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Original Research Article

Determinants of forest land use decisions among rural farm households in south-western Nigeria

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Abstract

The study examined factors determining forest land use decisions among rural farm households in south-western Nigeria. Primary data on socio-economic and community characteristics as well as land use systems were obtained from 300 farm households using a structured questionnaire through a multistage sampling technique. The study revealed that marital status ($P < 0.01$), gender ($P < 0.01$), land tenure security ($P < 0.01$), dominant crop type ($P < 0.05$), and preference for tree on farm land ($P < 0.01$) are factors influencing forest land use decision in either agroforestry, pure cultivation or in both practices. Land use choice proportion estimation shows that 63 % are still willing to retain their existing land use practice (pure cultivation). A total of 32 % are willing to shift completely from their existing land use practice while 4% of the respondents are willing to practice both "agroforestry and pure cultivation" simultaneously. The study therefore suggests the need for a change in forest land use policy, particularly, with a view influence the pattern of use, limitation on type of crop that can be grown, and compliance to sustainable land use practice. This would go a long way in driving forest land use towards agroforestry – a practice identified as a means of ensuring food security while ensuring safe environment.

Keywords: forest; land use; carbon sequestration; agroforestry.

INTRODUCTION

Over the years, people have lived within and around forests. In most tropical regions of the world with Nigeria inclusive, human settlements, especially, the rural households strongly depend on forest and forestland for survival (FAO, 2003; Adetoye et al., 2017). Greengrass (2006) observed that most of the households living within the forest communities are farmers, and timber workers, and their livelihood depends solely on forests and its resources. Worst still, illiteracy and poverty level of rural households within forest communities are very high, and these contribute to the level of unhealthy forest land use practices among them (Borokini et al., 2012).

The incidence of forest clearance for farming activities among rural households in Nigeria covers over 80% of the estimated annual national deforestation (NPF, 2006). It is a common practice among rural farm households to cultivates a plot of land for a period of time, and after the soil nutrients have been depleted, the farmer relocates to a virgin land. This means more deforestation, particularly, during land preparation, trees are felled and burnt on forestland. Such deforestation act opens forestland to other land use change activities like grazing, fuel wood collection, hunting, etc. (Adekunle et al., 2011).

It has been reported that forest estate in Nigeria is declining annually at an alarming rate (FAO, 1999; Oyekale 2007; Orimoogunje et al., 2009). The declining rate of forest areas is connected mainly to human activities like encroachments, excisions, and outright de-reservations, etc. (FAO, 2001). It is evident that forests are being displaced and depleted by other forms of land-use such as agriculture, grazing and flooding leading to formation of deserts, bare surfaces, severe environmental degradation, biodiversity loss, reduced forest productivity, etc. (FAO 2006; Adekunle et al., 2011).

Studies have shown that deforestation contributes about 25% of the total atmospheric carbon (CO_2), a major culprit precipitating global warming, also known as climate change (Adams et al. 1993; IPCC 2007; Nobi, 2013). Further this global challenge,

there has been much advocacy for sustainable environment, particularly, on the need to ensure forest and forestland protection. This is because forests store a large quantity of carbon, thereby acting as "sinks" to heat trapping "greenhouse gases" and thereby providing means of addressing global warming (IPCC, 2013).

The need to achieve sustainable environment in the face of increasing demand for fertile land for agricultural production among rural households is becoming of great importance (Henshaw and Fyneface, 2014). This will mean reducing forest degradation and its elements, and more importantly, existing land use practices among farm households will need to be altered. Also, rural farm household would have to adopt a land use system that will ensure livelihoods, food security, as well as sustainable environment. Therefore, the willingness of rural farm household to shift from their existing land use system would be an important issue to be considered.

Nair and Nair (2003), and FAO (2005) stated that agroforestry practices offer a sustainable means of ensuring forest land use for environmental services and food security among rural households. Hence, there is the need to consider agroforestry practices among forest land dependent households (farm households). This suggests that factors influencing forest land use decisions among farm households need to be understood to facilitate the much-needed forest land use change. Against this backdrop, the study seeks to understand the drivers of forest land use decisions among rural farm households in the study area.

