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The impact of e-wallet on informal farm entrepreneurship development in rural Nigeria[1]

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Joseph I. Uduji
(Corresponding Author)
Department of Marketing
Faculty of Business Administration
Enugu Campus
University of Nigeria, Nsukka, Nigeria
E-mail: joseph.uduji@unn.edu.ng;joseph.uduji@gmail.com;
joseph.uduji@yahoo.com
Phone: +2348037937393.

Elda N. Okolo-Obasi
Institute for Development Studies,
Enugu Campus
University of Nigeria, Nsukka, Nigeria
E-mail: eldanduka@yahoo.com; ndukaelda@yahoo.com
Phone: +2348063631111; +2349094501799

Simplice A. Asongu
African Governance and Development Institute,
P.O. Box 8413, Yaoundé, Cameroon
E-mails: asongusimplice@yahoo.com /
asongus@afridev.org
Phone: +32 473613172

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Research Department

The impact of e-wallet on informal farm entrepreneurship development in rural Nigeria

Joseph I. Uduji, Elda N. Okolo-Obasi & Simplice A. Asongu

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Abstract

Transforming agriculture from a largely subsistence enterprise to a profitable commercial venture is both a prerequisite and a driving force for accelerated development and sustainable growth in sub-Saharan Africa. The objective of this investigation is to assess the impact of the Federal Government of Nigeria (FGN) e-wallet programme on informal farm entrepreneurship development in rural Nigeria. Informal sector farmers are those that are not legally registered at the national level though could be connected to a registered association.

The research is motivated by the absence of literature focusing on the problem statement or objective of study. One thousand, one hundred and fifty-two rural farmers were sampled across the six geo-political zones of Nigeria. Results from the use of a bivariate probit model indicate that the mobile phone-based technology via the e-wallet programme is a critical factor that has enhanced farm entrepreneurship in rural Nigeria. However, results also show that the impact of mobile phones (as a channel to accessing and using modern agricultural inputs) is contingent on how mobile networks are able to link farmers who live in rural areas and work mainly in farming. The results suggest that increasing mobile phone services in rural Nigeria enhances farmers' knowledge, information and adoption of improved farm inputs and by extension, spurs rural informal sector economic activities in sub-Saharan Africa. Implications for practice, policy and research are discussed.

JEL Classification: Q10; Q14; L96; O40; O55

Keywords: Informal sector's adoption, electronic wallet technologies, rural farmers' entrepreneurship, Nigeria, developing countries.

1. Introduction

The role of agriculture in the economies of sub-Saharan African countries cannot be overemphasized. With agriculture accounting for about 65 percent of the region's employment and 75 percent of its domestic trade, significant progress in reducing hunger and poverty across the region depends on the development and transformation of the sector (World Bank, 2014). Transforming agriculture from a largely subsistence enterprise to a profitable commercial venture is both a prerequisite and a driving force for accelerated development and sustainable economic growth in sub-Saharan Africa. Consequently, in 2003, a meeting of heads of African countries launched the Comprehensive African Agriculture Development Programme (CAADP), including a commitment to invest 10 percent of their total national expenditures in the agricultural sector – a commitment popularly known as the Maputo Declaration (AU-NEPAD, 2003; Benin & Yu, 2013). In order to realise these common objectives, governments have been leveraging on modern technologies to improve agricultural development outcomes.

In the light of the above, as telecommunication markets have increased dramatically over the past decades, mobile phones in Africa have evolved from simple communication tools to service delivery platforms. This has shifted the development paradigm surrounding mobile phones from one that simply reduces communication and coordination costs to one that could transform lives through innovative application and service (Aker & Mbiti, 2010; Asongu & Nwachukwu, 2016a, 2016c; Tchamyou, 2017; Uduji & Okolo-Obasi, 2018a).

In 2012, the Federal Government of Nigeria (FGN) launched the growth enhancement support scheme (GESS) to transform the delivery of agricultural inputs in the country (Adesina, 2012). Under the GESS, the FGN's role shifted from direct procurement and distribution of inputs to facilitation of procurement, regulation of the quality, and promotion of the private-sector input value chain (Akinboro, 2014). The mobile phone (electronic wallet system) is at the heart of technology applications under the GESS. The e-wallet system technology ensures that a Nigerian farmer receives farm input subsidy support from the FGN through accredited agro-dealers; provides vital agro-information alerts; is available to the agricultural extension system; and facilitates micro-lending and insurance schemes (Olomola, 2015). The rapid adoption of the e-wallet programme has generated a great deal of speculation and optimism regarding its effect on economic development in the country (Adesina, 2013; Grossman & Tarazi, 2014; Wossen *et al*, 2017; Adenagen *et al.* 2018; Uduji & Okolo-Obasi, 2018b). However, an emerging body of research shows that the reduction in communication costs associated with the e-wallet programme has intangible economic

benefits, including the improvement of agricultural and labour market efficiency as well as producer and consumer welfare in specific circumstances and areas (Adebo, 2014; Fadairo *et al,* 2015; Nwalieji *et al,* 2015; Trini *et al,* 2014). It is important to note that while the term "e-wallet" is broad to include electronic(e)-cards, online/internet payments, mobile phones which form part of the e-wallet is exclusively used in this research to represent e-wallet because of the consistency of the mobile phone with the government intervention programme. Hence the concepts of e-wallet and mobile phones are used interchangeably throughout the study.

The foregoing deliberation highlights the complexity of the different perspectives surrounding e-wallet contribution to agricultural development in the country. Meanwhile, agricultural productivity is low and the smallholder farmers depending on agriculture are generally poor in Nigeria (FGN, 2017; Uduji & Okolo-Obasi, 2018c). Notwithstanding, the discussion has not been extended to the role of e-wallet in farm entrepreneurship development in rural Nigeria. Against this background, this paper contributes to the "information technology for the informal sector in developing countries" debate by assessing the empirical evidence related to the following question or objective:

- What is the impact of the Federal Government's e-wallet on rural farmers' access to improved agricultural inputs to enhance farm entrepreneurship development in rural Nigeria? This main research question builds on an underlying or descriptive research question: what is the level of rural farmers' participation in the mobile phone-based technology (e-wallet) programme of the Federal Government of Nigeria?

In this study, we use the term Farm entrepreneurship to refer to entrepreneurial efforts made by farmers to access farm inputs (improved seeds, fertilizers and crop protection products) to enhance farm development in rural Nigeria through their participating in the e-wallet model.

Moreover, target farmers are largely in the informal sector of the economy. Hence, the underlying entrepreneurship is within the framework of the informal sector. In the light of recent literature on the comparative relevance of the formal and informal economic sectors (Asongu & Nwachukwu, 2017; Tchamyou & Asongu, 2017; Uduji *et al,* 2018), informal sector farmers are those that are not legally registered at the national level though could be connected to a registered association.

The positioning of this study in answering the main question above, contributes to the evolving stream of literature on the relevance of mobile technologies on formal and informal

developmental outcomes (Afutu-Kotey *et al*., 2017; Asongu & Boateng, 2018; Bongomin *et al*., 2018; Gosavi, 2018; Humbani & Wiese, 2018; Isszhaku *et al*., 2018; Minkoua Nzie *et al*., 2018; Muthinja & Chipeta, 2018; Abor *et al*., 2018; Uduji & Okolo-Obasi, 2017) which has failed to critically engage the dimension of e-wallet on farm entrepreneurship development in the rural areas of African countries. As critically engaged in Section 2.1 below, the literature specifically aligned with the importance mobile technologies in agricultural outcomes has not focused on farm entrepreneurship in rural Nigeria (Abraham, 2007; Bhavnani *et al*, 2008; Fafchamps & Minten, 2011; Fafchamps & Minten, 2011; Aker & Mbiti, 2010; Muto & Yamano, 2009).

Noticeably, the FGN's GESS programme offers a unique opportunity to extent this growing body of literature. On the policy front, the relevance of the findings in Nigeria could apply to other African countries and by extension developing nations. This is essentially because: (i) these economies substantially rely on the agricultural sector for employment and (ii) compared to more technically-advanced countries, the penetration of mobile technologies is low in developing countries (Efobi *et al*., 2018; Uduji & Okolo-Obasi, 2017). Hence, such a potential for penetration can be leveraged by policy makers in order to address the discussed challenges of economic development through the agricultural sector.

The rest of the paper is structured as follows: Section 2 discusses the background and theoretical underpinnings while the methodology and data are covered in Section 3. Section 4 focuses on the empirical results and corresponding discussion. Concluding remarks, caveats and future research directions are discussed in Section 5.

2. Background and theoretical underpinnings

2.1 Mobile telephony and informal agricultural development

Literature shows that the use of mobile phones leads to agricultural development (Minkoua Nzie *et al*., 2018). For example, in most developing countries, information search costs constitute a significant part of the total cost incurred by farmers in the agricultural cycle, starting from the decision to sow through the decision to market of the produce (Bhavnani *et al*, 2008). In some studies, mobile phone usage by farmers has reduced information search costs, thereby lowering transaction costs and enabling more farmers to participate in commercial agriculture (Fafchamps & Minten, 2011). Farmers have reported that the search cost of inputs has been reduced as mobile phone-based technologies enabled them connect to

input dealers for input purchases (Mittal & Mehar, 2012). Mobile phones have been identified as a new search technology that reduces the search cost of farmers by almost 50 percent in Niger (Aker & Mbiti, 2010). The adoption of mobile phones by farmers and agricultural traders in Uganda has helped reduce both transportation and transaction costs (Muto & Yamano, 2009). The farmers involved in trade networks using mobile phone-based technologies in South-Western Uganda reported that they were able to run their agribusiness activities in a better organized, more efficient and cost-effective manner (Masuki *et al*, 2010). The steady growth of mobile telephony and the introduction of mobile-enabled information services provide ways to improved information dissemination and reduction of asymmetry existing among farmers. Moreover, it helps to bridge the gap between the availability and delivery of agricultural inputs and agriculture infrastructure in India (Mittal & Mehar, 2013).

