

## Article

# Effects of Agricultural Programmes and Land Ownership on the Adoption of Sustainable Agricultural Practices in Nigeria

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**Abstract:** Many countries promote food security through agricultural policies to boost agricultural productivity without looking at the effect of such policies on sustainability. This study investigates the effect of agricultural policies and land ownership on the adoption of sustainable agricultural practices in Nigeria. A structured questionnaire was used for data collection from a survey of 288 smallholder farmers in November 2018. The results of the Logistic Regression Model revealed that programs affected the adoption of SAP. Farmers that participated in E-wallet were more likely to adopt fertiliser trees and use animal manure and were less likely to adopt planting basins than non-users. Farmers who participated in Fadama were less likely to adopt crop diversification. Participation in Farmers' Field School (FFS) contributed to a greater likelihood of farmers adopting crop diversification and cover crops. Landowner farmers were found to be more likely to adopt mulching and less likely to adopt fertiliser trees. This study provides practical implications to foster sustainability through effective agricultural policies and land ownership to facilitate sustainable agricultural practice adoption rates.

**Keywords:** E-wallet; policies; land ownership; sustainable agricultural practices



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## 1. Introduction

Agricultural input subsidies support policies and programmes that have been used in many countries to boost food production as an effort to achieve food security for a growing population [1]. However, the provision of this support to farmers mostly encourages them to increase their production through intensification or expansion of the land under cultivation, which may endanger agricultural sustainability and the environment if they are poorly designed and implemented [2,3]. Studies show that over the years, policy focus was given to intensification without much concern for the ecological effects [4,5]. For example, the utilisation of input subsidies on non-sustainable farming practices, including intensive tillage together with the extensive application of chemical inputs (e.g., pesticides, herbicides, and mineral fertilisers) has resulted in severe degradation and erosion of soils in Moldova [6].

Subsequently, the farming sector is faced with the challenge of finding a balance between boosting food production and reducing its environmental consequences, which makes Sustainable Agricultural Practices (SAP) a viable linkage to address this challenge [2,7]. SAP is “a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment” [8]. The adoption of sustainable agricultural practices has the potential to improve agriculture sustainability through a reduction in agricultural input and less waste generation from the resources [9]. A substantial amount of attention has been paid to SAP's positive contribution to the sustainability of the ecosystem. For example, cover cropping, crop rotation, and minimal tillage have environmental benefits such as reducing carbon through sequestration, reducing nutrient leaching and erosion, and promoting insect pollination [10,11]. Similarly, crop diversification promotes

biodiversity and economic diversification that protect farmers against climate and market risk [12,13]. SAP support available agricultural land fertility to sustain productivity [14]. Losing agricultural fertility of the land due to some environmental and human factors could be a huge loss to the farmer [15]. The need for improved fertility of the soil leading to an increase in crop yield, food security, effective land management, and income of household influences the adoption of SAP by farmers [16].

This case study was conducted in Nigeria, a country that faces many challenges regarding the agricultural sector. The sector is under serious pressure to meet the food needs of a growing population. This has led to a heavy burden on agricultural production systems, resulting in some negative setbacks to the environment; for example, erosion, deforestation, soil degradation, and biodiversity loss [17]. Many smallholder farmers in Nigeria were not active adopters of SAP due to their meagre resources and poor engagement in adopting agricultural innovation over the unproductive traditional methods used [18]. D'Souza and Mishra [19] noted that land fragmentation, lack of technical know-how, and sustenance of agricultural programmes were known to pose challenges on the adoption of Sustainable Agricultural Practice (SAP) in Sub-Saharan Africa, including southwest Nigeria.

Agricultural policies implemented in Nigeria in the last decade, such as the E-wallet programme and Fadama, have brought increased production and improvement in the livelihood and standard of living of the rural population in the southwestern part of Nigeria, thereby stimulating great potential for the adoption of SAP in the region [20,21]. The Farmer Field School is a program where farmers gathered as a group to learn sustainable agricultural production practices through an adult education capacity-building approach. The training on agricultural production is conducted through regular meetings, farming experiments, and demonstrations on the farms, which are developed to match with the farmers' production needs and expected to lead to improved yield. The Fadama system occurs where a piece of land is waterlogged during the rainy season, and the moisture is retained during the dry season. The aim of the World Bank-supported program is for farmers to experience a year-round cropping system that will lead to the production of marketable and high-value crops such as vegetables and other food crops with the expectation of boosting the productivity of the farmer. This approach is also expected to encourage sustainable land and water management all year. The Growth Enhancement Support Scheme (GESS), which gave birth to the E-wallet mobile phone enabled input distribution platform is one of the transformational initiatives by the Nigerian Government to boost farm productivity. The E-wallet initiative was developed to supply farm inputs such as improved seeds, agrochemicals, and fertilisers at a subsidised price directly to farmers. The inputs are distributed directly to the farmer without the involvement of middlemen via the use of an exchange of SMS between the farmer and the selected government agents. However, there is no scientific evidence about the effects of agricultural policies on SAP. Therefore, in this study, we investigate the effect of the use of policy programmes on the adoption of SAP.