MATERIALS AND METHODS

Study Area

The study was done in three major forest reserves in south-western Nigeria. The climate of South-western Nigeria is tropical in nature and it is characterized by wet and dry seasons. The temperature ranges between 21 °C and 34 °C while the annual rainfall ranges between 1500 mm and 3000 mm (Adebisi, 2004). The forest reserves that were considered include: the one considered as the largest forest reserve in Ogun – Omo forest reserve (134,730 ha); Osun – Shasha forest reserve (36,834 ha); and Ondo – Oluwa forest reserve (84,636 ha). The rationale for the selection follows that the forest reserves contain some of the last remaining forest in South-Western Nigeria. i.e. 40% of the natural forest in the reserves still remains (NCF, 2017). Likewise, the number of dependent rural communities around forest reserves is a function of size of the forest reserves and the selected forest reserves represent the largest forest reserves in each of the states (NCF, 2017; Adetoye et al., 2017). According to the official gazette document of these reserves in 1952, certain families were given legal rights to dwell and cultivate allotted portion of forest lands (FAD, 1952). Estimated population of the study is about 32, 000 inhabitants (over 5,000 households) containing both timber workers and farmers (Amusa et al., 2014).

Data Sources and Analysis

The study was based on primary data collected from a rural farm household (crop farmers) through the use of personally administered questionnaire using a multi-stage sampling technique. The first stage involves purposive selection of three (3) forest reserves; Omo, Shasha and Oluwa, from southwest Nigeria. The second stage involves a proportionate selection of 10 enclaves (villages) where rural farm households are predominantly domiciled. The final stage involves a random selection of a minimum sample (30 households) from each of the enclaves. The sample selection gives a total 300 farm households. Data were elicited from the household head. This is because household head is the principal decision maker within a household. Data collected include the socioeconomic characteristics, choice of forest land use (i.e. either agroforestry, pure cultivation or both), type of crops grown, land security status, preference for forest tree(s) on farm land, etc. were elicited from the household heads.

Possible forest land use options among the rural farm households are basically three (3). These include pure cultivation, agroforestry, and pure cultivation and agroforestry. Pure cultivation involves the use of forest land with zero tolerance for forest trees while agroforestry involves the growth of arable crop and forest trees on farm plot; and both practices can as well be done either on a single or different farm plot depending on farm size, dominant crop type, etc. Land use practice like pure cultivation contributes significantly to forest degradation while a shift (either partly or totally) from pure cultivation reduces incidence of atmospheric carbon (CO_2). The starting point for each farm household is the pure cultivation. Complete or partial shift from the existing land use practice will mean "agroforestry" or "agroforestry and pure cultivation", respectively.

Once a farmer agrees to shift completely from his/her existing land use practice say for instance, pure cultivation to agroforestry, the other option becomes zero (0). Similarly, a partial shift from pure cultivation will leave him/her with "pure cultivation and agroforestry" option while the other option (agroforestry) becomes zero (0). The "status quo" or "do nothing" is included as part of the options to capture the possibility of a farmer's willingness to retain his/her existing land use practice (pure cultivation). The need to choose one out of the three (3) options

available to him/her suggests the dichotomous approach. However, a farmer is expected to shift (partly or totally) from pure cultivation to reduce the incidence of deforestation. This will enhance carbon sequestration potential of forests reserves in south western Nigeria.

Multinomial Logit model was used to analyse the factors influencing choice of participation among rural farm household in the study area. According to Oscar et al. (2012), the model was preferred because it permits the analysis of decisions across more than two categories in the dependent variable. However, the binary probit or logit models are limited to a maximum of two choice categories (Maddala, 1983). Hence, multinomial logit becomes applicable to determine choice probabilities for carbon sequestration through different land use option like agroforestry. The model was preferred for the analysis of this objective because it is simple to compute than the multinomial probit model (Hassan and Nhemachena, 2008). The model is expressed as follows:

$$P\left(y=\frac{j}{x}\right)=\frac{\Sigma\exp\left(x\beta_j\right)}{1+\sum_{h=1}^{J}\exp\left(x\beta_h\right),} \quad j=1,2,3,\ldots,J \qquad (1)$$

where,

y = a random variable taking on the values (1, 2, 3, … , J) for a positive integer J and these include; agroforestry, agroforestry and pure cultivation, and a baseline alternative of no participation (i.e. pure cultivation). A baseline alternative is usually included in a choice set category. This is because one of the options must always be in the respondent's currently feasible choice set in order to be able to interpret the results in standard welfare economic terms (Louviere et al., 2000).

