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Time Preferences, Land Tenure Security, and the Adoption of Sustainable Land Management Practices in Southeast Nigeria

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Abstract: Sustainable land management (SLM) practices are important for tackling agricultural land degradation. This study investigates the association between farmers' time preferences and their adoption of SLM practices (agroforestry, terracing, and land fallow practices) with intertemporal benefits, and further documents the moderating role of land tenure security in this relationship. The analysis in the paper is based on data from a survey of 480 farmers in south-east Nigeria, complemented by semi-structured interviews. Farmers' time preferences were elicited using both a survey and experiments with hypothetical payouts. Land tenure was conceptualised as a composite concept to suit the legally pluralistic context of the study area. This study found that many of the sampled farmers have high discount rates. The result further shows that farmers' time preferences are negatively associated with their adoption of agroforestry and land fallow practices. Moreover, the result shows that both legal and de facto tenure security encourage the adoption of SLM practices. Other factors influencing the adoption of SLM practices include gender, household size, education, credit constraints, marital status, risk attitude, farming experience, and farm characteristics (e.g., erosion problems and steepness of slope). Furthermore, this study found that the security-enhancing effect of land tenure security (de facto) can alleviate the negative influence of time preferences on farmers' adoption of SLM practices. The findings suggest that farmers with higher discount rates, who have secure tenure rights to land, are more likely to adopt SLM practices, compared to similar farmers without tenure security.

Keywords: time preferences; time preference experiment; risk attitude; risk experiment; tenure security; adoption; sustainable land management practices; climate change adaptation

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1. Introduction

In the agricultural sector, land degradation remains one of the main environmental concerns, with important implications for the sustainability of the products derived from the land (e.g., food, firewood, forage, and medicines) and of the associated ecosystems [1]. For these reasons, land degradation has been identified as an international policy priority and is recognised in various international policy responses including the Convention on Biological Diversity and the United Nations Convention to Combat Desertification [2,3]. Land degradation is negatively affecting farm yields and farmers' wellbeing across the globe and is a particular problem for small-scale subsistence farmers in Sub-Saharan Africa (SSA), whose livelihood strategies are dependent on what the land produces [4]. In recent years, the adoption of sustainable land management (SLM) practices has emerged as an important strategy to tackle agricultural land degradation. SLM as defined by the World Overview on Conservation Approaches and Technologies (WOCAT) is "the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions" [5] (p. 1). Past

studies have demonstrated that SLM practices including minimum tillage, land fallowing, terracing, agroforestry, and crop residue management are important for enhancing the water retention capacity of agricultural soils, reducing soil nutrient losses from erosion, increasing land productivity, and ultimately improving household food security [6,7]. Moreover, other studies show that many SLM practices such as mulching, farmyard manure and contour cropping, are important strategies to adapt agricultural systems to the negative impacts of climate change [8,9].

As decisions around land use and management lie largely with farmers, they are undoubtedly central in achieving the widespread use of SLM practices to tackle land degradation problems. Several research studies have investigated the factors that drive farmers' decision to adopt SLM practices [10–12]. However, these studies, especially those focusing on smallholder farmers in developing countries, have tended to concentrate on familiar concerns, such as economic and social factors, farm characteristics, policy incentives, and social capital, and have neglected the importance of underlying psychological factors that can influence farmers' adoption decision. It is argued that innovation adoption models based on the random utility framework focusing solely on economic variables to explain technology adoption are potentially limited and insufficient to capture unobservable factors underlying adoption decisions [13]. Hence, there has been a rising interest in applying socio-psychological models to study how important intrinsic factors such as farmers' time preferences, self-efficacy, risk attitude, and beliefs influence their adoption decisions [14–16].

In this light, this paper aims to investigate farmers' decision to adopt SLM practices by focusing on an important socio-psychological factor—time preference. The term time preference is used to describe the value that an individual places on goods and services at different time periods. The time preference of an individual is estimated by their discount rate, which is indicative of their willingness to forgo current for future benefits [17]. Individuals with higher discount rates will prefer to receive earlier but smaller rewards to receiving larger rewards later. The role of time preferences in farmers' decisions to adopt SLM practices is particularly pronounced given that such decisions are usually made in an intertemporal context; that is, they involve a trade-off between costs and benefits occurring at different times [18,19]. The time lag between the costs associated with the adoption and the realisation of benefits can make investing in SLM practices unattractive to farmers with higher discount rates who are unwilling to wait for benefits that accrue in the long term. Thus, knowledge of farmers' time preferences is critical to understanding their decision to adopt SLM practices.

One subsequent important question also addressed by this study is whether or not land tenure security moderates the relationship between farmers' time preferences and the adoption of SLM practices. Past studies document the role of land tenure security in significantly increasing farmers' investment propensity in SLM practices with longer payback periods [19–21]. Therefore, it is reasonable to assume that tenure security has a moderating effect on the relationship between farmers' time preferences and the adoption of SLM practices. This study makes important contributions to the literature. First, using field experiments, this study measures the time preferences of farmers in southeast Nigeria, thereby enriching research on farmers' time preferences in a developing country context. Second, recognising the argument in the land tenure literature about the definition of the concept of tenure security, particularly in the SSA context [20], land tenure security is conceptualised as a composite concept. This broader conceptualisation of tenure security enabled the investigation of how the different components of tenure security interact in determining farmers' decisions regarding adopting SLM practices, especially in the legally pluralistic context of Nigeria. From a policy standpoint, this study will provide an empirical basis for the formulation of efficient and effective intervention policies to improve the adoption of SLM practices in Nigeria as well as other African countries with similar land tenure structures and farming systems.

2. Conceptual Framework of the Study and Hypothesis Development

2.1. Conceptualising Time Preferences

The time preference of an individual characterises how they choose between immediate smaller rewards and delayed larger rewards. Previous studies measuring individual time preferences have differed widely in their approaches and methods of estimation, but most apply the same fundamental principle. In general, individual time preferences are usually quantified based on two methods: (i) observations of how an individual makes a buying decision involving trade-offs between the near future and the more distant future in real life [22]; and (ii) choice experiments (such as choice tasks, matching tasks, pricing tasks, and rating tasks) in which participants are invited to complete questionnaires where they are required to choose between real or hypothetical small payments available immediately or larger payments available later [23]. Choice experiment methods have been criticised on the grounds that the discount rate derived is not indicative of the actual time preferences of the respondents but rather the hypothetical parameter, given that the participants do not actually carry out their choices in real life [23]. It is argued that observation of individual purchasing decisions in the real world can circumvent these shortcomings. Nevertheless, the limitations of real-world observations of individual choices have been highlighted by other scholars. For example, it is argued that real-world observations of individual choices are subject to several confounding factors arising from the intricacy of making decisions in real life and the difficulties in controlling for some important external factors such as the specific conditions under which the decision is made [17].

In general, these two elicitation methods yield very different discount rates, and there is no agreement about the best methods. Common reasons for choosing a particular method include the relative ease of estimating the discount rates, the simplicity of conducting the experiments, and the ease with which participants can follow the experiment, especially the less educated ones [24]. In this study, the choice experiment method used by [25] and adapted by [16] was adopted to measure the time preferences of farmers.

