Willingness to Accept Incentives for a Shift to Climate – Smart Agriculture among Smallholder Farmers in Southwest and Northcentral Nigeria

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Abstract:

Abstract Shifting to agricultural practices with Climate –smart Agriculture (CSA) potential is crucial in mitigating greenhouse gas emissions. This study applied choice experiment data collected from 548 farm households across two geopolitical zones in Nigeria to assess the preferences for shifting to CSA among smallholders' farmers using Best Worst Scaling (BWS) technique. Data analysis within ranked –ordered logit regression framework revealed that stronger preference was given to GAPs with manure followed by GAPs without manure and agroforestry across the three models. However, the farmers show strong preference for status quo as against agroforestry in the less restrictive model. Also, farming households' attribute stronger preference to cultivating agroforestry on freehold and communal lands followed by strong preference for cultivating agroforestry and GAPs with manure on lease and communal land respectively. This shows that tenure type was only important for a shift to agroforestry and GAPs with manure. Willingness to accept (WTA) results suggested that farming households were willing to accept $237/ha & $137/ha to embrace GAPs with and without manure respectively while they were willing to pay $204/ha to avoid shifting to agroforestry in the study area.

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Keywords:

Climate Smart Agriculture, Smallholder farmers, Nigeria, Willingness to Accept Incentives,

1.0 Introduction

There is substantial evidence that climate change is already impacting livestock, fishery and crop production sectors and would continue to have disastrous effects in the future if appropriate mitigation and adaptive measures are not in place (Zougmore *et al.*, 2016). Predictions indicate that climate change will adversely affect agricultural production in sub-Saharan Africa through declining crop yields and livestock productivity caused by rainfall variability, rising temperatures, increased pest/disease incidences (Kurukulasuriya *et al*., 2006) and variations in frequency and intensity of extreme climatic events such as floods and droughts (Brida and Owiyo, 2013). More recent findings confirm that climate change is likely to cause considerable crop yield losses thereby adversely affecting smallholder livelihoods in Africa (Lobell *et al.*, 2011). As a result, food security and income generation opportunities for the farming households that are most reliant on agriculture may be in jeopardy.

One major cause of climate change is the increase in concentration of heat –trapping gases otherwise known as Greenhouse Gases (GHGs) in the Earth's atmosphere. Of these gases, the most abundant is carbon dioxide, but methane, nitrous oxide, and certain hydrocarbons and fluorinated gases also play significant roles (Smith *et al*., 2007). Climate change mitigation refers to reduction in the amount of greenhouse gases that are entering the atmosphere. This can be achieved by –reducing human emissions of greenhouse gases and increasing the uptake of carbon dioxide by plants, soils and the oceans. Agriculture is a significant contributor to GHGs, particularly in a developing country like Nigeria. It is estimated that about 10 to 12 per cent of total anthropogenic emissions of GHGs are directly generated in agriculture (IPCC, 2014). If indirect emissions from the fertilizer industry, rice production and emissions from deforestation and land conversion are added, the total contribution of the agriculture sector is increased to about 26-35 per cent.

Therefore, high priority should be given to reinforce adaptive mechanisms to cope with the negative effects of climate change. The promotion of agricultural practices with climate smart agriculture (CSA) potential is one mainstream opportunity to mitigate climate change while sustaining the productivity of agricultural systems (World Bank, 2011). In addition, CSA can help build adaptive capacity, so that farmers, service providers to farmers and key institutions have the ability to respond effectively to longer-term climate change as well as being able to manage the risks associated with increased climate variability (FAO, 2013). This is achieved through the three core pillars of CSA which are to sustainably increase agricultural productivity and income; adapt and build resilience to climate change and reduce and/or remove greenhouse gas (GHG) emissions where possible (FAO, 2010).

In this paper, we use a choice experiment to assess the preferences for shifting to CSA among smallholders' farmers in two geopolitical zones in Nigeria using Best Worst Scaling (BWS) technique. This technique has becoming increasingly popular to elicit preferences in health care (Marley & Louviere, 2005) and it is quite different from traditional Discrete Choice Experiments (DCEs) in that it elicits additional information on the least preferred option (Flynn *et al*., 2007). BWS consists of choice tasks, with a minimum of three options, in which an individual is asked to indicate the best and the worst options, with the overall aim being to obtain a full ranking of items in a manner that is easy for respondents and can then be analyzed in various ways (Marley & Louviere, 2005). However, this approach is yet to be used and evaluated for nonmarket valuation based on multi-attribute discrete choice data, even though traditional DCEs has been used in many environmental valuation applications. This paper aims to fill this gap, both from an empirical and a methodological point of view.

We carried out an unlabeled choice experiment with 591 farming households out of which 548 respondents supplied the choice experiment data. We apply rank-ordered logit to elicit the farming households' preference for specific attributes of Climate Smart Agriculture scheme, payment vehicle and management institutions and thereafter calculate the respondents' willingness to accept incentives for those attributes. Our results demonstrate that farming households were willing to accept \$237/ha & \$137/ha to embrace GAPs with and without manure respectively while they are willing to pay a tax of \$204/ha to avoid shift to agroforestry in the study area.

In the next section, we outline the theoretical and econometric framework underpinning choice modelling in conjunction with climate smart agricultural practices as well as rank-ordered logit. In section three we describe the methods in which we have the study area, discrete choice experiment design, key variables measurement and method of data analysis. In section four we describe and discuss our results. We conclude with the implications of our findings in a final section.

