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Growth Enhancement Support Scheme (GESS) and Farmers' Fertilizer Use in Rural Nigeria[1]

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Research Department

Growth Enhancement Support Scheme (GESS) and Farmers' Fertilizer Use in Rural Nigeria

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

January 2019

Abstract

Fertilizer use in Nigeria is estimated at 13 kg/ha, which is far below the 200 kg/ha recommended by the Food and Agricultural Organization (FAO). The objective of this investigation was to identify the determinant factors of farmers' participation in the Nigeria's growth enhancement support scheme (GESS). In addition, we determined the impact of the GESS on fertilizer use in rural areas. One thousand, two hundred rural farmers were sampled across the six geopolitical zones of Nigeria. Results from the use of recursive bivariate probit model indicated that GESS significantly impacted on the access and usage of fertilizer among the rural farmers; and that contact with extension agents, ownership of mobile phones, power for charging phone batteries, value output, mobile network coverage, ability to read and write were positive determinants of rural farmers participation in the GESS; whereas increased distance to registration and collection centers, and cultural constraints to married women reduced farmers' tendency to participate in the GESS. The findings suggest that farmers' participation in the GESS is a critical factor for raising fertilizer use in Nigeria. This implies that food security in sub-Saharan Africa can be achieved by increasing the participation of rural farmers in the growth enhancement support scheme.

Keywords: Growth Enhancement Support Scheme, Fertilizer Use, Rural Farmers, Recursive Bivariate Probit Model, Nigeria.
JEL Classification: O13, Q1, N27

1. Introduction

Fertilizer has immense possibility of assisting sub-Saharan African countries to attain food security. In 2012, the Federal Government of Nigeria (FGN) liberalized fertilizer distribution by launching the Growth Enhancement Support Scheme (GESS) to transform the delivery of input subsidy as part of its Agricultural Transformation Agenda (ATA). Under the GESS, the government's role shifted from direct procurement and distribution of fertilizer to facilitation of procurement, regulation of fertilizer quality, and promotion of the private-sector fertilizer value chain (Adesina, 2012; Uduji *et al,* 2018a; Uduji et al., 2019a). In this process, the FGN and state governments each contribute 25 percent of the fertilizer cost resulting to 50 percent subsidy offered directly to smallholder farmers in the country (IFDC, 2013). The states and local governments were responsible for registering the farmers, with 3.91 million farmers in 2012; 9.5 million farmers in 2013 and 10.47 million farmers in 2014 (Olomola, 2015). Compared to the prior subsidy programme, GESS appeared to be more efficient and transparent in subsidy delivery to smallholder farmers in the country. For example, FGN spent ₦30 billion ($180 million) in 2011 to reach 800, 000 smallholders with inputs; whereas it spent N5 billion ($30 million) in 2012 to reach 1.2 million smallholders (Grossman and Tarazi, 2014; Uduji and Okolo-Obasi, 2018b, 2019).

However, the extent to which the GESS initiative had contributed to farmers' agricultural production in rural Nigeria remain contested (Tiri *et al.,* 2014; Nwalieji *et al.,* 2015). Yet, Adenegan *et al* (2018) recently added some nuance to the debate as they suggested that the GESS initiative impacted on the farm income of cassava and maize farmers in Oyo State, Nigeria; indicating that productivity-enhancing agricultural innovations can contribute to raising the income of farming households, improve poverty alleviation and food security in developing countries. Uduji and Okolo-Obasi (2018a) introduced gender perspective to the debate, suggesting that participation of young rural women would intensify the use of modern agricultural inputs in Nigeria. The preceding deliberations portray the complexity of GESS in rural Nigeria. Meanwhile, fertilizer application in Nigeria is estimated at 13kg/ha by the Federal Ministry of Agriculture and Rural Development (FMARD); which is far below the 200 kg/ha recommended by the Unites Nations Food and Agriculture Organization (World Bank, 2014). This translates to about 6kg/ha of nutrients and is also well below the Abuja Food Summit recommendation of at least 50 kg/ha nutrients in line with the declaration of the African Union Heads of States and Government on food security and hunger reduction in the continent (Benin and Yu, 2013, Asongu *et al,* 2019a, 2019b, 2019c, Anyanwu, 2014a,

2014b). As low fertilizer use has been identify as a major challenge that must be overcome in order to increase Nigeria's agricultural productivity (FGN, 2017), we hypothesize that GESS does not impact on farmers' fertilizer use in rural Nigeria. Thus, this investigation, which is in line with the agricultural transformation agenda (ATA) contributes to agricultural and rural development debate by assessing the empirical evidence in two areas that have received much attention in the literature:

- What are the factors that determine rural farmers' participation in the GESS in Nigeria?
- Does GESS impact on farmers' fertilizer use in rural Nigeria?

The rest of the paper is structured as follows: Section 2 describes the methodology. Section 3 presents the main findings and their implications. Finally, Section 4 concludes with policy recommendation.

2. Methodology

In this study, we adopted a quantitative method, given the scarcity of quantitative works on the intricacies of production, allocation and extensive use of fertilizer in the region (Uduji and Okolo-Obasi, 2018a, 2018b, Uduji *et al,* 2019d, 2019e). This study made use of a survey research technique targeted at obtaining information from a representative sample of farmers. It is, for all intents and purposes, cross-sectional, which revealed the data that are currently in existence.