2.2. Conceptualising Time Preferences and Adoption of SLM Practices

Within agriculture, individuals' time preferences are a key factor in making intertemporal choices, including the decision to adopt SLM practices. This study considers three SLM practices, agroforestry, terracing, and land fallow practices, which are promoted by extension agents (EAs) in the study area for their ability to help tackle soil erosion and improve cropland productivity. The nature of these SLM practices in terms of their costs and the timing of the delivery of their benefits might influence farmers' adoption decisions. Agroforestry entails the intentional planting of trees or intentionally leaving trees that are already well established on farmland. Besides their soil and water conservation benefits, such as protecting soil from erosion, implementing agroforestry can also provide direct economic benefits that improve households' food and livelihood security [26]. However, agroforestry usually entails medium- to long-term investments, as their benefits usually take a long time to materialise—typically more than one planting season. In terms of cost implications, implementing agroforestry requires high initial upfront costs during the establishment phase (e.g., costs of tree planting and improved seed varieties). Furthermore, trees occupy valuable agricultural land that would otherwise be used for planting arable crops. Smallholder farmers often associate planting or retaining trees with a loss of land, thus discouraging their adoption of agroforestry [18].

Furthermore, the construction of terraces on sloping land helps to protect the soil from surface runoff and erosion problems, therefore preserving the fertility of the land [27]. However, the benefits of terracing increase over time. Moreover, terracing generates additional operational and maintenance costs (such as the costs of maintaining terrace structures and the additional labour required for weeding after implementation), in addition to the high initial upfront costs during the establishment phase [18]. Additionally, constructing terraces uses a significant amount of land and the gains from the practice may not sufficiently compensate farmers for the decrease in yields resulting from the loss in land area during

construction, especially over the short term [28]. Under land fallow systems, the farmer cultivates the land for a period of time, and then the land is allowed to lay fallow for a period to allow the soil nutrients to rejuvenate. Implementing land fallow system comes at a cost to the farmer, e.g., the cost of acquiring alternative land to cultivate during the fallow period, while the soil fertility improvement from implementing land fallow materialises over a relatively long time [29]. Given that many farmers prefer more immediate rewards from their investments, the inter-temporal features of these SLM practices may make the decision to adopt them challenging.

Previous studies on the role of time preference on the adoption of sustainable farming practices have found that farmers who have high discount rates have a lower likelihood of adoption, compared to individuals with lower discount rates. For example, a study in China found time preferences are negatively related to farmers' technology adoption behaviour; in particular, farmers with higher discount rates have a lower probability of adopting green agricultural technology [30]. In Zambia, Mubanga and Umar [31] show that the proportion of farmers interested in planting fertiliser trees dropped from about 69% when the benefits from tree planting are realised in five years, to about 38% when the benefits were expected to materialise in the longer term. Alemayehu et al. [32] study in Ethiopia found that farmers are generally impatient and are not willing to make investments with longer-term yields. Based on these findings, this study proposes the following hypothesis:

Hypothesis 1 (H1). *Time preference is negatively associated with the adoption of SLM practices.*

2.3. Conceptualising Land Tenure Security, Time Preferences, and Adoption of SLM Practices

Land tenure security concerns the assurance of the land rights of an individual including access, use, control, and transfer rights to land, as well as how these rights are recognized, secured, and implemented either legally or customarily. Previous studies have identified different ways in which land tenure security is defined and operationalised in practice. There is the legal aspect of tenure security, defined as the case where farmers obtain land tenure security through formal registration and obtaining formal individualized titles to land (see [33]). In this context, land tenure security (also legal tenure) is proxied as the possession of legal title or documentation of land to evidence legal ownership of land. The possession of legal documents to prove land rights reduces ambiguity about the ownership of land and also enables the landowner to invoke the coercive hand of the state in cases where land rights are being breached. Other scholars have argued that farmers can also gain tenure security via sources other than legal [20]. They maintained that land tenure security can be attained based on customary and non-formal land tenure arrangements, particularly in the SSA context where issuance of formal land use certificates is uncommon, and where land tenure security is mostly acquired through non-formal means [20]. Studies demonstrate that in regions where customary and non-formal land tenure arrangements are recognised and efficiently secured by the local authorities, such tenurial arrangements give farmers sufficient assurance of protection of land rights, and thus incentivise their investment in land management [20,21]. In this context, land tenure security (also de facto tenure) is measured by proxies such as ownership of control and transfer right to land, e.g., right to transfer land to relatives or next of kin or to sell/lease out land, regardless of its legal status.

Past studies suggest that land tenure security (both legal and de facto) is one of the key factors that motivates the adoption of SLM practices and contributes to addressing agricultural land degradation across SSA, including Nigeria [19,20]. As documented in the literature, secure tenure rights can motivate land-related investments through four pathways. First, land tenure security can enable farmers to access credit, with the land being used as collateral [34], thereby enabling farmers to fund SLM practices. Second, the ownership of formal legal titles to land can strengthen land claims, thereby incentivising land-related investments [35]. Third, farmers with improved land tenure, particularly those

engaged in farming part-time, can allow their land to lie fallow without being afraid of experiencing land-related conflicts. The fallowed land eventually becomes more productive leading to increased yields and farm income, which can support farmers' adoption of SLM practices [36]. Finally, farmers with secure tenure rights have the freedom to make long-term land management decisions about their land without worrying about how their landlords view their decisions or about losing their investment in land management after their tenancy expires.

The relationship between land tenure security and the adoption of SLM practices is well documented. For example, a study in Tanzania found that farmers are more likely to use short-term soil fertility augmentations, such as chemical fertilizer, on rented farms than on their farms [37]. Another study of smallholder maize farmers in southwest Nigeria found that the ownership of rights to farmland positively influences the adoption of SLM practices [21]. In Brazil, Foguesatto and Machado [38] found that farmers who cultivate predominantly rented land have a higher likelihood of adopting maize-crop rotation but were less likely to adopt agroforestry practices. A plausible reason for this finding is the more immediate gains from investing in maize-crop rotation practices, compared to the deferred benefits from investing in agroforestry practices. In summary, farmers pay attention to the timing of the benefits from any land-related investments they undertake and, consequently are reluctant to adopt SLM practices that offer longer-term returns, especially where they are uncertain about their right to use the land in future years. Land tenure insecurities are particularly a main challenge for farmers in many developing countries where inequitable distribution of resources and land tenure insecurity are the leading challenges for land use policy [39,40]. As indicated in the literature, farmers in many developing countries operate on marginal land with uncertain or informal land rights, which exposes them to the risk of losing property rights to land and the associated farm income at some point in the future [39]. Insecurities about land tenure often make farmers reluctant to undertake land-related investments with longer-term benefits.