2.0 Theoretical Framework and Modelling

This study is primarily by choice experiment, which has its theoretical foundation in Lancaster's attribute theory of consumer choice (Lancaster, 1966) and an econometric basis in models of random utility (Luce, 1959; McFadden, 1974).

Lancaster and Random Utility Theory

Lancaster proposed that consumers derive satisfaction not from goods themselves, but from the attributes they provide. It is also based on the random utility theory according to which observation of utility can only be made imperfectly, so the utility from a good consists of systematic (deterministic) component, V and an error (random/stochastic) component, ε which is independent of the deterministic part and follows a predetermined distribution (McFadden, 1974; Hanemann *et al*., 1991).

$$U_{kn} = V_{kn} + \varepsilon_{kn} \quad (1)$$

Thus, an individual i will choose an alternative k from a specific choice set, n, given the utility U, if U_k is greater than the utility of any other choice j in the choice set:

The probability that individual i chooses alternative k is:

$$P_{kn} = \Pr(U_{kn} > U_{jn}) \, \forall_j \neq i \quad (2)$$

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

V thus, becomes the explainable proportion of the variance in choice and ε the non-explainable. Random utility model assumes that individual acts rationally and chooses the alternative with the highest level of utility, this implies that the individual is a utility-maximizer.

Rank – Ordered (Exploded) Logit

The rank-ordered logit (ROL) model is one of the extensions of multinomial logit as it has been established to provide efficiency gains because it allows more information to be collected from the respondents by asking them to rank various alternatives instead of simply choosing the option they considered to be the best.

The ROL model was introduced in the literature by Beggs *et al*., (1981) and it is the standard tool to analyze the preferences in case rank data is available. Ranked data, depending on the way data is inputted can be handled in a standard logit or mixed logit model. One of the assumptions of standard logit states that the probability of any ranking of the alternatives from best to worst can be expressed as the product of logit formulas. Supposing a farmer who was presented with four alternatives labelled A, B, C and D ranked the alternatives as follows: B, D, C, A, where B is the first choice. If the utility of each alternative is distributed independently and identically extreme value, then the probability of this ranking can be expressed as the logit probability of choosing alternative B from the choice set A, B, C, D, times the logit probability of choosing D from the remaining alternatives D, C, A, times the probability of choosing alternative C from the remaining alternative C and A.

Let $U_{nj} = \beta' X_{nj} + \varepsilon_{nj}$ for $j = A, \ldots, D$ with ε_{nj} independently identically distributed, iid with an extreme value distribution.

Where

U_{nj} = utility that farmer n would obtain from choosing alternative j.

X_{nj} = observable attributes of alternative j to farmer n.

β = an estimable taste parameter.

ε_{nj} = unobservable component of utility accruing to farmer n from alternative j.

Then

$$\text{Prob (ranking B, D, C, A)} = \frac{e^{\beta' X_{nB}}}{\Sigma_{j=A,B,C,D} e^{\beta' X_n}} \frac{e^{\beta' X_{nD}}}{\Sigma_{j=A,C,D} e^{\beta' X_n}} \frac{e^{\beta' X_{nC}}}{\Sigma_{j=A,C} e^{\beta' X_n}} \quad (4)$$

The equation (4) implies that the ranking of the four alternatives can be represented as being the same as three independent choices by the respondent. These three choices are called ***pseudo-observations***, because each respondent’s complete ranking, which constitutes an observation, is written as if it were multiple observations. Usually, ranking of J alternatives provides $J - 1$ pseudo-observations in a standard logit model. For the first pseudo-observation, all alternatives are considered available, and the dependent variable identifies the first ranked alternative. For the second pseudo-observation, the first ranked data is discarded. The remaining alternatives constitute the choice set, and the dependent variable identifies the second-ranked alternatives, and so on. A logit model on ranked alternatives is often called an exploded logit, since each observation is exploded into several pseudo-observations for the purpose of estimation.

To create the input file for logit estimation, the explanatory variables for each alternative are repeated $J - 1$ times, making that many pseudo-observations. The dependent variable for these pseudo-observations identifies, respectively, the first-ranked, second-ranked, and so on, alternatives. For each pseudo-observation, the alternatives that are ranked above the dependent variable for that pseudo-observation are omitted (censored out). Once the data are constructed in this way, the logit estimation proceeds as usual.

Best-Worst Scaling and Types

Best –Worst Scaling (BWS) was developed in the late 1980s as an alternative to Discrete Choice Experiment (DCE). BWS attempts to overcome limited information provided by DCEs with respect to the underlying preference structure for the alternatives in question, as no information is captured on the relative desirability of the remaining non chosen alternatives. Three cases of BWS which have in common that respondents, rather than just identifying the best alternative, simultaneously select the best and worst alternative from a set of three or more attributes, attribute levels or alternatives (Lancaster & Louviere, 2008; Louviere & Flynn, 2010; Flynn, 2010). One of the three types is very similar to DCEs, making it well anchored in economic theory. The three types of BWS are object case, profile case and multi –profile case.

Object Case BWS

This is the original form of BWS and was proposed by Finn and Louviere (1992). The object case is designed to determine the relative importance of attributes (Louviere & Flynn, 2010). Accordingly, attributes have no (or only one) level, and choice scenarios differ merely in the particular subset of attributes shown. The BWS object case was initially conceived as a replacement for traditional methods of measurement such as ratings and Likert scales (Louviere & Flynn, 2010).