2.1 Study Area

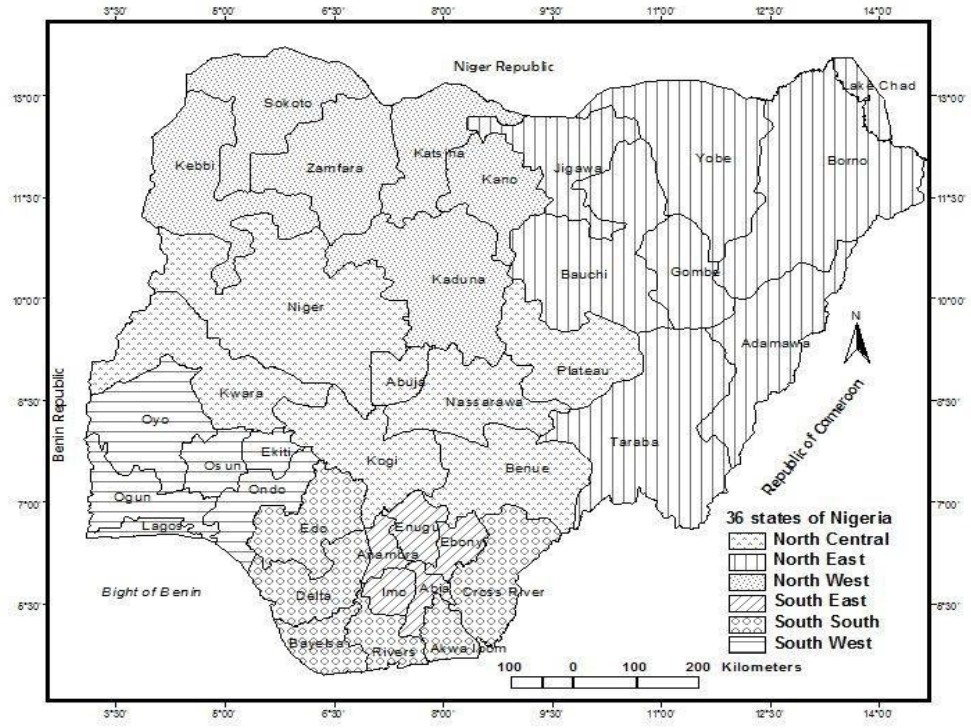

Figure 3: Constituent Sampled States of the Six Geo-Political Zones, Nigeria
Sources: Authors' Window Shade

Figure 1: Constituent Sampled States of the Six Geo-Political Zones in Nigeria
Source: FGN, 2017.

Nigeria comprises six geopolitical zones, with three zones each making up the north and south, as shown in Figure 1. The study was carried out in six states in Nigeria selected on purpose, as shown in Table 1.

Table 1: Population of the selected states

States/Geopolitical Zones	Male	Female	Total
Adamawa (North-East)	1,607,270	1,571,680	3,178,950
Benue (North-Central)	2,114,043	2,109,598	4,223,641
Cross River (South-South)	1,471,967	1,421,021	2,892,988
Ebonyi (South-East)	1,064,156	1,112,791	2,176,947
Ekiti (South-West)	1,215,487	1,183,470	2,398,957
Kano (North-West)	4,947,952	4,453,336	9,401,288
Total	12,420,875	11,851,896	24,272,771

Source: Population Commission, 2007

2.2 Sample Size

The sample size (n) in this study was determined for finite population according to Taro Yamane (1964) as shown in Equation 1 below:

$$n = \frac{\mathrm{N}}{1+\mathrm{N}(\mathrm{e}*\mathrm{e})} \qquad \text{Equation 1}$$

Where n = the sample size

N = total of the study area

e = level of significance (limit of tolerable error)

1 = unity (constant)

Therefore, the sample size for the study was determined thus:

$$\mathrm{n} = \frac{24{,}272{,}771}{1 + 24{,}272{,}771(.05 * .05)}$$

$$n = \frac{24{,}272{,}771}{60{,}681.93} = 400$$

This was multiplied by 3 to ensure that adequate sample was selected for the study.Hence,the total sample size determined is 1,200.

Table 2: Sample Distribution Table

States/Geopolitical zone	Male	Female	Total	%	Reg. Farmers	Non Reg Farmers	Total
Adamawa (North-East)	1,607,270	1,571,680	3,178,950	13	78	78	156
Benue (North-Central)	2,114,043	2,109,598	4,223,641	17	102	102	204
Cross River (South-South)	1,471,967	1,421,021	2,892,988	12	72	72	144
Ebonyi (South-East)	1,064,156	1,112,791	2,176,947	9	54	54	108
Ekiti (South-West)	1,215,487	1,183,470	2,398,957	10	60	60	120
Kano (North-West)	4,947,952	4,453,336	9,401,288	39	234	234	468
Total	12,420,875	11,851,896	24,272,771	100	600	600	1,200

Sources: FMARD, 2010/Authors' Computation

2.3 Data Collection

Data for this study were collected from both primary and secondary sources. However, primary source was the main source of data. Participatory rural appraisal (PRA) technique, namely semi-structured interview (SSI) questionnaire, was employed in the primary data collection. The use of participatory research technique in collecting e-wallet impact data especially as it concerns rural poor farmers is based on the fact that it involves the people being studied, and their views on all the issues are paramount. The semi structure interview questionnaire was the major tool the study used for the household survey. It was directly administered by the researcher 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.