In investigating the connection between time preferences and land-improving investments, it is crucial to investigate whether an improvement in land tenure security can reduce the negative influence of time preferences on farmers' adoption of SLM practices. This study posits that farmers with high discount rates with land tenure security and without tenure security will behave differently as regards their decisions on whether or not to adopt SLM practices. Farmers with a high discount rate but with strong and continuous use and transfer rights to land may be more likely to take a positive long-term view of the long-term benefits associated with SLM practices and, thus, may be more likely to adopt them. On the other hand, tenure insecurity may influence farmers' time preferences and make them more impatient to realise a return from their investments (i.e., increase their discount rates), and therefore make them less likely to adopt SLM practices, the benefits of which are very unlikely to accrue in the short terms of their rental tenancies. In sum, this study argues that land tenure security can cancel out the negative effect of time preferences on farmers' likelihood of adopting SLM practices, indicating that tenure security plays a moderating role between the time preferences of farmers and their decision to adopt these practices. Therefore, based on the previous literature, this study offers two further hypotheses:

Hypothesis 2 (H2). *Legal land tenure is positively associated with the adoption of SLM practices.*

Hypothesis 3 (H3). *De facto land tenure is positively associated with the adoption of SLM practices.*

Hypothesis 4 (H4). *Farmers with high discount rates who have secure legal tenure rights to land are more likely to adopt SLM practices compared to similar farmers without tenure security.*

Hypothesis 5 (H5). *Farmers with high discount rates who have secure de facto tenure rights to land are more likely to adopt SLM practices compared to similar farmers without tenure security.*

3. Materials and Methods

3.1. Description of the Study Area

This study was conducted in Anambra and Imo states in the southeast region of Nigeria (Figure 1). The region is located within latitudes 5° N–6° N of the equator and longitudes 6° E and 8° E of the Greenwich (Prime) Meridian. The region is characterised by two major seasons—the dry season (between November and March) and the rainy season (between April and October). In terms of its climatic feature, the southeast region of Nigeria is classed as a tropical rainforest area that favours agricultural activities including the farming of crops such as cassava, maize, vegetables, cocoyam, etc., and livestock production [41]. The study area was chosen for two main reasons. First, Imo and Anambra states were highlighted as land degradation hotspots in Nigeria's Land Degradation Neutrality Target Setting Programme (LDN-TSP) workshop held in Abuja [42]. Both states experience severe land degradation problems because of soil erosion and fertility loss due to the high erodibility of the soils in the region [43]. Unsustainable practices, such as deforestation, and overgrazing, have further exacerbated land degradation problems in the region [43].

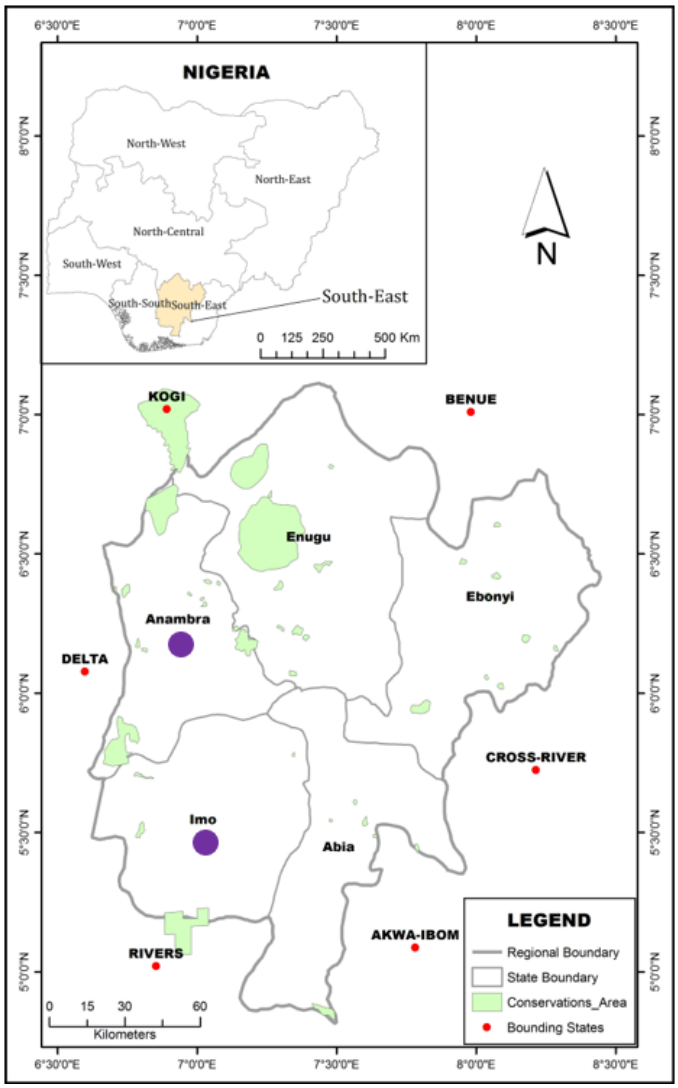

Figure 1. Map of Southeast Nigeria showing the study locations (Anambra and Imo states). Source: [40]. Note: Anambra and Imo states are denoted by purple circles.

Second, the study area is an important agricultural production area with a favourable climate for farming. However, farming activities in many parts of the region are disrupted by persistent soil erosion and gully development and expansion, which have resulted

in the loss of viable agricultural land [44]. The deteriorating soil fertility and reduction in the availability of agricultural land pose major threats to the majority of smallholder farmers in this region, nearly all of whom depend on farming for their livelihoods. There is a clear need to understand farmers' adoption decisions around SLM practices to protect agricultural soil in the area, and ultimately sustain the food and livelihood security of land-dependent households.

3.2. Sampling Techniques and Sample Size

A four-stage sampling procedure was used for the household survey. In the first stage, Imo and Anambra were purposively selected from among the five states in the southeast region of Nigeria. A simple random sampling technique was then employed to select the 480 farmers: 240 farmers each from Anambra and Imo states. Specifically at stage 2, two local government areas (LGAs) were chosen from each of the three senatorial zones in both states, giving a total of twelve LGAs. Then, at stage 3, four autonomous communities were randomly chosen from each of the twelve selected LGAs, giving a total of forty-eight autonomous communities. At the final stage, 10 farming households were randomly selected in each of the selected autonomous communities to yield a total of 480 respondents for the study across both states. Given that lists of farmers in these communities were not available, after interviewing a particular farmer in a household, the researchers omitted the next two households and then surveyed the third available household. While this approach may not be perfect, it has often been used in previous studies to achieve a random sample in a situation where a formal sampling frame is absent [45].

3.3. Data Sources and Data Collection Tools

Household surveys and interviews with farmers were employed to collect primary data. In the household survey, detailed household- and farm-level data were collected from the sampled farmers between February and April 2022 using a questionnaire. The questionnaire was structured into two main parts: survey questions and experimental questions. The survey questions collected information about farmers such as their socio-economic characteristics, farm-level factors (e.g., farm quality, slope, farm size), institutional factors, and the types of SLM practices adopted (Table 1). The experimental questions elicited the risk and time preferences of the farmers. Following Hardeweg et al. [46] the experiments were conducted after the survey questions to reduce any potential bias that could arise from a psychological desire to select options that align with previous choices made in the survey. The structured questionnaire was administered by trained research assistants through household interviews. The questionnaire was pretested on four non-sample farmers and the clarity of the questionnaire was improved accordingly. The questionnaire was designed on Qualtrics and administered using a computer-assisted personal interviewing (CAPI) technique.

Table 1. Descriptive statistics for variables from the household survey.