Profile Case BWS

The second BWS variant is the profile case (Marley *et al.*, 2008). Here, the level of each attribute is shown and the same attributes appear in each scenario, while their levels change. Respondents identify both the best (most preferred) and worst (least preferred) attribute level in each scenario presented (Flynn, 2010).

Multi-profile Case BWS

Contrary to the two previous cases, in multi-profile case BWS, respondents repeatedly choose between alternatives that include all the attributes, with their levels varying in a sequence of choice sets (Marti, 2012). Thus, the multi-profile case BWS amounts to a Best-worst Discrete Choice Experiment (BWDCE) which extracts more information from a choice scenario than a conventional DCEs because it asks not only for the best (most preferred) but also the worst (least preferred) alternative. A complete ranking of more than three alternatives requires the exclusion of alternatives already identified as best and worst and asking the same question again with reference to the reduced choice set (Lancaster & Louviere, 2008).

3.0 Designing Choice Modelling Experiments

Step 1: Definition of Problem

The choice experiment design process begins with problem definition, which allows the researcher to define the research question and set the objectives and outcomes of the research project. A better understanding of the problem may be achieved through the following questions (Louviere *et al*., 2000, Hensher *et al*., 2005):

- What are the existing alternatives (goods or services) available?
- What are the attributes of existing alternatives?
- What are the determinants influencing demand for existing alternatives?
- Is the choice process consistent over time or is it seasonal?
- What is the population under study?
- What is the output required? (i.e., valuation or demand modelling study).

An alternative here refers to a good or service that the respondent could have chosen in the choice context of interest, be that the one that they are known to have selected in an existing choice situation (observed through revealed preference data) or the other options which they could have considered instead in making their choice.

Step 2: List of Potential Alternatives, Attributes and the Attribute Level.

List of Alternatives

DCEs usually draw on qualitative research in order to identify each and every possible alternative that may exist. Identification of all possible alternatives is particularly important in the discrete choice experiment exercises in order to meet the global utility maximizing criteria of Random Utility Theory. It should be noted that failure to identify all alternatives produces a constraint, a threshold on utility maximization outcome (Louviere *et al*., 2000). However, in some cases, it might be necessary to select (e.g., exclude 'insignificant' alternatives), merge some alternatives or assign a randomly sampled number of alternatives to respondents in order to reach a manageable number of alternatives to study (Hensher *et al*., 2005).

Another approach is to develop experiments without naming the alternatives (unlabeled alternatives) (Hensher *et al*., 2005); within such an approach, respondents are asked to consider two or more alternatives which differ in terms of the levels at which the attributes are presented but which are not given any additional 'branding'; such experiments may still require a 'choose neither' option to be exhaustive. The alternatives in our DCEs are of an unlabelled type (Louviere et al., 2000) and have generic titles (options 'A', 'B' and 'C') because this fits with the generic nature of the project's investigation of the willingness to accept incentives for a shift towards CSA.

Attributes and Attribute Levels

There is no standard method for selecting attributes however, the following two criteria serve as a guide in selection of our attributes (Bennett & Blamey, 2001; Bateman *et al*., 2002) – Attributes should be relevant to policy makers, meaningful and important to respondents.

There are no strict rules with respect to the number of attributes to be included; some researchers believe that all relevant attributes should be included whereas others argue that the maximum number of attributes in a single DCEs should be no more than eight (Ortuzar & Willumsen, 2001). The objective is to include a smaller number of attributes because the required sample size increases exponentially with the number of attributes (Bateman *et al.*, 2002), whilst balancing against this the concern that the exclusion of relevant attributes may result in biased estimates and inaccurate welfare measures (Kjaer, 2005).

Literature reviews, focus group discussions or direct questioning, interviews with key persons such as policy makers, and expert opinion can be of help when deciding on the list of attributes (Bateman *et al*., 2002). The inclusion of a monetary cost attribute in choice experiments allows the estimation of willingness to pay (WTP). However, in doing so the values of price need to be credible and realistic so as to minimize the possibility for strategic behaviour (Bateman *et al.*, 2002).

Attribute levels are the levels assigned by the analyst to an attribute at the experimental design stage and have no particular meaning to the respondent (Hensher *et al.*, 2005). On the other hand, attribute-level labels are the narratives assigned to each attribute level for a given attribute. Attribute-level labels can be either qualitative or quantitative. Quantitative attribute-levels can be represented in either absolute or relative terms (when compared to the status quo) (Bennett & Blamey 2001). Three things to consider when choosing attribute-level labels according to Ryan (1999) are:

- Attribute-level labels should be plausible to the respondents and provide meaningful information and capable of being traded,
- The labels must be constructed so that respondents are willing to trade-off between combinations of the attributes.

- Although attribute levels are commonly presented in words and numbers, attribute levels may be communicated via pictures (static or dynamic), computer graphics, charts, etc. (Adamowicz *et al*., 1998).

