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DECISION TO PRACTICE AGROFORESTRY AMONG FARMERS IN OGUN STATE OF NIGERIA: IMPLICATION FOR CLIMATE CHANGE MITIGATION

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ABSTRACT

Mitigating climate change through carbon sequestration centered on the availability of trees. This study evaluates farmers' specific socioeconomic features that affect decision to practice agroforestry for the purpose of climate change mitigation among smallholder farmers in Ogun State of Nigeria. The study adopted a multi-stage sampling technique in the selection of was n of 196 farmers. Primary data were collected with the application of structured questionnaires. The collected data were analysed using descriptive statistics and logit regression analysis. Based on the findings of the study, male farmers were the majority with mean age of 36 years cultivating an average farm size of 7.1hectares. Only 10.20% had no formal education. The average experience in farm production was 14 years More than half 59.69% of the farmers acquired their land through purchase. Majority (70.41%) of the farmers were practicing agroforestry. This is a good indication for climate change mitigation and environmental resource management. Factors influencing agroforestry practice among farmers were farm size, experience in farming and income received from farm business. The study recommends a policy strategy that will facilitate famers' access to farmland with long tenure security.

Contribution/Originality: This study is one of the few studies that examined agroforestry and factors that influence adoption of agroforestry with a view of mitigating and adapting to climate change. This will promote sustainable land management among farmers.

1. INTRODUCTION

Changing climate is one of the major constraints facing the world today. This must be dealt with in order to achieve socioeconomic development. This global phenomenon is a threat to food production and human health [1]. Alteration of surface features and changes land use are part of drivers of long term climatic changes. Hence, the vulnerability of environment to climatic change is a function of adaptive responses taken by individual especially farmers who have direct impact through agricultural practices. Agriculture is one of the major sectors responsible for changes in climatic related variables. Most farm production process are associated with removal of forest cover thereby reduce carbon storage of forest biomass consequently increase green house gas emission.

There is need to approach climate change mitigation from sustainable agricultural practices as against campaign for intensification without considering its impact on fragile environment. Climate change problem can be

addressed by changing the production practices without affecting the productivity. The need to focus more on agriculture in addressing ecological problems is due to fact that the sector has potential to reduce food insecurity, achieving economic development, reducing environmental degradation and climate change mitigation. Farmers can adapt and mitigate the change that is occurring in the climate with the adoption of improved land management practices such as the practice of agroforestry. Adoption of improved land management strategies can with a view of providing appropriate mitigation strategies benefits and removing adverse effects of changes in climate [2].

Food production sector has reported as sub-sector contributing to climate change mitigation in terms of climate greenhouse gas emissions reduction [3]. With the adoption of improved management practices such as agroforestry, food production sector can increase the removal of greenhouse gas emissions. It was earlier reported that carbon sequestration from the soil constitutes 89% of the mitigation potential from crop and animal production [4]. This implied that carbon sequestration is an important option in climate change mitigation.

In order to reduce the impact of climate change on the environment and livelihood sustainability in particular strategic approach must be adopted. One of the approaches to climate change mitigation is sustainable management of forest ecosystem [5]. Combination of tree and crops on the same plot is a sustainable land management option of the productivity of crop yield. This will help to promote productive and resilient agricultural environments. It will also enhance ecosystem while enabling agricultural lands to withstand environmental problems such as floods, drought and climate change.

There is interlinks between forest and climate change [6]. Forest can mitigate climate change by absorbing carbon. Forest ecosystem that is functioning would serve as a virtual clean machine. This is because it will improve the air by removing particulate matter. It will also improve the moisture content. The function of such forest also include absorption of existing air separating the element, cooling and releasing the oxygen, disposing of the minor elements thereby making use of carbon dioxide to grow food. One of the major causes of decreasing forest estate that supposed to mitigate climate change is clearing of land for agricultural production. The most vulnerable to changing climate is the food production system that is affected by poor management practices. The practice of agriculture could lead to shortfall in carbon stocks as a result of the removal of biomass above ground as harvest with decomposing and burning as well as loss of carbon from the soil as carbon dioxide and loss of soil C by erosion [6]. Considering the life cycle of farm production which is associated with deforestation, agriculture is therefore described as fifth sector after transportation and manufacturing contributing to increase green house gas emission. Hence, less effort is paid made within the food production sector by climate change policy stakeholders to reduce the problem. Most effort to improve productivity in agriculture focused on achieving food sustainability thereby, strengthening the smallholder farmers and reducing degradation as a result of consistent agricultural production. Also, little is done to change stakeholder process and adoption of practices reducing emission.