Variables	Measurement Strategy	Mean	Std. Dev	Expected Sign [a]
Explained variable				
Agroforestry	If farmer adopts agroforestry = 1; 0 otherwise	0.73	0.45	
Terracing	If farmer adopts terracing = 1; 0 otherwise	0.62	0.47	
Land fallow system	If farmer adopts land fallow system = 1; 0 otherwise	0.88	0.33	
Main explanatory variables				
Time preferences				
Experiment method	Discount rate of farmers	0.30	0.24	–
Survey	I am someone who generally is patient and willing to wait for future benefits (range: 1 = strongly disagree to 5 = strongly agree).	4.41	1.07	–

Table 1. *Cont.*

Variables	Measurement Strategy	Mean	Std. Dev	Expected Sign [a]
Control variables				
Legal tenure security	If the farmer has formal/unofficial tenure documentation, attesting to use and ownership of land [b] = 1; 0 otherwise	0.27	0.44	+
De facto tenure security	If the farmer has the right to use, own and/or transfer land to their kindred or to sell/lease out land [c].	0.61	0.49	+
Gender of the farmer	Female = 1; male = 0	0.61	0.49	+/−
Household size	Number of household members feeding from the same food basket in the last 6 months	6.05	2.84	+
Education	Number of years spent in school	9.52	4.09	+/−
Age	Number of Years	50.77	14.48	−
Marital status	If the farmer is married = 1; 0 otherwise	0.76	0.43	+
Credit constrained	If the farmer is credit-constrained = 1; 0 otherwise	0.35	0.48	−
Membership in social organisation	If the farmer is a member of any village group or cooperative society = 1; 0 otherwise	0.65	0.48	+
Risk aversion	Elicited using risk experiment; Risk-averse farmer = 1; 0 otherwise	0.65	0.48	+/−
	Elicited using survey: I am someone who generally is fully prepared to take risks (1 = strongly disagree to 5 = strongly agree).	3.71	1.55	+/−
Farming experience	Number of years of farming as a livelihood/business	20.28	14.13	−
Farm size	Total farm sizes measured in hectares	1.05	1.63	+
Erosion problems on farmland	If the farmer perceives a soil erosion problem on any of their farmlands = 1; 0 otherwise	0.30	0.46	+
Moderate soil fertility	If the farmer reports moderate soil fertility on any of their farmlands = 1; 0 otherwise	0.35	0.48	+
Poor soil fertility	If the farmer reports poor soil fertility on any of their farmlands = 1; 0 otherwise	0.07	0.26	+
Good soil fertility	If the farmer reports good soil fertility on any of their farmlands = 1; 0 otherwise	0.58	0.50	+/−
Steep slope	If the farmer reports a steep slope on any of their farmlands = 1; 0 otherwise	0.11	0.31	+
Climate awareness	If the farmer perceives changes in rainfall or temperature patterns over the last 5 years = 1; 0 otherwise	0.87	0.33	+
Plot remoteness	Distance from main farm to nearest output market in walking minutes.	26.49	24.60	−
Location	If the farm is located in Anambra State = 1; 0 otherwise	0.50	0.50	+/−

Note: [a] A positive sign (+) implies that a positive relationship is expected, a minus sign (−) implies a negative relationship, while both a positive and negative sign (+/−) implies that either a negative or a positive relationship is expected, based on the review of the literature. [b] This study asks farmers about the possession of unofficial land documents (in addition to formal documents) because the possession of deeds or land certificates to evidence legal land rights in accordance with the statuary land tenure of Nigeria is uncommon in the study area. Other scholars have used informal documents as a proxy for legal land tenure in situations where respondents do not possess formal land documents [20]. [c] tenure security gained via the purchase of the land or inheritance.

Additionally, ten semi-structured interviews were conducted with farmers (five males and five females) to explore their perspectives regarding the adoption of SLM practices. With the help of the local extension agents, a purposive sampling strategy was used to choose the farmers interviewed. They included farmers who are currently adopting or have previously adopted SLM practices. The qualitative data obtained were used to help explore the quantitative results. Data collection was carried out after obtaining informed consent from the respondents. Ethical approval for this study was granted by the Newcastle University Ethics Committee—Ref: 16628/2018.

3.4. Data Analysis

The quantitative data were analysed using descriptive statistics and econometric models, such as the Multivariate Probit (MVP) model, using STATA version 15. Qualitative data were analysed based on the thematic analysis procedures of Braun and Clarke [47] using NVivo software (version 12) by QSR International.

Econometric Model Specification: Multivariate Probit (MVP) Technique

The MVP model was employed to answer the research questions. The main motivation for the choice of MVP is that, unlike univariate models, such as probit and logit, the MVP allows for the simultaneous modelling of the effect of the independent variables on each of the three SLM practices, while allowing the error terms to be correlated [48]. Moreover, the MVP model trumps univariate models by recognising the interdependent associations among adoption decisions regarding the different SLM practices [49]. Several empirical studies have argued that farmers do not adopt agricultural technologies independently, rather they implement such technologies simultaneously and/or sequentially [49]. In other words, the choice of these SLM practices is interdependent and their adoption decision is inherently multivariate. Consequently, to account for such interdependent relationships, the MVP technique was employed to model farmers' adoption of SLM practices.

In this study, an MVP model with three sets of binary dependent variables representing the three SLM practices of interest to this study (i.e., agroforestry, terracing, and land fallow practices), was estimated to analyse farmers' adoption decisions.

The MVP econometric model is specified as follows:

$$Y_{im}^{*} = \beta_{im}' X_{im} + \varepsilon_{im}, \quad (1)$$

(m = agroforestry, terracing, land fallow practices).

$$Y_{im} = 1 \text{ if } Y_{im}^{*} > 0 \text{ and } 0 \text{ otherwise} \quad (2)$$

where Y_{im}^{*} represents the dependent variable (adoption decision of SLM practices); β_{im}' represents the vector of the explanatory variables (e.g., socioeconomic, farm level, and climatic characteristics) that influence farmers' adoption decisions; (X_{im}) represents the vector of an unknown parameter to be estimated; and ε_{im} represents the unobserved disturbance or error term, m = 1, . . ., 3. In the MVP model, the error terms are assumed to be jointly distributed multivariate normal random variables (MVN) each with zero conditional mean and a unitary variance. The symmetric covariance matrix δ is represented below:

$$\delta = \begin{bmatrix} 1 & \boldsymbol{\rho 12} & \boldsymbol{\rho 13} \\ \boldsymbol{\rho 21} & 1 & \boldsymbol{\rho 23} \\ \boldsymbol{\rho 31} & \boldsymbol{\rho 32} & 1 \\ \boldsymbol{\rho 41} & \boldsymbol{\rho 42} & \boldsymbol{\rho 43} \\ \boldsymbol{\rho 51} & \boldsymbol{\rho 52} & \boldsymbol{\rho 53} \end{bmatrix} \quad (3)$$

The bold-text figures in the matrix presented in Equation (3) denote the pairwise correlation coefficient of the error terms of the different types of SLM practices. A positive correlation suggests complementarity between a farmer's decision to adopt the types of SLM practices, while a negative correlation suggests that the types of SLM practices are implemented as substitutes.

3.5. Specification of Variables in the Model

3.5.1. Dependent Variables

As indicated earlier, this study considers three SLM practices: agroforestry, terracing, and land fallow practices. Three dummy variables were created as a measure of adoption for each of these SLM practices, each taking a value of one if the farmer adopts the practice on their land, or a value of zero otherwise.

3.5.2. Key Explanatory Variable

The main explanatory variable is the time preference parameter of farmers. Farmer's time preferences were measured using both survey questions and experiments with hypothetical payments. The survey method required farmers to answer the statement "I am someone who is generally patient and willing to wait for future benefits", based on a Likert-type scale ranging from 1 strongly disagree to 5 strongly agree. For the experiment, this study used the multiple price list (MPL) time preference experiment of [25], which was adapted by other scholars for use among farmers in a comparable developing country to Nigeria [16]. In the experiment, farmers had to decide between receiving a hypothetical payment in one month (option A) or receiving a larger hypothetical payment in two months (option B). The choices between immediate and delayed financial rewards were restated eight times, with increasing payoffs in option B and a fixed amount in option A. The design and procedures for the experiment are shown in Supplementary S1 and Table S1 in the Supplementary Materials and were easy for farmers in the study area to understand, despite their low literacy levels, thereby reducing the chances of measurement error. Small monetary payments were made to participating farmers after the experiments in appreciation of their time. The risk and time preference experiments were conducted after the survey questions to diminish probable bias that may arise from a psychological desire to select options that align with the previous choices made in the survey.