In view of the above DCEs design, we conducted DCEs along with the interviews which were aimed at assessing the farmers' land use preference, trade-offs and Willingness to Accept (WTA) incentives to shift from current farming system to one of a set of context/crop specific – Climate Smart Practices (CSPs). The CSPs are those that have the potentials to sequester carbon, in addition to the relevance in restoring/conserving soil health, helping farmers to build resilience to climate change and raising productivity. The CSP options presented include agroforestry as well as adoption of Good Agricultural Practices (GAPs) with or without use of Organic Manure/Compost. The GAPs include integrated/combined use of Zero/Minimum tillage, retaining/incorporating refuse on the soil rather than burning, and Integrated Water, Pest, and Fertility Management – including micro-dosing of fertilizer where absolutely necessary.

We estimated the carbon sequestration potentials of the CSP options under various climate and soil conditions in Nigeria using FAO Ex-Ante Carbon Balance Tool (Ex-Act), and these were valued at specific carbon prices in determining incentive presented to farmers in the Choice Experiments. The choice attributes of concern and their levels are summarized in Table 1. These were combined into profiles (i.e. options presented in the choice sets) using the orthogonal design procedures in Statistical Package for Social Scientists (SPSS) version 17. This procedure creates a reduced set of profiles that is small enough to include in a survey but large enough to assess the relative importance of each factor (attribute). The orthogonal main-effects design framework permits statistical testing of several factors without testing every combination of factor levels.

Table 1: Attributes and Levels of CSPs for Upland Rice and Maize Farmers

Attributes	Levels
CSA Scheme	Agroforestry; GAPs with manure; GAPs without manure
Intervention Management	Government; Non-governmental organizations; 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 ($/t$CO_2$ Eq.)	10; 20; 30; 40; 50

Step 3: Experimental Design

Experimental design refers to the way the alternatives levels are set and structured into choice sets (Bennett & Blamey 2001). A designed experiment is a way of manipulating attributes and their levels to permit rigorous testing of certain hypotheses of interest. (Louviere *et al*., 2000). The number of possible alternatives increases exponentially when the number of attributes and levels increases ($alternatives = levels^{attributes}$). The most popular way of combining the levels of the attributes is the use of factorial design. Factorial design has very attractive statistical properties from the standpoint of estimating the parameters of models that test hypotheses. The questionnaire is designed so that each level of each attribute is combined with every level of all other attributes. Factorial design is all possible combinations of attributes and levels in an experimental design including main (linear) effects and interaction (cross) effects. It is divided into complete/full factorial design and fractional factorial design. The former is only a real possibility for small experiments that involve a limited number of either attributes or levels.

For the purpose of this study, two sets of orthogonal main-effect designs – each consisting of 25 profiles - were generated in two runs per crop/context specific scenarios; and were randomly combined with the *status quo ante* in creating the tasks that were presented to the respondents (see Table 2 for example). This process produced 25 sets of tasks, which were divided into five blocks, each with five tasks that were presented sequentially to all respondents. The blocks were randomly assigned to respondents in a systematic manner: the first respondent to be interviewed gets tasks in Block A, the second B, . . . and the fifth E. The cycle was in the same order for respondents 6 – 10, 11 – 15, etc. The task was simply for the respondent to choose the most and the least important options from the three options (labelled A, B and C) if presented with a legally enforceable contract that will entail payment of specified incentive annually, under the following terms / conditions.

(i) The farmer will undertake investment in one of the bundle of GAPs [entailing cultivation of a high yielding, drought tolerant and early maturing variety (e.g. FARO 44), coupled with integrated use of zero/minimum tillage, residues retention on the soil, rotational & cover cropping, micro-dosing of fertilizer where absolutely necessary, and integrated weed, pest and water management] with or without organic manuring, or agroforestry (see options in Table 2);
(ii) Inputs to be used on the farm would be procured only from accredited input suppliers who would also be under a contract obligation to supply these inputs to you as at when needed, including access to government guaranteed credit at single-digit interest rate as well as regular advisory services.
(iii) Farm produce would be duly certified and allowed to be sold at a premium price, and its sales supported by a Guaranteed Minimum Price policy, based on average market price in previous season.
(iv) If agroforestry option is chosen, seedlings of the carefully selected tree species shall be planted in rows with arable crops grown in the alleyways between the rows. In this case, the effective cropping area would ultimately reduce to 70 – 80% of the arable land in 10 – 30years when the trees have formed canopy.
(v) In the agroforestry option, farmers would have full right to prune the trees from time to time as to maintain agreed effective cropping area, and harvest the fruits as well as other non-wood forest products therefrom, but cannot cut down trees established under the contract.
(vi) Payment of benefits under the contract shall be after an annual monitoring visit in which it is established that none of the terms of the contract has been violated.
(vii) Entitlements shall be reviewed every 5 years, to ensure that payment maintain the purchasing power at base year.
(viii) In event of a violation of the contract term at any time over the 30 years' period, the farmer will be under obligation to pay appropriate compensation to remedy the resulting increase in carbon emission.

Table 2: Typical Tasks Presented to Respondents

LAC-MOIST Regions – Northern & Southern Guinea as well as Derived Savannah Zones									
Task	**Option**	**CSA Scheme**	**Management**	**Mode**	**C. Price ($/tCO2)**	**C. Seq. (tCO2/ha)**	**Incentives ($/ha)**	**Incentives (₦/ha)**	**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 was an average of ₦305.44/US$1

Step 4: Choice Set Generation

This stage involves the design of a DCEs is to generate the hypothetical alternatives and to combine them to create choice sets. A full factorial design can be generated which consists of all possible combinations of the levels of the attributes, and permits estimation of main effects and interactions. A main effect refers to the direct independent effect on the choice variable of the difference in attribute levels while an interaction effect is the effect on the choice variable obtained by varying two or more attribute levels together. However, because of cost implication and tediousness of full factorial design, fractional factorial designs are often used to consider a selection of possible alternatives.

