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RESEARCH ARTICLE

Willingness to Accept Incentives for a Shift to Climate-Smart Agriculture among Smallholder Farmers in Nigeria

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Abstract

We used choice experiment data collected from 542 farmers in Nigeria to assess smallholders' preferences for shifting to Climate-Smart Agriculture (CSA). Results suggest that the higher the size of the incentive, the more the likelihood of farmers' willingness to invest in CSA schemes. Similarly, the farmers were in favor of community development associations and non-governmental organizations-managed schemes over other project managements and also prefer government-based institutions as opposed to the private sector. Willingness to accept results suggest that an average farmer is willing to accept $540/ha/year and $386/ha/year to embrace good agricultural practices (GAPs) with and without manure application.

Keywords: Best–worst scaling; choice experiment; climate-smart agriculture; Nigeria; rank-ordered logit; willingness to accept incentives

JEL Classifications: Q15; C25

1. Introduction

Climate change already has a negative impact on livestock, fisheries, and crop production and, if adequate mitigation and adaptation measures are not implemented, it will continue to have a negative impact in the future (Mccarl *et al*., 2016; Zougmore *et al*., 2016). Climate change is expected to adversely affect agricultural production in sub-Saharan Africa by reducing crop yields and livestock productivity because of variability in rainfall, increased temperatures and incidences of the disease and pest (Kurukulasuriya *et al*., 2006), and variations in the frequency and severity of extreme climatic events such as floods and droughts (Brida *et al*., 2013). Recent results indicate that climate change would most likely result in significant crop yield losses, impacting the livelihoods of Africa's smallholder farmers (Lobell *et al*., 2011). As a result, food security and income opportunities for farm households most reliant on agriculture may be jeopardized.

Climate change is largely caused by an increase in the concentration of heat-trapping gases, also known as greenhouse gases, in the Earth's atmosphere. The most abundant of these gases is carbon dioxide, but methane, nitrous oxide, and some hydrocarbons and fluorinated gases also play important roles (Smith *et al*., 2008). Reducing greenhouse gas emissions and increasing carbon dioxide uptake by plants, soils, and oceans are two ways to reduce the amount of greenhouse gases entering the atmosphere. Agriculture makes a significant contribution to emissions of greenhouse gases, especially in developing countries such as Nigeria. It is estimated that agriculture accounts for 10–12% of total anthropogenic greenhouse gases (IPCC, 2014). The agriculture sector's overall contribution rises to about 26–35% when indirect emissions from the fertilizer industry, rice cultivation, and emissions from deforestation and land conversion are included (Padfield *et al.*, 2012).

As a result, prioritizing the development of adaptive mechanisms to deal with the negative effects of climate change should be a top priority. The promotion of agricultural practices with Climate-Smart Agriculture potentials (AP-CSAPs) is one major opportunity to mitigate climate change while maintaining agricultural system productivity (World Bank, 2011; Kehinde *et al.*, 2019). Agricultural practices with Climate-Smart Agriculture potentials will also help with the creation of adaptive capacity, enabling producers, service providers to farmers, and key organizations to respond to long-term climate change effectively, while also managing the risks associated with increased climate variability (FAO, 2013). This is accomplished through the three core pillars of CSA, which are to increase agricultural productivity and income sustainably; adapt to and build resilience to climate change; and reduce greenhouse gas emissions where possible (FAO, 2010).

In this study, the AP-CSAPs are contextualized as a set of good agricultural practices (GAPs) that include GAPs with and without manure application, as well as agroforestry. Good agricultural practices are a set of farming operations aimed at improving food safety and quality of agricultural products during the production and postproduction phases, as well as environmental and socio-economic sustainability (FAO 2016; Lotz *et al.*, 2018). The GAPs include but are not limited to the combined use of zero/minimum tillage, early maturing and drought-tolerant varieties, mulching, crop rotation, mixed cropping, retaining refuse on the soil rather than burning, cover cropping, manuring (green manuring, application of farmyard manure, and compost), microdosing of fertilizer where absolutely necessary, integrated weed and pest management, improve water use efficiency, water harvesting, among others.

The adoption of AP-CSAPs in sub-Saharan Africa is typically low (FAO, 2013; Byamugisha, 2013; Liniger *et al.*, 2011). This could be because implementing the AP-CSAPs usually requires upfront investments that take time to yield productivity gains. It is also worth noting that the present markets do not correctly reflect the value of the environmental benefits provided by AP-CSAPs. Various incentives, such as transition funds, payment of ecological services, carbon price under carbon dioxide, and others, have been proposed to address this challenge (FAO, 2013; Wollenberg *et al.*, 2012; Shittu *et al.*, 2018), to encourage more farmers to adopt AP-CSAPs. However, little is known about how smallholder farmers in sub-Saharan Africa, especially in the Southwest and North central Geopolitical Zones (GPZs) in Nigeria, may respond to such incentives. This may, however, not be unconnected with insecure land tenure and property rights (LTPRs), which is often cited as a barrier to the adoption of improved technology and investment in land development in Africa (Byamugisha, 2013; Liniger *et al.*, 2011).

Emerging literature evidence (Deininger, 2003; Tenaw *et al.*, 2009; Roth and McCarthy, 2013) suggests that LTPRs may be important in various ways for economic growth. First, secure LTPRs encourage increased land investment, thereby fostering capital accumulation that is important to economic growth. Second, secure LTPRs enable landowners to use their property as collateral for loans, allowing for greater access to credit, which would not only improve investments but also provide a safe haven in the event of a shock (Tenaw *et al.*, 2009). Third, generally secure LTPRs in a society tend to facilitate the emergence of more efficient land and labor markets, as well as attract foreign direct investment, both of which are critical in boosting economic growth (Roth and McCarthy, 2013). Land tenure and property rights give incentives to farmers to adopt technologies that increase their efficiencies in relation to productivity and ensure environmental sustainability (Roth and McCarthy, 2013). Similarly, Deininger (2003) noted that without secure property rights farmers often don't have the emotional attachment to the land they cultivate, and would thus not invest in land improvement that can enhance their productivity in the long run and promote sustainable development.

It is against this background that this paper[1] presents the report of a choice experiment with the focus on best scaling techniques (BWS) to assess the readiness of smallholder farmers in Nigeria to accept incentives for a shift to the CSA. This technique became increasingly popular in the area of healthcare preferences (Marley & Louviere, 2005) and is very different from traditional discrete choices, as additional information is obtained about the least preferred choice (Flynn et al., 2007). BWS consists of at least three-option choice tasks in which an individual is asked to classify the best and worst choices, with the ultimate aim of obtaining a complete ranking of items in a way that is easy for respondents to understand and can then be analyzed in different ways (Marley & Louviere, 2005). Despite the fact that traditional discrete choice experiment has been used in many environmental valuation applications, only a few studies (Greiner, 2016) use this approach for non-market valuation based on multi-attribute discrete choice data.