Approaching climate change from sustainable form of production practices is a good option. Climate change problem can be addressed by changing the production practices without affecting the productivity. The need to focus more on agriculture in addressing ecological problems is due to fact that the sector has potential to reduce food insecurity, achieving economic development, reducing environmental degradation and climate change mitigation. However, meeting increase food demands with increasing population is the major global targets. Agroforestry is one of these sustainable practices that can assist in restoring the status of forest for climate change mitigation. Agroforestry is land use system that is sustainable that can maintain and increase total yield through integration of food crops (annuals) with forest trees (perennials) and animal production on the same unit of land [7]. This is because it includes combination of of woody perennial ecologically and economically with the arable crop and animal. Agricultural crops (herbaceous plants), woody perennials (tree crops/ forest plants) and animals are the component of Agroforestry.

Agroforestry practice has been reported as a potential agricultural practice that can result to carbon sequestration and while providing enormous benefits in terms of environmental sustainability and socioeconomic

benefits. This implied that with this form of practice accumulation of carbon in living biomass and soil are possible and. It also has possibility of providing ecosystem services. Planting of trees with food crops is therefore offers alternative approach to sequestering carbon on farm lands because it can sequester large amounts of carbon while leaving the unpackaged of land in food production [8]. As reported by Gebre [8] combination of food crops with woody tree has the potential to generate carbon in large quantity. The reasons include the following: Land area under cultivation of crops and rearing of animals will increase. Despite that fact that storage carbon density storage when comparing with forests is low, the woody biomass that can be derived from agroforestry systems could serve as source of fuel for local use. Hence, there will be reduction in the rate of deforestation on other forest land, at the same time provide alternative source for fossil fuel. The importance of these cannot be overemphasized because it provides effective means of land use for atmospheric stabilization through afforestation but through the replacement of wood fuel for fossil fuel.

According to an estimate by IPCC [9] the world land area under food production is 49%. Traditional method of farming with adoption of low inputs has sustained the livelihoods for many decades in developing nations [10] however, this is now causing adverse effect and posing serious threats to ecosystems and human survival with population increase and climate change. In Africa, arable crops such as maize and rice have experienced low output which is a great concern about the achievement of sustainable income and food security objectives [11, 12]. Hence, livelihood sustenance can only be ascertain through expansion of cultivable land at the expense of natural land with negative impact on biodiversity and changes in climate which are negative predictions that can affect crop production [13]. On the other hand sustainability of crop production is influenced by climate change thereby affect food availability and accessibility [14]. Rainfed agricultural practice particularly is affected negatively by increase temperature and water stress [14].

Despite the benefits of agroforestry practices particularly as a form of land management strategy and climate change amelioration. However, the rate of adoption and information on adoption of agroforestry with farmers' specific features that are influencing the adoption limited in Nigeria compared to many other parts of the world. The reasons for the inadequate in the rate of adoption with failures and successes highly localized [15]. Most studies on adoption of agroforestry focus on the rate of adoption. The impact of agroforestry in most cases is evaluated from an individual, household, social, economic, technological, or environmental perspective [16]. A study that will evaluate adoption of agroforestry is therefore important to provide information for policy strategies that will further enhance adoption of agroforestry.

Furthermore, it is essential to examine factors that influence farmers decision to practice agroforestry on their farm as this will help to determine ecosystem services priorities among land users. Also, tree planting decisions by farmers could be influenced by the level of knowledge among farmers and other factors that largely depend on resource endowment since most farmers are rational decision-makers. It has been found that since preference and perception of household to tree planting could be difficult to measure [17]. Socio-demographic characteristics could be used as proxies to decision making process associated with tree planting. This study examines the socioeconomic characteristic of the respondents and factors influencing their decision to embrace agroforestry practice.