The pairing of the alternatives into choice sets is crucial here, the pairing needs to be made in such a way that the difference in attribute utilities for each alternative in attribute levels for each choice set are not multi-correlated. To ensure maximum statistical efficiency in choice design (i.e. the extraction of maximum information from the choice task), design efficiency principles, also termed D-efficiency must be jointly satisfied. D-efficiency relates to the design matrix in such a way that efficiency is maximized when the size of the covariance matrix of the estimated parameters is minimized. The four principles are: Level balance; Orthogonality; Minimal overlap and Utility balance.

Step 5: Development of the Survey Instrument

It is important that respondents are first introduced to the choice task prior to asking them to complete the DCEs. Typically, it is the first section in a stated choice survey that offers information about its context and provides instructions on how to complete the choice tasks. In particular, the aim of the introduction is to define the objectives of the study, the reasons for the choice of respondent and, also, stress the importance of respondents' participation (Adamowicz *et al*., 1998). Moreover, the introductory text should mention the length of the survey and assure the confidentiality of responses.

Methodology

The Study Area

The study was carried out in selected farming communities across two geo-political zones - Southwest and Northcentral, in Nigeria. Nigeria is situated in the West African region and lies between longitudes $3^{\circ}$and 14° and latitudes 4° and 14°. It has a land mass of 923,768 sq.km. Southwest and Northcentral Nigeria shares land borders with the Republic of Benin in the West, Northeast in the East, Northwest in the North and Southern Nigeria in the South. The study area comprises 12 out of 36 states of Nigeria as well as the FCT, grouped into four agro-ecological zones: Rain forest, Mid-altitude, Derived and Southern guinea savannah, all of which are suitable for maize and rice, among several other crops like cassava, yams, etc. Administratively, Nigeria is made of 36 Federating States and the Federal Capital Territory (FCT). The States are commonly grouped into six (6) geopolitical zones: Northeast, Northwest, North-central, Southeast, Southwest and South-south geopolitical zones. The North central States are native homes to the Hausa-Fulanis, Nupe, Gwari Tiv and the Igalas while the Southwest is native homes to the Yorubas. The estimated human population as of 2015 was 191.8 million people, about 29% of which were Hausa-Fulanis and 21% Yorubas (Worldometers, 2017; Kaplan, 2012).

Data Collection and Sampling

The study was based on primary collected through cross-sectional survey by interview and choice experiments, in which 600 rice and/or maize farmers were interviewed across 84 farming communities that were spread across seven States, in two geopolitical zones and three (3) of the seven AEZs in Nigeria. The dataset for this study was from 548 farmers that cultivated maize and/or rice in upland and/or rain-fed lowland ecologies.

The respondents were drawn in a multi-stage sampling process, as follows:

Stage I: Purposive selection of seven States that have been the leading rice and/or maize producers in Southwest and Northcentral Nigeria based on production statistics from NBS.

Stage II: Purposive selection of Three (3) Agricultural Blocks per crop from the main rice and/or maize producing areas of the State, and two (2) Extension Cells per block - that is, 12 Cells per State, and 84 Cells in all.

Stage III: Proportionate stratified random selection of 5 - 10 Rice and/or maize farmers from members of Rice Farmers Association (RFAN) in each of the selected Cells,

This process yielded a total of 548 rice farmers that were interviewed from Southwest and Northcentral Nigeria.

LTPRs' Measurement

Two indicators were employed in assessing Land Tenure and Property Rights (LTPRs) of farmers in this study. They include:

(i) **Tenure Type**: This was measured on a nominal scale, using three dummy variables – Freehold, Leasehold and Communal - that takes the value of one if the right to use the parcel of land was acquired through direct inheritance and/or 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 assigned a zero.

(ii) **Tenure security (legal):** A tenure was classified as *de jure* secured, if the parcel has been surveyed and duly registered with the Land registry; otherwise it was classified as unsecured (de jure). This variable was meant to assess the importance of title registration.

Method of Data Analysis

Data analysis was by a combination of descriptive and econometric techniques. Data from the household survey, land acquisition and key rights held was analysed using descriptive statistical methods to generate frequencies and percentages. Data on WTA incentives for a shift into CSA schemes and the influence of land titling and tenure type on this was analysed within the framework of rank-ordered logit regression method.

The choice of the rank-ordered logit analytical framework was motivated by the fact the respondents rank the alternatives instead of just choosing the best out of the set of alternatives presented to them.

Following Hjelmgren and Anell (2007), the parameter δ_z are marginal utilities of the attributes. They were used in computing marginal willingness to accept. The estimated parameters in the empirical model were used to estimate the trade-off (marginal rate of substitution) of one attribute in terms of another. 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 parameters value δ_z with the bid parameter (i.e. δ_z/δ_{price}).

4.0 Results and Discussion

Socio-economic Characteristics of the Rice/Maize Farmers

Table 1 summarised the socio-economic profiles of 548 farmers that supplied the complete dataset used in this study. As shown in Table 1, a typical cereal crop farmer in the study area is about 45years old with mean years of schooling of 10years. He is 93.1% likely to be a male and 91.3% likely to be married. The mean household size was seven (7) people.