x = a set of conditioning variables. x is a 1 × k vector with first element unity and β_j is a $K \times 1$ vector with $j = 2, \ldots, J$. Here, y represents categories of participation while x represents specific personal and socioeconomic characteristics of a farming household. It is therefore important to understand how changes in the personal and socioeconomic characteristics of the individual household affect the response probabilities $P\left(y=\frac{j}{x}\right)$ where $j = 1, 2, \ldots, J$. Since the probabilities must be equal to one, $P\left(y=\frac{j}{x}\right)$ is determined once the probabilities for $j = 1, 2, \ldots, J$ are known. Since the parameter estimates of the multinomial logit model in equation (1) must unbiased and consistent in order to satisfy multinomial logit assumptions, the Independence of Irrelevant Alternatives (IIA) is assumed to hold (Deressa et al., 2008). The IIA assumption requires that the probability of choosing one agroforestry practice by a given rural farm household must be independent of the probability of choosing another practice by i.e., P_j/P_k is independent of the remaining probabilities. The basis of this assumption is the independent and homoscedastic disturbance term of the basic model in equation (1). According to Greene (2000), the parameter estimates of the Multinomial logit model only provides the direction of the effect of the independent variables on the dependent (choice) variable; thus, the estimates represent neither the actual magnitude of change nor the probabilities. Instead of the parameter estimates, the marginal effects are thus used to measure the expected change in probability of a specific technique being chosen with respect to a unit change in an independent variable from the mean (Greene, 2000). To obtain the marginal effects for the model, equation (1) is differentiated with respect to the explanatory variables as shown in equation (2):

$$\frac{\partial P_j}{\partial X_k}=P_j(\beta_{jk}-\sum_{j=1}^{J-1}P_j\beta_{jk}) \qquad (2)$$

It has also been noted that the signs of the marginal effects and respective coefficients may be different (Hassan and Nhemachena, 2008), since the former depends on the sign and magnitude of all other coefficients.

The empirical specification for examining the influence of explanatory variables which are described in Table 1 on the choice of agroforestry practices is given as follows:

$$Y_{ij} = b_0+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_{5+}b_6x_6+b_7x_7+b_8x_8+ \\ +b_9x_9+b_{10}x_{10}+b_{11}x_{11}+b_{12}x_{12}+b_{13}x_{13}+b_{14}x_{14}+e \qquad (3)$$

where,

$b_0, b_1 \ldots b_{13}$ = Parameters to be estimated
x_1 = Age of the respondents (years)
x_2 = Sex of the respondents (1 if female and 0 if male)
x_3 = Marital status (0 if married and 1 otherwise)
x_4 = Household size (i.e. number of household members)
x_5 = Level of education (no formal education = 0, otherwise = 1)
x_6 = Farm size (hectares)
x_7 = Farming experience (years)
x_8 = Farm income (naira)
x_9 = Non-farm income (naira)
x_{10} = Current farm debt (naira)
x_{11} = Land ownership (1 if owned and 0 otherwise)
x_{12} = Land tenure security (0 if secured and 1 otherwise)
x_{13} = Dominant crop type (permanent = 0, otherwise = 1)
x_{14} = Preference for tree on farm land (1 if a farmer prefers forest tree(s) on farm land and 0 if otherwise)
ε_i = Random error

All the variables included in the model and the rationale for their selection is clearly presented in Table 1.