3.5.3. Control Variables

Other potential variables affecting farmers' adoption of SLM practices suggested by the literature, were included as control variables in the MVP model. They include land tenure security, farmers' socio-economic characteristics (gender, household size, education, age, credit access, marital status, membership in social organisation, and farm experience), risk preferences, farm characteristics, and environmental and regional characteristics.

Just like in other SSA countries, land property rights in Nigeria are determined by a combination of statutory and customary laws [50]. Therefore, recognising the legally pluralistic contexts of the study area, this study operationalises tenure security as (i) legal security and (ii) de facto security. As highlighted in Section 2.3, it is expected that tenure security (legal and de facto) increases the likelihood of the adoption of SLM practices. The gender of the farmer/head of household has often been included in such models but is difficult to link to the adoption of SLM practices, given that studies have reported mixed results. For example, drawing from cases in Malawi and Ethiopia, Kirui and Mirzabaev [12] found that male-headed households (MHHs) were less likely to adopt SLM practices in Malawi, but more likely to adopt them in Ethiopia compared to female-headed households (FHHs). Furthermore, Nigussie et al. [51] found that male farmers were less likely to undertake manure application, though more likely to use inorganic fertiliser. The authors explain that because female farmers often cannot afford to purchase external inputs such as inorganic fertilisers, they often rely on the application of organic fertiliser in their fields. The household size reflects the availability of family labour within the household. Thus, the larger the household size, the greater the likelihood of farmer's adoption of SLM practices, especially labour-intensive practices like terracing [52]. Thus, it is expected that household size can increase the likelihood of the adoption of SLM practices.

Previous studies have found a mixed relationship between education and the adoption of SLM practices. Some studies show that the educational level of farmers positively affects their adoption of certain SLM practices, such as constructing stone bunds and the use of organic and chemical fertilisers [38,52,53]. These authors argue that farmers with higher educational attainment may be better able to understand the problems of land degradation and the need to adopt SLM practices. However, other studies, such as the Nyanga et al. [54] study in Tanzania, have found a negative relationship between farmers' educational levels and the adoption of some SLM practices, such as the use of stone-faced and traditional stone bunds, and the application of inorganic fertiliser. This finding was supported by the generally low literacy status of the farmers in the study area and the low emphasis on

environmental issues in the curriculum for elementary-level education in Tanzania. Thus, the educational status of farmers could either positively or negatively affect SLM practices. The age of the farmers is reported by some scholars to be negatively related to the adoption of SLM practices [55]. By implication, the older the farmer, the less likely they are to adopt SLM practices. This finding was argued to be a consequence of the shorter career planning horizon of older farmers and their reluctance to change their long-serving but unsustainable farming practices and embrace new SLM practices. Furthermore, studies have found that married farmers have a higher likelihood of adopting SLM practices compared to single farmers because married farmers tend to have a greater number of household members who can provide the labour necessary to carry out more labour-intensive farming activities [21]. Thus, it is expected that marital status will be positively related to the adoption of SLM practices. In addition, empirical studies suggest the positive effect of membership of social groups on farmers' decisions to adopt SLM practices [15,56]. Therefore, it is expected that membership in a social group can positively affect SLM practices adoption. Farmers' access to informal and formal credit enables them to invest in SLM practices that are costly and offer deferred benefits [12], and thus, it is expected that credit constraints can negatively affect the adoption of SLM practices. Farming experience is expressed as the number of years the farmer has engaged in farming. Studies report a negative association between farm experience and the adoption of SLM practices, suggesting the tendency of experienced farmers to be more confident about their current practices and therefore feel less need to adopt SLM practices [57]. Thus, it is expected that farming experience can negatively affect the adoption of SLM practices.

There are mixed results regarding the association between farmers' risk aversion and the adoption of SLM practices. Some studies have found that risk-averse farmers are reluctant to adopt new technology because they try to avoid the risk of making losses on their investments [58]. However, other studies have observed risk aversion to be positively associated with the probability of adopting SLM practices, depending on their risk-reducing features and the opportunity costs of inputs within the overall household economy [15,59]. Thus, it is expected that farmers' risk aversion can positively or negatively affect the adoption of SLM practices. In terms of farm characteristics, some scholars suggested that an increase in farm size significantly increases the likelihood of farmers' investing in SLM practices [60]. The authors implied that large-scale farmers are better able to devote some portion of their farmlands for on-farm trials and experiments with SLM practices; hence, the potential for loss is more manageable than it would be in smaller farms.

Farmers who experience soil erosion and other soil-related challenges on their farms have a higher likelihood of adopting SLM practices [61]. Similarly, farms with poor soil quality are more likely to implement SLM practices [11]. In addition, several studies agree that farmers' perceptions of increased climate variability have a positive impact on the adoption of SLM practices [52]. Overall, it is expected that farm size, the experience of soil erosion and other soil-related challenges (e.g., sloping land), and climate awareness can all positively affect the adoption of SLM practices. In terms of the relationship between proximity to markets and farmers' decisions to adopt SLM practices, several studies report that an increase in distance to the market reduces the probability of adopting SLM practices [62]. A plausible explanation for this is that a greater travelling distance not only translates into an increased transaction cost but also reduces the opportunity to access credit institutions, which consequently reduces farmers' ability to adopt SLM practices. Thus, it is expected that being in a more remote location has a negative influence on the adoption of SLM practices. Moreover, the location of the farm can either positively or negatively affect the adoption of SLM practices as demonstrated by [11].

4. Results and Discussion

4.1. Summary Statistics for Variables from the Household Survey

Table 1 reports the descriptive statistics of the variables from the household survey. The result shows that approximately 73%, 88%, and 62% of the sample farmers adopt

agroforestry, land fallow practices, and terracing, respectively. An analysis of the time preference experiment data reveals that the average time discount rate across the sample is 0.30. This suggests that, on average, the sampled farmers are very impatient relative to the distant future. This result contrasts with the outcome from the survey method, which indicates that, on average, farmers are patient and willing to wait for future benefits ($\bar{x}$ = 4.41). The discrepancy in the results of the two different elicitation methods is also reported by other scholars, who observed that the elicited time preferences of respondents differed depending on the method used [63]. Given the popularity of the MPL time preference experiment method in the literature [16,58,64], the time preference parameter (discount rate) determined by the experiment method was used for the subsequent analyses conducted in this study. These findings align with some comments noted during the experiments, such as "Let me go for the earlier option, the payment of 10,000 Nigeria naira"; "I love doing something that will give me quick money"; and "I will take the one month offer because it's closer". The estimate of the farmers' discount rate is similar to the elicited discount rate (δ = 0.32) for a sample of maize farmers in Burkina Faso who participated in a similar time preference experiment [16].