Table 1: Household Characteristics of Sampled Respondents

	Freq.	Percent
Age group		
< = 30	61	10.41
31-40	157	26.79
41-50	152	25.94
51-60	112	19.11
Above 60	104	17.75
Mean Age (years) = 45		
Household size		
1 – 5	239	42.15
6 – 10	239	42.15
11 – 15	61	10.76
Above 15	28	4.94
Household size (Mean) = 7		
Sex		
Male	540	93.1
Female	40	6.9
Marital status		
Married	534	91.28
Single	36	6.15
Once married	15	2.56
Education Attainment		
No formal education	53	9.98
Arabic	22	4.14
Basic education	114	21.47
Secondary education	173	32.58
Tertiary education	169	31.83
Mean Education Attainment (years) =10		

The 548 farmers whose data were used in this study provided plot-level information on a total 1,810 parcels of land that were cultivated by members of their farm households during the 2016/2017 farming season. Tables 2 summarize the farmland characteristics in terms of the size, mode of acquisition, the property rights enjoyed by the households on those lands and the status of registration on those parcels.

Table 2 shows the distribution of 1,810 cultivated parcels by title registration, tenure and property rights characteristics among rice farmers across Southwest and Northcentral geo-political zones in Nigeria. As shown in Table 2, the average parcel size was 3.67acres. About 47.68% and 9.56% of the parcels have been inherited or purchased by the farm household, 33.65% on leasehold while 7.51% were communal land. The proportion of parcels held on purchase and communal were found to be extremely lower among farmers drawn from north central (8.41% & 6.77%) respectively. In general, the tenure duration was such that it may transcend the lifetime of the plot manager in about half of the respondents (55.97%).

With respect to key rights held, majority of the respondents across the study area (61.34% - 74.21%) possess rights to – restrict others from their farm, grow tree crops and develop their parcels further by investing in an irrigating scheme for example, while about half of them could either sell or transfer their land to the next generation. Also, about 18.74% and 4.63% of the cultivated parcels were duly surveyed and registered with the state government, with only 3.33% and 6.23% of the parcels registered in both north central and southwest respectively.

Table 2:Distribution of Cultivated Parcels by Title Registration, Tenure and Property Rights Characteristics

	Northcentral	***Southwest***	***All***
Land size (Ha)	3.65	3.72	3.67
Lowland (%)	50.97	18.88	42.71
Acquisition Mode (%)			
Inherited	54.99	26.61	47.68
Purchase	8.41	12.88	9.56
Leasehold	27.90	50.21	33.65
Communal	6.77	9.66	7.51
Right Held (%)			
Restrict others	81.79	52.58	74.21
Tree crop	67.80	58.37	65.35
Develop	62.98	56.65	61.34
Lease out	61.32	53.00	59.16
Sell	54.25	51.29	53.48
Bequeath	52.67	46.35	51.03
Land Survey	18.01	21.08	18.74
Agency Registered With (%)			
Traditional	18.00	7.96	13.5
Local Government	4.91	5.16	5.02
State	3.33	6.23	4.63

Source: Field Survey; 2017

4.5 Willingness to Accept Incentive to Shift to Climate Smart Agriculture Options

Diagnostic Result

Table 3 showed three (3) nested models of rank-ordered logit. We specified a rank-ordered logit (ROL) without covariates as model 1, ROL with the main crop interacting with CSA scheme as model 2 and the full model (model 3) nested the first two models with the interaction of CSA scheme with tenure type and land registration. Likelihood ratio test are used to test for differences among the nested models. All the three models are strongly significant ($p < 0.01$) according to standard likelihood ratio chi square. Looking at the three models, we can vividly detect that virtually all the variables were significant ($p < 0.01$ & $p < 0.05$) respectively.

Likelihood ratio test on the other hand was conducted on all the three models to know which one fits significantly better than the other. The null hypothesis for all the three models is that the set of coefficients are not significantly different from zero and that the smaller model is the true model. The null hypothesis was therefore rejected indicating that any of the three ROL models is appropriate for the analysis. The likelihood ratio test results vary from model 2 (22.01) to model 3 (41.51) indicates that the less restrictive model (df = 24) fits significantly better and appropriate framework for the analysis than the first two models with few covariates.

Preference for CSA Scheme

A total of 8,220 choice sets were included in the estimation (548 respondents, 15 choice sets each). Sixty-seven percent of choices were in favour of CSA options. By contrast, 33% of respondents never chose any of those measures and must therefore be considered wanting to continue with the status quo.

In line with *a-priori* expectations, the coefficients associated with the size of incentive were all positive and significant at 1% levels. This confirm the expected positive supply response to increase in value of the incentives that may be provided to the farmers to invest in to invest in agricultural practices that have potentials to sequester carbon, while promoting soil heath and raising productivity and income. This is in consonance with Schulz *et al*., (2014) in which higher payment increases the likelihood of "greening" being preferred to opt –out option.