2.4 Analytical Frameworks

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 GESS (e-wallet) on rural farmers' access and usage of fertilizer, we used the bivariate probit model to test the hypothesis of the study, i.e., there is no significant correlation between the error terms of rural farmers participating in the e-wallet

program and access/usage of fertilizers. Also both descriptive and inferential statistics were used to achieve the objectives of the study which are as follows:

- Ascertain the determinants of rural farmers' participating in the GESS in Nigeria
- Examine the impact of GESS on rural farmers' access to and usage of fertilizer in Nigeria.

In modeling the impact of GESS on access and usage of fertilizer, so many statistical models like tobit, logit, and probit models, could be applied. As good as these specifications may be, this study noted that two major decisions - to participate in the government GESS program and to use the program to access fertilizer are involved and the decisions are interdependent. Using a single independent model specifications, e.g., logit, tobit or probit might result in ineffective parameter estimation, as single independent model may fail to capture the correlations between the two major decisions (Kefyalew *et al.*, 2016; Tura *et al.* ,2010). In modeling two interdependent decisions like we have in hand, a model like the bivariate probit according to Greene (2012) is very essential. The bivariate probit model is a natural extension of the probitmodel; it appears in both the decisions to participate in the government GESS and that of using the model to access fertilizer as farm inputs. In this case, the first leg of the model is decision to participate. This has participation in GESS as the dependent variable; the other leg is the decision to use the participation to access fertilizer having participation in GESS as one of the explanatory variable. Therefore, we adapted, with modification, the recursive bivariate models developed and used by Kassouf and Hoffmann (2006) to suit our data analysis. We used STATA 13 software to analyze the data generated.

2.5 Model Specification

In specifying the model, we consider the equations,

$z^* = \alpha' w + \mu_1$ $\quad z{=}1 \; if \; a^* {>} 0 \; otherwise \;\; z{=}0$ Eqn. 1

$y^* = \beta' x + \delta z + \mu_2$ $\quad y{=}1 \; if \; y^* {>} 0 \; otherwise \;\; y{=}0$ Eqn. 2

In the above equations, 'x' and 'w' are column vectors of explanatory variables which acknowledged that;

$$\sum[\mu_1 \mid w, x] \quad = \quad \sum[\mu_2 \mid w, x] = 0,$$

$$Var[\mu_1 \mid w, x] \quad = \quad Var[\mu_2 \mid w, x] = 1,$$

$$Cov[\mu_1, \mu_2 \mid w, x] \quad = \quad \rho$$

We equally acknowledged that μ_1 and μ_2 have bivariate normal distribution which is thus stated:

$$\int_{-\infty}^{x_2}.\int_{-\infty}^{x_1}\emptyset_2(z_1,z_2,\rho)\delta_{z_1}\delta_{z_2}\ where\ \emptyset_2(z_1,z_2,\rho) = \frac{\exp(-(\frac{1}{2})(x_{2+}^1 x_2^2 - 2\rho_{x_1 x_2}\quad)/(1-\rho^2)}{2\pi(1-\rho^2)^{1/2}} \quad \text{Eqn. 3}$$

This according to Greene (2003) is a specific case of recursive bivariate probit model of simultaneous equations. It is recursive in the sense that the variable (z) appears on both equations 1 and 2. The variable is the dependent variable in equation 1 and an explanatory variable in equation 2. On the other hand, the endogenous variable (y) does not appear on the right-hand side of any equation.

Applying this to our study, z = 1 represents when rural farmers decide to participate in the GESS programme, otherwise, z = 0. Also, y = 1 represent when farmers access and use fertilizer, otherwise, y = 0.

In this work, we used B# to represent equation 3 which indicates the distribution function of the bivariate standard normal distribution with correlation ρ. Hence, four basic probabilities are obtainable in this recursive bivariate probit model and are represented as thus:

$$prob[y = 1, z = 1] = B\#(\alpha' w, \beta' x + \delta, \rho) \quad \text{Eqn. 4}$$

$$prob[y = 1, z = 0] = B\#(-\alpha' w, \beta' x - \rho) \quad \text{Eqn. 5}$$

$$prob[y = 0, z = 1] = B\#(\alpha' w, -\beta' x - \delta - \rho) \quad \text{Eqn. 6}$$

$$prob[y = 0, z = 0] = B\#(-\alpha' w, -\beta' x - \rho) \quad \text{Eqn. 7}$$

Therefore, when 'x' and 'w' are known, the expected value for y is represented as follows:

$\sum$ (y|w, x) = Prob [z = 1]$\sum$ [y|z = 1,w, x] + Prob [z = 0]$\sum$ [y|z = 0,w, x]

= Prob [z = 1]Prob [y = 1|z = 1,w, x]

+ Prob [z = 0]Prob [y = 1|z = 0,w, x]

= Prob [y = 1, z = 1] + Prob [y = 1, z = 0]

$= B\#(\alpha' w, \beta' x + \delta, \rho) + B\#(-\alpha' w, \beta' x, -\rho)$ Eqn. 8

2.6Estimating the Marginal Effects

Having $\phi(.)$ as the distribution function of the standard normal distribution, we obtained the probability of z = 1 from the marginal distribution using:

$$Prob(z = 1) = \phi(\alpha' w)$$

This is the probability of participating in GESS.