Table 1 shows that 61% of the sampled farmers have de facto tenure security, while less than a third (27%) of the farms have legal tenure security; that is, they possess either formal or unofficial documents to attest to their tenure. The result further shows that female farmers accounted for approximately 61% of the sample. An average farmer has spent about 10 years in school, indicating low literacy levels among the sampled farmers. The average age of the farmers is approximately 51 years. The majority (76%) of the farmers are married and the average household size is six. Access to credit is an issue for the sample, as just over a third of the sampled farmers indicated that their activities were constrained by a lack of available credit. In terms of social capital, nearly two-thirds of the sample belong to either a village group or a cooperative society.

The risk preferences of farmers were measured based on their responses to a general risk assessment question (see Table 1) and with the use of a lottery-choice experiment with hypothetical payoffs devised by [65], shown in Supplementary S2 and Table S2 in Supplementary Materials. This simple risk experiment can be easily understood by farmers in the study area who have, on average, low literacy levels. An analysis of the responses from the risk experiment reveals that the majority (65%) of the sampled farmers are risk-averse. The result of the self-reported risk assessment methods shows a mean score of 3.71, suggesting that the sampled farmers are, on average, risk-loving. Again, the result of this self-assessment method of farmers' risk attitude contrasts with the results from the lottery-choice experiment, as observed by other scholars [66]. The risk preference determined by the experiment method was used for the subsequent analyses conducted in this study, given its popularity in the literature.

Furthermore, this study found that an average farmer in the study has undertaken farming as their own business and main livelihood source for about 20 years. This suggests that on average, farmers in the sample have long-term farming experience which has implications for their decisions to adopt SLM practices [67]. It was observed that most of the farmers are smallholders, with an average farm size of 1.05 hectares. Meanwhile, 30% of farmers said that they suffer from problems with erosion on their farms. Furthermore, 58% of the farmers reported that their cultivated land had good soil fertility, about 35% of farmers reported that their cultivated land was moderately fertile, and only 7% complained of poor soil fertility. In terms of the farm terrain, 11% of the farmers stated that their farmland has a steep slope. Also, in common with the findings of Anugwa et al. [68], the majority (87%) of farmers have noticed changes in the climate over the past five years in terms of temperature changes and erratic rainfall patterns. Also, Table 1 shows that it takes an average of 26 min to walk from the main farm to the nearest output market. The distance to the nearest major market is indicative of households' ease of access to market information, input supplies, and other market-related facilities.

4.2. Interrelationships between the SLM Practices

Two sets of MVP models were estimated to answer the research questions. Model I is the main effect model that estimates the factors influencing the adoption of SLM practices, especially the variable of interest—farmers' time preferences. Model II is the interaction effect model that reports the interaction effect between time preference and land tenure security (de facto and legal) on the adoption of SLM practices. The log-likelihood ratio (LR) of Model I and Model II are −191.348 and −188.042, respectively, with Wald chi-square (57) = 106.98 and Wald chi-square (63) = 110.49 values both significant at ($p < 0.01$), indicating that the MVP models are of good fit. It is observed that including the interaction terms (time preference × tenure security) in Model II marginally improves the MVP models' log likelihood value. This suggests that the addition of the interaction terms improved the quality of the model.

Before discussing the main MVP results, the error term correlation matrix of the MVP models presented in Table 2 indicates a possible association between the adoption of the three SLM practices considered in this study. The result indicates interdependence between the SLM practices, therefore justifying the choice of the MVP model as more appropriate than estimating independent regression models.

Table 2. Correlation matrix of the adoption of SLM practices from the MVP models.

	Model I			**Model II**		
SLM practices	**Agroforestry**	**Terracing**	**Land fallow**	**Agroforestry**	**Terracing**	**Land fallow**
Terracing	0.564 *** (0.151)			0.560 *** (0.156)		
Land fallow	−0.132 (0.231)	0.306 (0.243)		−0.156 (0.246)	0.300 (0.243)	
Likelihood ratio test for rho21 = rho31 = rho 32= 0.00 chi2(3) = 13.89 ***				Likelihood ratio test for rho21 = rho31 = rho 32= 0.00 chi2(3) = 13.37 ***		

*** Indicates statistical significance at $p < 0.001$, respectively. rho shows the correlation between SLM practices; 1 = Land fallow practices; 2 = Agroforestry; 3 = Terracing.

Table 2 shows that only the correlation of error terms for agroforestry and terracing are significant and positively correlated. The positive relationship suggests complementarity between a farmer's decision to adopt agroforestry and terracing. In other words, a farmer who practices agroforestry on their farm is more likely to adopt terracing on their land.

4.3. Time Preferences and the Adoption of SLM Practices

Table 3 shows that farmers' time preferences are negatively associated with the adoption of each of the three SLM practices, but this result is only significant in the case of agroforestry and land fallow practices. This result marginally supports H1. The result indicates that farmers with high discount rates (therefore impatient) are less inclined to adopt agroforestry and land fallow practices. This is plausible given the intertemporal benefits of these SLM practices. Given that agroforestry and land fallow practices can only improve land quality after several years, farmers with higher discount rates are more focused on current gains and thus will have a lower likelihood of adopting these SLM practices. On the other hand, farmers with low discount rates appreciate the significance of the intertemporal benefits delivered by these SLM practices and thus are more inclined to adopt them. Overall, this result suggests that the high discount rate observed in the sampled farmers is one reason for their low adoption of SLM practices. The result of this study is supported by other scholars who report that farmers with higher discount rates have a lower likelihood of adopting agricultural technologies with intertemporal benefits [30,69].

Table 3. MVP Model I: Factors influencing the adoption of SLM practices.

Variables	Agroforestry		Terracing		Land Fallow	
Key explanatory variable	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error
Time preferences (discount rate)	−1.192 **	0.528	−0.771	0.552	−1.838 **	0.857
Control variables						
De facto tenure security [a]	0.645 ***	0.245	0.513 **	0.262	0.607 *	0.359
Legal tenure security [b]	0.641 *	0.351	1.805 ***	0.319	0.664	0.542
Gender of the farmer	−0.891 ***	0.303	0.416	0.280	−0.746	0.482
Household size	−0.152 ***	0.050	0.127 **	0.052	0.032	0.076
Education	0.050	0.033	0.067 **	0.033	0.026	0.048
Age	−0.018	0.012	−0.002	0.012	−0.019	0.017
Marital status	0.684 **	0.333	−0.368	0.334	−1.304 **	0.626
Credit constrained	−0.254	0.251	0.543 **	0.255	−0.940 **	0.409
Membership in social organisation	0.017	0.294	0.375	0.308	0.346	0.410
Risk aversion [c]	−0.062	0.275	−0.028	0.278	−0.927 **	0.435
Farm experience	0.037 ***	0.013	0.016	0.012	0.047 **	0.023
Farm size	0.170	0.148	−0.034	0.057	0.349	0.295
Erosion problems on farmland	0.625 **	0.249	0.071	0.245	−0.120	0.352
Good fertile soil [d]	0.017	0.240	0.097	0.244	−0.278	0.356
Steep slope [e]	0.678 **	0.298	0.572 *	0.298	1.325 **	0.607
Climate awareness	−0.331	0.397	−0.055	0.399	0.433	0.549
Plot remoteness	0.105	0.124	−0.014	0.123	0.065	0.205
Anambra state [f]	0.454	0.290	0.692 **	0.283	−1.461 ***	0.558
Constant	0.545	1.119	−3.609	1.101	3.860	1.786

Notes: [a] tenure insecurity (farmers operating on communal, sharecropped, or rented land); [b] tenure insecurity (land without formal or unofficial documentation); [c] risk neutral and risk loving are the reference categories; [d] perceived poor and moderate soil fertility are the reference categories; [e] flat slope is the reference category; [f] Imo state is the reference category; ***, **, and *: significant at 1%, 5%, and 10%, respectively.