Influence of Choice Attributes: CSA Scheme, Payment Vehicle and Management

Direction of attribute influence was consistent with economic theory. Table 3 shows that stronger preference was given to GAPs with manure ($p < 0.01$) followed by GAPs without manure and agroforestry ($p < 0.01$) across three models. However, the results further reveals that the farmers show strong preference for status quo as against agroforestry ($p < 0.05$) in the less restrictive model, this might be because of high opportunity cost in terms of land. Despite the scarcity and higher cost of manure application relative to investing in other measures to combat land degradation and effect of climate change on agricultural production, GAPs with manure was still given stronger preference and highest priority by the farmers in the study area. The possibility of farmers receiving incentive in both cash and kind and kind only was not significantly different from zero across the models. In addition, Table 3 reveals farmers were more in favour of community based association (CDA) ($p < 0.01$) and non-governmental organizations (NGOs) ($p < 0.01$) over other project management/ payment vehicles, they would also prefer government based institutions (status quo) as against private sector as they did not trust them enough to render effective services. Hence, project management to build adaptive capacity to climate change by either CDA or NGO will increase the likelihood of farming households' willingness to invest in agroforestry, GAPs with and without manure.

ROL Main Effects Interacting with Main Crop, Tenure Type and Land Registration

The result (Table 3) shows that farming households with GAPs with and without manure when interacted with rice were not significantly different from zero whereas stronger preference was given to agroforestry when interacted with sole rice. Also, farming households' attribute stronger preference to cultivating agroforestry on freehold and communal lands ($p < 0.01$) followed by strong preference for cultivating agroforestry ($p < 0.05$) and GAPs with manure ($p < 0.05$) on lease and communal land respectively. This shows that tenure type was only important for a shift to agroforestry and GAPs with manure. This indicates that they have secure tenure to make a long –term investment on the land as they would be able to recover their returns from the land. In the same vein, land titling was only important to promote a shift to GAPs with manure ($p < 0.05$) while for other CSA schemes it was not significantly different from zero –most likely because most of those that registered land are elites (possibly, land grabbers) whose main mission might be to dispose it off later at a premium.

WTA Incentives for a Shift to CSA Schemes

Table 4 shows the willingness to accept (pay) based on parameter estimates from Table 3. The results reveals that farming households were willing to accept $237/ha & $137/ha to embrace GAPs with and without manure respectively while they are willing to pay $204/ha to avoid shift to agroforestry in the study area. Estimated WTA values for famers that cultivated GAPs without manure on leased and owned land alongside GAPs with manure on leased land were positive, suggesting a Willingness to Pay (WTP) some taxes to maintain the status quo, the WTP per hectare are US$ 10.18, US$8.86 & US$37.07 respectively. The farmers' willingness to pay/accept highlight the extent to which they value ecosystem sustainability and land conservation. However, it is only those that who registered their land with all the three CSA schemes –GAPs with and without manure, agroforestry that were willing to accept incentives to shift to measure that mitigate GHGs emission and build adaptive capacity to climate change with respect to agricultural production.

Table 3: Estimated Rank-Ordered Logit of Willingness to Accept Incentives to Shift to CSA Options

Parameters	***Coef.***	***Z***	***Coef.***	***z***	***Coef.***	***z***
Incentive	7.67E-06	8.06***	8.64E-06	8.86***	8.87E-06	9.05***
GAPs without manure	0.3792	5.88***	0.3675	5.3***	0.3721	2.19**
GAPs with manure	0.7823	11.8***	0.7510	10.5***	0.6450	3.66***
Agroforestry	0.4351	3.85***	0.2044	1.66*	-0.5534	-2.43**
CDA	0.3895	5.66***	0.3944	5.72***	0.3985	5.77***
NGO	0.3035	4.91***	0.3043	4.91***	0.3105	5***
Private	-0.0517	-0.76	-0.0605	-0.89	-0.0674	-0.99
Kind	-0.0020	-0.04	-0.0101	-0.19	-0.0162	-0.3
Cash & Kind	0.0640	0.98	0.0549	0.84	0.0492	0.75
GAPs without manure*Rice			0.0187	0.21	0.0077	0.09
GAPs with manure*Rice			0.0364	0.38	-0.0030	-0.03
Agroforestry*Rice			0.6205	4.55***	0.5141	3.67***
GAPs without manure*Freehold					-0.1005	-0.59
GAPs with manure*Freehold					0.1003	0.56
Agroforestry*Freehold					0.8527	3.94***
GAPs without manure*Leasehold					-0.0240	-0.14
GAPs with manure*Leasehold					-0.0276	-0.15
Agroforestry *Leasehold					0.4650	2.15**
Agroforestry*Communal					1.4939	4.45***
GAPs without manure*Communal					0.3604	1.5
GAPs with manure*Communal					0.5702	2.21**
GAPs with manure*Registered					0.1393	0.88
GAPs without manure*Registered					0.3098	2.02**
Agroforestry*Registered					0.2643	1.18
Df	9		12		24	
LR Chi Sq.	1067.19		1089.2		1130.71	
LR Test: Chi-Sq (Df2-Df1)			22.01***		41.51***	
Log likelihood	-4350.18		-4339.18		-4318.42	
Prob Chi-Sq	0.00		0.00		0.00	