According to Aker (2010), one of the advantages of mobile telephony is that instead of being passive recipients of information through television, radio and newspapers, farmers have the privilege of interaction and access to multiple sources of agribusiness information. Other studies like Kameswari *et al.* (2011), Aker and Ksoll (2015), Labonne and Chase (2009), Abraham (2007), Mittal and Tripathi (2009) have demonstrated a positive relationship between mobile telephony and agricultural development in various areas. The results from these studies emphasized that the introduction of mobile-enabled agriculture information services have a higher impact in regions which are poor and are remote from markets. However, the extant literature lacks an approach of farm entrepreneurship development from mobile phone-based technologies in rural Nigeria. This study further differs from extant literature by investigating the relationship between the NFGs e-wallet programme and transformation of rural farm enterprise.

2.2 Technology applications of e-wallet programme in the informal sector

The technology application for the realization of the GESS in Nigeria is the e-wallet. It is a technology that enables a Nigerian smallholder farmer to obtain farm input subsidy from the government through a certified agro-dealer in the local community. The conditions for a farmer's participation include: (i) the farmer's age, who should be more than 18; (ii) he/she must have taken part in a survey approved by the government to capture farmer's individual comprehensive information; (iii) the farmer must have a cell phone with a subscriber identity module (SIM) card that is registered and with a least a sixty Naira (0.16 USD) credit on the cell phone. After these conditions are satisfied, an identification number is issued to the

farmer, which is used for the collection of fertilizer, seeds and other agricultural inputs from agro-merchants at half the actual cost (Adebo, 2014). Figure 1 illustrates the operational structure of GESS in Nigeria.

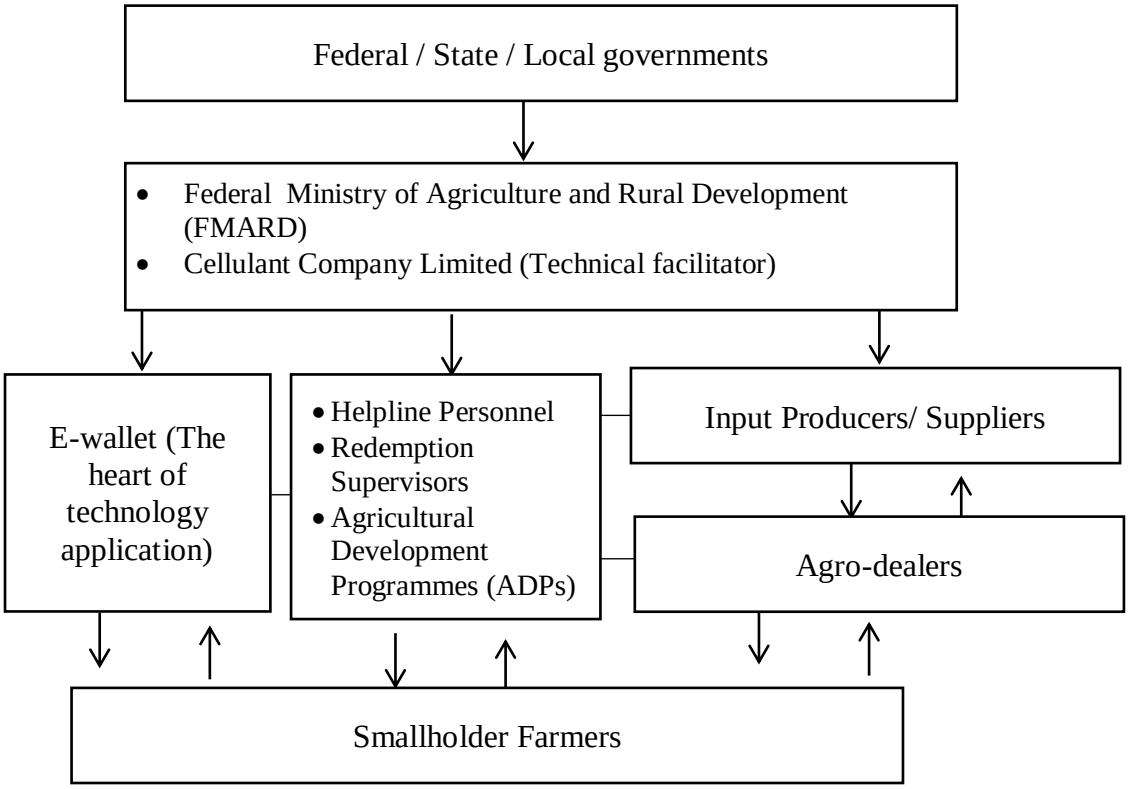


Figure 1.The structure of GESS operation

Source: Authors' Illustration

Under the GESS, it is the duty of state and local governments to register eligible smallholder farmers (who should have less than 5 hectares of farmlands). Farmers fill out by hand a machine-readable form; then, data are processed before being captured in the national database (Adebo, 2014). Farmers, who have undergone registration with mobile phones claim their subsidized seed(s) using such phones, whereas farmers who do not have their phones registered can use a neighbor's phone to make such claims (Adesina, 2012). The GESS allots a definite sum of subsidy credit to all farmers; such credits are connected to the farmer's GESS ID number, and if valid, to the farmer's mobile phone number. In either case, funds are not directly given to the farmers (Akinboro, 2014). On the other hand, farmers duly registered but without phones would know the time for redemption of subsidies when the registered farmers with phones within the community get alerted via the short message service (SMS) messages. Those who are not informed by neighbors would likely miss the redemption of

their subsidized input or get it late (Uduji & Okolo-Obasi, 2016). At the subsidy redemption center, the farmers make payments of the 50 percent balance and collect the subsidies by placing a request to the center platform through an SMS for approval of subsidy redemption (Trini*et al.*, 2014). If the deal goes through, both the farmer and the agro-merchant receive confirmatory alerts (text messages) about approval of the subsidy redemption. In 2013, the Federal Government reached out to 4.3 million smallholders with an approximate cost of about ₦12 billion (about US $96 million) at a cost of ₦3000 (US $25) per smallholder (Olomola, 2015). This scheme is mostly managed by Celluant Nigeria Limited, a technology company certified as a mobile payment service provider. A critical component in the feasibility of this scheme rests on the famers' willingness to adopt mobile technologies. Hence, some insights into the theoretical underpinnings surrounding the adoption of mobile technologies are worthwhile.

2.3. Theoretical perspectives

In the light of the preceding two sections, there are two contending perspectives on the acceptance of technology for various purposes, including use by farmers to improve agricultural outputs. In accordance with recent literature on ICT adoption (Yousafzai *et al.*, 2010; Nikiforova, 2013; Cusick, 2014; Lee & Lowry, 2015; Asongu *et al.*, 2018), there are three dominant theories that can motivate famers to adopt mobile technologies that are used for the FGN's GESS programme, namely: the theory of reasoned action (TRA), theory of planned behavior (TPB) and technology acceptance model (TAM). According to the TRA, customers are rational when it comes to the acknowledgement of their actions (Ajzen & Fishbein, 1980; Bagozzi, 1982; Fishbein & Ajzen, 1975). Within the framework of the TPB (which is an extension of the TRA), emphasis is placed on the absence of disparities between customers who have a degree of conscious influence surrounding the actions they take, and customers that do not have such influence (Ajzen, 1991). According to the TAM, the assumption motivating the customer's adoption of a specific type of technology can be elucidated by a voluntary will of the customer to accept and use the specific technology (Davis, 1989). Consistent with the corresponding literature (Asongu *et al.*, 2018), the common denominator of the attendant theories is the fact that information technology reflects a number of fundamental characteristics. These include on the one hand, composite dimensions such as utilitarian, behavioral, personal and psychological traits and on the other hand, customers' belief formation.

The highlighted traits are characteristics of farmers in rural Nigeria who are participating in the FGN's GESS programme from the following perspectives. (i) From the utilitarian angle, adopting a mobile phone is useful because its e-wallet application enables farmers to actively participate in the underlying programme. (ii) With regard to the behavioral framework, some farmers may adopt the mobile technologies for the scheme in order to remain in line with prevailing changes to the agricultural system. (iii) Personal and psychological factors also reflect motivations for adopting mobile phones for the GESS programme that are purely idiosyncratic and not determined by any common trends. This may include farmers' personal objectives to increase their farm output and/or increase the annual income. (iv) The relevance of customers' belief formation rest on the fact that, if it is generally accepted in society that mobile phones are indispensable for the successful implementation of the FGN's GESS programme, then such adoption may be a social norm underpinning the success of the programme. Within the framework of this study, all the four sets of characteristics can influence a farmer's adoption of the mobile technology for the GESS programme. Hence, we use the term Farm entrepreneurship to refer to entrepreneurial efforts made by farmers or groups of farmers to adopt mobile technologies for various agricultural outcomes.

3. Methodology

In this study, we chose a quantitative method because on the one hand, the research aims to test a hypothesis and on the other hand, given the dearth of quantitative works on the intricacies of production, allocation and extensive use of agricultural inputs in the region (Uduji & Okolo-Obasi, 2018a; Uduji & Okolo-Obasi, 2018b). This study made use of a survey research technique targeted at obtaining information from a representative sample of farmers. A multi-stage sampling technique involving both cluster and random sampling was used to select 1152 respondents out of an estimated population of 18, 204, 578 (FMARD, 2010). We present the constituent states of the study area in Figure 2.

