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Effects of Arable Land Tenure and Use on Environmental Sustainability in North-Central Nigeria

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Abstract. The study analysed the effects of arable land tenure and use on sustainability of the environment in North-central Nigeria. Multistage sampling technique was adopted to select 356 respondents for the studywith the aid of a well structured questionnaire and analysed using descriptive and inferential statistics.It was found that land acquisition was predominantly (47.5%) through inheritance. The result of environmental sustainability index (ESI) showed an average score of 16.38 and only farmers from Kogi (16.83) and Plateau (18.44) States in the study area had values above the average. Furthermore, the result of the analysis of variance showed a significant difference ($F = 28.28$; $p < 0.01$) in the ESI among the three States. A positive coefficient of education of household heads (0.40), farming experience (0.05), extension contact (0.07), crop diversification (0.34), irrigation use (3.89), land tenure security (0.82), tree planting (3.13) and quantity of fertilizer used (0.35) implied increase in environmental sustainability with increase in these variables. However, population density (-0.19) reduced environmental sustainability. It was concluded that land tenure security impacted substantially on the increase in environmental sustainability and that land use, coupled with management practices is key instrument for achieving environmental security. It was recommended that, Government should establish a more effective and efficient arable land title registration system that would enhance individual tenure security to the arable land.

Key Words: Arable, Land Tenure, Land use, Environment, Sustainability.

INTRODUCTION

Agricultural development has positive and adverse effects on man and his environment. It has brought reward to people all over the globe-higher incomes, food security and material wealth. The aftermath of it is pollution, environmental degradation and destruction of resources. It is recognised that many agricultural communities have been devastated by depletion of forests, disruption of water systems, and intensive fisheries. As the main foundation for agricultural production and sustainable rural livelihoods, land is at the core of the challenges of triggering off a Green Revolution for improved food and environmental security. Consequently, access to, and security of land rights are prime concerns for policies and strategies aimed at reducing food insecurity and environmental degradation. Land is therefore, a very strategic socio-economic asset, particularly in poor societies where wealth and survival are measured by control of, and access to land (Titilola & Jeje, 2008).

The accessibility of most agricultural lands especially in the North-central part of the country, depends largely on land tenure system and the extent of competition by non-agricultural land uses (Udoh, 2000). Land tenure systems influence the use to which land is put for economic and social development. Land tenure is a mix or bundle of entitlements (rights and duties) concerning the use of land resources. It covers the rules under which those rights and duties are exercised and the time horizon or guarantee of continued claim to such entitlements (Bromley, 1991). Although, tenure systems vary from one rural community to another, it is pivoted on three broad systems of communal, individual and family ownership.

If farmers do not have secure land rights, they will have few incentives to engage in sustainable agricultural production or to consider the long-term environmental impact of over-exploitation of the land's nutrients (Oyekale, 2012). In the absence of rational and conscious sustainable exploitation of the physical and natural resources like land, irreplaceable and probably irreversible damages will inevitably result. This will be catastrophic for food production and rural development.

With the continued growth of the human population, competition for limited land resources has steadily increased over recent years and most countries in Sub-Saharan Africa like Nigeria, have experienced an intensive use of the arable land. Although, scholars like Buckles and Erenstein (1996) and Erbaugh (1999) had affirmed the potential of achieving agricultural growth through intensification. However, commensurate use of modern inputs were identified as fundamental condition for sustainable growth through increase land-use intensity. In the absence of this, increased land-use intensity could lead to continuous depletion of soil fertility, decline in productivity, loss of soil structure, soil erosion and land degradation (Cassman 1999; Erbaugh 1999). The intensity of land use has been recognised as one of the most significant human alteration to the global environment (Matson, Parton, Power and Swift, 1997).

More so, eroding soils, deteriorating rangeland, infertility of soils, dwindling forests and polluted water bodies, are results of environmental mis-management, especially from land use. To sustain the environment via agricultural land tenure and use,there is need to understand the relationship between land tenure and use and environmental sustainability to the Nigerian ecosystem. Hence, sustainable environmental-friendly agriculture and rural development should be the overriding issue in future planning and this, among other requirements, demands adequate knowledge, sensitivity towards land ownership and management. It was against this backdrop that this study was carried out to examine the effects of arable land tenure and use on environmental sustainability in North-central Nigeria, with the specific objectives to: describe households' land tenure and use characteristics; develop an index of environmental sustainability; and evaluate the factors influencing environmental sustainability.

MATERIALS AND METHODS

The Study Area: The study was carried out in North-central Nigeria. The zone has a land area of 296, 898 km^2 representing nearly 32 percent of the country's total land area (NBS, 2008). There are six states in the zone and the Federal Capital Territory, Abuja. The States include Benue, Kogi, Kwara, Nasarawa, Niger and Plateau. It is located in the central part of Nigeria and in the sub-humid region of the country, and bounded to Bauchi, Kaduna, Zamfara and Kebbi States to the north; Cross-River, Ebonyi, Enugu, Edo, Ondo, Ekiti, Osun and Oyo States to the south; Taraba State and Republic of Cameroon to the east and the Republic of Benin to the west. Situated between latitudes 6^o 30" - 11^o 20"N and longitude 7^o – 10^{o}E, the zone has 20.36 million people with the rural population constituting 77 percent (NPC, 2006).