Table 4: Willingness to Accept (Pay) Incentives to Shift to CSA Options

Attribute/Factor	Marginal WTP		Lower Limit		Upper Limit	
	Naira	US$	Naira	US$	Naira	US$
GAPs without manure	(41,929.66)	(137.23)	(81,173.79)	(265.66)	(2,685.54)	(8.79)
GAPs with manure	(72,684.47)	(237.88)	(116,794.48)	(382.24)	(28,574.46)	(93.52)
Agroforestry	62,351.85	204.06	15,994.20	52.35	108,709.49	355.78
CDA	(44,898.82)	(146.94)	(61,716.24)	(201.98)	(28,081.40)	(91.90)
NGO	(34,981.85)	(114.49)	(50,177.39)	(164.22)	(19,786.31)	(64.76)
Private	7,596.08	24.86	(7,323.79)	(23.97)	22,515.95	73.69
Kind	1,820.24	5.96	(10,172.51)	(33.29)	13,812.99	45.21
Cash and Kind	(5,544.19)	(18.14)	(20,203.93)	(66.12)	9,115.56	29.83
GAPs without manure*Rice	(864.73)	(2.83)	(20,765.28)	(67.96)	19,035.82	62.30
GAPs with manure*Rice	339.97	1.11	(21,473.22)	(70.28)	22,153.16	72.50
Agroforestry*Rice	(57,927.41)	(189.58)	(88,971.27)	(291.18)	(26,883.56)	(87.98)
GAPs without manure*Freehold	11,326.67	37.07	(26,294.40)	(86.06)	48,947.75	160.20
GAPs with manure*Freehold	(11,303.99)	(37.00)	(50,665.15)	(165.82)	28,057.18	91.83
Agroforestry*Freehold	(96,085.84)	(314.47)	(147,203.66)	(481.77)	(44,968.01)	(147.17)
GAPs without manure*Leasehold	2,708.69	8.86	(35,505.57)	(116.20)	40,922.95	133.93
GAPs with manure*Leasehold	3,111.09	10.18	(36,728.59)	(120.20)	42,950.77	140.57
Agroforestry *Leasehold	(52,396.35)	(171.48)	(101,277.15)	(331.46)	(3,515.54)	(11.51)
Agroforestry*Communal	(168,337.39)	(550.93)	(250,353.58)	(819.35)	(86,321.20)	(282.51)
GAPs without manure*Communal	(40,610.87)	(132.91)	(94,318.04)	(308.68)	13,096.31	42.86
GAPs with manure*Communal	(64,254.01)	(210.29)	(122,735.61)	(401.69)	(5,772.40)	(18.89)
GAPs with manure*Registered	(15,700.47)	(51.38)	(50,960.18)	(166.78)	19,559.24	64.01
GAPs without manure*Registered	(34,912.46)	(114.26)	(69,567.08)	(227.68)	(257.83)	(0.84)
Agroforestry*Registered	(29,778.98)	(97.46)	(79,719.27)	(260.90)	20,161.32	65.98

Note: Figures in parentheses are WTAs i.e., (WTA = -WTP) while those in parentheses are WTPs

5.0 Conclusion and Policy Implications

This study has contributed to literature on the preferences for shifting to CSA among smallholders' farmers in two geopolitical zones in Nigeria using Best Worst Scaling (BWS) technique. LTPRs was analysed on plot level and is summarized as the farm land characteristics in terms of the size, mode of acquisition, the property rights enjoyed by the households on those lands and the status of registration (dejure) on those parcels. The average parcel size was 3.67Ha of which about 47.7% and 9.6% of the parcels were held on inheritance and purchase basis, 33.6% on leasehold while 9.6% were communal land. However, LTPRs results show that only 18.8% of the parcels had been surveyed while only 4.6% had their title registered with the State land registry.

Using ROL model, we evaluated attributes such as CSA scheme, payment vehicle and management institutions –CSA scheme mitigate climate change while sustaining the productivity of agricultural systems. The ROL reveals sixty-seven percent of choices were in favour of measures to mitigate and build resilience to climate change (CSA scheme) while 33% of respondents never chose any of those measures, therefore, they were considered to continue with the status quo. This result indicates that higher incentive increases likelihood that farming households will be willing to shift from the status quo to invest in agricultural practices that have potentials to sequester carbon, while promoting soil heath and raising productivity and income. Stronger preference was given to GAPs with manure followed by GAPs without manure and agroforestry across the three models. However, the farmers show strong preference for status quo as against agroforestry in the less restrictive model, this might be because of high opportunity cost in terms of land. The possibility of farmers receiving incentive in both cash and kind and kind only was not significantly different from zero across the models. Project management to actualize preferences for shifting to CSA among smallholders' farmers by either CDA or NGO will increase the likelihood of farming households' willingness to invest in agroforestry, GAPs with and without manure. Also, farming households' attribute stronger preference to cultivating agroforestry on freehold and communal lands followed by strong preference for cultivating agroforestry and GAPs with manure on lease and communal land respectively. This shows that tenure type was only important for a shift to agroforestry and GAPs with manure. This indicates that they have secure tenure to make a long –term investment on the land as they would be able to recover their returns from the land. In the same vein, land titling was only important to promote a shift to GAPs with manure while for other CSA schemes it was not significantly different from zero –most likely because most of those that registered land are elites whose main mission might be to dispose it off later at a premium.

Virtually all of the estimated standard deviations are statistically significant, indicating a clear rejection of homogeneous preferences (that is, fixed coefficients) for these attribute levels. Finally, WTP/WTA results shows that farming households were willing to accept $237/ha & $137/ha to embrace GAPs with and without manure respectively while they were willing to pay $204/ha to avoid shift to agroforestry in the study area. The farmers' willingness to pay/accept highlight the extent to which they value ecosystem sustainability and land conservation.

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