2. METHODOLOGY

2.1. Study Area

The study area for this study was Ogun State, Nigeria. The State lies approximately between latitude 3° 30 N and 4° 30N and longitude 6° 30 E and 7° 30E [18]. There are two distinct seasons with short dry season. This covers a period of four months from November to February. It lies within humid tropical agro-ecological zone. The area supported agricultural production with maize as one of the main crops by the farmers. The agro-ecological nature of the State is tropical climate. The rainy season spread through month of March and November. This is followed by the dry season. In the northern part of the State the estimated annual rainfall is about 1,200mm while

the southern part could experience. The temperature of the area varies between 23°C in July to 32°C in February. The estimated average mean daily sunshine hours varies between 3.8 and 6.8. Relative humidity consists of 76 percent and 95 percent coinciding with dry and wet season, respectively. There are two nature of the vegetation. These include derived savanna in the northern part and rainforest in the southern part of the State. Ogun State is blessed with fertile arable land thereby making growing of different types of arable crops, tree crops and rearing of animal possible. According to Ogun State Agriucltural Development Programme (OGADEP), the State has been divided into four agricultural zones. These include, Ijebu-ode, Ilaro, Abeokuta and Ikenne. The agricultural zones are further sub categorised into twenty one (21) blocks while the blocks are sub-divided into one hundred and twenty five (125) cells.

2.2. Sampling Procedure and Data Collection

The respondents of the study were 196 maize farmers which were selected through a multistage sampling procedure. In the first stage purposive method was employed to select two agricultural zones based on agricultural development classification. In the second stage selection was based on random method. Selection of one agricultural block from each of selected zones was made and four cells were selected from each block. Determination of sample size was achieved with the application of formula provided by Kabatesi and Mbabazi [19] after which proportional sampling was used to select the farmers. The study made use of primary data and this were collected through the use of structured questionnaires. Information collected include socio-demographic characteristics of the respondents, land ownership status and form of land use, the decision to plant trees for climate change mitigation and factors influencing their decision to plant trees on their farm

2.3. Analytical Techniques

Descriptive statistics such as frequency count and percentages was used to analysis the socio-demographic characteristics, mode of land acquisition and form of land use. Logit regression, a binary choice model was used to identify factors influencing decision to practice agroforestry. It is an analytical tool could be applied when the research method focused on the occurrence and non occurrence of an event occurred, rather than when it occurred (time course information is not used). Logit regression model is peculiar to decision making study, that is yes or no [20]. In logit regression analysis, the response variable must be dichotomous; the response variable need not be interval; nor normally distributed, nor linearly related, nor of equal variance within each group, and lastly, the categories (groups) must be mutually exclusive and exhaustive. A case can only be in one group and every case must be a member of one of the groups. Logit regression has the power to accommodate both categorical and continuous independent variables [20]. In this study, the dependent variable takes a value of one if the farmer decides to practice agroforestry on the farm for climate mitigation and zero value if not. The model is expressed as follows:

$$Ln\left[\frac{p_i}{1-p_i}\right] = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + - - - - - - \beta_9 X_9 + \varepsilon$$

Where the 'P' is the probability of the outcome, β_0 represents constant term and $\beta_1 - \beta_9$ are the estimated parameter associated with each of explanatory variable, X_1 ----- X_9. The ε is the error term. The dependent variable which is the likelihood of observing the samples is formed by introducing a dichotomous dependent variable Yi such that Y is equal to 1 if the decision is yes 0 if it is no. The factors hypothesized to influence decision to plant tree are defined as follows:

X_1 = Age (years).

X_2 = Education (This is measured through the number of years in formal schooling).

X_3 = Farm size (This is measured in hectare).

X_4 = Experience (years).

X_5 = Household size (number in the household).

X_6 = Membership of social organization (years of membership).

X_7 = Extension contact (number of contact).

X_8 = Farm income (Naira).

X_9= Non farm income (Naira).

3.RESULTS AND DISCUSSION

3.1. Socioeconomic Characteristics of the Farmers

The results presented in Table 1 show the socio-demographic characteristics of the farmers. It was revealed that more than two-third of the respondents (70.92%) were male.

Table 1. Farmers socio-demographic characteristics.

Variables	Frequency	Percentage
Sex		
Male	139	70.92
Female	57	29.08
Marital Status		
Married	154	78.57
Single	42	21.43
Age (years)		
21-30	68	34.69
31-40	67	34.18
41-50	52	26.53
51-60	7	3.57
>60	2	1.02
Mean	36	
Education		
No formal education	20	10.20
Primary education	6	3.06
Secondary education	93	47.45
Tertiary education	77	39.29
Farm size (hectare)		
1.1-5.0	94	47.96
5.1-10.0	37	18.88
>10	65	33.16
Mean	7.1	
Experience (years)		
1-10	68	34.69
11-20	78	39.80
>20	50	25.51
Mean	14	
Household size		
1-5	76	38.78
6-10	118	60.20
>10	2	1.02
Mean	5	
Extension Contact		
Yes	153	78.06
No	43	21.94
Total	196	100.00