Sampling Techniques: Multi-stage random sampling technique was used to select a sample size of 360 respondents. In the first stage, a random selection of three States from North-central Nigeria was made. Hence, Benue State, Kogi State and Plateau State were selected. Secondly, two agricultural zones were randomly sampled from each State selected for the study making six agricultural zones. Thirdly, two local government areas were randomly selected from each agricultural zone, giving a total of twelve local government areas. In the fourth stage, three farming communities were randomly selected from each local government area making a total of thirty-six farming communities. Lastly, ten arable crop farmers were randomly selected from each farming community, giving a sample size of 360 arable crop farmers (i.e. 120 respondents from each state). Apart from Plateau State which returned all the 120 copies of the questionnaire,117 and 119 were returned from Benue and Plateau States respectively giving a total of 356 respondents analysed for the study.

ANALYTICAL TECHNIQUES

Environmental sustainability index: In order to obtain environmental sustainability by farming households, environmental sustainability index was developed. The indicator method of quantifying Environmental Sustainability was used and this was done by systematically combining the selected indicators to determine the levels of Environmental Sustainability. The variables used to compute indices of environmental sustainability are presented in table 1. To be able to combine the variables denominated in different units, it was necessary to convert them to unitless measures. This was done by standardizing the values by converting them to natural logarithms. Furthermore, before the calculation of the Environmental Sustainability Index (ESI), different weights were assigned to the variables to avoid the uncertainty of equal weighting given the diversity of indicators used. The Principal Component Analysis (PCA) was used to determine the weights. The PCA is frequently used in research that is based on constructing indices for which, there are no well-defined weights (Deressa, Hassan &Ringler, 2008). Intuitively, the first principal component of a set of variables is the linear index of all the variables that captures the largest amount of information common to all the variables. As a result, factor scores from the first principal component were employed to construct indices for each household in the study area as follows:

$$ES_i = \Sigma(AX_i) \quad i = 1, 2..., 356 \quad \text{.................................} (1)$$

Where,

A = factor loading from PCA

X = normalised indicators of environmental sustainability for the *ith* household

The values of the variables are specified such that a higher value implied high sustainability.

Table 1: Variables used in the Computation of Environmental SustainabilityIndex

Component	Indicator	Variable	Unit
Environmental quality	Air quality	Fuelwood use (proxy for CO_2 emission)	Categorical
	Climate change	Temperature	Categorical
		Rainfall	Categorical
	Exposure to hazards	Drought	Categorical
		Frequent flooding	Categorical
	Land	Farm size	ha
	Vegetation	Area under tree plantation	ha
	Environmental protection	Construction of drainages	Categorical
		Bush fallow	ha
		Minimum or zero tillage practice	Categorical
		Investment in environmental protection	₦
Human wellbeing	Environmental health	Healthcare access	Categorical
	Education	Years of educational attainment	Years
		Training in crop production practices	Categorical
	Housing quality	Availability of electricity	Categorical
	Income	Household farm income	₦
		Off-farm income	₦
	Household stress	Household size	Number
Social and institutional capacity	Natural resource management	Hectares under irrigation	ha
		Quantity of fertilizer	kg
		Quantity of herbicides	l
		Quantity of pesticides	l
	Wealth	Ownership of livestock	Categorical
	Science and technology	Access to mobile phone	Categorical
		Access to radio	Categorical

Note: Categorical, denotes low, moderate and high respectively

Source: Adapted from Madu (2010) with modifications

Multiple regression analysis: Environmental sustainability (ES) indices that were obtained for each household were then regressed against land tenure, land use factors and farm and farmer-specific variables. The data was fitted to three functional forms and the lead equation was selected based on the highest R^2 and the number of significant coefficients.

Linear functional form:

$$ESi = \beta_0 + \beta_i \sum_{i=1}^{16} X_i \quad \text{......................... ......(2)}$$

Semi-log functional form:

$$LnESi = \beta_0 + \beta_i \sum_{i=1}^{16} X_i \text{............................(3)}$$

Double log functional form:

$$LnESi = \beta_0 + \beta_i \sum_{i=1}^{16} lnX_i \text{........................... (4)}$$

Where,

ESi is environmental sustainability index, β_0 is the constant term, βi's are the parameters,

X_1 = educational attainment of household head (years),X_2 = years of farming experience,

X_3 = off-farm income (₦), X_4 = Amount of loan (₦), X_5 = number of extension contact in a year, X_6 = population density (household size per hectare), X_7 = Crop diversification (number of crops grown), X_8 = Farm size (ha), X_9 = cropping intensity index, X_{10} = mining activity (yes=1, otherwise 0), X_{11} = irrigation use (use=1, non-use=0), X_{12} = Fallow rotation index,