This study was deemed necessary for Nigeria and other developing countries experiencing declining agricultural productivity due to land degradation and other climate change-related issues, in order to empirically determine what incentives farmers will be willing to accept in order to shift to climate-smart practices (CSPs) capable of reversing land degradation, restoring ecosystem health, and enhancing livelihood outcomes. In a number of ways, the paper contributes to the ongoing debates on willingness to accept incentives and CSA in Africa's smallholder agriculture.

First, it contributes to the methodological debate on choice experiments by comparing model results from the best–worst scaling data set with results from the best choice subset to determine which of the two models produced a better result. Second, it provides new empirical evidence on the types of LTPRs that exist for agricultural lands in both Southwest and North central regions of Nigeria. Third, it offers empirical evidence on how CSA schemes, payment vehicles, intervention management, tenure types, and tenure security (title registration) influence smallholder farmers' choice of CSPs in Nigeria.

Several studies have used traditional discrete choice experiments to investigate how the willingness of the farmers in Nigeria to accept incentives for climate-smart cultivation is affected by LTPRs (Shittu *et al.*, 2018), to explore future responses of farmers to German greening of the common agricultural policy in Germany (Schulz *et al.*, 2014), and investigate farmers' preferences for drought tolerance traits and explore heterogeneity in these preferences embodied in different rice backgrounds in rural Bihar, India (Ward *et al.*, 2013), investigate Ethiopian farmers' preferences for crop variety traits (Asrat *et al.*, 2010), and explore Ethiopian potato farmers' preferences for specific contract design attributes (Abebe *et al.*, 2013). Arising from the foregoing, this paper seeks to fill the already identified gaps.

The theoretical and econometric framework underlying choice modeling in conjunction with CSPs is outlined in the following section. Section three describes the methods, which include the discrete choice experiment design, study area, key variable measurement, and data analysis method. Section four describes and discusses our findings. In the final section, we discuss the implications of our findings.

1.1 Climate-Smart Agriculture in Africa

Promoting CSA is critical for African countries. This is due to the fact that food production will need to increase by 70% by 2050 to meet the demands of a rapidly growing population and changing diets (Suleman 2017). As a result, sub-Saharan Africa's agricultural sector requires major transformation to address the multiple challenges of climate change, food insecurity and malnutrition, poverty, and environmental degradation (Nyasimi *et al.*, 2014). A variety of agricultural

[1]An earlier version of this paper, titled "Willingness to Accept Incentives for a Shift to Climate-smart Agriculture among Smallholders Farmers in Southwest and Northcentral Nigeria", was presented at the 30th International Conference of Agricultural Economists of International Association of Agricultural Economists, held in Vancouver, British Columbia, Canada from July 28 to August 2, 2018.

management solutions are available to increase crop productivity, build resilience to climate shocks, and reduce carbon emissions. Obtaining this triple win is critical to addressing Africa's food security agenda (FAO 2013; FMARD, 2014; Hou *et al*., 2016).

Nwajiuba *et al*., (2015) used Nigeria, Cameroon, and the Democratic Republic of the Congo (DRC) as case studies to critically examine the current state of CSA knowledge in Africa. They found that CSA is yet to be an explicit government policy and there are no agricultural practices defined as CSA in the three African countries mentioned earlier. However, elements of CSA are employed by farmers in Nigeria, Cameroon, and DRC, who engage in quite a number of agricultural practices despite the fact that they do not deliberately regard them as CSA practices. This assertion is based on the premise that the smallholders aim at improving productivity, build resilience against climate change, and reduce/mitigate greenhouse gases. However, some of the identified gaps in policy across the three countries include key stakeholders' engagement on national CSA dialogue, low awareness about CSA, mainstreaming CSA into national agricultural development policy to expedite holistic approach in facilitating stakeholders' engagement in the agricultural sector, building capacity, and training of the extension workers (government and private) with respect to core proficiencies in CSA using training of the trainers approach; actively engaging the youth and schools in CSA extension program strategies to widen dissemination and achieve greater impact.

Conservation agriculture, integrated crop management, organic agriculture, agricultural water management, and indigenous knowledge (local knowledge) are some of the CSA practices identified in Nigeria. Similarly in Cameroon, the CSA practices used include organic fertilizer, agroforestry, intercropping, multiple cropping and crop rotation, water harvesting, sprinkler, and drip irrigation, late planting, blocking of drainage, wood ash application, shade trees, riverbank farming, changing of planting dates, and soil conservation strategy. Identified CSA practices in DRC include soil and water conservation structures, sustainable land management practice, tree planting, and agroforestry, early-maturing varieties, mulching, fertilizer and manure application, livelihood diversification and new crops, changing of planting date.

Hou *et al*., (2016) highlight successful CSA projects in Africa. The first case study is the establishment of Climate-Smart Villages (CSVs) in Kenya. Farmers in the CSVs discovered that crop diversification will make their farms more resilient to climate change, sequester carbon while simultaneously increasing productivity and income as well as improving the soil quality. CSVs approach is all-encompassing and it has improved food security and adaptation to climate change, and also provides several options to smallholder farmers for adapting their agriculture.

The second case study focuses on incentivizing agriculture in Zambia—conservation through sustainable agricultural practices. Community Markets for Conservation (COMACO) is a rural development model that uses inputs, technologies, and markets to assist smallholders in achieving food security and increasing incomes while conserving the natural resources on which they rely. Community Markets for Conservation's premise is that if smallholders are given the right incentives and training, they will prefer sustainable agriculture practices over more destructive ones, especially if their basic food and income needs are met. COMACO sells goods at above-market prices that are produced in accordance with sustainable soil, farming, and conservation agriculture practices. Community Markets for Conservation has trained 87,000 farmers (52% of whom are women) in climate-smart and sustainable agriculture. The trained farmers now practice minimum tillage, mulching, and composting, in addition to beekeeping, dry season gardening, and poultry husbandry. The CSA practices have increased productivity and reduced conventional agriculture such as deforestation and bush fires, hence reducing greenhouse gas emissions.