This indicates that male farmers were the dominant maize producers in the study area. The percentage age of farmers who are above 60 years and could be classified as non working population was just 1.02%. The average age of 36years is an indication that the respondents are youth and still in active age group. This is a good indication for agricultural production especially agroforestry practice. Age could be used to determine how active and productive

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a farmer could be. Only 10.2% did not have access to formal education. This indicates that literacy level among the respondents is considerable high. In fact, 39.29% had beyond secondary education. Educational attainment is an important variable because it could affect the level of awareness of the possible advantages of improved modern farming methods. The average farm size was 7.1 hectares. This group of farmers could be classified as small to medium scale farmers. The average farm size is slight above the small scale farmers' classification with farm size of 0.1-6.0 hectares according to Ojuekaiye [21]. The average household size was 5 members per household. This is a good indication for family labour especially if household member fall within the working age group. The selected farmers in the study area had average experience of 20 years in farm business. The implication of this is that farmers are familiar with production practices and are producing agricultural crops for a long time. The results revealed a good extension activity in the area as 78.6% had contact with extension during the farm production year considered in the study.

3.2. Land Ownership Status and Form of Land Use

The result of land ownership status and method of land use presented in Table 2 indicate that more than half (59.69%) of the respondents purchased their land. Those that acquire their land through inheritance constitute 25%. Only 1.02% got their land through gift. The larger percentage of respondents who acquire their land through purchase is a good indication for agroforestry practice. Farmers could be discouraged due to the fact that most tree take long time period to mature and if the tenure of land is a short duration. Mode of land acquisition determines farmer accessibility to farm land and limited access to farm land may not be good for the practice of agroforestry technique. Access to land is also a determining factor associated with scale of production. According to Herbohn, et al. [22] land tenure security is a major constraint to tree planting in developing countries. Similarly, Otsuka, et al. [23] opined there is a positive effect of land tenure security on tree planting. Mode of land use indicates that 26.53% put their land under annual crops. Those that put their land under tree plantation constitute 29.08%. About 39% of the farmers are already practicing agroforestry system. The farmers under this practice of combining tree species with arable crops must have known the economic value of tree. Essentially farmers under this group are expected to be willing to plant and retain trees on their farm plot. Only 5.10% of the farmers put their land under fallow period.

Table 2. Land ownership and form of land use.

Estimates	Frequency	Percentage
Land ownership		
Inheritance	49	25.00
Purchase	117	59.69
Rent	26	13.78
Lease	2	1.02
Gift	2	1.02
Under annual crops	52	26.53
Under tree crops	57	29.08
Under fallow	10	5.10
Under agroforestry	77	39.29
Total	196	100.00

3.3. Mode of Agroforestry Practice among Farmers: Implication for Climate Change Mitigation

Result presented in Table 3 showed the rate of agroforestry practice among farmers. It was revealed that majority (70.41%) of the respondents practice agroforestry on a regular basis. Those that do not practice agroforestry constitute 14.80%. The mean average score was 4.12. The implication of this is that farmers could be classified as agroforestry farmers. The larger percentage of farmers involving in agroforestry practice indicates that farmers were aware of the benefits of agroforestry. This is good indication for climate change mitigation as more

trees will be available to sequestrate carbon that would enhance the environment. It has been revealed that agroforestry practices has the ability to reduce or reverse the degraded land, sink carbon from the environment and provide ecological and economic benefits to the rural communities. Apart from the soil reclamation potential of the trees, they also provide numerous benefits associated with ecosystem services and functions with the inclusion of socioeconomic benefits that motivated farmers to cultivate them [24].

Table 3. Mode of agroforestry practice among farmers.

Mode of agroforestry practice	Frequency	Percentage
Never	29	14.80
Rarely	2	1.02
Sometimes	23	11.73
Often	4	2.04
Regularly	138	70.41
Total	196	100