One of the most identified limitations in adopting SAP are issues related to land tenure insecurity [22]. Land ownership positively affects SAPs adoption [16,23]. Empirical evidence shows that the farmers who have secured land ownership and rights implemented higher climate-smart agriculture practices [24]. On the contrary, Tesfu [25] argued that land tenure was not a precondition to farmers' decisions on soil conservation practices but noted that the farmers' income, education, and labour determined the adoption of sustainable agricultural practices. Previous studies investigated the effect of land ownership on the adoption of SAP in Nigeria. A land ownership system is a process of managing how farmland is acquired, the usage, the size acquired, and the exploitation of certain parts of the land. The system of land ownership in Nigeria could be communal where we have cases of leasehold, inheritance, purchase, gift, and tenancy. The government also plays a major role in land acquisition through the land tenure system a substantial landmass is owned by the government for farmers to acquire for agriculture. Bamire and Fabiyi [26] revealed that farmers in the southwestern part of Nigeria cultivated farmland for about

13 years before allowing it to go fallow for an average period of 2 years. Farmers who do not have a permanent right to a farm, for example, women or tenants, are usually discouraged and prevented from planting trees [27–30]. Bamire and Fabiyi [26] further noted that farmers in southwest Nigeria who acquire their land through borrowing, gifting, leasing, and sharing, as opposed to purchasing and inheritance, are typically less secure in embarking on long-term agricultural activities, which leads to limitations in adopting some SAPs.

A considerable amount of attention has been paid to factors that influence the adoption of sustainable agricultural practices by farmers. For example, several studies investigated the effect of socioeconomic, institutional, and agro-ecological factors that influence the adoption of SAP [12,16,31,32]. Prior literature considers the role of agricultural policies to encourage the implementation of sustainable agricultural practices. Farmland policies have been stressed as one approach to stimulate the adoption of pro-environmental agricultural practices to enhance farm and environment quality [33]. Agriculture policies promote farmers' behaviour change and agricultural integration through institutional innovations to support positive, sustainable agriculture development to attain farm productivity [34]. However, in previous studies, very little attention was paid to the effect of agricultural policies/programmes on the adoption of SAP by farmers. The study hypothesises that the implementation of agricultural policy/programmes that were not intended for SAP may unintentionally affect the SAP adoption behaviour of farmers significantly.

To close this gap, this study analyses the effects agricultural policies such as the Agricultural Transformation Agenda's E-wallet scheme, Fadama, and Farmers' Field School (FFS) have on the adoption of sustainable agricultural practices such as crop diversification, adoption of fertiliser trees, mulching, animal manure, cover crop, and planting basin amongst farmers in southwest Nigeria. Further, the effect of land ownership is studied. The following questions were addressed in this study:

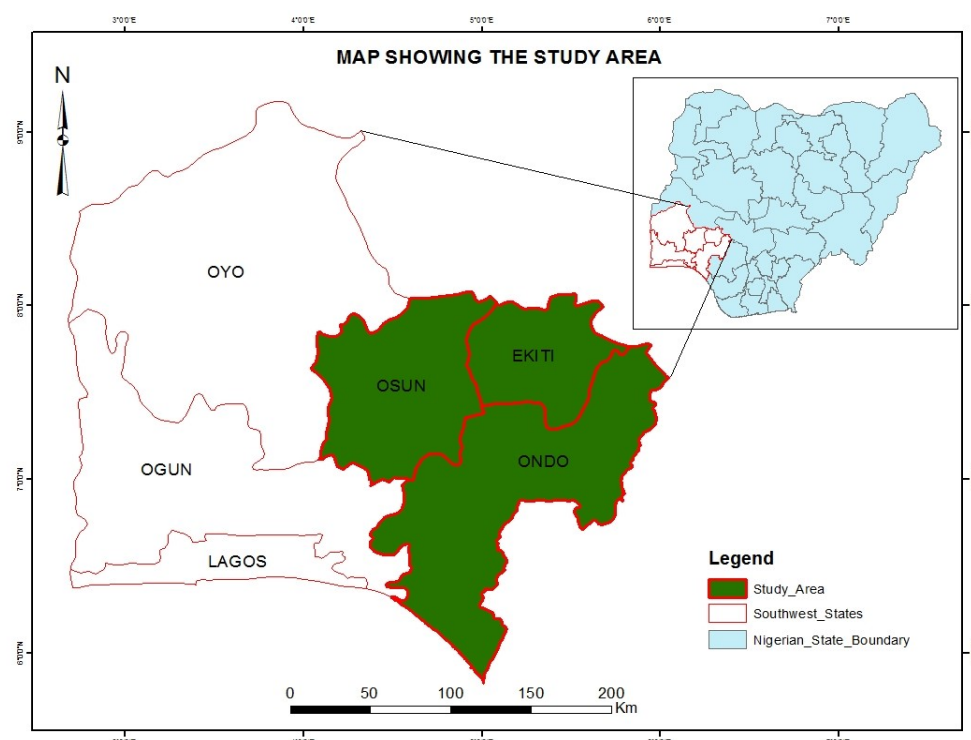
(i) Do government policy programmes affect the adoption of sustainable agricultural practices? (ii) Does land ownership affect the adoption of sustainable agricultural practices?