X_{13} = clean clearling/bush burning (yes 1, otherwise 0), X_{14} = tenure security (purchase/inherited land =1, otherwise 0), X_{15} = land conflict (experienced 1, otherwise 0),

X_{16} = tree planting (yes 1, otherwise 0), and X_{17} = fertilizer application (kg)

RESULTS AND DISCUSSION

Farm and Farmer Specific Characteristics

The farm and farmer specific characteristics of arable farmers in the study area are presented in table 1. Majority of the respondents (62.4%) were found within the age group of 41-60 years. On the average, the age of the respondents was 48 years. This implied that majority of the farmers were within the active and economic age bracket of between 21- 60 years. The result agreed with the findings of Ogunwale (2000), Ezedinma and Otti (2001) that the mean age of farmers in Nigeria was between 45-48 years.

Analysis of sex of household head showed that, majority of the respondents (79.5%) were males. The result implied that arable crop production was primarily male dominated. This could be due to the cultural and religious background of most African communities that still put women's enterprise under their husbands' care as a form of submission. This result on sex of household head agreed with the study of Bamire (2010) on the effects of tenure and land use factors on food security among rural households in the dry savannas of Nigeria, where majority (92.5%) of the respondents were males.

Analysis of the size of the arable farmers' household showed that majority of the respondents (76.7%) had household size of more than six people with the average household size of nine people. Large family size is assumed to be the source of labour, skills and strong social capital to adapt to changing situations. This result agreed with Obamiro, Doppler and Kormawa (2003) who reported that the average number of people in a farm household was seven. In addition, a study by Tsue, Lawal and Ayuba (2013) found a mean household size of nine people in Benue State, Nigeria.

The result of level of education of arable farmers showed that 82% of them had formal education at varying levels. On the average, years of educational attainment of the respondents were 8.74. The result implied that arable farmers in the study area attempted secondary education and or its equivalence. This result suggested that majority of the arable crop farmers in North-central Nigeria could read and write. The result was similar to Abu, Alumuku and Tsue (2012) that the average years of educational attainment of tomato farmers in Benue State Nigeria were 8.32.

Many of the respondents (56.4%) were found to have farming experience of 20 years and below. On the average, arable farmers in the study area had a farming experience of 20.47 years. This implied that, the respondents were experienced farmers, hence, they had over the years acquired enough farming experience needed to perceive and handle the effect of environmental degradation on farming activities in their areas. This conformed with Ashaolu *et al.* (2010), that the average experience of beniseed farmers in Obi and Doma LGA of Nasarawa State was 20.5 years.

The result further showed that many (74.2%) of the respondents had farming income of ₦300,000.00 and below. The average farm income was ₦370,000.00. Majority (51.7%) of the respondents had no non-farm employment, while the average income from non-farm jobs of ₦ 183000 per year. This showed that farm income was the most important source of income for the farm household income. The low engagement in off-farm employment could hinder farmers from owning and operating large farm size and investing in both farm and environmental protection.

Access to credit was generally low in the study area. The result indicated that majority (89.9%) of the respondents had no access to formal sources of credit. This situation is likely to decrease farmers' efficiency by limiting investment and adoption of new technologies and farming practices that would reduce environmental degradation as well as information needed on climate change and increased land productivity. The result agreed with the findings of Otubusin (1986) and Lawal (2000) that, access to formal credit was a major constraint to farmers in Nigeria. Access to credit is essential for farmers to finance their investment to achieve higher productivity and sustain the environment. The average number of extension contacts in a year was 6.75 times. The more the number of contacts farmers had with extension services, the better their skills in the use of land for environmental sustainability.

Table 1 Descriptive Statistics of Farm and Farmer-specific Characteristics (n = 356)

Variable	Frequency	Percentage (%)	Mean
Age (years)			47.86 (10.65)
≤ 20	1	0.3	
21 – 40	94	26.4	
41 – 60	222	62.4	
>60	39	11.0	
Sex			
Female	73	20.5	
Male	283	79.5	
Household Size			8.52 (4.26)
≤5	83	23.3	
6 – 10	184	51.7	
11 – 15	66	18.5	
>15	23	6.5	
Education (years)			8.74 (5.51)
Non-Formal	64	18.0	
Primary	81	22.8	
Secondary	115	32.3	
Tertiary	96	27.0	
Farming Experience (years)			20.47 (11.29)
≤10	92	25.8	
11 – 20	109	30.6	
21 – 30	101	28.4	
>30	54	15.2	
Annual Farm Income (₦)			370000 (753619.67)
≤100000	78	21.9	
100001 – 200000	105	29.5	
200001 – 300000	81	22.8	
>300000	92	25.8	
Off-Farm Income (₦)			183000 (344256.52)