The third case study is combating drought in Morocco—supporting smallholder farmers in a changing climate. Morocco is prone to drought, and climate change is already resulting in higher temperatures and lower and more unpredictable rainfall. This has implications for the agricultural sector, which is critical to the country's demographic and socioeconomic situation. Water management is crucial under drought conditions and climate change. In irrigated areas, the

Plan Maroc Vert (PMV) and the related National Irrigation Water-Saving Program promote improved water service and the adoption of more efficient irrigation technologies. As a result, water is provided when it is best for crop needs, and can be used by small farmers more effectively and efficiently. In rainfed areas, the PMV promotes—among others—the transition from cereals to tree crops: olive trees are well adapted to drought, provide a higher return to small farmers, and are less at risk of year-to-year fluctuations than annual crops especially when practices like rainwater harvesting are put in place.

Mutoko (2014) classified the broad factors influencing the adoption of CSA practices as socio-economic and cultural barriers, as well as policy and institutional frameworks. They discovered that composting and biogas adoption is low in Kaptumo, which was attributed to the type of farming system and availability of resources such as small quantities of manure and high labor demand. The farmer trainers pointed out that the county's open grazing system makes collecting scattered fresh cow dung labor intensive. Addressing this challenge would imply the need for farmers in that area to shift to a zero-grazing system which will be too costly to establish for most of the smallholder farmers. The main limitation of the use in agroforestry and fodder trees is the availability of seeds/seedlings, as described in the household survey and the focus group discussions. Men are generally the *de facto* landowner and the primary decision maker for allocating land to family members for various uses. Given that tree planting is viewed as defining one's piece of land, the challenge is real for women, sons, and daughters who took part in the project to embrace agroforestry and fodder trees. This is due to a lack of authority to make such decisions for the household head, who may or may not have participated in project activities.

Emphasizing the policy and institutional frameworks that affect the adoption of CSPs, Mutoko (2014) stated the need for a policy framework that clearly specifies the terms and conditions of how smallholders who have adopted CSA practices such as agroforestry can benefit from carbon credit schemes. Similarly, existing agricultural extension services need to be strengthened and extension workers' capacity built, in particular, on promising CSA practices. Many public institutions face resource constraints when it comes to service delivery; however, the innovative farmer trainers' approach is capable of making the extension delivery systems more efficient and more effective. The farmer trainers' approach would ensure the sustainability and scale-out of climate-smart activities in this and other areas if integrated into the mainstream of extension delivery systems properly (Kiptot *et al.*, 2011). The adoption rate of CSA practices can be accelerated through effective partnership and collaboration with other interested organizations in the county.

2. Theoretical Framework and Modeling

The random utility theory is the basis for the discrete choice experiment and best–worst scaling; therefore, the models for the two methods are similar with the exception of additional information that is included in the BWS method. The central premise of random utility theory is that decision makers maximize their utility by selecting their preferred alternative from a set of alternatives (Luce, 1959; McFadden, 1974; Shen, 2006).

The real utility of an alternative for a farmer i cannot be observed; however, it could be seen as consisting of systematic component, V and an error (random) component, ε which is independent of the systematic part and follows a predetermined distribution (McFadden, 1974; Hanemann *et al.*, 1991).

$$U_{ikn} = V_{ikn} + \varepsilon_{ikn} \tag{1}$$

Thus, a farmer i will choose an alternative k from a specific choice set, n, given the utility of U, if the utility of farmer i making a choice of an alternative k from a specific choice set, n (U_{ikn}) is greater than the utility of any other alternative j in choice set n:

The probability of farmer i choosing the alternative k is

$$P_{ikn} = Pr\left(U_{ikn} > U_{ijn}\right)\forall_j \neq k \tag{2}$$

$$U_{kn} > U_{jn} \rightarrow V_{kn} + \varepsilon_{kn} > V_{jn} + \varepsilon_{jn}\ \forall_j \neq k; k, j \in J \tag{3}$$

V is, therefore, the explainable proportion of the variance in choice while ε is the unobservable part. The random utility model assumes that an individual acts rationally and chooses the choice that provides the highest degree of satisfaction, implying that the person is maximizing his utility. In addition, the above-mentioned choice procedure is interpreted with error terms following Gumbel distribution by both discrete choice experiment and best–worst scaling technique.

3. Method

3.1. Survey Design

Analyzing discrete choice data entails the design of an experiment to investigate the influence of various attributes of the alternatives on the preferred choice. The choice experiment design process, according to Hensher *et al.*, (2005) and Louviere *et al.*, (2000), begins with identifying the problem and defining the objectives of the experiment. Answers to the following questions will help you gain a better understanding of the problem:

1. What are the possible alternatives, that is, other options that could have been taken into account by the respondent instead of making the choice?
2. What characteristics do the existing alternatives have?
3. What are the most likely factors influencing the demand for such alternatives?
4. Who is the intended audience?

According to Louviere *et al.*, (2000) and Hensher *et al.*, (2005), generic[2] AP-CSAPs were presented to respondents, who were asked to select the best and worst alternatives, which differed in terms of the levels at which the attributes were presented, with a *status quo* option to be exhaustive. The response format was a multi-profile best–worst scaling technique (Flynn and Marley 2012). The BWS is structured to provide a complete ranking of all alternatives present in an option range, whereas the conventional discrete choice experiment format only shows the first preference among the alternatives. BWS provides a way to augment data and is particularly useful in situations where the number of choice tasks needs to be minimized by providing choice data in addition to the first preference (Potoglou *et al.*, 2011; Lancsar *et al.*, 2013). It differs mainly from traditional DCEs because it receives additional information about the least preferred option (Flynn, 2010). BWS has also proven to be superior when dealing with qualitative data, such as various conservation criteria and monitoring arrangements (Flynn *et al.*, 2007).

There is no standard method for selecting attributes, as established in the literature (Bennett & Blamey, 2001; Bateman *et al.*, 2002), but the attributes should be relevant to policy makers and meaningful to respondents. As a result, the attributes and attribute levels for this study were determined through a multistage process that included literature reviews, direct questioning, and interviews with key stakeholders such as crop specialists and extension agents, among others. The carbon price was included as part of the attribute so that willingness to accept could be estimated.

The experiment was performed in conjunction with interviews to determine the farmers' land-use preferences, trade-offs, and WTA incentives to move from their current farming system to one of a collection of context/crop-specific AP-CSAPs, based on the above discrete choice experimental design. In addition to the importance of restoring soil health, AP-CSAPs have

[2]That is, that no additional branding was given to the alternatives.

Table 1. Attributes and levels of Climate-Smart Practices for smallholder farmers

Attributes	Levels
CSA scheme	Agroforestry; GAPs with manure; GAPs without manure
Intervention management	Government; Non-governmental organizations (NGOs); Community Development Association (CDA); Private Companies
Mode of payment	100% in Cash; 100% in Kind; Both (50% in Cash and 50% in Kind)
Carbon price (US\$/tCO_2 equivalent)	10; 20; 30; 40; 50

the potential to sequester carbon, help farmers to build resilience to climate change, and increase productivity. The presented AP-CSAPs include agroforestry and the adoption of GPAs with or without manure application. The GAPs include the use of Zero/Minimum tillage, retaining/incorporating refuse on the soil rather than burning it, and Integrated Water, Pest, and Fertility Management—including microdosing of fertilizer when absolutely necessary.