The implication of this study contributes towards promoting the adoption of sustainable agriculture to increase the efficient use of resources, which is an essential component for food production. Our findings provide policymakers with knowledge on how agriculture policies and land ownership could be beneficial in implementing sustainable agricultural development.

## 2. Methodology

### 2.1. Study Area

The study was carried out in Southwestern Nigeria (Figure 1). The study area is divided into six states geographically, namely Ekiti, Ogun, Oyo, Osun, Ondo, and Lagos State. These states are in the tropical rainforest agro-ecological zone with swamp forest in the coastal regions of Ondo, Lagos, and Ogun states. The zone has an area of about 114,271 km<sup>2</sup>, which represents 12% of the country's total land area. It had a total population of about 27,581,99 million but is estimated to be 30,416,396 million by 2016 [35]. Climatic conditions of the zone are humid, with rainfall between 1500 mm and 3000 mm per annum, and 36.38% of the population is engaged directly in agriculture [36].



**Figure 1.** Study area (Author, 2019).

## 2.2. Policy Programmes

Fadama (National Fadama Development Project) is a World Bank-sponsored project which focuses on economical irrigation technology launched in 1990 and is now in its third phase [37]. The project is aimed at producing marketable and high-value crops such as vegetables and other food crops. The focus of the programme is to boost the productivity of small-scale farmers to make sustainable use of the land and water available to them through community-driven development approaches [38], as well as increasing the income of farmers under the Fadama program through expansion of farm and non-farm activities for productive output [39]. Apata and Saliu [20] revealed that the participating farmers in the programme had a better livelihood and were more food secure than the non-participants. Smallholder farmers in Fadama areas are faced with challenges of competing for available land space for farming and managing agricultural intensification activities [40]. Lawal et al. [41] confirmed that Fadama farming households in the Southern Guinea Savannah of Nigeria adopted various agricultural diversification strategies as a way to fully maximise the Fadama land space available to them.

Farmer Field Schools (FFS) is an adult learning system with the objective of training farmers to experiment and find solutions independently to problems around them, using a group-based approach [42]. This project was introduced to Nigeria through the International Institute for Tropical Agriculture (IITA)'s Sustainable Tree Crop Programme (STCP) in 2003. It was first developed to teach Integrated Pest Management (IPM) techniques in rice farming, but it has also been used in organic agriculture, animal husbandry, and in support of non-farm income-generating activities such as handicrafts [43,44]. Integrated crop management (ICM) is one of the components of FFS which focuses on helping farmers to understand the interactions between the soil, the natural environment, and biological pests or weeds to enhance sustainable crop production.

The Growth Enhancement Support Scheme (GESS) was an agricultural programme that was launched in 2012. It provided farmers with information on government policies, particularly in the area of agricultural innovations and input support. It included input supply distribution through the utilisation of an Electronic Wallet (E-wallet, where farmers receive subsidised input vouchers per SMS) to allow direct access to farmers.

### 2.3. Land Ownership

Land ownership throughout Nigeria is communal with cases of inheritance, leasehold, gifting, purchase, and tenancy. The regulated procedures relating to land deals are documented in the Land Use Act of 1978. The Act empowers the government (the states) the custodian right to issue Certificates of Occupancy for those people interested in land acquisition within their boundaries [45,46]. The Act gives the governor of a state the responsibility to allocate land in all urban areas to individuals or organisations resident in the state for agricultural, commercial, residential, and other purposes with the same authority given to the local government authorities for non-urban areas. The Act was inspired by the need for all Nigerians to have unhindered access to land; to prevent speculative purchases of communal land; to regulate and simplify the management and ownership of land; to enhance land availability to governments at all levels for purposes of development; to develop a system of government administration of rights with a focus on promoting land tenure security.

### 2.4. Sampling Procedure and Data Collection

The study uses a multi-stage sampling procedure. The first stage involved the selection of three states (Ondo, Ekiti, and Osun states) out of six states in Southwestern Nigeria. The second stage involved particularly selecting two Local Government Areas (LGAs) from each state (Ondo State—Akure North and Akure South; Ekiti State—Gbonyin and Moba; and Osun State—Ife South and Ife East). The third stage involved the selection of two communities from each LGA, selected because of their active agricultural practices. The final stage of the selection involved the sampling of 288 farmers, with 24 farmers from each community selected. Thus, three states, six LGAs, 12 communities, and 288 farmers (155 E-wallet users and 133 non-users) were selected for the study as a minimum of 250 farmers should be used for a 95% confidence interval, considering an estimated population of above 200,000 [47].

$$n_0 = \frac{Z^2 pq}{e^2} \quad (1)$$

$n_0$  = sample size

$Z^2$  = abscissa of the normal curve that cut across  $\alpha$  at the tails, e.g., 95%

$p$  = estimated proportion of farmers in the population

$q = 1 - p$  (the  $Z$  – value found in the statistical table/0.5)

$e^2$  = desired level of precision

A structured questionnaire was used as an instrument for data collection from the respondents. The data were collected from farmers between August and November 2018 via a face-to-face interview with the farmers, mostly on their farms, and in some cases, during farmers' meetings. English, Yoruba (the native language in the study area), and pidgin language were used during the interviews. The data were collected with the help and support of trained agricultural researchers from Ekiti State University, Ado Ekiti, staff of the State and Federal Ministries of Agriculture. The information collected includes household and farm characteristics, sustainable agricultural practices, participation in the E-wallet scheme, and other government agricultural programmes. The questionnaire was pre-tested with 30 respondents to examine the internal consistency of the research instrument. Necessary amendments were made according to the feedback of the farmers, and the pre-tested data was not included in the main data.