≤100000	230	64.6	
100001 – 200000	44	12.4	
200001 – 300000	15	4.2	
>300000	67	18.8	
Off-Farm Employment			
Not engaged	184	51.7	
Engaged	172	48.3	
Access to Formal Credit			
No access	320	89.9	
Access	36	10.1	
Extension Contact(number per year)			6.75 (7.13)
≤5	206	57.6	
6 – 10	49	13.8	
11 – 15	60	16.9	
>16	41	11.5	

Note: Values in parentheses represent standard deviation

₦ represent Nigerian currency (155 = 1 USD)

Source: Computed from field data, 2013

Land Tenure System

The result in table 2 showed that land tenure system in the study area was predominantly (47.5%) through inheritance. About 32.3 percent of the respondents indicated using family owned land. The rent tenure type accounted for 14.6 percent of the respondents while 9.8 percent of them purchased their land. Only about 5.3 percent of the respondents indicated using communal land tenure system. This implied that private ownership (inheritance and purchase) of arable land was predominant in the study area. This could enhance credit access, investment and environmental conservation. Rugege*et al.* (2007) asserted that land tenure was a key factor in any economy since it conferred property rights and defined access to and control over land assets, including natural resources that existed in or on the land. Additionally, it conferred rights in relation to the manner in which people own, occupy and transact land. This also entails decisions pertaining to residential and business development, agricultural production and mining, and the use of other natural resources. Bamire (2010) also found that farm land acquisition through inheritance was predominant in the dry savannas of northern Nigeria.

Table 2: Percentage Distribution of Land Tenure Characteristics of Arable Farmers (n = 356)

Index	*Frequency	*Percentage (%)
Source of Land		
Purchased Land	35	9.8
Inheritance	169	47.5
Family	115	32.3
Community	19	5.3
Rent/Hired	52	14.6
Gift	3	0.8
Government	1	0.3

* = multiple responses recorded

Source: Computed from field survey data, 2013

Land-use Management Practices

The result on land-use management practices by farmers is presented in table 3. The result showed that mixed-cropping was commonly practiced by 67.4% of the farmers in the study area. The need to create security against potential risk of monoculture had been identified as one of the driving forces behind mixed-cropping as a form of diversification among smallholder farmers (Muhammad, Muhammad, Asif & Rashid, 2003; Preston, 2003). Nevertheless, one of the basic challenges in multi-cropping systems is the inherent competition among the component crops for space, soil nutrients and moisture. When the cultural practices adopted by the farmer do not cater for such competitions adequately; reduction in soil fertility, land degradation and consequently, environmental degradation would result (Makinde, Saka & Makinde, 2007).

The distribution of arable farmers by their use of modern technologies (fertilizer, herbicides and tractor) showed that majority of the farmers used fertilizer (95.2%) and herbicide (92.4%), while a few (16.6) used tractor on their farm. Tractorisation encourages large-scale farming. However, if overused or not properly used on the farm land, it could affect the structure of the soil and hence, lead to soil erosion and water logging, thereby causing land degradation and making it unfit for agricultural production.

Majority (83.2%) of the farmers in the study area practiced complete tillage, while minimum or zero tillage was practiced by a few (16.9%) farmers. Minimum or zero tillage is an appropriate soil conservation technology in Nigeria as it reduces erodibility (Braide, 1986). This form of conservation tillage results in long-term maintenance of the soil structure and an increase in water retention and hydraulic conductivity.

Manure usage was practiced minimally (41.3%) in the study area. Application of domestic wastes (including animal waste) is an age-long traditional practice on farmlands. It is a source of nutrient as well as an ameliorative material for degraded soils. Results from a study by Ahaneku*et al.* (2004) using animal wastes as soil amendments showed a reduction in soil strength parameters like compaction and bulk density, arising from increased pore spaces and enhanced infiltration capacity which ultimately minimised runoff and soil erosion. A good percentage (45.5%) of the respondents in the study area practiced slash and burn method of land clearing. While result on irrigation use showed that only a few (13.5%) farmers were engaged in this practice.

Majority of the farmers (82.3%) in the study area used improved and resistant varieties on their farms. In addition, the result showed that, 51.1 percent of the respondents used mulching on their farm. The advantages of mulching include keeping the soil cooler in the heat, preventing erosion of valuable topsoil, conserving nitrogen by preventing sun from heating the soil surface, allowing easy water penetration into the soil and preventing wind erosion.

Mining activity on arable land was reported by 20.2 percent of the respondents in the study area. Andrew (2003) stressed that small-scale mining found in remote areas of developing countries routinely generated land use conflicts (occasionally involving armed conflicts), usually with large mining companies, which had significant adverse impacts on the natural environment and local populations.

Table 3: Percentage Distribution of Respondents by Land-use Management Practices (n= 356)

Land use practice	*Frequency	*Percentage (%)
Intercropping	240	67.4
Bush clearing/burning	162	45.5
Complete tillage	296	83.2
Zero Tillage	60	16.9
Irrigation	48	13.5
Improved seed	293	82.3
Cover cropping	245	68.8
Mulching	182	51.1
Fertilizer application	339	95.2
Manure use	147	41.3
Herbicide application	329	92.4
Tractorization	59	16.6
Mining activity	72	20.2

*= multiple responses recorded

Source: Computed from field survey data, 2013

Environmental Sustainability (ES)

The result of the Principal Component Analysis for the household-based computation of environmental sustainability indicators showed eight components with Eigen value of one and above accounting for 61.13 % of the total variance. The first component had an Eigen value of 4.25 and accounted for 16.98% of the total variance. The variables and the loadings of the first principal components are presented in table 4.