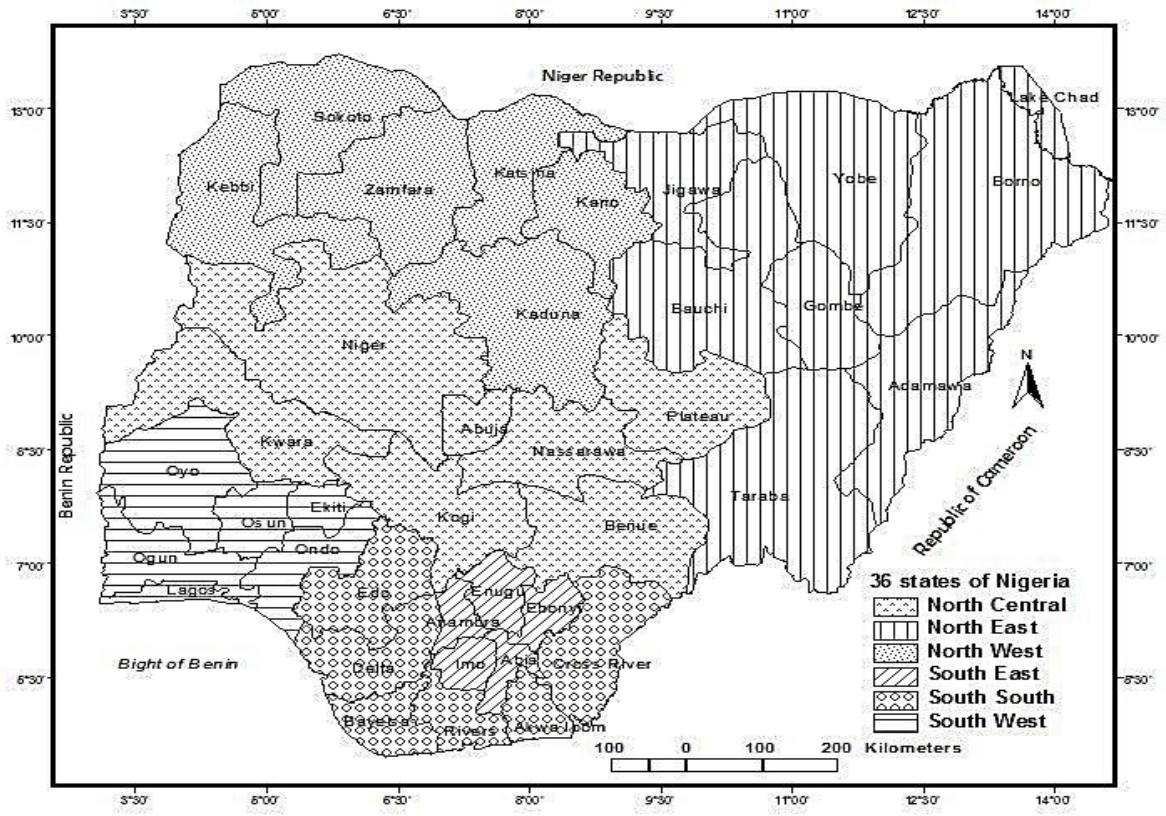


Figure 2. Constituent states of the geo-political zones in Nigeria.

3.1 Sample size

The Cochran's formula was used to determine the sample size for this study, and it is expressed as follows:

$$n = \frac{(Z*Z)(pq)}{(e*e)} \quad , \qquad \text{Eq. (1)}$$

where,

n = the estimated sample size

e = the desired level of precision

p = the estimated proportion of the population which has the attribute in question,

q = 1 – p.

The maximum variability, which is equal to 50% (p =0.5)

Taking 95% confidence level with ±5% precision, the calculation for the required sample size for this study is as follows:

p = 0.5 and hence q =1-0.5 = 0.5; e = 0.05; z =1.96

$$\text{n} = \frac{(1.96)^2(0.5)(0.5)}{0.05^2} = 384.16 = 384$$

To minimize the error level, this was multiplied by three to represent the three categories of respondents, namely: (i) Registered and Accessed farm input (ii) Registered and not accessed farm input, and (iii) Not Registered.

The sample size assigned to the zones as represented by a State in line with the estimated population of rural farmers in the State is as shown in Table 1, with total sample size of 1,152 respondents.

Table1: Sample size distribution

State	Estimated population of rural Farmer	% Assigned	Registered and accessed farm Inputs	Registered and not accessed farm inputs	Not Registered at all	Total
Adamawa	2,384,213	13%	50	50	50	150
Benue	3,167,731	17%	65	65	65	195
Cross River	2,169,741	12%	46	46	46	138
Ebonyi	1,632,710	9%	35	35	35	105
Ekiti	1,799,218	10%	38	38	38	114
Kano	7,050,966	39%	150	150	150	450
	18,204,579	100%	384	384	384	1152

Source: FMARD, 2010/ Authors' Computation

3.2 Sampling procedure

To make for good responses in the study, multi-stage probability involving both cluster and simple random samplings were used to select the respondent households for the study. In the first stage, to ensure that the farming population is adequately represented, the States were clustered according to the six geopolitical zones: North-East, North-Central, North-West, South-East, South-South and South-West. In stage two, a purposive sampling was used to select one State from each of the six clusters (geopolitical zones). The purpose was based on the intensity of agricultural practices in the States. They are as follows: Benue State (North-Central), Adamawa State (North-East), Kano State (North-West), Ebonyi State (South-East), Cross Rivers State (South-South), and Ekiti State (South-West). In stage three, all the Local Government Areas (LGAs) in each of the selected States were listed, and using purposive sampling, two LGAs were purposively selected from each state. The purpose was based on the intensity of agricultural practices in the LGAs. Thus, a total of 12 LGAs were selected for the study. In the fourth stage, to ensure proper representation, the main communities in the selected LGAs were listed and three communities were randomly selected from each LGA, giving a total of 36 rural farming communities for the study. In the last stage, out of the

36 communities selected, with the help of the community leaders, 384 registered farmers who accessed farm input through e-wallet and 384 registered farmers who did not access farm input were selected. To complete the sample, 384 non-registered farmers were also selected, giving a total of 1,152 respondents (see Table 1).

3.3 Data collection

Data for the study were collected using a participatory rural appraisal (PRA) technique. A semi-structured interview (SSI) questionnaire (presented in Appendix 1) was used for the primary data collection. It was directly administered by the researchers with the help of a few local research assistants. The use of local research assistants was because of the inability of the researchers to speak the different languages and dialects of the sampled rural communities in the geo-political zones of the country (Figure 2).

3.4 Analysis technique

Data collected from respondents in the field were subjected to a series of treatments. Both descriptive and inferential statistics were used to analyze the data to achieve the objectives of the study. In modeling the impact of e-wallet on rural farm entrepreneurship, we used the bivariate probit model to test the hypothesis of the study. This hypothesis states that: Mobile phone-based technology adoption via the e-wallet programme determines farm entrepreneurship in rural Nigeria.

As we have made clear, farm entrepreneurship refers to entrepreneurial efforts made by farmers to access farm inputs (improved seeds, fertilizers and crop protection products) to enhance farm development in rural Nigeria through their participating in the e-wallet model.

Hence, in attempt to assess what the government has done to help the rural farmers in their entrepreneurial effort, and also what the farmers are doing to access government efforts, the following questions clearly emerged for the study:(i) What is the impact of the federal government's e-wallet on rural farmers' access to improved agricultural inputs to enhance farm entrepreneurship development in rural Nigeria? (ii) What is the level of rural farmers' participation in the mobile phone-based technology (e-wallet) programme of the federal government of Nigeria? Given that e-wallet programme has receive much attention in the literature, an exploratory study could not be appropriate for this work; instead, a large sample study that can validate the nature of the impact of the programme could be more suitable to enhance the understanding of the role e-wallet plays in improving farm entrepreneurship

among the rural farmers in Nigeria. Hence, the need for adopting a quantitative approach to address the challenging research questions of this study. Therefore, both descriptive and inferential statistics were employed to achieve the study objectives stated as follows: to assess the impact of the federal government's e-wallet programme on rural farmers' access to improved agricultural inputs to enhance farm entrepreneurship development in rural Nigeria. This focus has an underlying target which is to ascertain the level of rural farmers' participation in the mobile phone-based technology (e wallet) programme of the federal government of Nigeria.

In modeling the impact of e-wallet and adoption of improved agricultural inputs, so many statistical models are available for binary outcome variables, namely, the: logit, probit and tobit models. As good as these specifications may be, we noted that two major decisions - to participate in the government e-wallet programme and to adopt agricultural inputs are involved, and the decisions, are interdependent. According to Kefyalew *et al.* (2016) and Tura *et al.* (2010), using such single independent model specifications (e.g., logit, tobit or probit) might result in ineffective parameter estimation, as a single independent model may fail to capture the correlations between the two major decisions. Greene (2012) pointed out that modelling two interdependent decisions like we have in hand requires a model like the bivariate probit model. The bivariate probit model is a natural extension of the probit model, which appears in both the decisions to register and participate in the government's e-wallet model and using the model to access improved farm inputs. Therefore, we adapted, with modification, the bivariate models used by Kefyalew *et al.* (2016) and Tura *et al.* (2010) to suit our data analysis. We used econometric view (E-views) software to analyze the data generated. The E-views was used because it is particularly suitable to deal with the Probit case in E-Views, as there is an in-built cumulative bivariate Normal Function that we explored and used to carry out the necessary tests.