### 2.5. Data Description and Analysis

Descriptive and inferential statistics were employed to analyse the data collected using Stata (Version 13). Descriptives in the form of mean, mode, and standard deviation were



used in grouping and summarising sustainable agricultural practices, farmers' characteristics, household characteristics, farm characteristics, and institutional characteristics.

Logistic regression models were used in finding the determinants for the adoption of sustainable agricultural practices among small-scale farmers as used in the literature [48,49]. The formula used is presented below:

$$Y = \alpha + \beta_1 \times 1 + \beta_2 X_2 + \dots \beta_{13} X_{13} + e \quad (2)$$

where: Y = dependent variable (sustainable agricultural practices, 1 = adopter, 0 = non-adopter)

$\alpha$  = regression constant,  $\beta_1$ – $\beta_{13}$  = regression coefficient, X1 = gender (1 = male, 2 = female), X2 = age (<30, 30–50, 51–70, and >70 years), X3 = level of education (1 = no formal education, 2 = adult education, 3 = primary school, 4 = tertiary education), X4 = farming experience (years), X5 = income (Naira/month), X6 = E-wallet (1 = adopter, 0 = non-adopter), X7 = household size (number of people), X8 = land size under cultivation (ha), X9 = land owners percentage, X10 = extension contact (how frequent in farming season 1–5), X11 = participation in Fadama programme (yes = 1, no = 0), X12 = Farmers' Field School (participation in Farmers' Field School (yes = 1, no = 0), X13 = farmers' groups (participation in farmer group, yes = 1, no = 0), e = error term.

The models were tested for multi-collinearity using correlation, Variance Inflation Factor (VIF), and coefficient of tolerance. The results indicated that the variables were independent as the VIF coefficient fell within the acceptance level of 5 [50]. The Durbin–Wu–Hausman did not show any effect of potential endogeneity.

### 2.5.1. Description of the Dependent Variables

The dependent variables in the six regression models are binary (adopted/non-adopted) and based on six SAPs adopted by smallholder farmers in Nigeria.

- (i). Crop diversification is defined as the practice of cultivating a variety of crops on a given farm area. This is viewed as an ecological practice linked to reducing risks and uncertainties in food production [51]. Additionally, Nguyen et al. [52] indicate that crop diversification can serve as a strategy in terms of weather shocks in different environments. Crop diversification provides benefits of nutritional diversity from a variety of crops [53].
- (ii). The practice of planting fertiliser trees is attributed an increasing supply of nutrients for crop production through nitrogen fixation in the soils and improvement of soil fertility [54]. Further, Akinnifesi et al. [55] argued that agroforestry ensures sustainability in crop yields and delivers food security to households.
- (iii). Mulching is a soil and water conservation practice. This involves the retention of crop residues on the field to improve water holding capacity, better aeration, and improving soil fertility. The residues include maize straws, rice straws, and leguminous leaves, among others [56].
- (iv). Animal manures are a source of nutrients and improve soil fertility. The amount of animal manures is influenced by livestock ownership. The farmers, in most cases, accumulate the manure from their livestock, and in other cases, the manure is obtained from neighbours or other farmers owning more livestock.
- (v). Cover crops and green manures are an important SAP in sustainable land use in fixing nitrogen in soils. The cover crops are ploughed back into the soils, thus enriching soil nutrients through decomposing residues [57]. Furthermore, cover crops and green manures are used in suppressing weed growth, and some common species include leguminous cover crops: sun hemp (*Crotalaria* spp.), pigeon pea (*Cajanus cajan*), jack bean (*Canavalia ensiformis*), velvet bean (*Mucuna pruriens*), and non-leguminous cover crops such as sunflower (*Helianthus annuus*) [58].

- (vi). Planting basins are usually prepared in the dry season, and with the onset of the rains, the crops are planted in the basins [59]. The method is commonly used in West Africa, including Nigeria, to reduce the risk of crop failure due to erratic rainfall [60].