Using the FAO Ex-Ante Carbon Balance Tool (Ex-Act), we estimated the carbon sequestration potentials of shifting to a CSA option versus not using any CSA with CSA potentials under various climate and soil conditions in Nigeria. To offer a project period of 30 years, we set the implementation phase at 10 years and the capitalization phase at 20 years. In determining the incentives offered to farmers, the estimated carbon sequestration potentials were valued at carbon prices ranging from US\$10/tCO_2 equivalent to US\$50/tCO_2 equivalent. This was based on the World Bank Carbon Pricing Watch (World Bank and ECOFYS 2016), which estimated global carbon prices as of April 1, 2016, to be between US\$6/tCO_2 equivalent and US\$53/tCO_2 equivalent.

Table 1 shows the choice attributes of concern and their levels. Using the orthogonal design procedures in the Statistical Package for Social Scientists (SPSS) version 17, these were combined into profiles (i.e., options presented in the choice sets). This method produces a compact collection of profiles that are small enough to fit into a survey but broad enough to determine the relative value of each attribute. The orthogonal main effects design framework enables statistical testing of multiple attributes without requiring testing of each grouping of attribute levels.

In the context of this study, two series of orthogonal main effect designs, each comprising 25 profiles, were generated in two sets per crop/context-specific scenario and the tasks presented to respondents were randomly combined with the *status quo* (e.g., Table 2). This procedure yielded 25 task sets, which were divided into five blocks of five tasks each, and was presented sequentially to all respondents. The blocks were assigned to respondents at random in a systematic manner: the first respondent to be interviewed receives tasks in Block A, the second B . . . , and the fifth E. The cycle was repeated for respondents 6–10, 11–15, and so on. In any given choice task, respondents were asked to select the most preferred options and then indicate which option was less preferred than the second preferred option. This BWS format allowed for the ranking of all AP-CSAPs alternatives and the *status quo*. It is worth noting that the incentive (Table 2) is calculated by multiplying the carbon price by the potential carbon that will be sequestered by each of the CSA schemes.

3.2. The Study Area

The research was conducted in selected farming communities in Nigeria's two GPZs (Southwest and North central). Nigeria is located in West Africa, between the longitudes of 3° and 14° and the latitudes of 4° and 14°. It has a land area of 923,768 square kilometers. Nigeria is bordered on the west by the Republic of Benin, on the east by Chad and Cameroon, and on the north by Niger. Its coast faces the Gulf of Guinea in the south and Lake Chad in the northeast. The study area includes 12 of Nigeria's 36 states as well as the Federal Capital Territory, which are divided into

Table 2. Typical tasks presented to respondents

LAC-MOIST Regions—Northern and Southern Guinea as well as Derived Savannah Zones									
Task	Option	CSA Scheme	Management	Mode	C. Price (US$/$tCO_2$)	C. Seq. (tCO_2/ha)	Incentives ($/ha/year)	Incentives (N/ha/year)	Rank
Block A: Tasks 1–5									
1	A	*Status quo*	None	None	0	–	–	–	
	B	Agroforestry	Government	Cash	40	4.5	180	54,979	
	C	GAPs with manure	Government	Cash	30	2.2	66	20,159	
2	A	*Status quo*	None	None	0	–	–	–	
	B	Agroforestry	Government	Kind	30	4.5	135	41,234	
	C	GAPs without manure	Government	Kind	50	1	50	15,272	
3	A	*Status quo*	None	None	0	–	–	–	
	B	GAPs with manure	NGOs	Both	40	2.2	88	26,879	
	C	GAPs without manure	Private	Kind	30	1	30	9,163	
4	A	*Status quo*	None	None	0	–	–	–	
	B	Agroforestry	Government	Kind	30	4.5	135	41,234	
	C	GAPs with manure	Government	Cash	30	2.2	66	20,159	
5	A	*Status quo*	None	None	0	–	–	–	
	B	Agroforestry	CDA	Both	10	4.5	45	13,745	
	C	GAPs without manure	Private	Both	10	1	10	3,054	

Note: Official exchange rates at the time of the study were an average of N305.44/US$1.

4 agro-ecological zones: rain forest, mid-altitude, derived, and southern Guinea Savannah all of which are suitable for maize and rice, as well as other crops such as cassava, yams, and others. Nigeria comprises 36 Federal States and the territories of the Federal Capital. The states are usually divided into six (6) geographical zones: the northeast, the northwest, the north central, the southwest, and the south–south. The Hausa–Fulani's, Nupe, Gwari Tiv, and Igalas are indigenous to the North central states, while the Yorubas are indigenous to the Southwest. In 2015, the estimated human population was 191.8 million, 29% of which were Hausa–Fulani's and 21% Yoruba's.

3.3. Study Design

The research was conducted as part of the FUNAAB-RAAF-PASANAO project, which was funded by the Economic Community of West African States and carried out by the Federal University of Agriculture, Abeokuta (FUNAAB) in collaboration with the National Cereals Research Institute, Baddegi. The focus was on encouraging the adoption of CSA practices in cereals production in Nigeria. The respondents were selected in a three-stage sampling process, described as follows:

Stage I: Purposive selection of seven states that have been the leading rice and maize producers in Southwest and North central Nigeria based on production statistics from (National Bureau of Statistics [NBS], 2016).

Stage II: Purposive selection of Three Agricultural Blocks per crop from the state's main rice and maize production areas, as well as two Extension Cells per block, for a total of 12 Cells and 84 Cells.

Stage III: In each of the selected cells, a proportionate stratified random selection of 5–10 rice and maize farmers from members of the maize and rice farmers' associations.

This process resulted in 542 maize and rice farmer households, from which a full data set was compiled through personal interviews with the farmer and other family members. Data on a wide range of topics were collected, including household socioeconomics, land-use choices, and ecosystem service valuation, as well as LTPRs on farmland cultivated during the 2016/2017 farming season.

3.4. Method of Data Analysis

The data were analyzed using a combination of descriptive and econometric techniques. Data from the household survey, land acquisition, and key rights held were analyzed using descriptive statistical methods to generate frequencies and percentages. Data on WTA incentives for shifting to CSA schemes, as well as the influence of land titling and tenure type on this, were analyzed using the rank-ordered regression method.