We evaluated the effect of participating in GESS by measuring the difference between the conditional probabilities of accessing fertilizer as a GESS farmer or not. The effect is measured with the function below:

$$G(z) = Prob(y = 1|\mathrm{w}, \mathrm{x}, \mathrm{z} = 1) - Prob(y = 1|\mathrm{w}, \mathrm{x}, \mathrm{z} = 0)$$

$$= \frac{B\#(\alpha'w, \beta'x + \delta, \rho)}{\phi(\alpha'w)} - \frac{B\#(-\alpha'w, \beta'x - \rho)}{1 - \phi(\alpha'w)} \quad \text{Eqn. 9}$$

The effect of participating in GESS on access to and usage of fertilizer can also be obtained by calculating its effect on the probability of the marginal distribution. This marginal distribution is represented thus:

$$M(z) = \phi(\beta'x + \delta) - \phi(\beta'x) \quad \text{Eqn. 10}$$

We obtained the probability in the bivariate distribution when $\rho = 0$, by the product of the marginal probabilities as stated below:

$$B\#(\alpha'w, \beta'x + \delta) = \phi(\alpha'w)\phi(\beta'x + \delta)$$

Hence, it becomes possible for us to verify that at the level $\rho = 0$, the difference between conditional probabilities is equal to the effect of participating in the GESS programme on access and usage of fertilizer i.e., G(z) = M(z).

In line with this, we analyzed the marginal effect of an explanatory variable x_i on the probability of a farmer accessing and using fertilizer and this is denoted by $H(x_i)$. We first established how to calculate the effect of a binary explanatory variable x_i that belongs to the vectors 'w' and/or 'x'. Assuming w_0 and x_0 are vectors with binary variable of value 0 and $w_1$and x_1 take the value 1, and the other variables having their mean value. In the context of this our study, the binary variable is given by

$$H(x_i) = \sum(y|w_1x_1) - \sum(y|w_0x_0)$$
$$= B\#(\alpha'w, \beta'x_1 + \delta, \rho) + B\#(-\alpha'w, \beta'x_1, -\rho)$$
$$-B\#(\alpha'w_0, \beta'x_0 + \delta, \rho) - B\#(-\alpha'w_0, \beta'x_0, -\rho) \quad \text{Eqn. 11}$$

Splitting this effect into two parts, we have:

$$H(x_i) = H_i(x_i) + H - 2(x_i) \quad \text{Eqn. 12}$$

with

$$H_i(x_i) = B\#(\propto' w_1, \beta'x_1 + \delta, \rho) - B\#(\alpha'w_0, \beta'x_0 + \delta, \rho) \quad \text{Eqn. 13}$$

and

$$H_2(x_i) = B\#(-\alpha'w_1, \beta'x_1 - \rho) - B\#(-\alpha'w_0, \beta'x_0 - \rho) \quad \text{Eqn. 14}$$

The first part corresponds to the effect of the binary variable x_i on the probability of participating in the GESS whereas the second part is the effect on the probability of accessing and using fertilizer for farmers not participating in the GESS.

Another indicator that can be used to analyze the effects of a binary explanatory variable is the ratio between the probabilities of participating in GESS when this variable is equal to 1 and when it is equal to 0:

$$\theta = \frac{B\#(\alpha' w_1, \beta' x_1 + \delta, \rho) + B\#(\alpha' w_1 - \beta' x_1 - \delta - \rho)}{B\#(\alpha' w_0, \beta' x_0 + \delta, \rho) + B\#(\alpha' w_0 - \beta' x_0 - \delta - \rho)} \text{Eqn. 15}$$

We also analyzed the effect of a continuous variable x_h, such as per capita family income, which belongs to the vectors w and/or x. In this case, the effect is the partial derivative of $\sum(y|w, x)$ in relation to x_h. It is interesting to distinguish between the two different parts of this effect, which are the derivatives of each of the two terms on the right-hand side of equation 8.

Assuming $\emptyset(\cdot)$ as the value of the density function of the standard normal distribution, the effect of x_h is

$$H(x_h) = \frac{\partial \sum(y|w,x)}{\partial x_h} = H_1(x_h) + H_2(x_h) \quad \text{Eqn. 16}$$

with

$$H_1(x_h) = \emptyset(\alpha' w)\phi(\beta' x + \delta - \frac{\rho \alpha' w}{\sqrt{1-\rho^2}})\alpha_h + = \emptyset(\beta' x + \delta)\phi[\alpha' w - \frac{\rho(\beta' x + \delta)}{\sqrt{1-\rho^2}}]\beta_h \quad \text{Eqn. 17}$$

and

$$H_2(x_h) = \emptyset(\alpha' w)\phi(\beta' x - \frac{\rho \alpha' w}{\sqrt{1-\rho^2}})\alpha_h + = \emptyset(\beta' x)\phi[-\alpha' w + \frac{\rho(\beta' x)}{\sqrt{1-\rho^2}}]\beta_h \text{ Eqn. 18}$$

3. Main Findings and their Implications

3.1 Descriptive Characteristics

Table 3: Socio-Economic Characteristics of the Respondents

Variables	Registered Farmers			Non-Registered Farmer		
	Freq	**%**	**Cum**	**Freq**	**%**	**Cum**
Males	467	78	78	250	42	42
Females	133	22	100	350	58	100
	600	**100**		**600**	**100**	
Years of Experience						
0- 10 Years	281	47	47	45	8	8
11- 20 Years	229	38	85	56	9	17
21 - 30Years	61	10	95	221	37	54
31 - 40 Years	22	4	99	152	25	79
Above 40 Years	7	1	100	126	21	100
	600	**100**		**600**	**100**	
Age of Respondents						
Less than 20years	138	23	23	54	9	9
21-35 years	352	59	82	97	16	25
36-50 years	86	14	96	330	55	80
51 years and above	24	4	100	119	20	100
	600	**100**		**600**	**100**	
Level of Education						
None	106	18	18	377	63	63
FSLC	222	37	55	128	21	84
WAEC/WASSCE	153	26	80	65	11	95
B.Sc. and Equivalent	48	8	88	11	2	97
Post Graduate Degrees	26	4	93	4	1	98
Others	45	8	100	15	3	100
	600	**100**		**600**	**100**	
Ownership of Mobile phone						
Have a set	392	65	65	35	6	6
Uses a neighbor's set	172	29	94	102	17	23
Have no set	36	6	100	463	77	100
	600	**100**		**600**	**100**	
Mobile Network coverage						
Network is good	270	45	45	145	24	24
Poor	148	25	70	225	38	62
Very poor	148	25	94	72	12	74
No network at all	34	6	100	158	26	100
	600	**100**		**600**	100	
Access to Credit						
Yes	104	17	17	82	14	14
No	496	83	100	518	86	100