### 2.5.2. Independent Variables

The literature was reviewed to explore the effect of agricultural policies, land ownership, and control variables in the models that have been found to affect the adoption of SAPs previously. Agricultural policies were found to affect the adoption in some studies [21,41]. Several studies [16,28–30] identified land ownership as a factor affecting SAP adoption. Household size, farmer training, and knowledge were identified as factors influencing compost manure adoption among smallholder farmers [61,62]. Farmers' years of farming experience, frequency of visits by the extension agents, and social status significantly determined the adoption of SAP in southwest Nigeria [63]. Mishra et al. [64] noted that factors affecting the adoption of sustainable agriculture practices among Kentucky farmers were the type of cultivated crop, the age of the farmer, education, and knowledge about SAPs. Lesch and Wachenheim [65] identified the barriers to adoption of conservative agricultural practices, including a reduction of programme base acreage, lower income, reduced flexibility in land use, poor market dynamics, and negative relationship between landlord and tenant.

## 3. Results

### 3.1. Description of the Results

Table 1 shows the description of the variables imported into the six logistic regression models with which different sustainable agricultural practices were considered. The table revealed that 185 (62.4%) of the farmers adopted crop diversification, 70 (24.3%) fertiliser trees, 141 (49%) mulching, 121 (42%) animal manure, 67 (23.3%) cover crops, and 27 (9.4%) planting basin. The results revealed that 53.8% of the respondents used the *E-wallet* programme, 19.4% of them participated in the *Fadama* project, while 31.9% were in *Farmers' Field School*. A majority (82.6%) of the respondents were male with a mean age of 48.11 and had on average 16 years of farming experience, with a mean monthly income of 52,656.25 NGN (138.57 USD), with a household mean of five people and a standard deviation of one person, the mean agricultural land under cultivation was 3.82 ha and 43.66% of the respondents owned the land under their cultivation, the mean yearly extension contact was three times, and the mean yearly meeting participation was 14.67 times.

**Table 1.** Description of variables in logistic regression model ( $n = 288$ ).

Variable	Description	Frequency (Yes)	(%)
Sustainable Agricultural Practices			
Crop diversification	Farmer adopted practice (yes = 1, no = 0)	185	64.2
Fertiliser trees	Farmer adopted practice (yes = 1, no = 0)	70	24.3
Mulching	Farmer adopted practice (yes = 1, no = 0)	141	49.0
Animal manure	Farmer adopted practice (yes = 1, no = 0)	121	42.0
Cover crop	Farmer adopted practice (yes = 1, no = 0)	67	23.3
Planting basin	Farmer adopted practice (yes = 1, no = 0)	27	9.4
Independent variables			
Policy programme			
E-wallet	Farmer adopted E-wallet (yes = 1, no = 0)	155	53.8
Fadama	Participated in programme (yes = 1, no = 0)	56	19.4
Farmers' Field School	Participated in programme (yes = 1, no = 0)	92	31.9

Table 1. Cont.

Variable	Description	Frequency (Yes)	(%)
Farmer characteristics			
Gender	Female = 0, Male = 1	238	82.6
Age	Number of years	48.11 (9.34)	
Educational level	1 = none, 2 = adult education, 3 = primary, 4 = secondary, 5 = tertiary		1 = 4.5
Farming experience	Number of years spent in farming	16.65 (10.47)	
Income	Monthly earning	(138.57 USD) <sup>1</sup>	
Household characteristics			
Household size	Members of the house	5.27 (1.79)	
Farm characteristics			
Land size	Land under cultivation (ha)	3.82 (3.09)	
Land ownership (%)	Share of owned land cultivation (ha)	57.78 (43.66)	
Institutional characteristics			
Extension contacts	How frequent (1–5)	3.79 (1.23)	
Farmers group	Participated in farmer group meeting	14.67 (4.38)	

Note: The numbers in parentheses indicates the standard deviation of the mean value. <sup>1</sup> 1 USD = 380 NGN.

### 3.2. Logistic Regression Model

The results in Table 2 show the influence of agricultural policies, farmers, household, and farm characteristics, including land ownership and institutional factors, on the adoption of the different SAPs considered in the study.

Table 2. Logistic regression model analysis.