The result of environmental sustainability index (ESI) is presented in table 5. The result showed that, the average ESI score was 16.38 and that, only farmers from the Kogi (16.83) and Plateau (18.44) States had values above the average. The farmers from Benue State had an average score of 13.82 which fell below the average for the full sample. Furthermore, the result of the analysis of variance showed a significant difference ($F = 28.28$; $p < 0.01$) in the ESI among the three States. This implied that, the capacity of the farmers to sustain the environment differs across these States. As noted by Harris (2000), the need to achieve environmental sustainability is rooted in the recognition of the fact that the benefits of development have been distributed unevenly and there have been major negative impacts of development on the environment and on the existing social structure. The result of ESI for farmers from Kogi State was in agreement with the findings of Madu (2010) that, of the Northern States in Nigeria, only Kogi and Kwara States had environmental sustainability values above the Nigerian average. The ESI was interpreted according to Sherbinin (2003), as a measure of the relative likelihood that a locality (or household) would be able to achieve and sustain favourable environmental conditions for several generations into the future.

Table 4: Factor Loading for the First Principal Component of Environmental Sustainability Indicators

Environmental Sustainability Indicators	Loading(A)
Fuelwood use	-0.029
High temperature	-0.045
High rainfall	-0.031
Drought	-0.087
Frequent flooding	0.088
Farm size	0.873
Tree plantation	0.068
Healthcare access	-0.011
Education	0.090
Access to electricity	0.145
Household farm income	0.849
Off-farm income	0.012
Household size	0.199
Hectares under irrigation	0.325
Quantity of fertilizer	0.722
Quantity of herbicides	0.577
Quantity of pesticides	0.199
Access to mobile phone	0.023
Access to radio	0.219
Ownership of livestock	0.138
Construction of drainages	0.260
Bush fallow practice	0.143
Minimum or zero tillage	0.119
Training in crop production practices	0.212
Investment in environmental protection	0.247

Source: Computed from field data, 2013

Table 5: Descriptive Statistics of Environmental sustainability indices

Study area	N	Minimum	Maximum	Mean	ANOVA
Full sample	356	-0.41	28.09	16.38	
Kogi State	119	0.03	24.22	16.83	
Benue State	117	-0.41	25.57	13.82	28.28*
Plateau State	120	6.62	28.09	18.44	

*= F statistic significant at 1% level

Source: Computed from field data, 2013

Factors influencing environmental sustainability

The result in table 6 showed the parameter estimates of the three functional forms of Ordinary Least Square regression analysis for the factors influencing environmental sustainability in the study area. The linear model (with superscript b) was selected as the lead equation because it had the highest R^2 (0.759) and the highest number of significant coefficients. The included variables were first subjected to the test of the presence of multi-collinearity using the variance inflating factor (VIF). The result showed that, all the variables were fit to be in the model as the highest VIF value was 1.8, a value well below 10, which, was the acceptable standard (Frees, 1996)

The adjusted R-square of 0.759 showed that 75.9% of the variations in the Environmental Sustainability Index (ESI) were explained by the changes in the explanatory variables. The F value for the model was statistically significant at 1% implying that the included farm and farmer-specific variables, tenure and land use factors significantly influenced environmental sustainability in the study area.

Furthermore, years of formal educational attainment of household heads positively (0.40) and significantly influenced environmental sustainability at 1 % level. This implied that a percentage increase in formal education of household heads led to 0.40% increase in environmental sustainability in the study area. As noted by Gutu *et al.* (2012), household heads with higher level of education have better level of planning, access and understanding of early warning information, better decision making skills during natural shocks, alter agricultural operation, and adopt extension packages. Thus education was one of the key factors in sustaining the environment.

Farming experience was found to be positively and significantly related to environmental sustainability at 1% level. This implied that, increase in farming experience of farmers by one year increased environmental sustainability by 0.05%. The experience that a household has under challenging environmental situations has contribution in terms of perceiving the future and taking preventive, mitigation and adaptation measures to reduce the impact and sustain the environment. This was because an experienced farmer should have known those practices that conserved the ecological configuration of the fragile ecosystem. According to Nhemachena and Hassan (2008), farming experience increased the probability of uptake of adaptation options because experienced farmers had better knowledge and information on environmental conditions and management practices.

The number of farmers' contacts with extension agents had a positive and significant influence to environmental sustainability at 1%. This implied that, an increase in extension visit by one contact increased environmental sustainability by 0.07%. Increased access to extension services was expected to increase the farmers' awareness about environment change and empower them with better information for adapting to the adverse effects of land use to the environment. The aim of extension service is to provide farmers with the necessary education, skills and technical information to enable them take effective and efficient farm management decisions for enhanced daily farm practices.