The qualitative findings corroborate the MVP result. During his interview, one male farmer mentioned that he does not practice agroforestry because of *"the time factor"*. Another female farmer expressed the following concerning the implementation of any of the SLM practices introduced by EAs in the area:

> *"I think about cost-effectiveness and profit before I practice anything on my farm. I wouldn't want to wait for a long time before I get my money back. So, I don't practice anything that would tie my money down. I want something that will give me a quick harvest, I take the produce to the market, and return the money to my farm business"*. (female farmer, Imo state)

A male farmer added:

> *"... there is hunger everywhere, no money to take care of the family. These practices that you are talking about like agroforestry or bush fallowing are good for the soil, but they don't ameliorate the soil as fast as when I apply chemical fertilisers. In our area, farmers are not patient to wait for their slow effect on the soil. So that is the main issue here. We need quick money here to feed our family"*. (male farmer, Anambra state)

This result strongly suggests that financial constraints associated with farmers' time preferences impede farmers' adoption of SLM practices. This is especially the case for smallholder farmers, who must prioritise meeting their immediate food needs and who cannot afford to make investments that do not generate benefits within a relatively short period.

4.4. Land Tenure and the Adoption of SLM Practices

As shown in Table 3, legal tenure security is positively related to the adoption of agroforestry, terracing, and land fallow practices, but is only statistically significant in the case of the first two. This result marginally supports H2. This finding suggests that the possession of legal title of land can act as an incentive to undertake SLM practices such

as agroforestry and terracing which entail structural adjustments to the farm landscape. Furthermore, the results in Table 3 show that de facto tenure security is positively and significantly associated with the adoption of each of the three SLM practices considered, consistent with H3. This finding indicates that de facto tenure security creates a high level of tenure security (regardless of the possession of formal land titles) and encourages farmer's adoption of these SLM practices. Taken together, these findings reflect the fact that in customary dominant rural contexts such as the case of the study area, de facto tenure security offers farmers a similar level of security over their land, just as the possession of formal land rights. This assertion reinforces Ayamga et al.'s [70] argument that labelling customary/informal land tenure rights as insecure can be misleading.

Broadly speaking, the results suggest that land tenure security encourages farmers' adoption of SLM practices. The explanation for this finding may reflect the fact that these SLM practices are long-term practices and demand significant investment, so without land tenure security, their adoption becomes riskier. These results are consistent with other studies suggesting that legal land tenure security encourages farmers to invest in SLM practices [20,52], as well as other scholars showing that de facto tenure security significantly influences investments in land-improving measures [20]. During the qualitative interviews, some of the farmers argued that tree planting was often difficult given the specific land use restrictions imposed by landowners. One of the farmers interviewed, who cultivates rented land, explained that they cannot plant trees on their rented land as this would go against the tenancy agreement. According to the farmer:

> *"...the landowner will not like it, he will just say, stop doing those things, to avoid trouble, you manage what you see there"*. (male farmer, Anambra state)

Moreover, the qualitative interviews revealed that the short duration and uncertainty of their tenancy discourage farmers from implementing SLM practices with deferred benefits. For example, a farmer interviewed stated:

> *"I am not allowed to plant trees because before the trees grow the landowner may want the land back. Because the land is rented, I will plant crops that I can harvest within a shorter period"*. (female farmer, Anambra state)

Another farmer stated:

> *"I find it difficult to use my limited finances to implement farming practices that cost money on land that is not my own. Will I keep the land after the investment? No! So, because I do not have ownership of the farmland; I have limited time to do whatever I want to do there. I must vacate the land within the agreed tenancy period of 2 years. So, constructing a terrace will not favour me in the long run"*. (male farmer, Imo state)

4.5. Other Factors Influencing the Adoption of SLM Practices

Regarding other control variables in the models that showed significant association with the adoption of SLM practices, the results in Table 3 show that compared to men, women farmers were less likely to adopt agroforestry. The lower probability of agroforestry adoption among women farmers might be ascribed to the fact that in the study area, planting or keeping trees on land is a common strategy used by farmers to retain or protect land rights. Unlike male farmers, female farmers usually do not own their farmlands, and hence, they are less likely to practice agroforestry, especially because of the fear of being evicted by the landlord who might accuse them of wanting to claim the land by planting trees.

A female farmer stated:

> *"No, you can't plant trees because you are not the owner of the land. Your tenancy will expire, and you have to leave and look for other land. Moreover, the landlord will warn you. They might be thinking that you want to claim their land, if you put trees there"*. (female farmer, Anambra state)

This result strongly suggests that the perceptions of landlords around land tenure and agroforestry act as a disincentive to their adoption by female farmers, who usually lack land rights.

The results in Model I also show that household size is positively related to the adoption of terracing but negatively related to the adoption of agroforestry. This indicates that larger households are more likely than smaller households to adopt terracing, but less likely to adopt agroforestry. This finding is plausible given that the adoption of soil conservation practices, such as terracing, requires large amounts of labour, and household members can provide a source of family labour for such activities, thus encouraging the adoption of terracing. This result concurs with Legesse et al. [71], who found that an increase in household size increased the likelihood of adopting terracing among farmers in Ethiopia. On the other hand, the adoption of agroforestry is capital-intensive, requiring money for purchasing improved seedlings and sufficient land area. A large household may mean there is more pressure on the available resources in the household and, thus, lower financial capacity to adopt SLM practices, especially capital-intensive practices such as agroforestry. Also, consistent with the study of Issahaku and Abdul-Rahaman [52], this study found that the educational level of farmers positively influences their adoption of terracing. This result is linked to the fact that farmers with higher educational attainment may be better able to understand the problems of land degradation as well as the technical details of constructing terraces on the land.

Furthermore, Table 3 also shows a mixed effect of marital status on the adoption of agroforestry and land fallow practices. The results show that married farmers are more likely to adopt agroforestry but less likely to adopt land fallow practices. The increased likelihood of the adoption of agroforestry by married farmers is expected and supports the findings of other scholars who report that married farmers are more likely to adopt SLM practices [21]. Compared to single farmers, married farmers can contribute more of their resources to fund investment in SLM practices, thus leading to a greater probability of adoption. Moreover, the greater preference for agroforestry by married farmers could be because they are more attracted to the multiple benefits it offers, such as fertility improvement plus money from sales of the tree products, compared with land fallow practices that offer mainly soil fertility improvements.

Also, the results in Table 3 show that credit-constrained farmers are less likely to adopt land fallow system but more likely to adopt terracing. This finding partly agrees with other studies, which report that farmers' access to credit could have an important effect on the adoption of SLM practices [12]. The unexpected positive effect of credit constraints on the adoption of terracing can be explained based on the fact that farmers without access to credit would have a greater likelihood of implementing terraces to improve their yield (especially on sloping land) and thus earn more farm income to improve their finances. The results further show a negative and significant relationship between the risk-averse attitude of the farmers and the adoption of land fallow practices. This result suggests a lower probability of risk-averse farmers adopting this SLM practice. This result is consistent with the findings of other scholars who found that risk-averse farmers are less likely to use certain SLM practices because they try to avoid the risk of making losses on their investments [15]. Implementing land fallow practices requires abandoning the land for a certain period, which may be risky if the right to land is insecure. Moreover, the cost implications of land fallow practices may lead risk-averse farmers not to adopt this practice.