3.5 Model specification

In specifying the model, we noted that the latent Y* from the decision to register and participate in the e-wallet depends on a vector of explanatory variables 'x' so that the binary outcome Y= 1 arises when the latent variable Y*> 0. Another observation to the interdependency of the decision is the Y2, which is that of using the e-wallet model to access and adopt the improved agricultural inputs is only observed if Y1 (participation in the e-wallet model) =1. The outcome of the decision represented by the first probit equation is

fully observed. However, there is a censored sample in the second equation representing the use of the model to access improved agricultural inputs because it is an offshoot of the original response of the rural farmer. According to Tura *et al.* (2010), this censoring of observations implies the importance of taking into account self-selection at the registration and the participation in decision-making stages to ensure proper estimation of model parameters. Hence, having the knowledge that there are two latent variables (Y1*and Y2*) and that Green (2012) assumed each observed variable takes on the value 1 if and only if its underlying continuous latent variable takes on a positive value, the bivariate model can be stated as follows:

$$Y1=\begin{cases} 1, \text{if } Y1 *> 0 \\ 0, \text{otherwise} \end{cases} \qquad \text{Eq(2)}$$

$$Y2=\begin{cases} 1, \text{if } Y2 *> 0 \\ 0, \text{otherwise} \end{cases} \qquad \text{Eq(3)}$$

with

$$\begin{cases} \gamma 1 *, X1\beta 1 + \varepsilon 1 \\ \gamma 2 *, X2\beta 2 + \varepsilon 2 \end{cases} \qquad \text{Eq(4)}$$

and

$$\binom{\varepsilon 1}{\varepsilon 2} \backslash X \sim \mu \binom{0}{0}, \binom{1P}{P1} \qquad \text{Eq(5)}$$

Note:

Y1*and **Y2*** are underlying latent variables

Y1 = 1, if a sampled rural farmer registers and participates in the government e-wallet model, 0 otherwise (Not registered and Not participated in the government e-wallet at the time of survey).

Y2= 1, if sampled rural farmer uses the e-wallet to access improved inputs, 0 otherwise.

$\boldsymbol{\beta 1}$and$\boldsymbol{\beta 2}$ are vectors of estimation parameters to be computed.

X1 and **X2** are explanatory variables entered into the estimation model.

$\boldsymbol{\varepsilon 1}and\boldsymbol{\varepsilon 2}$ are normally distributed error terms.

From the above, we estimated the values of $\beta 1$, 1 and ρ to properly fit the model and maximize the likelihood of the bivariate model as follow:

$L(\beta 1, \beta 2) = (\pi\rho(Y1=1, Y2=1/ \beta 1, \beta 2)Y1Y2\ \rho(Y1=0, Y2=1/ \beta 1, \beta 2)(1-Y1)Y2\ \rho(Y1=1, Y2=0/ \beta 1, \beta 2)Y1(1-Y2)\ \rho(Y1=0, Y2=0/ \beta 1, \beta 2)(1-Y1)(1-Y2)$ Eq. (6)

After substituting the latent variables Y1*and Y2*in the probability functions and taking logs, we have the following:

$$\sum Y1Y2\ln\rho(\varepsilon 1>-X1\beta 1,\varepsilon 2>-X2\beta 2)+(1-Y1)Y2ln\rho(\varepsilon 1<-X1\beta 1,\varepsilon 2)>-X2\beta 2)+(1-Y1)(1-Y2)ln\rho(\varepsilon 1<-X1\beta 1,\varepsilon 2<-X2\beta 2) \quad \text{Eq.(7)}$$

The above equation is simplified by rewriting so that the log-likelihood function appears; thus, we have:

$$\sum Y1Y2\ln\Phi\ (X1\beta 1,X2\beta 2,\rho)+(1-Y1)Y2ln\Phi(-X1\beta 1,-\rho)+(1-Y1)(1-Y2)ln\Phi(-X1\beta 1,-X2\beta 2,\rho) \quad \text{Eq. (8)}$$

In Eq. (8), Φ is the cumulative distribution function of the bivariate normal distribution. Similarly Y1and Y2 in the log-likelihood function above are observed variables, being equal to one or zero, depending on the farmer's decision regarding participation in the e-wallet model and using the model to access improved seed. From the above, there are three possible different observations obtainable from each respondent farmer. These observations are stated below as follows:

$Y2 = 0 : prob(\ Y2 = 0) = 1 - \Phi(X2\beta 2)$ Eq. (9)

$Y1 = 0, Y2 = 1: prob(Y1 = 0, Y2 = 1) = \Phi_2(-X1\beta 1x, X2\beta 2, -\rho)$ Eq. (10)

$Y1 = 1, Y2 = 1: prob(Y1 = 1, Y2 = 1) = \Phi_2(-X1\beta 1x, X2\beta 2, \rho)$ Eq. (11)

Hence the study used the empirical model below to run a bivariate probit regression using the explanatory variables discussed below.

$$PeW \text{ and or } AIE = \beta_0 + Age\beta_1 + Edu\beta_2 + MS\beta_3 + HHSz\beta_4 + Credit\beta_5 + FSZ\beta_6 + Mob\beta_7 + SoS\beta_8 + FExp\beta_9 + OFY\beta_{10} + Outpt\beta_{11} + MNcov\beta_{12} + LOT\beta_{13} + Ext\beta_{14} + Dis\beta_{15} + Coop\beta_{16} + \varepsilon \quad \text{Eq. (12)}$$

Where:

PeW = Participation in the e-wallet programmme

AIE = Access to input to enhance entrepreneurship development

Age = Age of a farmer (years)

Edu = Highest level of educational qualification (years)

MS	= Marital status of respondent farmer
HHSz	= Household size of farmer (number)
Credit	= Access to farm credit by farmers (1=accessed and 0 otherwise)
FSZ	= Size of farm cultivated by farmers (hectare)
Mob	= Ownership of mobile phones (1= owned, 0 = otherwise)
SoS	= Sources of seeds (1= e-wallet and 0= otherwise)
FExp	= Farming experience (years)
OFY	= Off-farm income
Outpt	= Value of farm output of farmers in Nigeria Naira (N)
MNCov	= Mobile network coverage (1= covered and 0 = otherwise)
LOT	= Land ownership type (1= inheritance, 0 otherwise)
Ext	= Contact with extension agent (number of times)
Dis	= Distance to improved seed selling point (1 = far, 0 = otherwise)
Coop	= Membership of cooperative organization
E	= Stochastic error term.

3.6 Explanatory variables

In modeling the bivariate probit of participation in the e-wallet model, accessing improved farm inputs and enhancement of rural entrepreneurship, some important covariates were included to maintain reasonable degrees of freedom in the estimates (Deaton, 1997). Previous studies have suggested that adoption of new technologies by farmers is an important determinant of improved productivity of the farmers (Onyenweaku *et al.*, 2010; Imoru & Ayamga, 2015). The decisions to participate in the government e-wallet model and the usage of the model to access improved farm inputs are outcomes of interdependent decisions; hence, the variables that determine the process of the decisions are overlapping. Such overlapping variables, which maybe household characteristics, farm and institutional characteristics used to estimate the bivariate probit model, are as follows: human capital endowments - family size and composition, and education, which are the main factors that influence adoption decisions of households (Tura *et al.* 2010). While family size and its composition influence the decision from both the demand and supply sides of labor, education, which includes skills and training, affects the profitability of modern technology. This is because such human capital assets reflect unobservable productive characteristics of the decision maker (Carletto *et al.*2013). To Wozniak (1997), education increases the ability of farmers to obtain, process, and use information relevant to the technologies. Also included

is off-farm income of the respondent specified as total income less farm income and expressed in the Nigerian Naira; income from the farming activities was excluded from the measure of income of the respondent and included as a separate covariate. Another important covariate included is the value of farm output of farmers measured in Nigerian Naira. The difference in the value of output between the e-wallet user and non-user will go a long way in determining the adoption and usage of the government e-wallet model.

Access to farm credit by farmers was another covariant included. It is either that a farmer accessed credit or did not. Also, of high importance is the age bracket of the respondent, which was included, as it plays a major role in accepting or rejecting changes. A gender dummy variable was used to account for the differential effects of the gender of the respondent on resource availability and decision-making. Though women are known to be more concerned about household welfare and development, they are often disadvantaged relative to social status and economic opportunities. Marital status of the respondent was included to buttress the issue of household decision-making. Another variable used which is size of the farm cultivated by farmers, measured in hectares, was included, as researchers have argued that the larger the size, the more the farmer adopts and uses improved seed. Also, a "Type of farming dummy" was used to account for the effect of the farming type on the decision of the respondent to participate in the e-wallet model, adopt and use improved seed. The experience of the farmer measured in total number of years spent in active farming will definitely play a role in adopting the e-wallet model. Land ownership type was added as a covariant, this was measured with a dummy, inherited – as 1 and otherwise as 0. Contact with extension agent measured was included this is very important as the complexity of the model requires constant explanations by the change agents. A distance dummy used to account for the impact of distance to a certified seed-selling point was also included to assess the decision of whether to use improved seeds or not.

4. The empirical results

This section is discussed in four main strands. Insights into the econometrics results are provided in section 4.1 whereas socio-economic characteristics of respondents needed for the assessment of the main objective and underlying objective of the study are discussed in section 4.2. Section 4.3 is concerned with the underlying objective (i.e. participation in the government's e-wallet programme), while section 4.4 focuses on the main objective of the study (i.e. adoption of agricultural inputs and enhancement of rural entrepreneurship).

4.1 Econometric estimation results

To estimate the factors affecting the rural farmers' decisions to register and participate in the government e-wallet scheme (i.e. the underlying objective of the study) and the adoption of improved farm input (i.e. the main objective of the study), a bivariate probit model was applied. This model was tested against other interdependent models like normal probit, logit and tobit. The results showed that the bivariate model was valid and fit for the estimation. Also, multicollinearity was measured using the variance inflation factor (VIF). The VIF assesses how much the variance of the estimated regression coefficient increases if the predictors are correlated. We noted that the VIF values of the independent variables were always less than three (i.e. <3). Hence, the bivariate probit regression coefficients are properly estimated. The bivariate probit used in the study was found to be valid, as the likelihood ratio test (LR ratio Test) carried on independent equations showed that random terms of registration and participation in the e-wallet model- accessing of improved farm input and entrepreneurship enhancement equations were strongly correlated with Likelihood ratio (LR) of 13212. 12. The significance of the Likelihood ratio (LR) test ($\rho=0$) is an indication that the decisions to register as a farmer and to access improved farm input are affected by almost the same set of unobservable heterogeneities, meaning that the two decisions are, to a large extent, jointly made. It is obvious that to estimate a univariate equation will result in inefficient parameterization. The results of the analysis showed that the educational level of the farmer, access to credit, mobile phone ownership, off-farm income, value of output, mobile network coverage, land ownership, and extension contact significantly affected both decisions positively. On the other hand, age, marital status, farming experience and distance negatively affected both decisions.