Variable	Crop Diversification	Fertiliser Trees	Mulching	Animal Manure	Cover Crop	Planting Basin
Agricultural policy programme						
E-wallet	0.051 (0.066)	0.013 ** (0.052)	0.111 (0.070)	0.153 ** (0.070)	−0.030 (0.050)	−0.035 * (0.022)
Fadama	−0.273 *** (0.011)	0.029 (0.069)	−0.043 (0.089)	−0.135 (0.082)	−0.078 (0.050)	0.053 (0.045)
Farmers' Field School	0.126 * (0.105)	−0.028 (0.057)	−0.090 (0.075)	0.038 (0.078)	0.268 ** (0.0690)	−0.006 (0.020)
Farmer characteristics						
Gender	−0.375 *** (0.087)	0.008 (0.068)	−0.162 (0.098)	−0.284 *** (0.104)	−0.087 (0.003)	−0.072 * (0.038)
Age	0.130 *** (0.004)	−0.003 (0.003)	0.011 ** (0.005)	0.022 *** (0.005)	−0.0003 (0.003)	0.0006 (0.001)
Education level	−0.010 (0.034)	−0.015 (0.025)	0.066 (0.036)	0.009 (0.036)	0.004 (0.027)	−0.007 (0.009)
Farming experience	−0.015 *** (0.003)	−0.000 (0.002)	−0.004 (0.004)	−0.012 *** (0.004)	−0.012 *** (0.003)	−0.002 ** (0.001)
Income	−5.550 (0.000)	5.580 (0.000)	1.010 (0.000)	−6.060 (0.000)	−2.570 (0.000)	−5.730 ** (0.000)
Household characteristic						
Household size	0.005 (0.019)	0.015 (0.015)	−0.031 * (0.021)	−0.284 *** (0.021)	0.061 *** (0.016)	0.025 *** (0.007)
Farm characteristics						
Land size	−0.053 *** (0.015)	0.016 (0.010)	0.019 (0.070)	0.010 (0.013)	0.031 *** (0.010)	0.004 (0.003)
Land ownership	−0.004 (0.008)	−0.002 *** (0.000)	0.002 *** (0.000)	0.001 (0.080)	−0.001 (0.007)	−0.0002 (0.0002)
Institutional characteristic						
Extension contact	−0.184 *** (0.040)	0.083 *** (0.030)	−0.080 * (0.040)	0.113 *** (0.041)	0.010 (0.0270)	0.003 (0.010)
Farmers group	0.046 *** (0.011)	−0.015 * (0.008)	0.004 (0.011)	0.018 * (0.010)	−0.012 * (0.007)	−0.001 (0.002)
Number of observations	288					
LR chi <sup>2</sup> (13)	86.89	44.11	57.79	75.27	73.08	45.20
Prob > chi <sup>2</sup>	0.0000	0.000	0.0000	0.0000	0.0000	0.0000
Pseudo R <sup>2</sup>	0.277	0.138	0.145	0.192	0.234	0.252

Significance levels \*\*\* =  $p < 0.01$ , \*\* =  $p < 0.05$ , \* =  $p < 0.1$ . The numbers in parentheses indicate the standard errors.

### 3.3. Policy Programmes

Farmers that participated in E-wallet were more likely to adopt fertiliser trees and use animal manure significantly at ( $p < 0.05$ ). On the contrary, farmers that participated



in E-wallet were less likely to adopt planting basins at  $p < 0.1$ . Concerning the Fadama policy programme, the finding shows that the farmers who participated in Fadama were less likely to adopt crop diversification ( $p < 0.01$ ). Participation in Farmers' Field School (FFS) contributed to a greater likelihood of farmer adoption of crop diversification and cover crops with a significant positive probability at  $p < 0.1$  and  $p < 0.05$ , respectively.

### 3.4. Farmers' Characteristics

Gender has a significant negative effect on crop diversification, animal manure, and planting basins. The result indicated that female-headed households were less likely to adopt crop diversification and animal manure at the probability value of  $p < 0.01$ . Similarly, female-headed households are less likely to use planting basins than male-headed households. We found a positive and significant contribution for age on adopting three of the practices including crop diversification ( $p < 0.01$ ), mulching ( $p < 0.05$ ), and animal manure ( $p < 0.01$ ). The findings show that older farmers were more associated with adopting crop diversification, mulching, and animal manure than the younger farmers. The results demonstrate that farmers with more farming experience were less likely to adopt crop diversification, animal manure, cover crops, and planting basins than farmers with less experience with a probability value of  $p < 0.01$ ,  $p < 0.01$ ,  $p < 0.01$  and  $p < 0.05$ , respectively. An increase in income correlates with a lesser likelihood of adoption of planting basins at  $p < 0.05$ .

### 3.5. Household Characteristics

Adoption of the two practices, mulching ( $p < 0.1$ ) and animal manure ( $p < 0.01$ ), indicated a significant negative effect if the household size increased. Crop cover and planting basins showed a significant positive effect on the increase of household size with probability values ( $p < 0.01$ ).

### 3.6. Farm Characteristics

The results (Table 2) revealed that an increase in land size negatively significant affect the probability of adoption of crop diversification and positively affected the adoption of cover crops. Farmers that were landowners were found to be less likely adopters of fertiliser trees. Our results further showed that adoption of mulching was higher among the farmers that owned land than the non-landowners or those on rented land.

### 3.7. Institutional Characteristics

Our results indicate that farmers who have more frequent contact with extension services were less likely to adopt crop diversification ( $p < 0.01$ ) and mulching at ( $p < 0.1$ ). However, the use of fertiliser trees and animal manure showed a positive contribution for farmers with contact to extension services at  $p < 0.01$  and  $p < 0.01$ , respectively. The farmers that belonged to farmers' groups were more likely to adopt crop diversification and animal manure when compared to non-members. However, a negative contribution from the adoption of fertiliser trees and cover crops was found for the members of farmers groups.