Table 1. Variable selection, rationale, and prior expectations

Variable	Reasons for selection	*A priori* expectation
Age	Age of a farmer has consistently been viewed by several studies as an important factor that influences farmers willingness to shift from existing farming pratice (Adesina and Baidu-Forson, 1995; Ntege et al. 1997; Tiamiyu et al., 2009)	Age is expected to be positive
Sex	Gender is also an important factor influencing the adoption of new farming practice. Brako (2015) stated that male farmers are more likely to adopt new farming practices/technology.	Males are expected to have higher probability compared to females
Marital status	Marital status has been modelled as one of the personal characteristics influencing farm decision among households (Fadare et al. 2014).	This is expected to be positive
Household size	Fadare et al. (2014) modelled the factors that influence the adoption decisions of maize farmers in Nigeria using the educational level of household head and found a positive relationship	This is expected to be positive
Level of education	Education exposes farmers to easily understand the concepts of environmental sustainability (Okojie and Akinwunmi, 2010).	Education is expected to be positive
Farm size	Farm size influences the decision by farmers to adopt agroforestry practices. A farmer with a large expanse of land is more likely to shift from pure cultivation to agroforestry practices	Farm size is expected to be Positive
Farming experience	Farming experience has been found to influence farmer diversification.	Higher experience is expected to be positive
Farm income	Farm income is often considered as a factor influencing choice of land use	
Non-farm income	According to Pender and Kerr (1998), and Holden and Shiferaw (2002), non-farm income is likely to have a positive effect, under the hypothesis that broadening out of agriculture would allow farmers to expand their income, thereby making more money available for on-farm development investments.	Non-farm income is expected to have positive effect
Current farm debt	A farmer with significant current farm debt is more likely to refuse shift from his/her existing land use system that will limit his/her expected income to cover his/her debt (Brako, 2015).	This is expected to be negative
Land tenure security	Land security has possibility of influence choice of activity to be carried on forest land. A farm household with land security may be willing to practice agroforestry.	This expected to be positive
Land ownership	Status of ownership is also expected to refusal to shift from the existing land use system especially when there is no compensation. Amusa et al. (2017) modelled land ownership as one of the factors influencing farm enterprise among farmers.	Land ownership is expected to be negative
Dominant crop type	Farmers with permanent crop like cocoa, kola-nut, palm tree often love to practice agroforestry at the early stage of farm establishment while annual crop farmers are not likely to participate.	This may either be positive or negative
Preference for tree(s) on farm land	Some farmers are well-aware of importance of trees on farm plot like soil protection, wind breaker, etc. and thereby prefer trees on farmland. A farmer who has preference for tree is more likely to adopt agroforestry practices.	This is expected to be positive

Table 2. Mean distribution of the socioeconomic characteristics

Variable	Mean	S.E Mean	Standard Deviation
Age (years)	45.92	0.82	14.19
Farm Size (ha)	3.16	0.23	3.99
Farming Experience (years)	17.84	0.78	13.59
Household Size (Number)	6.00	0.19	3.27
Farm Income (Naira)	510,043.33	55882.79	967,918.25
Non-farm Income (Naira)	148,035.80	28765.89	498239.90
Current Debt (Naira)	38,958.83	14135.31	244,830.81

Source: Computed from Field Survey, 2017. The exchange rate is $1 = ₦305 naira

RESULTS AND DISCUSSION

Mean Distribution of the Socioeconomic Characteristic

Mean age of the household head within the selected communities in forest reserves was estimated at approximately 46 years. They are economically active. Similar finding was reported by Adekunle et al. (2011). The finding supports the age distribution of the nation where the aged are minimal. An average household was estimated to have a farm size of about 3.16 ha. This implies that an average household head population living within the forest reserves is purely a commercial farmer. This is because majority are cash crop farmers cultivating cocoa, kola-nut, etc. An average household head has about 18 years' experience in farming with a household member of six (6) people. The finding was supported by NBS (2012) which indicates that an average rural household had about six members. Average farm income, non-farm income and current farm debt was estimated at ₦510,043; ₦148,035; ₦39,958, respectively. Summary of the result is presented in Table 2.

Socio-economic Factor Influencing Forms of Forestland Use

Table 3 shows the result of the multinomial logistic regression in determine factors influencing choice of participation in forest land use decision. The log pseudo-likelihood function was estimated at –206.96726 using robust standard error and the model was significant ($P < 0.01$) at 1%. The result revealed that personal characteristics of rural farm households do not exert significant influences on form of forest land use in this model. The result is in agreement with Adetoye et al. (2018) who reported that personal characteristics of forest land dependent households do not exert influence on choice of forest land use decision. However, land security ($P < 0.01$), dominant crop type ($P < 0.05$) and preference for tree on farm ($P < 0.01$) are factors influencing choice of participation in agroforestry system among farming households living within the forest reserves. The findings corroborate with the report of Adekunle et al. (2011) and Borokini et al. (2012). The coefficients of land security, and dominant crop type were estimated at negative signs. This suggests that household within forest reserves who have their land security status as secured are less likely to participate in agroforestry practices than their counterpart group i.e. those with insecured land status. Likewise, household with perennial crop type are less likely to participate in agroforestry system than their counterpart group i.e. those who cultivate annual or bi-annual crops. The reason because perennial crop like cocoa, kola-nut, competes with farm tree