4.2 Socio-economic characteristics of respondent farmers

We begin the analysis of farmers' participation in the GESS with a description of some of their social (gender, location, education), demographic (age, marital status, household size), and economic (occupation, household income, farm size) characteristics. These characteristics are important in our understanding of the differences in the socio-economic status of the farmers who are participating in the GESS compared with their non-participating counterparts. Our analysis in Table 2 shows that a total of 1152 farmers were sampled, 768 are registered farmers, while 384 are non-registered farmers. The statistics shows that men constitute 74 percent of the registered farmers; 35 percent of non-registered farmers; while women make up 26 percent of the registered farmers, and 65 percent of non-registered

farmers. This gap in registration in the e-wallet programme tends to be the result of the cultural practices that subject women to farm under their husbands. The result is confirmed in Uduji & Okolo-Obasi (2018) that young rural women rarely participate in the e-wallet programme due to the cultural and traditional context, anchored in beliefs, norms and practices that breed discrimination, and women's vulnerability to poverty in Nigeria. Further analysis also shows that the 75 percent of the registered female farmers are widowed, separated or divorced.

Table 2 Socio-economic characteristics of the respondents

	Registered Farmers			**Non-Registered Farmer**		
Variables	**Freq**	**%**	**Cum**	**Freq**	**%**	**Cum**
Males	567	74	74	134	35	35
Females	201	26	100	250	65	100
	768	**100**		**384**	**100**	
Years of Experience						
0- 10 Years	389	51	51	45	12	12
11- 20 Years	281	37	87	56	15	26
21 - 30Years	69	9	96	72	19	45
31 - 40 Years	22	3	99	85	22	67
Above 40 Years	7	1	100	126	33	100
	768	**100**		**384**	**100**	
Age of Respondents						
Less than 20years	138	18	18	54	14	14
21-35 years	420	55	73	97	25	39
36-50 years	186	24	97	114	30	69
51 years and above	24	3	100	119	31	100
	768	**100**	200	**384**	**100**	
Level of Education						
None	64	8	8	157	41	41
FSLC	369	48	56	130	34	75
WAEC/WASSCE	216	28	85	65	17	92
B.Sc. and Equivalent	48	6	91	11	3	95
Post Graduate Degrees	26	3	94	6	2	96
Others	45	6	100	15	4	100
	768	**100**		**384**	**100**	
Ownership Mobile phone						
Have a set	510	66	66	35	9	9
Uses a neighbor's set	252	33	99	22	6	15
Have no set	6	1	100	327	85	100
	768	**100**		**384**	**100**	

Mobile Network coverage						
Network is good	370	48	48	45	12	12
Poor	108	14	62	125	33	44
Very poor	188	24	87	86	22	67
No network at all	102	13	100	128	33	100
	768	**100**		**384**	100	
Access to Credit						
Yes	144	19	19	18	5	5
No	624	81	100	366	95	100
	768	**100**		**384**	100	
Land Ownership Type						
Inherited	381	50	50	53	14	14
Purchased	253	33	83	126	33	47
Leased	134	17	100	205	53	100
	768	**100**		**384**	100	
Contact with Extension Agent						
Yes	651	85	85	19	5	5
No	117	15	100	365	95	100
	768	100		**384**	100	
Distance to selling point						
Close	439	57	57	321	84	84
Far	329	43	100	63	16	100
	768	100		**384**	100	
Monthly Income Level						
0 - 50,000	34	4	4	76	20	20
51,000 - 100,000	73	10	14	114	30	49
101,000 - 150,000	82	11	25	116	30	80
151,000 - 200,000	120	16	40	36	9	89
201,000 - 250,000	148	19	60	18	5	94
251,000 - 300,000	112	15	74	11	3	97
301,000 - 350,000	86	11	85	7	2	98
351,000 - 400,000	65	8	94	4	1	99
Above 400,000	48	6	100	2	1	100
	768	**100**		**384**	**100**	

Source: Authors' computation from field data

From Table 2, we also noted that the average age of a registered farmer is 29 years, with average years of experience being 11. Moreover, the average age of the non-registered farmer is 42 years, with a corresponding average experience of 23 years. The registered farmers tend to be more educated with only an 8 percent illiteracy level; while the literacy level among the non-registered farmers is low, with about 41 percent not able to read or write. About 66 percent of the registered farmers have their own mobile phones, while 33 percent use the

phones of their neighbors' children or relatives, and only 1 percent has no access to mobile phone at all. Among the registered farmers, 48 percent have network coverage and only 13 percent have no network coverage at all. On the other hand, only 12 percent of non-registered farmers have access to mobile phone network coverage while 88 percent do not. This is a critical issue as much as the e-wallet model is concern, because the main application tool is having and being able to use mobile communication. However, this result tend to be an improved finding when compared with an earlier investigation of Grossman and Tarazi (2014), which suggested that while most urban Nigerian farmers have their SIMs and handsets, only about half of the Nigerian farmers have their own phones, and farmers who share a SIM were unable to use the mobile phone number as a unique identifier; while those who share a handset may not regularly receive messages sent to them.

Generally, among the farmers, both registered and non-registered, access to credits is very low as only 19 percent of the registered farmers have access to credit, while only 5 percent of non-registered have access to credit. Also findings show that 50 percent of the registered farmers have inherited lands, while 33 percent purchase theirs. Contrary, about 53 percent of non-registered farmers lease their farm land. This suggests that the registered farmers are surer of the availability of land than non-registered farmers. More so, about 85 percent of the farmers registered because they made contact with the extension agents, while about 95 percent of the farmers did not register as they did not have contact with the agents; while about 85 percent of non-registered farmers did not register because of the distance to the registration center. Again, result shows that about 44 percent of registered and 89 percent of non-registered farmers earn below N100, 000 ($276) annually.

4.3 Participation in the e-wallet programme: for the underlying objective of study

Table 3. Estimation rate of farmers' participation in the e-wallet program

States (Geopolitical Zones)	Estimated Farming Population	No. of Registered Farmers	Percentage
Adamawa (North-East)	2,384,213	476,843	20
Benue (North-Central)	3,167,731	823,610	26
Cross River (South-South)	2,169,741	455,646	21
Ebonyi (South-East)	1,632,710	310,215	19
Ekiti (South-West)	1,799,218	449,805	25
Kano (North-West)	7,050,966	2,326,819	33
Total	**18,204,578**	**4,369,099**	**24**

Source: FMARD, 2014 /Authors' Computation

Participation in the e-wallet starts with the registration of farmers. In Table 3, we show that only about 24 percent of the farmers in the study were registered. This implies that additional efforts need to be made to ensure that farmers actually take the first step of registration in the programme. Successful message campaigns as suggested by Donohew *et al* (1998) are worthwhile. Such campaigns should be characterized by novelty, movement, colour, intensity and other formal features which should be used to generate high level of activation in order to capture the attention of farmers and motivate them to participate in the e-wallet programme.

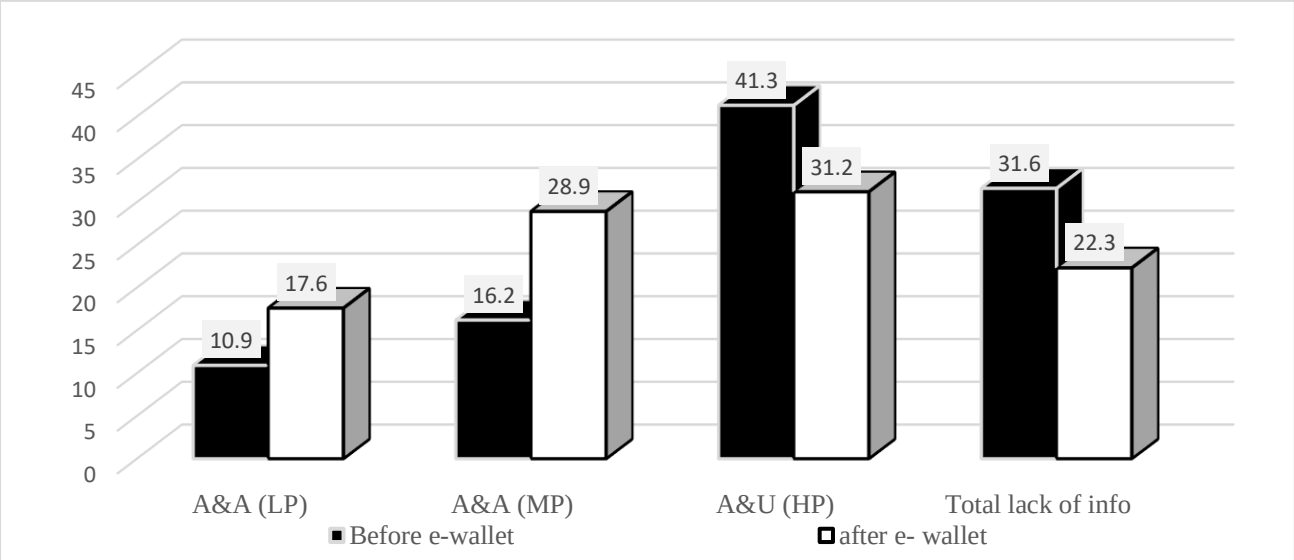


Figure 3. Distribution ofE-wallet participating farmers by access to and cost of inputs

Where A&A (LP) = Available and affordable (low price)

A&A (MP) = Available and affordable (moderate price)

A&U (HP) = Available and unaffordable (high price)

Total lack of information

Source: Authors' computation from field data

From Figures 3 above and 4 below, it is apparent that using e-wallet to access farm input has made inputs significantly accessible to the farmers participating in the scheme. The use of the e-wallet scheme increased the availability and affordability (low price) of input from 11.7 percent of the farmers to 26 percent of the registered farmers; while generally, the impact is also significantly increased from 10.9 percent to 17.6 percent. Available and affordable (moderate price) also increased for the e-wallet farmers from 16.5 percent to 40.8 percent; and generally from 16.2 percent to 28.9 percent. Among the e-wallet farmers, those who see input as Available and Unaffordable (high price) reduced from 39.6 percent to 20 percent;

while generally among all the farmers, it reduced from 41.3 percent to 32.1 percent. Also those in the category of total lack of information have reduced from 32.2 percent to 13.2 percent among the e-wallet farmers; while among all the farmers, it has reduced from 31.6 percent to 22.3 percent. The implication of these results is consistent with Mittal and Mehar (2012) that to leverage the full potential of information dissemination enabled by mobile telephony along with supporting infrastructure and capacity building among farmers, it is essential to ensure the quality of information, its timeliness and trustworthiness. Therefore, if agricultural information using mobile phone-based technologies is properly carried out with the extension agents on the ground, the access and usage of modern agricultural inputs will reach the smallholder farmers faster in developing countries.