Household population density negatively (-0.19) and significantly influenced environmental sustainability at 1%. This implied that increase in the number of people per hectare of farmland reduced environmental sustainability. This was also expected because, given the relatively inelastic supply of land on which agriculture and rural development projects are carried out, an unchecked population brought about immense pressure on the available land. In Nigeria, for instance, Okafor (1991) established that, population concentration in south eastern Nigeria was responsible for agricultural land use change which included fragmentation of land holdings and intensification of agricultural activities. This result was in conformity with Madu (2010) who found that a higher population density resulted in an increase in the pressure on the environment in Nigeria.

Crop diversification positively (0.34) and significantly influenced environmental sustainability at 1%. This showed that multiple cropping increased environmental sustainability by 0.34%. The diversity of crops play vital role in that, in an event, one of the crops is damaged by environmental degradation induced shocks, households would survive on the other alternatives. Bradshaw *et al*. (2004) assessed the adoption of crop diversification in agriculture system for managing a variety of risks, including climatic, and found that, individual farmers had risk-reducing benefits of crop diversification.

Irrigation use also positively (1.77) and significantly influenced environmental sustainability at 1% suggesting that a percentage increase in the use of irrigation increased environmental sustainability by 1.77% in the study area. Irrigated lands are generally of higher value when compared to farms that rely solely on rain. Adaptation efforts often emphasize changes in livelihood strategies to respond to changing environmental conditions. For instance, strategies such as installation of irrigation systems have potential to be effective in maintaining the moisture content of the soil (CARE, 2011). According to Gutu (2013), during time of rainfall failure and shifting in rainfall set-on and ceasing times, access to alternative moisture sources like ground water, access to rivers and lakes, access to water harvested and other similar sources play an important role in enhancing the production of smallholders and reducing their risk to serious agricultural disruption.

Security of land tenure was positively and significantly related to environmental sustainability at 5%. It implied that a percentage increase in land tenure security either through inheritance or purchase of land increased sustainability of the environment by 0.82 percent. Insecurity of land often leads to land conflicts. Land tenure and land-use conflicts have the potential to undermine both environmental stability and food security. These forms of conflict are prevalent across and between land tenure categories. According to ECA (2004), land and natural resources conflicts revolved around five major issues. First among these was the general scarcity of land, which forces villagers to occupy land perceived as vacant. Secondly, political issues had a tendency to encourage illegal settlements among villagers in return for political favours. Thirdly, communities also chose to dishonour boundaries in pursuit of their survival strategies. Fourthly, the marginalization of certain social groups forced them to defy certain rules and regulations. Lastly, armed conflict often resulted in the destruction of the environment. As noted by Roth and Haase (1998) (cited in Dube & Guveya, 2013), enhancement in tenure security increased farmers' demand for medium- to long term land improvements, and to a lesser extent, for mobile farm equipment. This increase in demand they noted was derived from two sources. First, greater tenure security increased the likelihood that the operator would capture the returns from investments. Second, increased tenure security would reduce the incidence of disputes, freeing up resources, which would otherwise have been used for litigation.

Tree planting (3.13) was found to impact positively on environmental sustainability. The result implied that a percentage increase in planting of trees would increase the indices of environmental sustainability by 3.13%. This was expected as trees act as barriers to hailstorms that could have destroyed farms and buildings as well as absorb CO_2 gas that could have caused health problems to humans. Accordingly, Gutu (2013), found that, constructing terrace, soil bands, ridges and planting trees were some of the soil and water conservation measures done by few of the households in Ethiopia.

Quantity of fertilizer applied by farmers had a positive (0.35) and significant influence on environmental sustainability in the study area at 1%. This implied that access to and increase use of a kg of fertilizer increased environmental sustainability by 0.35%. This was in agreement with Madu (2010) that fertilizer application reduced pressure on the environment in Nigeria. This was because the quantity of fertilizer used was too small (210.8kg/ha) to impact negatively on the environment. This was in consonance with the conclusion of Ayoola (2008) that the level of inorganic fertilizer usage in Nigeria was very low relative to Asia and some other African countries such as South Africa, Malawi, Benin and Ethiopia.