Table 3. Socioeconomic factors influencing the choice of participation in land use decision

Variable	Agroforestry System				Agroforestry and Pure Cultivation			
	Coefficient	Z	Robust S.E.	Marginal Effect	Coefficient	Z	Robust S.E.	Marginal Effect
Age	–0.00668	–0.49	0.013768	–0.01435	–0.00168	–0.06	0.027793	4.56E–07
Sex	–0.61269	–1.58	0.387289	–0.116763	–14.9301***	–31.91	0.467814	–0.009944
Marital Status	–0.22902	–0.51	0.446807	–0.052093	14.23468***	28.6	0.497637	0.0039774
Household Size	0.034281	0.76	0.045049	0.0073945	–0.08203	–0.76	0.107767	–0.000102
Level of Education	0.068247	0.40	0.170724	0.014467	0.573469	1.55	0.368957	0.0006071
Farm Size	0.003752	0.15	0.024432	0.000840	–0.09916*	–1.74	0.057027	–0.00011
Farming Experience	–0.00184	–0.14	0.013347	–0.000395	–0.00178	–0.06	0.028457	–1.33E–06
Farm Income	–2.68E–07	–0.92	2.90E–07	–5.77e–08	2.65E–07	1.13	2.33E–07	3.83E–10
Non-Farm Income	–6.12E–07*	–1.66	3.68E–07	–1.31e–07	–1.05E–06	–1.04	1.01E–06	–9.47E–10
Current Farm Debt	2.44E–06	1.57	1.56E–06	5.25e–07	1.59E–07	0.05	2.96E–06	–6.66E–10
Land ownership	–0.41334	–0.91	0.453902	–0.083665	0.504649	0.78	0.649857	0.000866
Land tenure security	–0.98922***	–3.25	0.304407	–0.226509	0.897072	0.79	1.140419	0.001064
Dominant Crop type	–0.7683**	–1.95	0.393377	–0.146635	–0.1484	–0.19	0.792982	0.0000579
Preference for tree on farm land	1.067093***	2.80	0.380937	0.200698	–0.86936	–1.35	0.646265	–0.001779
Constant	–0.30881	–0.37	0.84359		–17.4263***	–12.89	1.352353	
Log Likelihood	–206.96726							
Wald Chi²(28)	1784.63							
Prob > Chi²	0.00E+00							
Pseudo R²	1.27E–01							

Source: Computed from Field Survey, 2017.
*, **, *** represent 10%, 5% and 1% level of significance, respectively

Table 4. Proportion estimation of the choice category

Variable	Mean	Std. Dev.	Minimum	Maximum
Pure Cultivation	0.6333469	0.1584563	0.000162	0.968427
Agroforestry System	0.3233254	0.172971	0.019585	0.999749
Agroforestry and Pure cultivation	0.0433278	0.0577485	3.42E-15	0.412526

Source: Computed from Field Survey, 2017

and their production performance is usually being hindered by forest trees hence, the reason for the less likelihood in agroforestry participation. The findings justify the opinion of Henshaw and Fyneface (2014). Similarly, the land use related challenge necessitates argument proposed by Nair and Nair (2003) and FAO (2005) of the need for agroforestry practices among rural farmers irrespective of their interest. This will ensure food security and sustainable forest land use practice.