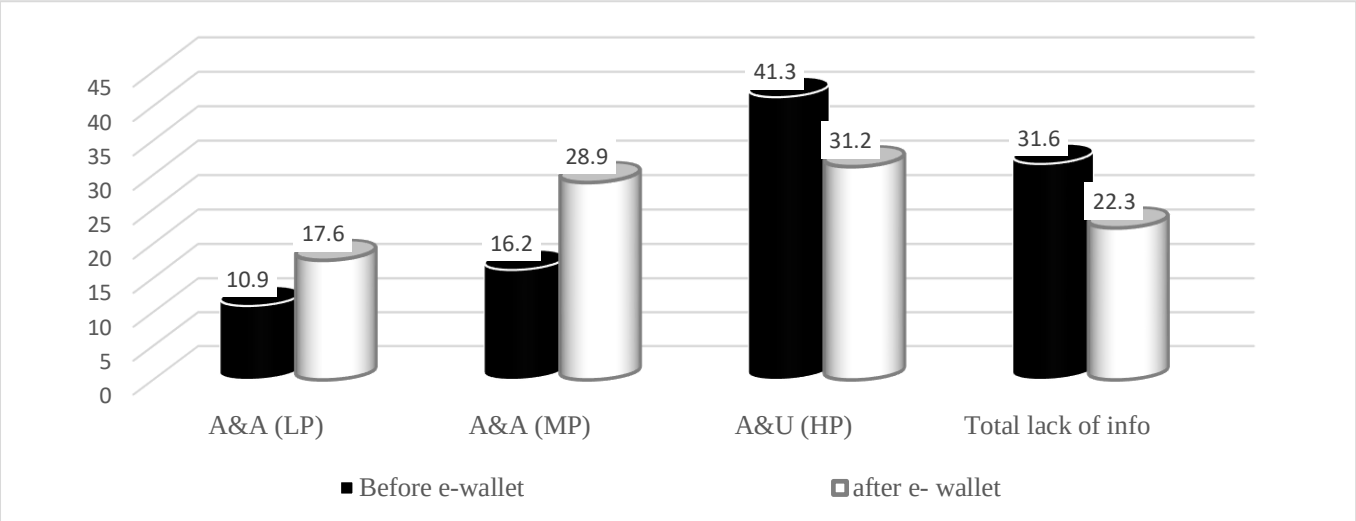


Figure 4. distribution of all farmers by access to and cost of inputs

Where A&A (LP) = Available and affordable (low price)

A&A (MP) = Available and affordable (moderate price)

A&U (HP) = Available and unaffordable (high price)

Total lack of information

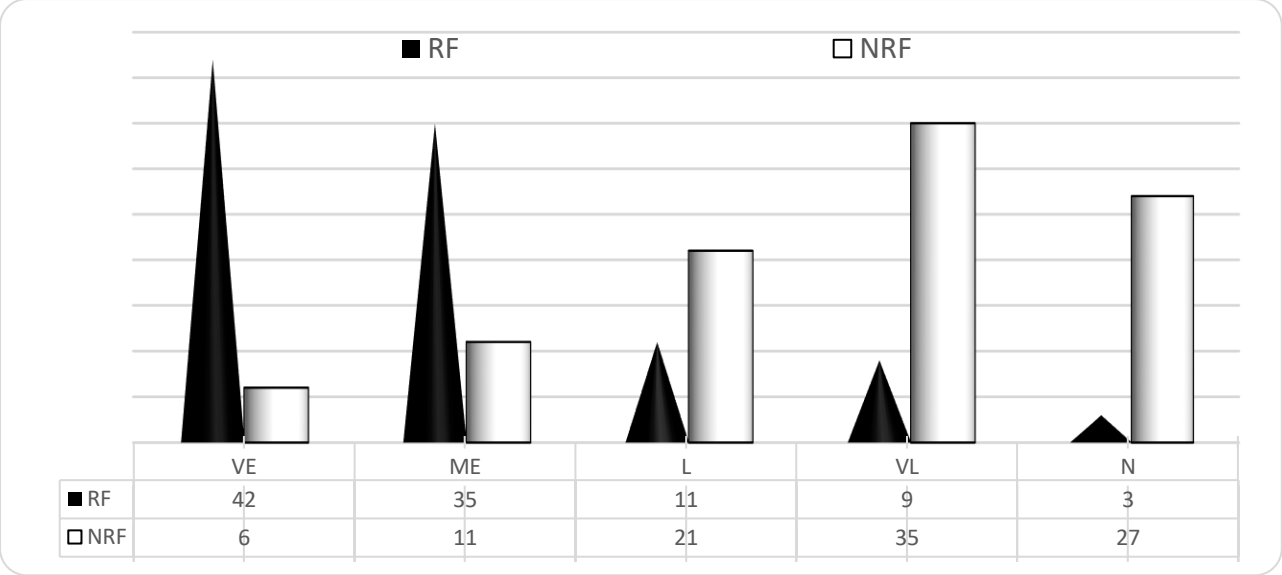


Figure 5. Distribution of respondents by timeliness of getting the modern agricultural inputs.
Source: Authors' computation from field data

Where:

RF = Registered farmers

NRF = Non-Registered farmers

VE = Very early

ME = Moderately early

L = Lately

VL = Very lately

N = Never

In Figure 5, we show that e-wallet usage by registered farmers has improved the timeliness of getting access to the improved farm inputs very early by 36 percent and 24 percent for those that get it moderately early. The e-wallet programme has also reduced late receipt of the modern agricultural inputs by 9 percent. Rate of receiving input very late reduced also by 24 percent, and the percentage of those who never access input was also reduced by 24 percent. This result is consistent with Aker and Ksoll (2015) that information has an extensive and multifaceted role in improving agricultural outcomes. This suggests that the rising spread of mobile telephony has shown the potential of delivering information through mobile phones; but the impact of the mobile phones as a source of information for farming depends on how mobile networks are able to link the farmers to required information in a timely and accurate manner.

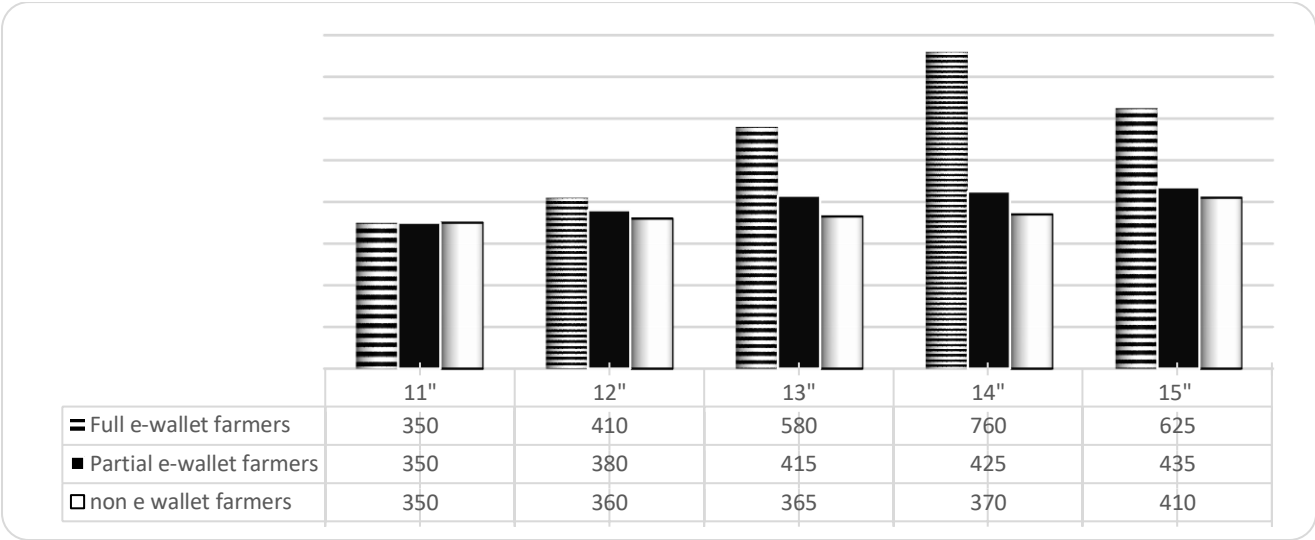


Figure 6. Average output per hectare of farmers

Source: Authors' computation from field data

In Figure 6, we illustrate that in 2011, the average output per hectare of all the farmers (both registered e-wallet and non-registered) was same, estimated at NGN 350,000 per hectare. In 2012 with a little number getting involved in the e-wallet, it shows a growth in the outputs of farmers with e-wallet farmers increased to NGN410, 000; while that of partial e-wallet farmers increased to NGN 380,000; and the non-registered e-wallet farmers increased to NGN360, 000. This implies that the adoption of e-wallet and using it to access farm input seriously impacted positively on the output of e-wallet farmers in particular and the general average productivity of the rural farmers, which is in harmony with Mittal and Tripathi (2009).