3.4.1. Measurement of Land Tenure and Property Rights

Two measures were used to determine farmers' LTPRs in this study. They include:

(i) **Tenure Type**: This was measured on a nominal scale using three dummy variables—Freehold, Leasehold, and Communal—with one indicating that the right to use the parcel of land was obtained by direct inheritance and/or outright purchase for freehold, leased or rented for leasehold, and joint ownership with extended family or other community members for communal. Otherwise, the dummy variables were given a value of zero.

(ii) **Tenure security (legal):** A tenure was considered *de jure* secured if the parcel was surveyed and properly registered with the Land Registry; otherwise, it was considered unsecured. This variable was designed to evaluate the significance of title registration.

3.4.2. Econometric Model

In marketing research, the rank-ordered logit (ROL) model is also known as the exploded logit model (Punj and Staelin 1978) and the choice-based conjoint analysis model (Hair *et al*., 2010). The ROL analytical framework is one of the extensions of the multinomial logit model and was chosen because respondents rank the alternatives rather than simply selecting the best option from a set of alternatives presented to them. The maximum likelihood approach is used to estimate the model coefficients and the ROL model is specified in equation 4 as follows:

$$\text{Let } U_{ikn} = \beta_i' \mathrm{X}_{\mathrm{ikn}} + \varepsilon_{\mathrm{ikn}} \tag{4}$$

for $j = A, \ldots, C$ with ε_{ikn} independently identically distributed, iid with an extreme value distribution.

Where

U_{ikn} = utility that farmer i would obtain from choosing alternative k.

X_{ikn} = observable attributes of alternative k to farmer i for each choice scenario n.

β_i = is a vector of coefficients of these variables for farmer i, which represents the farmer's taste.

ε_{ikn} = unobservable component of utility accruing to farmer i from alternative k.

Table 3. Definitions of study variables and their descriptive statistics

Variable	Description	Descriptive Statistics Minimum	Maximum	Mean	Std. Dev.
Outcome variable					
Best choice	Dummy	0	1	0.33	0.47
Ranked choice	Ranked	1	3	2.00	0.82
CSA attributes					
Incentive (Naira)	Continuous	0	220,000.00	24,574.58	36,010.85
GAPs without manure	Dummy	0	1	0.27	0.44
GAPs with manure	Dummy	0	1	0.27	0.44
Agroforestry	Dummy	0	1	0.13	0.34
Community development association	Dummy	0	1	0.12	0.33
Non-governmental organization	Dummy	0	1	0.13	0.34
Private institution	Dummy	0	1	0.14	0.35
Payment in kind	Dummy	0	1	0.29	0.45
Payment made in Cash and Kind	Dummy	0	1	0.14	0.35
CSA attributes with LTPRs interactions					
GAPs without manure × Freehold	Dummy	0	1	0.16	0.35
GAPs with manure × Freehold	Dummy	0	1	0.16	0.35
Agroforestry × Freehold	Dummy	0	1	0.08	0.25
GAPs without manure × Leasehold	Dummy	0	1	0.08	0.24
GAPs with manure × Leasehold	Dummy	0	1	0.08	0.24
Agroforestry × Leasehold	Dummy	0	1	0.04	0.19
Agroforestry × Communal	Dummy	0	1	0.01	0.09
GAPs without manure × Communal	Dummy	0	1	0.02	0.13
GAPs with manure × Communal	Dummy	0	1	0.02	0.13
GAPs with manure × Land titling	Dummy	0	1	0.04	0.17
GAPs without manure × Land titling	Dummy	0	1	0.03	0.16
Agroforestry × Land titling	Dummy	0	1	0.02	0.12

The trade-off (marginal rate of substitution) of one attribute in terms of another was calculated using the estimated parameters in the empirical model. One important trade-off is that of the bid and one of the other attributes. The WTA for attribute z is obtained by dividing the parameter's value δ_z with the bid parameter (i.e., $\delta_z/\delta_{incentive}$); where the parameter δ_z are marginal utilities of the attributes. Table 3 shows the outcome variables of interest as well as the sets of regressors used in the study.

4. Results and Discussion

4.1. Socioeconomic Characteristics of the Smallholder Farmers

Table 4 summarized the socioeconomic background of 542 farmers who provided the entire data set used in this study as a background for subsequent analyses. According to Table 4, the average

Table 4. Socioeconomic characteristics and percentage in the sample (n = 542)

Socioeconomic characteristics	Percentage
Age (mean = 46 years)	
Less than or equal to 30	10.02
31–50	49.91
51–60	20.04
Above 60	20.04
Gender	
Male	93.14
Female	6.86
Marital status	
Married	80.71
Single	17.63
Widow/Divorce	1.67
Education (mean = 9 years)	
No formal education	26.04
Arabic	0.21
Primary	15.63
Secondary	34.58
Tertiary	23.54
Household size (mean = 7 persons)	
1–5	42.92
6–10	42.5
11–15	10.21
Above 15	4.38
Access to extension	
Yes	46.04
No	53.96
Geopolitical zone	
North central	50.65
Southwest	49.35

Source: Field survey; 2017.

cereal crop farmer in the study area is around 46 years old, has 9 years of schooling, is 7% likely to be a female, and is 81% likely to be married. The average household had seven (7) members. During the 2016/2017 farming season, the 542 farmers whose data were used in this study provided plot-level information on a total of 1,810 parcels of land that were cultivated by members of their farm households. The characteristics of the farmland in terms of size, mode of acquisition, property rights enjoyed by households on those lands, and registration status on those parcels are summarized in Table 5.

Table 5. Distribution of cultivated parcels by title registration and tenure types

Land Variables	North Central	Southwest	All
Farm size (Ha)	1.46	1.50	1.49
Lowland (%)	50.68	19.01	42.45
Acquisition Mode (%)			
Inherited	56.07	26.78	48.46
Purchase	8.57	12.96	9.71
Leasehold	28.45	50.54	34.19
Communal	6.90	9.72	7.64
Right Held (%)			
Restrict others	82.25	52.92	74.62
Grow tree crop	67.91	58.75	65.52
Develop	63.13	57.02	61.54
Lease out	61.61	53.35	59.46
Sell	54.32	51.62	53.62
Bequeath	52.88	46.44	51.21
Land Survey	24.13	21.60	23.47
Agency Registered With (%)			
Not registered	73.76	80.65	76.85
Traditional	18.00	7.96	13.50
Local government	4.91	5.16	5.02
State	3.33	6.23	4.63

Source: Field Survey; 2017.