	600	**100**		**600**	**100**	
Land Ownership Type						
Inherited	281	47	47	153	26	26
Purchased	205	34	81	196	33	58
Leased	114	19	100	251	42	100
	600	**100**		**600**	100	
Contact with Extension Agent						
Yes	543	90	90	49	8	8
No	57	10	100	551	92	100
	600	100		**600**	**100**	
Distance to selling point						
Close	375	62	62	393	66	66
Far	225	38	100	207	35	100
	600	100		**600**	100	
Annual Income Level						
0 - 50,000	34	6	6	76	13	13
51,000 - 100,000	53	9	15	134	22	35
101,000 - 150,000	72	12	27	146	24	59
151,000 - 200,000	102	17	44	86	14	74
201,000 - 250,000	118	20	63	58	10	83
251,000 - 300,000	72	12	75	38	6	90
301,000 - 350,000	56	9	85	26	4	94
351,000 - 400,000	45	8	92	24	4	98
Above 400,000	48	8	100	12	2	100
Total	**600**	**100**		**600**	**100**	

Source: Computed from the Field Data

We showed in Table 3 that a total of 1200 (600 each for registered and non-registered) farmers were sampled. The result shows that 78% of the registered farmers are men, while 42% of the non-registered farmers are also men. On the other hand, women constitute 22% of the registered farmer and 68% of the non –registered farmers.This gap in registration tends to agree with Uduji and Okolo-Obasi (2018) in that cultural constraints mandate woman to farm under their husbands. Further analysis revealed that about 76% of the registered women farmer are widowed, separated or divorced, suggesting that this group were not compelled to farm under any husband or man. The average age of registered farmers was 30 years; with average16years of experience (Table 3).The average age of the non-registered farmer was 42 years, with 31 years of experience. The registered farmers were more educated, with only 1 percent illiteracy level, whereas the literacy level among the non-registered farmers was low, with about 61% not able to read or write. About 66% of the registered farmers have their

own mobile phone, whereas 33% used the phones of their neighbours' children or relatives; and only 1% had no access to mobile phone use. Among the registered farmers, 48% had network coverage and only 13% had no network coverage in their villages. On the other hand, only 12% of non-registered farmer had access to mobile phones; whereas 88% had no access to mobile phones. This finding tend to concur with Grossman and Tarazi (2014) in that farmers not having mobile phone is a major challenge to GESS communications with the rural farmers in Nigeria.

Generally, among the registered and non-registered farmers, access to credits was low, as only 19% of the registered farmer had access to credit, whereas 81% had no access to farm credit. Also, 86% of the non-registered farmers had no access to credit. Also, the findings revealed that 81% of the registered farmers either inherited or purchased their lands; whereas 42% of the non-registered farmers leased their farmlands. This suggests that the registered farmers were more certain of the availability of land than the non-registered farmers. About 90% of the farmers registered because they had contact with the extension agents, whereas 92% of the farmers did not register as they did have contact with the extension agents. Surprisingly, 62% the registered farmers complained that the distance to the registration and redemption point was far; whereas only 35% of the non-registered farmers complained of the distance. Also, result showed that average annual income of the registered farmer was N210, 000 ($583), whereasthe average annual income of the non-registered farmer was NGN80, 000 ($222).

3.2 Participation in the E-Wallet Program

Table 4: Estimated Rate of Farmers' Participation in the GESS

States (Geopolitical Zones)	Estimated Total Population	Estimated Farming Population	No of Registered Farmers	Percentage
Adamawa	3,178,950	2,384,213	476,843	20
Benue	4,223,641	3,167,731	823,610	26
Cross River	2,892,988	2,169,741	455,646	21
Ebonyi	2,176,947	1,632,710	310,215	19
Ekiti	2,398,957	1,799,218	449,805	25
Kano (North-West)	9,401,288	7,050,966	2,326,819	33
Total	**24,272,771**	**18,204,578**	**4,369,099**	**24**

Source:FMARD, 2010/Authors' Computation

Participation in the GESS starts with registration of farmers, and our analysis in Table 4 show that only 24% of the farmers in the study area were registered. Despite the similarities in the socio-economic and demographic characteristics of the farmers, there were different reasons why many of them did not participate in the GESS (Table 5).Following the socio- economic analysis which shows that the output of registered farmers was twice more than that of the non-registered farmers, we assent with Morris *et al.* (2007) in that to explore grassroots mobilization involved persuading the rural farmers to actually take the first step of registration in the GESS.