Contrary to this study's expectation, the result suggests that more experienced farmers are more likely to adopt agroforestry and land fallow practices. This result can be explained based on the fact that experienced farmers are likely to have relatively better knowledge of the spatial variability of their land and in judging the associated costs and benefits involved in implementing SLM practices and, thus, are more likely to adopt SLM practices. Moreover, regarding environmental factors, the results show that farms that experience erosion are more likely to adopt agroforestry. During discussions with farmers during the survey, they indicated that one of their motivations for keeping trees on farmland

is to control soil erosion. Moreover, as suggested in other studies, farmers with farms experiencing soil erosion and other soil-related challenges have a higher likelihood of adopting SLM practices [61]. Also, as expected, the result shows that farms with steep slopes are more likely to implement each of the three SLM practices. The slope of the farm is an important indicator of its vulnerability to degradation. Farms with steeper slopes are more likely to be exposed to degradation and are more susceptible to rapid surface runoff, hence the increased likelihood of adoption of these SLM practices on such land. This result is corroborated by other scholars who found that the bio-physical features of the farm are an important factor influencing the adoption of SLM practices [51]. Furthermore, the likelihood of adopting land fallow system significantly decreased when the farm is located in Anambra state compared to Imo state. Also, the likelihood of adopting terracing significantly increased when the farm is located in Anambra state compared to Imo state.

4.6. Effect of Land Tenure Security on the Relationship between Time Preference and SLM Practices Adoption

The results of the interaction effect MVP model presented in Table 4 show two important findings: (i) the direct effect of time preferences on the adoption of each of the three SLM practices is negative and statistically significant; (ii) the coefficient of the interaction term of time preferences and de facto tenure security becomes positive and statistically significant for the adoption of agroforestry and terracing practices, indicating the moderating role of de facto tenure security in the relationship between farmers' time preferences and their adoption of these SLM practices, thus supporting H5. This result underlines that farmers with higher discount rates, but who have de facto tenure security, have a greater likelihood of adopting these SLM practices compared to similar farmers who lack tenure security. One possible explanation for this might be that, compared with impatient farmers who lack tenure security, impatient farmers with tenure security are more future-oriented and therefore might be more likely to adopt SLM practices with intertemporal benefits, since they are not exposed to the risk of losing their rights to land and the benefits resulting from investing in SLM practices in later years. Moreover, land with tenure security can be used as collateral to improve access to credit for investment in SLM practices, which can then address the financial constraints of farmers during the period waiting for the gains from SLM practices to accrue. In general, this result suggests that the security-enhancing effect of land tenure security makes farmers more willing to adopt these SLM practices, notwithstanding their time preferences.

Table 4. MVP Model II: The interaction effect between time preference and adoption of SLM practices.

Variables	Agroforestry		Terracing		Land Fallow	
	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error
Time preferences (discount rate)	−2.415 ***	0.872	−1.878 *	1.076	−1.925 *	1.127
Time preference × de facto tenure security	2.048 *	1.070	2.111 *	1.223	0.058	1.527
Time preference × legal tenure security	0.130	1.315	−1.029	1.270	0.288	2.094
Control variables [a]	Yes	Yes	Yes	Yes	Yes	Yes

Notes: [a] All the explanatory variables used in MVP Model I were used as control variables; *** and *: significant at 1% and 10%, respectively

Furthermore, the results in Table 4 do not provide evidence for the moderating role of legal tenure security in the relationship between farmers' time preferences and their adoption of SLM practices. This result seems to reinforce the long-held view that land property rights interventions (e.g., rural land titling) may have a limited impact in bolstering land-related investments in areas where customary tenure systems already provide a relatively high level of tenure security [72,73].

5. Study Limitations and Future Research Suggestions

Although this study enriches the literature on sustainable land management, there are some limitations. The findings are based on smallholder farmers in the Southeast region of Nigeria; further studies can verify whether or not similar findings can be observed in other regions. Moreover, this study's methodology can be applied to conduct similar research in areas with comparable socio-economic and agrarian characteristics to Nigeria, and where time preferences and tenure security are important factors for farmers' decision-making regarding agricultural technology adoption. Also, future research can use longitudinal data that captures time-varying heterogeneities in the time preferences of farmers and better reflect the relationship with SLM practices adoption choices. Finally, future studies can examine other SLM practices with intertemporal benefits (e.g., crop residue management and planting vetiver grass), to examine whether similar conclusions can be drawn. It is also worth investigating whether the financial empowerment of farmers cancels out some or all of the negative effects of time preference on the adoption of sustainable agricultural technology.

6. Conclusions and Policy Implications

This study investigates the relationship between farmers' time preferences and the adoption of SLM practices (agroforestry, terracing, and land fallow practices) by recognising the intertemporal elements of these practices. More importantly, it adds to the literature by documenting the moderating role of land tenure security in the relationship between farmers' time preferences and the adoption of SLM practices. The time preference parameters for farmers were obtained using both a survey and experiments with hypothetical payouts. Given the legally pluralistic contexts of the study area, land tenure security was conceptualised as a composite concept of legal and de facto tenure security.

The findings of this study provide empirical support for the notion that time preferences are negatively associated with the adoption of SLM practices (agroforestry and land fallow practices). This result implies that farmers with higher discount rates are less likely to adopt these SLM practices. The results further show that both legal and de facto tenure security encourage the adoption of the SLM practices considered, thus indicating the significance of ownership of land rights in facilitating long-term land investments. This finding also highlights that farmers in the area accord the same level of importance to de facto security and legal security in safeguarding their tenure rights. Other characteristics of farmers, such as gender, marital status, access to credit, education, household size, farming experience, risk attitude, and farm characteristics (e.g., erosion problems and steepness of slopes), are also significant factors associated with the adoption of the SLM practices considered. Furthermore, a link was established between farmers' time preferences, de facto tenure security, and their adoption of SLM practices. This study shows that farmers with high discount rates who have tenure security have a greater likelihood of adopting agroforestry and terracing, compared to similar farmers who lack tenure security. This finding indicates that land tenure security (de facto) can alleviate the negative influence of time preferences on the adoption of these SLM practices.

The findings from this study have important policy implications. To tackle the problem of farmers with high discount rates, a key message for policy is the design and provision of targeted incentives, such as subsidies on farming inputs, agricultural insurance, and agricultural credit schemes, that address the financial constraints of farmers during the period they have to wait for the gains from their investment in SLM practices to accrue. It is equally important that credit institutions recognise the long-term nature of returns from certain SLM practices and factor this into the design of credit repayment plans. Additionally, it is recommended that policymakers devise approaches to internalise the positive externalities generated by the SLM practices, as this could lead to farmers reaping the "full" gains of their labour and creating greater incentives for SLM and ecosystem preservation. Currently, such policies are absent in the study areas and in Nigeria generally. Also, given that the security-enhancing effect of land tenure security (de facto) can cancel

out the negative influence of time preferences on farmers' adoption of SLM practices, we recommend greater policy attention is given to land tenure security perceptions of farmers as these play key roles in their land investment decisions. Policy recommendations from this study are important for Nigeria as well as other African countries with similar land tenure and agricultural systems.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su16051747/s1. S1: Design and procedures for the time preference experiment; Table S1: MPL time preference experiment. S2: Design and procedures for the risk experiment; Table S2: Risk experiment. References [16,25,65] are cited in the supplementary materials.

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