Table 6: Parameter estimates of factors affecting environmental sustainability

Variable	Linear[b]	VIF	Exponential	VIF	Double Log	VIF
Constant	5.91 (4.17)*		1.39 (4.57)*		1.46 (8.53)*	
Education	0.40 (13.01)*	1.5	0.04 (5.96)*	1.5	0.10 (9.72)*	1.3
Farming experience	0.05 (3.35)*	1.5	0.002 (0.68)	1.5	-0.05 (-1.17)	1.8
Off-farm income	-5.8e-7 (-1.16)	1.5	-4.0e-8 (-0.40)	1.5	9.2e-4 (0.30)	1.2
Loan	6.1e-7 (0.44)	1.3	-1.0e-8 (-0.05)	1.3	2.0e-4 (0.04)	1.1
Extention contact	0.07 (3.03)*	1.4	0.01 (1.85)	1.4	0.003 (0.36)	1.4
Population density	-0.19 (-5.18)*	1.5	-0.02 (-2.18)**	1.5	0.01 (0.15)	3.5
Crop diversification	0.34 (2.74)*	1.8	0.02 (0.86)	1.8	-0.05 (-0.89)	1.9
Farm size	0.93 (10.16)*	1.5	0.05 (2.75)*	1.5	0.06 (0.92)	4.5
CII	0.03 (0.10)	1.3	0.003 (0.04)	1.3	-0.03 (-0.46)	1.2
Mining activity	0.10 (0.25)	1.3	0.11 (1.27)	1.3	0.06 (1.07)	1.3
Irrigation use	1.77 (3.89)*	1.3	0.13 (1.30)	1.3	0.11 (1.57)	1.2
FRI	0.81 (0.76)	1.5	0.38 (1.67)	1.5	0.01 (0.10)	1.5
Bush burning	0.28 (0.96)	1.1	0.10 (1.68)	1.1	0.09 (2.03)**	1.1
Land tenure security	0.82 (2.29)**	1.7	0.22 (2.87)*	1.7	0.09 (1.58)	1.7
Land conflicts	-0.36 (-0.95)	1.2	-0.07 (-0.82)	1.2	-0.004 (-0.06)	1.2
Tree planting	3.13 (7.40)*	1.6	0.19 (2.07)**	1.6	0.11 (1.63)	1.7
Quantity of fertilizer	0.35 (7.84)*	1.1	0.04 (4.44)*	1.1	0.20 (15.87)*	1.5
R^2	0.759		0.359		0.656	
Adjusted R^2	0.747		0.327		0.639	
F-statistic	62.62		11.15		37.94	
Prob> F	0.00		0.00		0.00	

Note: * and ** denote t-test significant at 1% and 5% levels respectively

Values in parenthesis represent t-statistic

VIF = variance inflation factor, CII = cropping intensity index, FRI = fallow rotation index

b = lead equation

Source: Computed from field data, 2013

CONCLUSION

Arable land is the most important agricultural production input. Ownership affects land use, farming systems, ecological conditions, adoption and use of technology, food production and self-sufficiency, and overall environmental condition of the rural farm population. Land tenure security impacted substantially on environmental sustainability in the study area. Land use, coupled with management practices is key instrument for achieving environmental security, increase in yield and productivity. In other words, insecurity of tenure among arable farmers is a disincentive to conservation of resources. This is so because farmers are not willing to make necessary investments from which they may be unable to reap future benefits.

RECOMMENDATIONS

Government should formulate and implement economically viable land reform policies to ensure that the farmers feel emotional attachment to the land they cultivate. Such policies should focus on establishing a more effective and efficient land title registration system that would remove the bottlenecks in the land market and enhance individual tenure security.

Also there is need to mainstream environmental sustainability into rural development process. Some practical steps for mainstreaming environmental sustainability into rural development process in the study area should include improvement in technology (such as changes in crop management practices like: small scale irrigation projects, increased fertilizer usage, increased tree planting and increased farm size); environmental management and protection, enforcement of environmental impact assessment, monitoring and evaluation of agricultural land use, and the development of basic infrastructure in the disadvantaged States in the geo-political zone. This will make the rural farmers more economically efficient and hence able to harness the local environment in a more sustainable manner.

References

[1] Abu, O., Alumuku, M. & Tsue, P.T. (2011). Can Small-scale Tomato Farmers Flourish in Benue State, Nigeria? *Journal of Agricultural Science, 2*(2), 77-82.

[2] Ahaneku, I.E., James, D. &Edogi, K.S. (2004). Changes in soil quality indicators induced by field incorporation of selected animal wastes. *Journal of Agriculture, Environmental and Engineering Technology, 1*(1), 78-85.

[3] Andrew, J.S. (2003). Potential application of mediation to land use conflicts in small-scale mining. *Journal of Cleaner Production*, 11, 117–130.

[4] Ashaolu, O.S., Momoh, S., Ayinde, I.A. &Ugalahi, U.B. (2010). Analysis of resource-use efficiency in beniseed production in Obi and Doma Local Government areas of Nassarawa State, Nigeria. *Journal of Humanities, Social Sciences and Creative Arts, 5*(1),79-90.

[5] Ayoola, J.B. (2008). Economic assessment of fertilizer use and integrated practices for environmental sustainability and agricultural productivity in Sudan Savannah Zone, Nigeria". In: E.A. Aiyedun, P.O. Idisi and J.N. Nmadu (eds.) *Agricultural Technology and Nigeria's Economic Development.* Proceedings of the 10th Annual National Conference of the National Association of Agricultural Economists, University of Abuja (7th – 10th October,2008), 386-393.