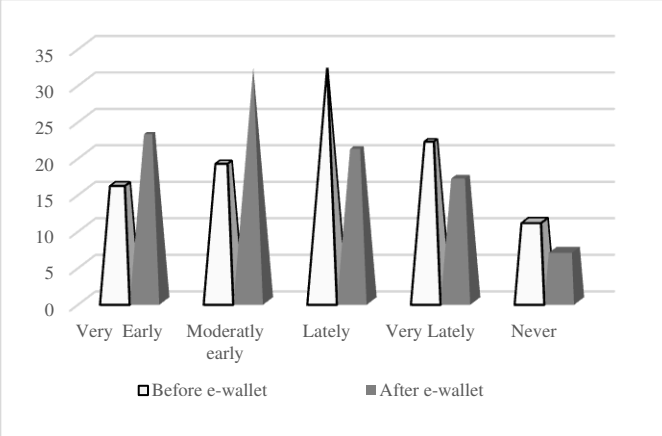

Figure 2: Timeliness of Getting FertilizerBefore and After GESS (E-Wallet) Introduction.
Source: Authors Computation from the Field Data.

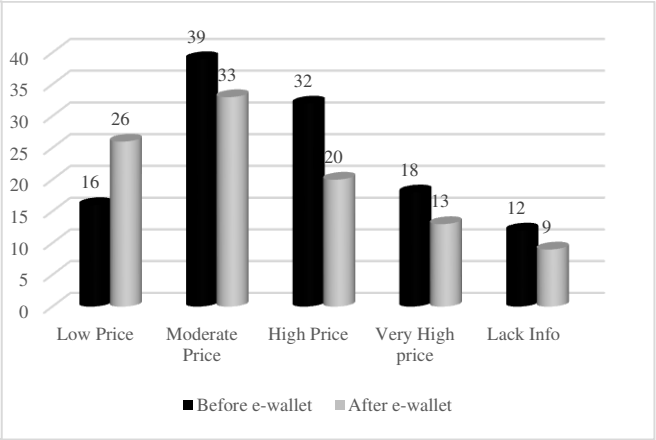

Figure 3: Constraints Faced in Accessing Fertilizer in Rural Areas Before and After GESS (E-Wallet) Introduction.
Source: Authors Computation from the Field Data.

The analysis of Figure 2 and Figure 3 showed that GESS had significantly impacted on the access and usage of fertilizer in rural Nigeria. For example, before the introduction of GESS, only 16% of the rural farmers gets fertilizer at low price and on time; about 39% gets fertilizer at moderate price; and 50% gets fertilizer at either high rate or very high rate. But after the introduction of GESS, 26% now gets fertilizer at low price; whereas 23% gets it on time. Also 33% and 32% gets the fertilizer at moderate price, and moderately early for the planting season. The percentage of the rural farmers that gets fertilizer at high or very high price had reduced to 33%. Further analysis of Figure 3 shows that before the introduction of GESS, 12% lacked information on accessing fertilizer in rural areas; 11% did not access fertilizer. However, after the introduction of GESS, only 9% still lack information, 7% did not access fertilizer. This findings support Olomola (2015) in that GESS is on the path of continuous improvement, as it is yielding some desired results of the federal government of Nigeria.

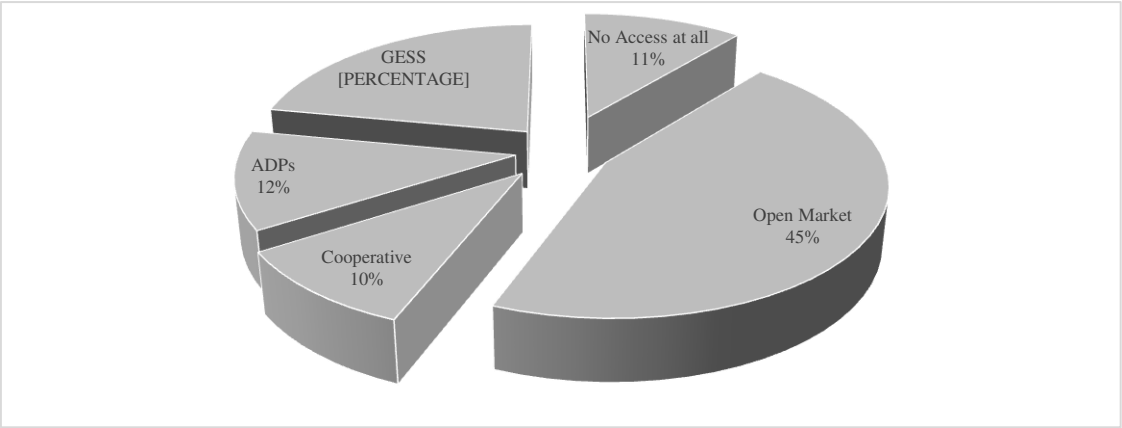

Figure 4: Rural farmers Sources of Fertilizer.

Source: Authors' Computation from the Field Data.

We observed in figure 4 that only 22% of the farmers access fertilizer through the GESS; 45% access fertilizer through the open market; whereas 12% access fertilizer through Agricultural development Programs (ADPs); 10% accesses fertilizer through cooperative societies; whereas 11% do not have direct access to fertilizer as farm input.

3.3 Econometric Estimations for Participating in the GESS and Usage of Fertilizer

The results of the recursive bivariate probit model estimation are presented in the table below The first column contains the variables included in the analysis. The type of variable (binary or continuous) is described in the second column, and the means of the variables are presented in the third column. The fourth column shows the coefficients and the tests for participating in the GESS, whereas the fifth column presents the coefficients and tests for the "Access and usage of fertilizer" equation. The estimated value of correlation ρ between the errors of both analyzed equations was 0.421, with p value equal to 0.0314 on Wald's test. The more important aspect of the output there is that GESS Participation which is a dependent variable in the fourth row of the table is also an explanatory variable in the fifth row and shows that at a 1% significance level, it has an impact on access to and usage of fertilizer by the rural farmers.