In Table 4, we identify that, factors like ownership of mobile phones, contact with extension agents, and access to electric power, positively impact on farmers' ability to participate in the e-wallet scheme. The three factors are positively significant at the one percent significance level. This shows that any increase in these factors will accelerate the impact of mobile phone-based technologies on farm entrepreneurship. At the 5 percent significance level, value of output of e-wallet participants, mobile network coverage, and the level of education were positively significant. This suggests that an increase in any of these factors positively influences participation in the e-wallet programme. The age of the farm and, farming experience are negatively significant at the five percent level. This show that as the age of the farmer increases and the farming experience also increases, the tendency to participate in the e-wallet programme decreases. Also, negatively significant at this level is distance to the input redemption or selling point. At the 10 percent significance level, access

to credit and off-farm income was positively significant. This indicates that increased access to credit and off-farm income provide funds with which to redeem the inputs. Farm size of the respondent is positive, but not significant while household size is negative but not significant.

Table 4. Estimates of bivariate probit models for farmers' participation in the e-wallet programme.

Variables	Coefficients	Standard error	|P| z > z|
Constant	-.3114	.4124	1.2351
Age (years)	-.432	.283	0.412**
Education (years)	0.151	.513	0.514**
Marital Status	-0.614	.123	1.317**
Household Size	- 0.324	1.245	1.183
Access to Credit	0.215	0.302	0.235***
Size of farm	1.214	0.146	1.134
Mobile phone	1.243	0.014	0.0415*
Farming experience (years)	-3.148	0.027	2.213**
Off Farm Income	0.412	0.214	0.401***
Value of output (N)	1.56	0.304	1.187**
Mobile network coverage	1.215	0.201	0.019*
Land Ownership Type	.908	0.141	1.215**
Extension Contact	0.484	0.018	0.302*
Access to power supply	0.925	0.407	0.003*
Distance	-.045	0.165	0.184**
Number of observations	1,152	1,152	1,152
(Likelihood Ratio) LR test (ρ=0)	$\chi 2$ (1) = 134.72*		
Pseudo R^2	0.42		

* = significant at 1% level; **= significant at 5% level; and *** = significant at 10% level

Source: Authors' computation from field data

4.4 Adoption of farm inputs (fertilizer, certified seed, and crop protection products) and enhancement of rural entrepreneurship: for the main objective of study

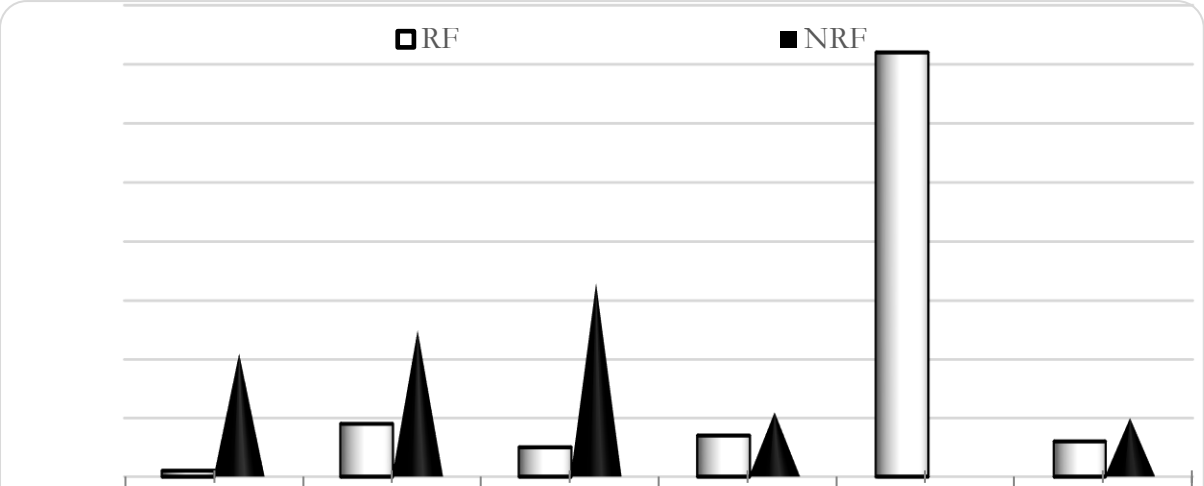
Table 5. Estimates of bivariate probit models for accessing of improved farm input and enhancing rural farm entrepreneurship by the rural farmers.

Variables	Coefficient	Std. error	|P| z > z|
Constant	28.413	4.707	3.512
Age of a farmer (years)	- 0.414	0.119	0.143**
Highest Level of educational qualification (years)	.512	.417	0.123**
Marital status of respondent Farmer	0.235	0.112	1.712*
Household size of farmer	- .341	0.214	.821
Access to farm credit by farmers	0.251	0.213	0.215**
Size of farm cultivated by farmers (hectare)	1.365	.804	1.051
Ownership of mobile Phone	2.437	.619	0.132*
Farming experience (years)	-0.121	0.1443	4.93*
Membership of cooperative body	0.631	0.301	0.031***
Sources of farm input	1.112	0.317	0.412*
Off Farm Income	1.206	1.117	0.013**
Value of farm output of farmers in naira (N)	1.141	1.123	.923*
Mobile Network coverage	0.215	0.344	.210*
Land Ownership Type	0.713	0.125	0.231*
Access to power source	0.126	0.142	.482**
Contact with Extension Agent	1.454	.813	0.151*
Distance to farm input/Selling Point	-0.124	0.041	0.0173**
n = 1152			
LR test (ρ=0)	$\chi 2$ (1) =128.15*		
Pseudo R^2	0.26		
*** = significant at 10% probability level			
** = significant at 5% probability level			
*= significant at 1% probability level			

Source: Authors' computation from field data

In Table 5, we noted that at the one percent significance level, the output of participants of the e-wallet programme, who used improved farm inputs, the land ownership type, contact with the extension agents and sources of farm inputs and ownership of mobile phone, were significant. This simply implies that usage of mobile phone-based technologies in the form of e-wallet to access improved farm input is a factor that has enhanced farm entrepreneurship in

the rural communities. Moreover an increase in the number of extension agents also enhances farm entrepreneurship in the rural communities as agents work towards changing farmers' behavior towards new technologies and information – a fact that is often attributed to a lack of knowledge or understanding of farmers' perspectives and needs on the part of information providers. Marital status of the farmer, distance to input redemption centers and farming experience are negatively significant at one percent probability level while the age of the respondent is significant at the 5 percent level. The marital status is explained by the cultural challenges faced by most of the married rural women farmers. This group of farmers does not take the decision to participate in the e-wallet or adopt any technology on their own. It is always a decision that would be taken with the husband who is the custodian of the land. This is why it appears that female headed households are more likely to become rural farm entrepreneurs than their counterparts who are under male headed households. These women's adoption of any kind of input is relatively restricted as it is always a function of availability of land, and culturally, married women have no land of their own but can access land through their husbands, or adult sons (Uduji & Okolo-Obasi, 2017). Accordingly, marriage mostly to the younger ones negatively influences their adoption decision. Also, as the age increases, it is expected that access to land can be guaranteed through their children since they have become so used to the tradition that adoption of innovation does not appeal to them. At the 5 percent level, access to credit, off farm income and the educational level of the respondent were positively significant. This implies that an increase in these factors definitely will increase the tendency of the farmer to use improved farm input which will definitely enhance farm entrepreneurship. Accordingly, our findings suggest that an increase in the number of those who use mobile phone-based technologies in the area of e-wallet to access farm inputs (fertilizer, certified seed and crop protection products…etc) will transform the rural farm entrepreneurship in Nigeria.



	None	Personal Reserve	Open Market	Cooperatives	e-wallet	ADP
RF	1%	9%	5%	7%	72%	6%
NRF	21%	25%	33%	11%	0%	10%

Figure 7. Distribution of respondents by Sources of farm inputs**.**

Source: Authors' computation from field data

We show in Figure 7 that about 96 percent of the registered farmers and 79 percent of the non-registered farmers are using improved farm inputs in their rural farm entrepreneurship. This is to say that about 86.5 percent of the rural farmers (both the registered and non-registered) are using improved farm inputs. However, the difference lies in the sources and time of getting the input and the proper knowledge of the usage of such input. Also, the result shows that only 21 percent of the non-registered and 4 percent of registered farmers are not using the improved farm input. While about 72 percent of the registered farmers get their input through the e-wallet programme (which also ensures that the input arrives on time), about 33 percent of non-registered farmers get theirs from the open market. Ironically, diverted inputs are largely sold in the open market (Uduji & Okolo-Obasi, 2018). The overall analysis shows significant improvements in the adoption and usage of improved farm inputs when compared with the earlier findings in World Bank (2014).

On the whole, this study has demonstrated that mobile phone-based technologies via the e-wallet programme have the potential to transform the rural farm enterprise in Nigeria. The findings concur with Mittal and Mehar (2013) in that access to reliable, timely and relevant information can help significantly and in many ways reduce farmers' risk and uncertainty and hence empower them to make informed decisions.