## 4. Discussion

### 4.1. Policy Programmes

Farmers that participated in E-wallet were more likely to adopt fertiliser trees and use animal manure. The explanation may be insufficient quantity of fertiliser provided through the subsidy to cover the entire farmland, and farmers have to resolve into other means of fertilising their farm. The E-wallet subsidy provided a 50% discount on only two 50 kg bags of fertiliser (NPK and urea) per farmer [66]. The E-wallet scheme, however, was not able to fully meet the fertiliser demands of the farmers due to the small quantity provided and sometimes late arrival of inputs. Thus, farmers had to use fertiliser trees and organic fertiliser as alternatives to mineral fertilisers [21]. The results further showed that farmers

that did not participate in E-wallet were less likely to adopt planting basins. The possible reason for that is that E-wallet was meant for small scale farmers with less than 5 hectares of farm size; therefore, those that did not participate are more likely to be medium- and large-scale farmers that practice commercial-oriented production with mono-cropping, which is more profitable on the principle of economy of scale.

Concerning the Fadama policy programme, the finding shows that the farmers who participated in Fadama were less likely to adopt crop diversification. This may happen because in the study area, the farmer has very few alternatives, as not all crops can thrive in this area. Further, the programme promoted crop intensification to meet food demand on the land, which promoted mechanisation that is not in conformity with cultivating different crops. However, the case is different in the case of Southern Guinea Savannah of Nigeria. Lawal et al. [41] confirmed that the Fadama farming household involved in food crop production in Southern Guinea Savanna of Nigeria adopted various crop diversification strategies to fully maximise the use of the area under Fadama, which may be attributed to the effect of different ecological zones, as the study area has mainly tropical forest agroecology.

Participation in Farmers' Field School (FFS) contributed to a greater likelihood of farmer adoption of crop diversification and cover crops. This was an expected result, as the field schools concentrate on the promotion of practices such as crop diversification and changing planting dates [67,68]. Our finding confirmed that by Tomlinson [69], where farmers in Jamaica that were involved in FFS adopted cover crops and crop diversification more than non-participants. The finding that most farmers who adopted cover crops attended FFS is also in line with results by Pratt and Wingenbach [57] in Paraguay.

#### 4.2. Farmers' Characteristics

Regarding gender, the result indicated that female-headed households were less likely to adopt crop diversification, animal manure, and planting basins than male-headed households. This can be confirmed by Raufu and Adetunji [70] when looking at the determinant of land management practices among crop farmers in Osun State, Nigeria, where male farmers dominated crop diversification and other sustainable agricultural practices. Usman et al. [48] confirmed that the use of animal manure was dominated by the male arable crop farmers in Taraba State, Nigeria, which could be due to the socio-cultural background of the people and how intensively labour demanding land management practices could be. On the contrary, Ndiritu et al. [49] indicated that male-headed households were less likely to adopt animal manure in Kenya. However, Hove, and Gwene [71] also revealed that smallholder farmers, especially women farmers in Zimbabwe, confirmed that the task was demanding, and the farmers who were interested in benefiting from planting basins opted for the creation of groups for teamwork and rotated among member farms in the preparation of planting basins.

Concerning age, the sample findings show that older farmers were more associated with adopting crop diversification, mulching and animal manure. Similarly, Agboola [72] ascertained that older farmer showed more technical efficiency in mulching, crop diversification, and the use of animal manure than the younger farmers in Northcentral Nigeria.

The results demonstrate that farmers with more farming experience were less likely to adopt crop diversification, animal manure, cover crops, and planting basins, which unexpectedly partly contradict the finding of age effects. The possible reason is associated with not being willing to divert from older practices with which they are more comfortable. This raises concerns of providing enough information and visible demonstrations of the benefits for more experienced farmers to adopt some practices. Regarding crop diversification, our finding is in line with Makate et al. [73], who found that farmers with more years of farming experience did not adopt crop diversification when compared to the farmers with less farming experience in Zimbabwe. Edmundo et al. [74] argued further that the knowledge gained by the farmers over the years in interacting with the soil gives them more advantages in adopting sustainable agricultural practices.

An increase in income correlates with a lesser likelihood of the adoption of planting basins. This is because planting basins are small-scale technology in nature; therefore, the increase in a farmer's income leads to an interest in other forms of cultivation that are not time-consuming and will lead to increased yield. The focus is given to crop diversification, animal manure use, and mulching in the study area.

#### 4.3. Household Characteristics

An increase in household size is associated with a lesser likelihood of adopting mulching and animal manure practices. This is in line with the findings of Amao et al. [75] in Osun State in Nigeria, who found that, despite large household sizes, which reflect the high proportion of children that constitute household labour, children could not effectively and efficiently carry out all farm operations. On the other hand, an increase in the number of people in a household led to a greater likelihood of adopting cover crop and planting basin practices. Concerning the adoption of planting basins by larger households, this is not surprising due to its labour sensitivity. Muhammad-Lawal [76] revealed that a large household size among small-scale food crop farmers in Kwara State, Nigeria, enhances land management practices due to the availability of more labour.

#### 4.4. Farm Characteristics

The results revealed that an increase in land size reduces the probability of adoption of crop diversification. The possible reason is that most of the farmers with a large farm size practice monocropping as it is more compatible with mechanisation and likely to be more profitable in line with the economics of scale in commercial agriculture. This confirms Kasem and Thapa [77], who found that crop diversification was mainly practised by farmers with smaller land sizes in Thailand. However, a larger land size indicated a greater likelihood of adopting crop covers.