We identified in Table 5 that within the explanatory variables, ownership of a mobile phone, mobile network coverage, and contact with the extension agents are significant at a 1% significance level to both participating in the GESS and accessing fertilizer. Also the value of output (farm income of the respondents) is significant at 5% for participating in the GESS whereas for accessing and usage of fertilizer, it is significant at 1%. At the same 1%

significance level, GESS Participation, as an exogenous variable is significant for accessing and using fertilizer.

Table 5: Means and coefficients of the recursive bivariate probit model whose dependent variables are "Participating in GESS" and "Access & Usage of Fertilizer" among rural farmers.

Variables	Type	Mean	Bivariate probit model	
			Participating in GESS	Access and Use Fertilizer
GESS Participation		0.215	-	.6521
				2.832***
Full time Farming	Binary	0.865	0.1421	. 0713
			0.379**	1.136*
Male Gender	Binary	2.114	-0.521	-0.019
			0.175	-2.167**
Education	Binary	3.236	0.218	0.1426
			1.312**	2.142***
Marital Status	Binary	1.063	-0.0241	-0.631
			-1.051**	-2.106**
Household Size	Continuous	1.007	-0.215	-0.112
			0.001	0.003
Access to other Credit source	Binary	0.0316	-0.371	0.094
			-0.041	-0.0031
Size of Farm	Continuous	0.254	0.864	1.5307
			1.086**	.903**
Mobile Phone ownership	Binary	0.915	0.925	1.215
			1.407***	2.682***
Farming Experience (years)	Binary	0.971	-0.037	-0.7956
			-0.094*	-1.019*
Off Farm Income (NGN)	Continuous	1.083	- 0.1421	- 1.4663
			-1.023**	0.002
Value of Output (NGN)	Continuous	1.105	1.521	0.126
			0.845**	2.025***
Per capita family (NGN)	Continuous	0.063	-0.018	0.3191
			0.021	0.034
Mobile Network Coverage	Binary	0.221	1.013	0.0713
			2.001***	3.112***
Land Ownership Type	Binary	0.013	-0.218	0.019
			0.011	0.004
Age (years)	Continuous	2.321	-0.725	-0.1426
			-0.241**	-0.128**
Extension Contact	Binary	1.007	1.243	2.162
			2.131***	3.381***
Distance to Registration	Binary	0.254	-0.121	-0.5612
			1.231**	0.827**
Access to Power Source	Binary	0.532	0.017	0.102
			0.104**	0.285**
Constant			-4.142	-1.671

	-7.819***	-5.685***

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

Source: Authors' Computation from the Field Data.

Meanwhile, size of farm, access to power source, farming type and education are positively significant at the 5% level for both participation and access. This simply implies that whatsoever that causes any of these variables to increase or improve, will definitely create more probability to participate in the GESS and to access and use fertilizer. Age respondent, off farm income and marital status are all negatively significant at the 5% significance level. This implies that as the variables increase, the tendency to access and use fertilizer decreases. Only farming experience is significant at 10% level.

The findings are consistent with Zinnbauer *et al* (2018) in that the liberalization and deregulation of the fertilizer distribution policy may have encouraged the private sector in the fertilizer market, but many factors still constrain the smallholders from participating and realizing their full potential.

3.4 Influence of the GESS on Fertilizer Use

As stated in equation 9 of the model, we evaluated the effect of participating in the GESS by measuring the difference between the conditional probabilities of accessing fertilizer as a GESS farmer or not.

Table 6**: Probabilities (in %) of access to fertilizer while participating or not participating in GESS in the estimated bivariate probit model**

Access and Usage of fertilizer on time	**Participation in the GESS Model**		**Total**
	Yes	No	
Yes	61.2	6.7	67.9
No	4.4	28.7	33.1
Total	65.6	35.4	100
Conditional Prob	8.84	3.32	-

Table 6 above shows that a positive association exists between the participation in GESS and fertilizer access and usage variables. The conditional probability of such usage increases from 3.12% when farmers are not participating in GESS to 8.84% when some started participating. This shows that the marginal effect H(z), as outlined in equation 9 above is positive as follows

G(z) = 8.84%− 3.12% = 5.57%.

The result also shows that obtaining the effect of participating in GESS on access to fertilizer by calculating its effect on the probability of the marginal distribution is negative when we applied equation 10 above.

$$M(z) = 2.72\% - 7.48\% = -4.76\%$$

This estimated model buttress also that if there is not positive correlation between participating in GESS and usage of fertilizer, the effect of participating in GESS would reduce the probability of using fertilizer by 4.76%.