5. Concluding remarks, caveats and future research directions

Transforming agriculture from a largely subsistence enterprise to a profitable commercial venture is both a prerequisite and a driving force for accelerated development and sustainable economic growth in sub-Saharan Africa. Thus, we set out to investigate the impact of federal government (FGN) e-wallet programme on farm entrepreneurship development in rural Nigeria. The research builds on the scant scholarly evidence on the relevance of the e-wallet programme on agricultural outcomes in Nigeria. In modelling the impact of e-wallet on rural farm entrepreneurship, we used the bivariate probit model to test the hypothesis that mobile phone-based technology adoption via the e-wallet programme determines farm entrepreneurship in rural Nigeria. Farm entrepreneurship in this study referred to entrepreneurial efforts made by farmers to access farm inputs (improved seeds, fertilizers and crop protection products) to enhance farm development in rural Nigeria through their participating in the e-wallet model. One thousand, one hundred and fifty-two rural farmers were sampled across the six geo-political zones of Nigeria. Results indicated that mobile phone-based technologies via the e-wallet programme are a critical factor that has enhanced farm entrepreneurship in rural Nigeria. However, results also showed that the impact of mobile phones (as a channel to accessing and using modern agricultural inputs) is contingent on how mobile networks are able to link farmers who live in rural areas and work mainly in farming. The results suggested that increasing mobile phone services in rural Nigeria enhances farmers' knowledge, information and adoption of improved farm inputs; which is capable of spurring rural informal sector economic activities in sub-Saharan Africa. In what follows, we discuss implications for practice, policy and research.

In terms of implications for practice, it is apparent from the findings that farmers productivity in rural areas of Nigeria can enhanced by means of the FGN's GESS programme. Hence, more rural farmers (especially those in the informal economic sector) need to leverage on the programme in order to benefit from associated rewards, *inter alia*: insurance of the Nigerian farmer receiving farm input subsidy support from the FGN through accredited agro-dealers, provision of vital agro-information alerts, availability of an agricultural extension system and participation in micro-lending schemes.

The implications for policy largely surround the relevance of how ICT can be consolidated by policy makers to act as an agricultural enhancement interface between the government and farmers in rural communities. Such consolidation can be made by designing and implementing ICT policies such that they improve, among others: reach, access, interaction, adoption, efficiency and affordability. (i) On the reach factor, owners of mobile phones

essential for the e-wallet programme can be restricted because of lack of network infrastructure. (ii) Access to ICT can be improved if rural farmers are empowered to be able to use their mobile phones anywhere at any time to address issues pertaining to the farming productivity and the GESS programme. (iii) Interaction options in mobile communication also enable farmers to share experiences on the benefits and challenges associated with the GESS. Hence, the sharing of experience also limits costs associated with information asymmetry between farmers on the how to address issues pertaining to the programme. (iv) Policies designed to improve agricultural productivity in the light of the GESS programme should be tailored towards encouraging farmers in rural areas to consider the usage of mobile phones as a factor of production. (v) The efficiency of communications from the government to rural farmers can also be increased if the GESS is tailored such that farmers' suggestions on and feedbacks to the programme are directly relayed by means of mobile phones. (vi) On the concern of affordability, given that affordability of mobile phones by some farmers could be difficult due to cost, ICT support mechanisms can complement the GESS programme. Mechanisms by which such complementary schemes are possible include, *inter alia*: the subsidization of mobile infrastructure and promotion of community ICT ownership, especially in very remote rural communities.

On the implications for research, although, this study shows that mobile phones play an important role in bridging the information gap for rural farm development, it is imperative to extend this research with a study that determines whether mobile phones can be a substitute for face-to-face interaction with farmers or whether their use to deliver information has to be complemented with other information sources, especially in rural sub-Saharan Africa. The main caveat of the study is that it is limited to the scope of rural areas in Nigeria. Hence, the findings cannot be generalized to other African countries with the same policy challenges. In the light of this shortcoming, replicating the analysis in other countries is worthwhile in order to examine whether the established nexuses withstand empirical scrutiny in different rural contexts of Africa.

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Appendix

DRAFT QUESTIONNAIRE FOR RURAL FARMERS IN NIGERIA

State _____ LGA _____

City/Town_____

Name of Respondent:_____

1. Sex of Respondent :

   Male [ ] Female [ ]

2. Age Bracket:

   a) Between 20 – 30 [ ] b) Between 31 – 40 [ ] c) Between 41 – 50 [ ]

   d) Between 51 - 60 [ ] e) Above 60 [ ]

3. Marital Status:

   a) Married [ ] b) Single [ ] c) Separated [ ] d) Widowed [ ] e) Divorced [ ]

4. Number living in household at present (Household Size):

   _____

5. Highest Educational Qualification of Respondent:

   a) None [ ] b) Primary [ ] c) Secondary [ ] d) Tertiary [ ]

6. Religion of the Respondent

   a) Christianity [ ] b) Islam [ ] c) Traditional d) others [ ]

7. Employment status of Respondent

   a) Government/Private non-farm Paid Employment [ ] b) Self-employed (non-farm)[ ]

   c) Full Time Farming [ ] d Full time Student [ ] e)Unemployed [ ] g) Others [ ]

8. If self-employed, what is the major occupation of Respondent?

   a) Trading [ ] b) Handicraft e.g mechanic, welding, bicycle repairs, etc [ ] c) Palm wine Tapping [ ] d) Others (Pls Specify)_____

9. If in other employment, are you involved in part time farming

   a) Yes [ ] b) No [ ]

10. How long have you been farming:

    a) 0- 10 Years [ ] b) 11- 20 Years[ ] c) 21 - 30Years [ ] d) 31 - 40 Years [ ] e) Above 40 Years [ ]

11. If you are involve in farming, what is the size of your farm:

    a) 0 - 1hectare [ ] b) 2- 3hectares[ ] c) 4 - 5hectares[ ] d) 6- 7hectares[ ] e) Above 7 hectares[ ]

12. Range of monthly income of Respondent

a) (0- 50,000) [ ] b) (51,000 – 100,000) [ ] c) (101,000 – 150,000) [ ] d) (151,000-200,000) [ ] e) (201,000 – 250,000) [ ] f) (251,000 – 300,000) [ ] g) (301,000- 350,000) [ ] h) 351,000- 400,000 [ ] i) Above 400,000) [ ]

13. Do you or any other person(s) in your household earn off farm income

a) Yes [ ] b) No [ ]

14. If yes, what is the range of the monthly income from other household members put together

a) (0- 50,000) [ ] b) (51,000 – 100,000) [ ] c) (101,000 – 150,000) [ ] d) (151,000-200,000) [ ] e) (201,000 – 250,000) [ ] f) (251,000 – 300,000) [ ] g) (301,000- 350,000) [ ] h) 351,000- 400,000 [ ] i) Above 400,000) [ ]

Section B: Knowledge and Participation in E-wallet

15. Are you registered as a farmer?

a) Yes [ ] b) No [ ]

16. If no, why

a) I know nothing about that [ ] b) The distance to the registration point is far [ ] c) I am not a party member [ ] d) Our religion is against it [ ] e) I have no access to telephone [ ] f) I don't know how to read and write [ ]

17. What is the walking distance between your house and the registration/redemption point?

a) Between 1 -20 minutes [ ] b) between 21-40 minutes [ ] c) between 41-60 minutes [ ] above 1 hour [ ]

18. Have you heard about e-wallet before

Yes [ ] No [ ]

19. If yes to 19 above, have you ever used it to access agricultural input

Yes [ ] No [ ]

20. If no, what is the major reason for not accessing input with e wallet.

_____

_____

21. Do you have access to a mobile phone

a) Yes, I have my own phone [ ] b) Yes, but I use that of relatives [ ] c) No, I have no access at all.

22. Is your village/location properly covered by mobile network

a) Yes fully [ ] b) Yes but partially [ ] c) No not at all

23. If yes to 22 above, how best do you charge your mobile phone

a)Our village is covered by the national grid [ ] b) we use solar power supply c) we use standby generator in our home [ ] d) we pay to use the public charging system [ ]

24. Before the last 8 years, how do you source your farm input

a) Personal reserve [ ] b) ADP [ ] c) Cooperatives [ ] d) E wallet [ ] e) Open market [ ]

25. In the last five years, how best do you source your farm input

a) Personal reserve [ ] b) ADP [ ] c) Cooperatives [ ] d) E wallet [ ] e) Open market [ ]

26. Before the last 8 years, how early do you source your farm input

a)Very early [ ] b) Moderately early [ ] c) Lately [ ] d) Very lately [ ] f) Not at all [ ]

27. In the last five years, how early do you source your farm input

a)Very early [ ] b) Moderately early [ ] c) Lately [ ] d) Very lately [ ] f) Not at all [ ]

28. Before the last 8 years, how costly was your farm input

a)Very early [ ] b) Moderately early [ ] c) Lately [ ] d) Very lately [ ] f) Not at all [ ]

29. In the last five years, how costly is your farm input

a)Very early [ ] b) Moderately early [ ] c) Lately [ ] d) Very lately [ ] f) Not at all [ ]

30. In the last five year, have there been any improvement in your farm entrepreneurship

a) Yes [ ] b) No [ ]

31. If Yes, how will you attribute it to the government e wallet system

(a) Wholly [ ] (b) To a large extent [ ] (c) To a little extent [ ] (d) Not at all [ ]

32. Which area of your entrepreneurship has e-wallet made a significant input

a) Providing input [ ] b) provision of farm credit [ ] c) provision of market information [ ]

d) Provision of counselling and extension services [ ] f) All the above [ ] g) None [ ]

h) other please specify_____

33. Do you have access to any source of farm credit

Yes [ ] No [ ]

34. If yes, where do you get the credits

a)Commercial bank [ ] b) Agric Bank [ ] c) bank of industry [ ] d) Micro finance bank [ ] e) Non-bank micro finance institutions [ ] f) Unregistered money lenders [ ]

g) Others pls specify_____

35. How do you get access to land

a) Inheritance [ ] b) Lease [ ] c) Outright purchase [ ] d) Exchanges

36. What do you see as the four major challenges of e wallet in your Locality

_____

_____

_____

_____

_____

_____

_____

We thank you most sincerely for your time and support in completing this questionnaire.
Name of Enumerator: _____
Signature: _____ Date: _____