Unexpectedly, farmers that were landowners were found to be less likely adopters of fertiliser trees. The possible reasons for this are that landowner farmers might like to derive maximum productivity from their land as soon as possible without considering long-run effects, or they are not interested in the long-term and large investments such as fertiliser trees, or they may simply lack the capital needed. Muhammad-Lawal et al. [76] reported that the transferability of property rights in Nigeria negatively affects the adoption of long-term SAPs. Similar to our study, Deininger's [78] results showed a negative relationship between farm size and some land management practices such as tree planting, which includes fertiliser trees.

Our results further showed that adoption of mulching was higher among the farmers that owned land than the non-landowners or those on rented land. Owombo [79] also found, when determining land conservation technology adoption among arable crop farmers in Nigeria, 56.6% of the mulching adopters, 59.4% of the cover-cropping adopters, and 73.4% of the tree-planting adopters owned the plots on which they operated.

#### 4.5. Institutional Characteristics

A review on the adoption of SAPs by Baumgart-Getz et al. [80] considered access to and quality of information and local networks of farmers as the variables with the most significant contribution on adopting sustainable practices. The agricultural policies facilitate the adoption of sustainable practices, and this can be necessitated by boosting information channels and extension services [33].

Unexpectedly, our results indicate that farmers who have more frequent contact with extension services were less likely to adopt crop diversification, mulching, and animal manure. The reason for this can be the problematic situation in the quality of extension services provided in Nigeria. Further, anecdotal evidence says that farmers expect monetary incentives to implement new practices, which the government does not provide. However, other studies demonstrate a positive relationship between extension services and the adoption of sustainable agricultural practices in Nigeria [79,81]. Concerning crop

diversification, our finding contrasts with McCord et al. [82], who found that farmers with access to extension contacts adopted greater crop diversification than those without access in Kenya. Our study is consistent with Wondimagegn et al. [83], where extension contacts did not influence the adoption of crop diversification in Ethiopia, which could be due to the focus of extension services on farmers' productivity and profitability with emphases on micro-level cultivation over crop diversification as a risk minimisation measure.

However, our study indicates the use of fertiliser trees was more likely to be adopted by farmers with contact to extension services. Contact with extension services is a channel to the provision of information and the exposure of the farmers to the management of fertiliser trees. In support of this, Coulibaly et al. [54] indicated that knowledge attained through training provides farmers with capabilities and skills to efficiently manage agroforestry in Malawi.

The farmers that belonged to farmers' groups were more likely to adopt crop diversification and animal manure, which could be related to the group's common interest, while a lesser likelihood was observed in the adoption of fertiliser trees and cover crops. Regarding animal manure, similar results were found by Materechera [84], who indicated that training provided technical information for farmers, and it resulted in more farmers adopting animal manure usage in South Africa.

## 5. Conclusions

Many countries use agricultural policies to boost agricultural productivity without looking at the effect of such policies on environmental sustainability. This study was conducted with the main objective of investigating the effect of governmental agricultural programmes and land ownership on the adoption of SAPs. The finding shows that government agricultural programmes have a statistically significant effect on the adoption of several SAPs in various ways.

The main objective of the E-wallet technology of the Growth Enhancement Scheme programme was the support of input and thus intensification of crop production. The results of this study show that the adoption of the programme influences the adoption of fertiliser trees and animal manure in a positive way. This implies that input support programmes can promote the use of some agricultural inputs that have the same effect on agricultural production. For example, fertiliser trees and animal manure serve the same purpose and are a substitute or complement chemical fertiliser. Therefore, agricultural input programmes can be used to help farmers realise the importance of some sustainable agricultural practices available in their area. The Fadama programme, which is oriented towards increasing the productivity of small-scale farmers, was found to have a negative effect on the adoption of crop diversification, and thus it seems that the objective of boosting productivity conflicted with the use of crop diversification by smallholder farmers. This may be explained that crop diversification does not always support the use of farm mechanisation. However, more research would be needed to explain this effect. The Farmers' Field School (FFS) programme is oriented toward farmer education, including the area of integrated crop management and its environmental effects. It was found that this programme successfully promoted the adoption of crop diversification and cover crops among the beneficiaries.

Land ownership, the result of the land use policy, was found to have a significant positive effect on the adoption of mulching. However, surprisingly, land ownership does not affect the adoption of fertiliser trees, as most landowner and non-owner farmers in the area see this as capital intensive and are not patient enough to wait for the long-term effects of this investment. This indicated the need for awareness creation on the benefits and importance of such a long-time investment in agricultural production.

Further, the use of extension services was found to have a negative effect on the adoption of several SAPs. Improved quality of extension services and promotion programmes that encourage farmers to adopt SAPs, especially the adoption of crop diversification,

mulching, and animal manure due to the low-cost characteristics of their adoption, could be beneficial in the improvement of soil quality and the reduction of production risk.

This explorative study identified effects of the existing policies on the adoption of the six considered SAPs. Some of these effects are unintended as the policies do not aim to achieve them. Further policy-impact studies are needed to understand the effect of various policies that aim at the intensification of and increasing productivity of smallholder farming on the adoption of SAPs.

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