Non-farm income ($P < 0.10$) also influences the decision of farming household in agroforestry participation but was significant at 10%. While preference for tree on farm land increases the likelihood of participation in agroforestry system, income; land security and the dominant crop type on farm land are more likely to reduce participation in agroforestry among farming among the households. The result of this estimation follows the *a priori* expectation of possible behaviour of an income driven individual. This was also supported by Adekunle et al. (2011) who stated fire wood collection and other rural livelihoods activities influences land use decision among rural farm households. Thus, a unit increase in preference for tree among farming household holding all other variable constant will increase the level of participation in agroforestry system among farming households by 38%. This implies that only farming household with preference for tree on farm land can successfully ensure carbon sequestration practice in forest reserves. This may include household whose dominant crop type are either annual or bi-annual hence the reason for less likelihood for participation among households who are primarily perennial crop farmers. Likewise, increase in the probability of the right to cultivate forest land among households (i.e. those with secured land status) will reduce the likelihood of participation in carbon sequestration programme within forest reserves.

The choice of participation in a level of carbon sequestration through agroforestry practices and pure cultivation among farming households was examined as the other group in the estimation. Factors influencing the choice of this group were also examined. The result of the multinomial logit estimation shows that personal characteristic; gender ($P < 0.01$), farm size ($P < 0.10$), and marital status $P < 0.01$) are the main factors influencing the choice of participation among the choice of this group. Similar finding was documented by Brako (2015) who observed that sex is one of the factors influencing adoption of new farming practices among farmers. Hence, the female group are less likely to participate than the male counterpart. Likewise, the married are more likely to participate in the choice of agroforestry and pure cultivation than their counterpart group i.e. if otherwise (single, widow or separated). The percentage difference of gender and marital status to their respective counterpart groups (i.e. the reference group) is equally less than 1 percent. However, the size of individual household farm will determine the choice of participation in the joint practice of agroforestry and pure cultivation. As farm size decreases in thousands of hectares, farm households are less likely to participate in agroforestry and pure cultivation practice.

Proportion of Choice Participation in Carbon Sequestration

Table 4 shows the proportion of choice category among respondents. About 63.3 percent of the sample respondents are willing to return their existing use of forest land i.e. pure cultivation. While about 32.3 and 4.3 percent are willing to participate in a level of carbon sequestration either in total involvement (as agroforestry) or partial involvement (through agroforestry and pure cultivation practices). The result implies that, without any intervention, about 32 percent of the entire households' population are willing to engage in the use of forest land for agroforestry practices. If the individual household is assumed to own at least one hectare, it thus implies that an approximate of 29–50 Megagram of Carbon per hectare (Mg C ha^{-1}) according to Nair (1993) carbon volume can be generated per individual household per annum. Thus, with a finite population of about 5,000 households, about 46,400–80,000 Mg C ha^{-1} sequestration capacity could be generated per annum in the study area. However, more can be achieved if the identified factors influencing the choice of participation can be positively modified by the government policies.

CONCLUSION

The study revealed that land use decision among rural farm households is influenced by marital status, gender, land security, dominant crop type,

and preference for tree on farm land. The significance of land security suggests the need for government to ensure proper monitoring of land allocation among rural farm households. The extent of control gained by the rural households significantly contributes to rate of forest land use change and the current rate of forest land conversion to agricultural land in the country has called for the need to review forest land use policy. This might mean forest land re-allocation among rural farm households and dictates on how forest land should be used (e.g. dictates should be given on dominant crop type). Also, rural farm households should be forced to grow forest trees on their farm land. Henshaw and Fynface (2014) stated that the increasing level of deforestation is strongly connected to uncoordinated forest land use policy. It is therefore suggested that forest land re-allocation among farm households should be conditioned on the significant variables; marital status, gender, land security status, dominant crop type and willingness to grow trees on farm plot. The significant factors suggest that male headed (female = 1) farm households, particularly those cultivating annual crop (permanent crop = 1) should be firstly considered during forest land re-allocation following their likelihood to shift from their existing land use practice. Farmers cultivating permanent crops like cocoa, kola-nut, citrus, etc. are less likely to shift from their existing land use practice. This implies forest land use policies that will ensure cultivation of annual crop should be implemented among forest land dependent households (farm households). This facilitates their willingness to practice agroforestry.

Currently, the percentage of forest land under pure cultivation outweighs the use in agroforestry practice. Right to cultivate forest land among rural household – a policy intended to ensure to ensure food security has turn a negative impact on the environment with over 63 percent of the population practicing pure cultivation. Hence, a change in forest land use policy particularly on pattern of use, limitation on type of crop that can be grown, and compliance to sustainable land use practice would go a long way in driving forest land use in favour carbon sequestration.

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