3.4. Factors Influencing Farmers' Decision to Practice Agroforestry on their Farm

The socioeconomic factors influencing farmers' decisions to practice agroforestry is presented in Table 4. It was revealed that farm size, experience in farm production and farm income were the factors that determine farmers decision associated with agroforestry practice. The estimated parameter of farm size exerts positive and significant relationship with farmers' decision to practice agroforestry. This implied that there is probability that farmer will plant tree if their land size increase. This is an indication that availability of land is a motivation for agroforestry practice. The coefficient of extension service was positive and significantly related to decision to participate in agroforestry. Extension contact can increase farmers' accessibility to information on conservation strategies and climate change mitigation through planting of trees. The estimated coefficient of farm experience was negative and significantly influences decision of farmers to practice agroforestry on their farm. The implication of this is that farmers with many years of experience in farming business would prefer to continue with their existing method of farming. Farming experience is expected to influence agroforestry practice due to the accumulation of skills over time. Those who are new in farm business would prefer to adopt new method. They would prefer to diversify farm production activities and include tree with arable crops. The coefficient obtained for age was positive though not significant but it implied that older farmers tend to adopt agroforestry compared to younger farmers. Age is very important in agricultural production and livelihood activities. It is associated with experience and has a significant effect on farmers' decision making process associated with risk aversion, level of adoption of improved agricultural practices and resource use.

Table 4. Factors influencing decision to plant tree on farmers' plot.

Variables	Coefficient (β)	Standard Error	T-Value
Constant	5.887	3.102	1.90*
Age	0.008	0.140	0.06
Education	0.023	0.519	0.04
Farm size	0.690	0.365	1.89*
Experience	-0.335	0.155	-2.16**
Household size	-0.346	0.496	-0.70
Association	1.282	0.418	3.07
Extension contact	0.406	0.525	0.77
Farm Income	0.290	0.152	1.90*
Non farm income	0.030	0.157	0.20

Note: * $p<0.10$ ** = $p<0.05$.

4. IMPLICATION OF AGROFORESTRY ADOPTION ON CLIMATE CHANGE ADAPTATION

Climate change and sustainable environment could not be separated from food production. Meanwhile the demand for food by the growing population is increasing in the midst of climate change crisis, and in order to meet the demand for food, there is need for sustainable agriculture practice to increase food production. Climate change and global warming through greenhouse gas emission such as gas flaring, deforestation, vehicle emissions, fires, pests, diseases and use of solid fossil fuel for cooking are some of the causes and has been a serious global crisis that has had subsequent adverse effect on food production. Similarly, disastrous events emanating from climate change such as drought, life-threatening heat, flooding, among others has led to soil degradation and in turn resulted in low crop yields. Meanwhile, situations like this discourage the poorest and most vulnerable among farmers to continue to engage in agricultural activities, thereby leading to shortage of food output in total production. Constant and severe climate condition has pushed agricultural sector to a devastating point of food inadequacy. It has affected and resulted in the decline of production of crops, livestock, fisheries and forestry economic trees.

Aside the fact that climate change has negative impact and it is a threat to food production, agriculture is also a major contributor as well as been a potential solution to mitigating climate change challenges. Most of the global greenhouse gas emissions come from the production, distribution, and consumption of food. When it comes to producing food, raising of livestock contributes to the majority of agricultural emissions, followed by rice cultivation and the production of synthetic fertilizers. Moreover, conversion of forests and grasslands to residential or industrial uses, makes the world to loss important ecosystems that remove greenhouse gases from the atmosphere. In order to avoid the yet destructive impact of climate change sustainable form of food production must be embraced by the farmers.

Agricultural practices particularly among the smallholder farmers is characterised by slash-and-burn systems wherein farmers use fallow to restore soil fertility. The use of fallow period has been the common practice among the farmers to sustain food production but increasing population has put pressure on land availability thereby reducing fallow duration that is required to sustain the production resulting to decline in the productivity of land. Farmers' have adjusted by expanding cultivation into marginal lands and bringing new forest areas under slash-and-burn cultivation, with negative environmental effects. Agroforestry therefore is one of the sustainable forms and alternative to traditional system of slash and burn methods. This system would allow farmers to combine trees with food crops. The presence of trees would into provide ecosystem services such as adverse climate amelioration. The implication of this finding is that farmers were found practicing agroforestry which is a good indication for forest restoration. Also, in order to ensure more adoption of this practice among non adopters and to ensure continuous practice of agroforestry policy strategies can focus on farmers' specific characteristics since this has a role to play in adoption decision.

5. CONCLUSION AND RECOMMENDATIONS

The study revealed a greater participation of youth in farm production. The farmers operate on medium scale level. Majority acquire their farmland through purchase. More than one third of the farmers are already practicing agroforestry. The decision to practice agroforestry was found to be influenced by size of land, experience in farm production and income realized from farm produce. The study recommends a policy strategy that will facilitate famers' access to farmland with long tenure security to encourage the planting of trees among farmers.

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