Table 5 depicts the distribution of 1,810 cultivated parcels in the Suthwest and North central geopolitical areas in Nigeria by title registration, tenure, and property rights characteristics among smallholder farmers. The plot size was 1.49ha on average. The proportion of land acquired through inheritance was extremely lower for the southwest (26.78%) as opposed to that of north central (56.07%). On the contrary, the smallholder farmers in the southwest (50.54%) tend to cultivate more leased land when compared to their north central counterparts (28.45%). In addition, about 9.71% and 7.64% of the sampled farmers cultivated farmland acquired through outright purchase and communal means.

In terms of key rights, the majority of respondents across the study area have the ability to exclude others from their farm (74.62%), grow tree crops (65.52%), and develop their plots further (61.54%) by investing in an irrigation scheme, while approximately half of them may either sell or transfer their land to the next generation. Also, 23.47% of the farmers' farmlands were duly surveyed with about 4.63% of the cultivated parcels registered with the state government, as well as only 3.33% and 6.23% of the parcels registered in both north central and southwest, respectively. This implies that only a few out of the sampled smallholder farmers had *de jure* tenure security while the majority had insecure tenure which can lead to eviction from their farmland and regular harassment by the land grabbers. The result is closely in line with the findings of Ghebru *et al.*, (2014) and Birner and Okumo (2012) who found that only 3% of the land in Nigeria is formally registered. It is worth noting that the right-held variables are not mutually exclusive, hence the reason for the values not summing to 100%.

Table 6. Best–worst scores of the CSA attributes by intervention management

CSA Attributes	Best Choice (Mean)	Worst Choice (Mean)	BWS Score	BWS Ratio
Agroforestry	0.52	0.17	0.35	3.11
CDA	0.45	0.17	0.28	2.67
Government	0.59	0.16	0.42	3.62
NGOs	0.39	0.16	0.23	2.37
Private	0.57	0.18	0.39	3.19
GAPs with manure	0.45	0.15	0.30	2.94
CDA	0.52	0.12	0.40	4.35
Government	0.40	0.18	0.22	2.22
NGOs	0.53	0.11	0.42	4.82
Private	0.41	0.20	0.21	2.07
GAPs without manure	0.26	0.26	0.00	1.01
CDA	0.39	0.18	0.21	2.15
Government	0.21	0.30	-0.09	0.70
NGOs	0.41	0.21	0.20	1.91
Private	0.17	0.28	-0.11	0.61
Status quo	0.22	0.60	-0.38	0.37

Source: Field survey; 2017.

4.2. Best–Worst Scores of the Smallholder Farmers

The best–worst scenarios of CSA attributes in combination with the intervention management and mode of payment are shown in Tables 6 and 7, respectively. The results show that agroforestry, GAPs with manure, and GAPs without manure are of most concern to about 52%, 45%, and 26% of the sampled smallholders, respectively. It is important to note that less than 20% of the respondents see agroforestry and GAPs with manure as the issue of least concern in the study area with 60% of the smallholder farmers ranking the *status quo* (conventional practice) as their worst choice. This implies that the farmers are willing to embrace AP-CSAPs. Agroforestry with government as the intervention management is chosen as the best choice in 59% of the cases followed by when it is managed by private organizations. Good agricultural practices with (53%) and without manure (41%) application tend to be of most concern to the farmers when managed by the NGOs. Similarly, Table 7 shows that agroforestry with incentive received in kind (57%), GAPs with manure when the incentive is given in both cash and kind (55%) as well as GAPs without manure when the incentive is received as a cash payment (32%) are of great concern to the farmers.

4.3. Hausman Specification Test

Given the study data, the Hausman test (Table 8) was used to see whether the unrestricted model (full ranking data) is superior to the restricted model (most preferred alternatives) or not. All studies and experiments were carried out in Stata 16 using the appropriate procedures.

As noted in Stata 16 documentations, the Hausman is a general implementation of Hausman's (1978) specification test, which compares an estimator $\hat{\theta}_1$ that is known to be consistent with an estimator $\hat{\theta}_2$ that is efficient under the assumption being tested. The null hypothesis states that the estimator $\hat{\theta}_2$ is an efficient (and consistent) estimator of the true parameters. There should be no

Table 7. Best–worst scores of the CSA attributes by mode of payment

CSA Attributes	Best Choice (Mean)	Worst Choice (Mean)	BWS Score	BWS Ratio
Agroforestry	0.52	0.17	0.35	3.11
Cash and Kind	0.48	0.17	0.31	2.84
Cash	0.47	0.17	0.29	2.70
Kind	0.57	0.16	0.41	3.51
GAPs with manure	0.45	0.15	0.30	2.94
Cash and Kind	0.55	0.09	0.46	6.20
Cash	0.46	0.17	0.29	2.66
Kind	0.39	0.17	0.22	2.30
GAPs without manure	0.26	0.26	0.00	1.01
Cash and Kind	0.25	0.26	0.00	0.98
Cash	0.32	0.24	0.08	1.32
Kind	0.22	0.27	−0.05	0.81
Status quo	0.22	0.60	−0.38	0.37

Source: Field survey; 2017.

systematic difference between the two estimators if this is the case. If the estimates differ in a systematic way, the assumptions on which the efficient estimator is based should be questioned. Table 8 shows that the null hypothesis of no systematic difference between the two estimators is rejected at the 1% level, implying that the unrestricted model outperforms the restricted model. As a result, we believe that an evidence-based full-ranking model is efficient and reliable, making it suitable for policy analysis.

4.4. Willingness to Accept Incentive to Shift to Climate-Smart Schemes

Table 8 shows the results for both the best–worst and first choice models. The estimation included eight thousand one hundred thirty selected observations (542 respondents, 15 choice sets each). At the 1% level, the coefficients associated with the size of the incentive were positive and significant. This implies that the higher the incentive provided to farmers, the more likely the farmer will be willing to abandon the *status quo* and invest in CSA schemes. This is consistent with the findings of Schulz *et al.*, (2014), who discovered that higher payment increased the likelihood of preferring greening to the “do nothing” alternative.

4.5. Influence of CSA Scheme, Mode of Incentive Payment, and Management

The coefficients of GAPs with and without manure application were significantly positive at a 1% level. This result shows that stronger preference was given to GAPs with manure followed by GAPs without manure in the best–worst model. This finding suggests that the smallholder farmers were willing to shift to GAPs with and without manure as against the *status quo* indicating their favorable disposition to CSA schemes. This shows that the farmers assign a higher value to both GAPs with and without manure application as opposed to the *status quo*. Despite the scarcity and higher cost of manure application relative to investing in other measures to combat land degradation, GAPs with manure were still given stronger preference and highest priority by the farmers in the study area.