Table 7 below presents the marginal effects $H_1(x_i)$, and $H(x_i)$ on the probability of accessing and using fertilizer for all explanatory variables. However the continuous variables and their marginal effects were obtained based on last three equations of the model equations 16 – 18. The ratio of probability of GESS participation θ for the binary explanatory variables is presented for the relationship between the probabilities of participating in GESS in the presence and absence of the characteristic associated with the explanatory variable. Marginal effects were all calculated using STATA 13.0

Table 7: Marginal effects and likelihood ratio based on the equations for the recursive bivariate probit model for rural farmers

Variables	Marginal Effect			
	GESS Participants $H_1(x_i)$	GESS Non-Participants $H_2(x_i)$	Total $H(x_i)$	Ratio of Probability of GESS Participation θ
Full time Farming	0.325	0.186	0.511	1.113
Male Gender	0.453	0.298	0.751	0.886
Education	-0.0546	-0.1003	-0.155	-
Household Size	-2.219	0.91	-1.307	-
Access to other Credit source	-1.05	-1.404	-2.454	0.063
Size of Farm	0.376	0.896	1.272	0.032
Mobile Phone ownership	3.441	1.008	5.449	2.065
Farming Experience (years)	-0.481	0.288	-0.193	-
Off Farm Income (NGN)	-0.0215	-0.172	-0.151	-
Value of Output (NGN)	1.662	1.033	2.695	-
Per capita family (NGN)	-0.4025	0.056	-0.346	-
Mobile Network Coverage	1.143	0.083	1.226	0.987
Land Ownership Type	-0.2835	0.004	-0.279	1.132
Age (years)	-0.00624	0.020	0.014	-
Extension Contact	3.1645	2.002	5.167	0.093
Distance to Registration	-1.105	-1.163	-2.058	0.321
Access to Power Source	0.8455	0.308	1.154	1.432

Source: Authors' Computation from the Field Data.

The analysis of Table 7 shows that measuring the marginal effect of GESS participation on access to fertilizer, only mobile phone ownership and contact with extension agents have up to 5% effects showing significance at 5%. Others that are significant at 10% are mobile network coverage, access to power source, value of output, size of farm, which are positively significant while access to other credit sources, distance to registration and household size are negatively significant.

This suggests that participation in the GESS to access fertilizer is a critical factor that enhances agricultural productivity of the rural farmers; and that increased participation in the GESS will increase access to fertilizer in rural Nigeria. Increased in the number of farmers who register and participate in the GESS will definitely increase access to fertilizer, as well as improve agricultural production in Nigeria. Also noted was that increased in the number of extension agents also raises the GESS awareness, which in turn boost access to fertilizer. On the other hand, cultural constraint of the married women (marital status), age of the farmer, distance to registration and redemption centers, and farming experience were negatively significant at a 5% probability level. The issue of marital status agreed with Uduji and Okolo-Obasi (2018) in that the young rural married women face cultural challenges and cannot take the decision to participate in the GESS or adopt any technology independently of their husbands, who are the custodians of the land. This is, because such decision must be taken with the husband who is the custodian of the land. At the 10% significance level, access to credit, off farm income, as well as the educational level of the respondent farmer, were positively significant. This result is consistent with Shamgo (2011) in that an increase in these factors would increase the tendency of the farmer to access and use fertilizer.

4. Conclusion and Policy Recommendation

Fertilizer use in Nigeria is estimated at 13 kg/ha, which is far below the 200 kg/ha recommended by the Food and Agricultural Organization (FAO). The objective of this investigation was to identify the determinant factors of farmers' participation in the Nigeria's growth enhancement support scheme (GESS). In addition, we determined the impact of the GESS on fertilizer use in rural areas. This paper contributes to agricultural and rural development debate by assessing the empirical evidence in three areas that have received much attention in the literature:

- What are the factors that determine rural farmers' participation in the GESS in Nigeria?
- Does GESS impact on farmers' fertilizer use in rural Nigeria?

One thousand, two hundred rural farmers were sampled across the six geopolitical zones of Nigeria. Results from the use of recursive bivariate probit model indicated that GESS significantly impacted on the access and usage of fertilizer among the rural farmers; and that contact with extension agents, ownership of mobile phones, power for charging phone batteries, value output, mobile network coverage, ability to read and write were positive determinants of rural farmers participation in the GESS; whereas increased distance to registration and collection centers, and cultural constraints to married women reduced farmers' tendency to participate in the GESS. The findings suggest that farmers' participation in the GESS is a critical factor for raising fertilizer use in Nigeria. This implies that food security in sub-Saharan Africa can be achieved by increasing the participation of rural farmers in the growth enhancement support scheme.

The policy implications in terms of practice, policy and research are discussed in what follows. From the perspective of practice, it is obvious from the results that the productivity of rural famers in Nigeria can be improved through the government's GESS programme. Therefore, a great proportion of rural farmers need to make use of the programme in order to leverage on the associated benefits which consist of among others: some guarantee that the farmer receives subsidy in farm inputs from government via the ago-dealers that are accredited; allocation of important agro-information; participation in schemes linked to micro-lending and the presence of a system of agricultural extension. The relevance of the study is premised on the importance of how information technology can be leveraged by policy makers in order to provide an interface of agricultural enhancement between the government of Nigeria and farmers based in rural communities. The underlying consolidation can be made through the design and implementation of information technologies that are focused on improving, *inter alia*: affordability, efficiency, adoption, interaction, reach and access.

With respect to the implications of the findings to research, whereas the study has shown that mobile phones have a crucial role to play in terms of bridging the gap of information with the ultimate aim of boosting rural agricultural, it is also relevant to extend this study with a research that clarifies if mobile phones can be substituted for interactions among farmers that are face-to-face or whether the employment of mobile phones can be

used to enhance complementary sources of information in rural communities. The principal caveat of this research is its restricted scope to rural communities in Nigeria. Therefore, the results of the study cannot be generalized to other African nations which are confronted with similar policy issues. Hence, replicating this study in the context of other rural communities in Africa in particular and the rest of the world in general is worthwhile for future research.

Disclosure statement

No potential conflict of interest was reported by the authors.

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