Table 8. Estimated best–worst models results and Hausman Specification Test Results

	Ranking		Best Choice		Hausman Specification Test Results			
Parameters	Coef.	z	Coef.	z	Choice (b)	Ranking (B)	Difference (b-B)	Sqrt (diag (V_b–V_B)) S.E.
Incentive	5.23E-06***	8.00	8.15E-06***	10.17	8.15E-06	5.23E-06	2.93E-06	4.65E-07
GAPs without manure	0.6171***	3.86	0.1736	0.77	0.1736	0.6171	−0.4435	0.1580
GAPs with manure	0.8630***	5.48	0.3916*	1.91	0.3916	0.8630	−0.4714	0.1310
Agroforestry	0.1407	0.73	−0.3931	1.58	−0.3931	0.1407	−0.5338	0.1565
Community development association	0.3220***	6.57	0.4276***	6.52	0.4276	0.3220	0.1057	0.0435
Non-governmental organization	0.3175***	6.52	0.4207***	6.56	0.4207	0.3175	0.1032	0.0418
Private organization	−0.0974**	−2.10	−0.2344***	−3.38	−0.2344	−0.0974	−0.1370	0.0516
Payment in Kind	−0.028	−0.73	−0.1065**	−2.01	−0.1065	−0.0280	−0.0785	0.0365
Payment in Cash and Kind	0.1375***	2.97	0.0912	1.46	0.0912	0.1375	−0.0463	0.0421
GAPs without manure × Freehold	0.0249	0.15	−0.2948	−1.27	−0.2948	0.0249	−0.3196	0.1650
GAPs with manure × Freehold	0.1556	0.97	0.0881	0.43	0.0881	0.1556	−0.0675	0.1306
Agroforestry × Freehold	0.7580***	4.00	0.8142***	3.41	0.8142	0.7580	0.0562	0.1458
GAPs without manure × Leasehold	0.0661	0.40	−0.2203	−0.93	−0.2203	0.0661	−0.2864	0.1687
GAPs with manure × Leasehold	0.0236	0.14	−0.0819	−0.39	−0.0819	0.0236	−0.1055	0.1328
Agroforestry × Leasehold	0.3778**	1.97	0.2321	0.96	0.2321	0.3778	−0.1458	0.1454
Agroforestry × Communal	1.5606***	5.37	1.7115***	4.68	1.7115	1.5606	0.1509	0.2217
GAPs without manure × Communal	0.6170***	2.61	0.4876	1.41	0.4876	0.6170	−0.1294	0.2532
GAPs with manure × Communal	0.7248***	3.05	0.7726**	2.45	0.7726	0.7248	0.0477	0.2062
GAPs with manure × Land titling	0.1902	1.26	−0.1146	−0.61	−0.1146	0.1902	−0.3048	0.1096
GAPs without manure × Land titling	0.3002**	1.99	0.1671	0.80	0.1671	0.3002	−0.1331	0.1439
Agroforestry × Land titling	0.3055	1.59	−0.0664	−0.29	−0.0664	0.3055	−0.3719	0.1251
Df	21		21				20	
LR chi Sq.	1532.01		690.77				418.75	
Log likelihood	−6529.96		−3970.58					
Prob chi Sq.	0.00		0.00				0.00	

The coefficient of community-based association and non-governmental organizations managed schemes were significant and positive at 1% level, respectively, while the coefficient of private-managed schemes was negative and significant at 5% level. The results indicate that farmers preferred CDA and NGOs-managed schemes over other project management, and they would also prefer government-based institutions (*status quo*) over the private sector, possibly because they did not trust them enough to provide effective services. As a result, project management by either the CDA or NGOs will increase the likelihood of farming households investing in CSA schemes. This finding supports the findings of Shittu *et al*., (2018) that there was clear discord with the PES schemes managed by the private sector in relation to the schemes managed by the public sector.

Focusing on preferences for mode of incentive payments in Table 8, the coefficient of cash and kind payment was positively significant at a 1% level while the result was not significantly different from zero for payment made in kind. The possibility of farmers receiving an incentive in cash and in-kind increased significantly the likelihood of shifting to CSA schemes among the smallholder farmers as against the reference category of cash payment.

4.6. Main Effects Interacting with Tenure Type and Land Titling

To examine the influence of tenure type and land titling on farmers' preferences for CSA schemes, the level of these factors were interacted with CSA schemes. The result (Table 8) shows that farming households with GAPs with and without manure when interacted with the land acquisition by freehold and leasehold, were not significantly different from zero. However, GAPs with and without manure application on communal land significantly and positively influence the preference for CSA scheme at 1% level, respectively. This implies that tenure type is important for a shift to the CSA scheme and that having a secure tenure to make a medium to long-term investment on the land will enable the smallholder farmers to recover their returns from the land. This result is in agreement with the findings of Roth and McCarthy (2013) who opined that secure land tenure provides incentives for farmers to invest and make improvements to their land to ensure full utilization of land

Similarly, agroforestry when interacted with land acquired by freehold and leasehold positively and significantly influence the preference for CSA schemes at 1% and 5% levels, respectively. Thus, farming households attribute a stronger preference to cultivating agroforestry on land acquisition by freehold followed by a strong preference for cultivating agroforestry on communal with the establishment of agroforestry on leased lands having the lowest preference. This implies that smallholder farmers will only agree to embrace agroforestry provided the farmland is acquired through freehold and/or leasehold means. Similarly, land titling was only important to promote a shift to GAPs without manure at a 5% level, while it was not significantly different from zero for other CSA schemes—most likely because the majority of those who registered land are elites (possibly, land grabbers) whose main mission is to sell it at a premium later. This finding is in line with the finding of Besley (1995) and Nigussie *et al*., (2017) who found that secure tenure enhanced agricultural investments in Ghana and Ethiopia, respectively.

4.7. Willingness to Accept Incentives for a Shift to CSA Schemes

Table 9 shows the willingness to accept (pay) based on parameter estimates from the unrestricted model in Table 8. The results reveal that an average farmer is willing to accept \$88, \$540, and \$386 per hectare per annum to embrace agroforestry, GAPs with and without manure, respectively, in the study area. In a case where any of the CSA schemes is managed by CDA and NGO, the farmers are willing to accept \$201 and \$198 per hectare each year, respectively. On the contrary, the farmers are willing to pay (give up) \$61/ha/annum if the CSA scheme will be managed by the private organization, implying they will prefer the CSA scheme to be managed

Table 9. Willingness to accept (pay)[1] incentives for a shift to CSA options

	Marginal WTP		Lower limit		Upper limit	
Attribute/Factor	Naira	US$	Naira	US$	Naira	US$
GAPs without manure	(118,087.37)	(386.61)	(49,787.47)	(163.00)	(186,387.27)	(610.23)
GAPs with manure	(165,134.30)	(540.64)	(88,444.98)	(289.57)	(241,823.61)	(791.72)
Agroforestry	(26,923.66)	(88.15)	47,883.44	156.77	(101,730.76)	(333.06)
Community development association	(61,609.38)	(201.71)	(40,100.18)	(131.29)	(83,118.57)	(272.13)
Non-governmental organization	(60,753.96)	(198.91)	(38,626.06)	(126.46)	(82,881.86)	(271.35)
Private organization	18,644.42	61.04	35,967.57	117.76	1,321.27	4.33
Payment in Kind	5,354.42	17.53	19,806.89	64.85	(9,098.05)	(29.79)
Payment in Cash and Kind	(26,311.21)	(86.14)	(8,547.16)	(27.98)	(44,075.26)	(144.30)
GAPs without manure × Freehold	(4,758.87)	(15.58)	56,511.67	185.02	(66,029.42)	(216.18)
GAPs with manure × Freehold	(29,767.47)	(97.46)	30,763.88	100.72	(90,298.82)	(295.64)
Agroforestry × Freehold	(145,042.65)	(474.86)	(67,349.53)	(220.50)	(222,735.77)	(729.23)
GAPs without manure × Leasehold	(12,651.58)	(41.42)	50,043.93	163.84	(75,347.08)	(246.68)
GAPs with manure × Leasehold	(4,521.21)	(14.80)	56,924.78	186.37	(65,967.19)	(215.97)
Agroforestry × Leasehold	(72,300.47)	(236.71)	1,597.77	5.23	(146,198.70)	(478.65)
Agroforestry × Communal	(298,620.32)	(977.67)	(170,004.19)	(556.59)	(427,236.46)	(1,398.76)
GAPs without manure × Communal	(118,072.91)	(386.57)	(24,920.84)	(81.59)	(211,224.99)	(691.54)
GAPs with manure × Communal	(138,698.94)	(454.10)	(43,719.08)	(143.13)	(233,678.79)	(765.06)
GAPs with manure × Land titling	(36,392.27)	(119.15)	20,671.34	67.68	(93,455.87)	(305.97)
GAPs without manure × Land titling	(57,452.28)	(188.10)	784.88	2.57	(115,689.44)	(378.76)
Agroforestry × Land titling	(58,450.98)	(191.37)	14,765.19	48.34	(131,667.15)	(431.07)

Note: Figures in parentheses are WTAs, i.e., (WTA = WTP).
[1]The WTA is at 95% confidence interval.

by the government. Estimated willingness to accept values per hectare/year for an average farmer that integrated agroforestry on freehold, leasehold, and communal land are $474, $236, and $977, respectively. Similarly, smallholder farmers that cultivate agroforestry, GAPs with and without manure on titled land are willing to accept $191, $119, and $181 per hectare per year, respectively, as incentives to shift to CSA schemes. Evidence from Shittu (2017) shows that the annual revenue per ha for an average maize and rice farmer in Nigeria is US$1,508 and US$1,861, respectively. Situating the WTA result in the context of annual revenue per hectare for an average farmer in the study area, we wish to state the WTA values for CSA schemes are realistic as the incentive is meant to support the farmers knowing full well that implementing agricultural practices with CSA potentials, in most cases, involves upfront investments that take time to bring about gains in productivity.

5. Conclusion and Policy Implications

Using the best–worst scaling technique, this study added to the literature on smallholder farmers' preferences for shifting to CSA in Nigeria. Land tenure and property rights were examined on a plot-by-plot basis and are summarized as farmland characteristics in terms of size, mode of acquisition, property rights enjoyed by households on those lands, and the status of registration (*de jure*) on those parcels. The average parcel size was 1.49ha, with approximately 48.46% and 9.71% parcels held by inheritance and purchase, respectively, 34.19% held by leasehold, and 7.64% held by communal land. However, LTPRs results show that only 23.47% of the plots were surveyed while only 4.63% had their title registered with the State Land Registry.

The policy implications from this study are stated as follows:

i. Government, private institutions, and relevant international agencies should make the incentives available to the farmers in form of payment for ecosystem services and/or conditional cash transfer so as to increase their willingness to shift from their current practice to CSA schemes.
ii. The smallholder farmers were willing to shift to the CSA scheme as against the *status quo*. Hence, the need for both Federal and State governments to pay proper attention to the moribund extension services in Nigeria such that there will be a reawakening of the extension services through adequate funding of the agricultural development program, as well as capacity building of the agricultural extension officers to demonstrate the CSA practices and principles to the farmers using experimental management plots.
iii. Secure tenure enhances medium to long-term investment on the land and also increases farmers' willingness to embrace CSA schemes. Therefore, policy measures that will focus on a more effective and efficient land title registration system should be established by the government. The policy should also aim at removing the bottlenecks in the land market and enhancing individual tenure security.
iv. An average farmer is willing to accept $88, $540, and $386/ha each year to embrace agroforestry, GAPs with and without manure, respectively. The farmers are willing to accept smaller payments for agroforestry and GAPs without manure, hence, policy directed toward the adoption of CSA schemes in Nigeria should focus mainly on agroforestry and GAPs without manure application.
v. Project management by CDA or NGOs would increase the probability of farming households investing in CSA schemes, thus, all the relevant stakeholders needed to implement the CSA scheme in Nigeria should be brought on board.

It is pertinent to note that one of the limitations of this study is that currently, there is no PES in Nigeria and most parts of sub-Saharan Africa, we have to rely on existing literature in Europe and North America to arrive at our carbon prices. Given that the carbon price was between US$1 and US$153, we removed the extreme values and we believed that this limitation would not affect our results. Despite this limitation, we believe that our research has made significant contributions to the body of knowledge on the subject.

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Authors' contribution. Adebayo M. Shittu: Conceptualization, methodology, project administration, supervision, formal analysis, and writing (review and editing).
Mojisola O. Kehinde: Conceptualization, data curation, formal analysis, investigation, methodology, writing (original draft), and writing (review and editing).
Abigail G. Adeyonu: Writing (review and editing) of the manuscript.
Olutunji T. Ojo: Writing (review and editing) of the manuscript.

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Data availability statement. The data will be made available on request.

Ethical standards. We agree upon standards of expected ethical behaviour for all parties involved in the act of publishing. Our paper presents an accurate account of the work performed and an objective discussion of its significance. Underlying data is represented accurately in the article. Each respondent was informed that his/her answers would be used as a part of a research project and agreed to that by filling in the questionnaire.

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