[6] Bamire, A.S. (2010).Effects of tenure and land use factors on food security among rural households in the dry savannas of Nigeria. *African Journal of Food Agriculture Nutrition and Development, 10* (1), 1982-2000.

[7] Braide, F.G. (1986). *Conservation tillage as a means of reducing erosion of erodible land*. National Workshop on Ecological Disasters in Nigeria - Soil erosion, Owerri, Nigeria, 8 - 12 September 1986.

[8] Bradshaw, B., Dolan, H. &Smit, B. (2004). Farm-level adaptation to climatic variability and change: cropdiversification in the Canadian Prairies. *Climate Change, 67*, 119-141.

[9] Bromley, D.W., (1991). *Environment and economy: Property rights and public policy.* Oxford: Basil Blackwell.

[10] Buckles, D. &Erenstein, O. (1996). Intensifying maize-based cropping systems in the Sierra de Santa Marta, Veracruz. NRG. Paper 96-07 D.F.: CIMMYT.

[11] CARE (2011). Poverty, environment and climate change network (PECCN). Retrieved from http://www.careclimatechange.org/files/adaptation/CARE_Understanding_Vulnerability.pdf.August 29,2013.

[12] Cassman K G. (1999). Ecological intensification of cereal production systems: Yield potential, soil quality and precision agriculture. *Proceedings of National Academy of Sciences,* 96, 5952-5959.

[13] Deressa, T., Hassan, R.M. &Ringler, C. (2008). Measuring Ethiopian farmers' vulnerability to climate change across Regional States. *International Food Policy Research Institute (IFPRI) Discussion Paper 00806.*

[14] Dube, L. &Guveya, E. (2013). Land tenure security and farm investments among small scale commercial farmers in Zimbabwe. Journal of Sustainable Development in Africa, *15*(5), 107-121.

[15] Erbaugh J. M. (1999). Agricultural Intensification in Uganda: Progress or environmental involution. In Proceedings of African Crop Science Society, (4), 599-607.

[16] Ezedinma, C. I. &Oti, N.N. (2001). Socio-economic issues in the development of cassava processing technology in Nigeria. *Journal of Sustainable Agriculture and Environment.3*(1),120-126.

[17] Frees, E .W. (1996). *Data Analysis Using Regression Models: the Business Perspective*. New Jersey: Prentice-Hall, Inc.

[18] Gutu, T. (2013). Individual level vulnerability to climate change impact among crop dependent communities of western Ethiopia. *Journal of Agricultural Economics and Development,* 2(9):356-370.

[19] Gutu, T., Emana, B. &Ketema, M. (2012) Analysis of vulnerability and resilience to climate change induced shocks in North Shewa, Ethiopia. *Agricultural Sciences*, *3*(6), 871-888. doi: 10.4236/as.2012.36106.

[20] Harris J.M. (2000) Basic principles of sustainable development. Global Development and Environment Institute Working Paper, Tufts University Medford MA 012155, USA http://asw.tufts.edu/gdae. Retrieved 26 April, 2014.

[21] Lawal, W.L. (2000). Profitability of fish culture in Benue state: a prelude to a thriving fish culture in Nigeria. *Nigerian Journal of Agribusiness and Rural Development,* 1(2).

[22] Madu, I.A. (2010). Population pressure, agricultural land use and environmental sustainability in Nigeria. Retrieved 25 November 2011, from www.strauscenter.org/ccaps/publication/workingpapers.

[23] Makinde, E. A., Saka, J. O. and Makinde, J. O. (2007). Economic evaluation of soil fertility management options on cassava-based cropping systems in the rain forest ecological zone of south western Nigeria. *African Journal of Agricultural Research,* 2.1:007-013.

[24] Matson, P. A., Parton, W.J., Power, A.G. & Swift, M.J. (1997). Agricultural intensification and ecosystem properties. *Science 277*(5325), 504-509.

[25] Muhammad, T., Muhammad, A.M., Asif, T. & Rashid, A. (2003). Agroeconomic advantages of different Canola-based intercropping systems. *Pakistan J.Agronomy,* 2(1):40-43.

[26] National Bureau of Statistics. (2008). *Annual abstract of statistics*. Abuja: Author.

[27] National population commission. (2006). 2006 national census data for Nigeria. Abuja: Author.

[28] Obamiro, E., Doppler, W. &Kormawa, P. (2003). Pillars of food security in rural areas of Nigeria. Food Africa Internat Forum, 31st March – 11th April. Retrived on 15 March, 2011 from www.foodafrica.nri.org/security/internetpapers/

[29] Ogunwale, B. (2000).Communication channels for information dissemination on puverty alleviation among small scale farmers in Oyo State. A paper presented at AESON conference, University of Ibadan, Ibadan, Nigeria.

[30] Okafor, F. C. (1991). *Population pressure, agricultural change and environmental consequences in South Eastern Nigeria.* New York: Social Science Council.

[31] Otubosin, S.O. (1986). Modern aquaculture practice for increased fish production in Nigeria. *Proceedings of the 4th Annual Conference of the Fisheries Society of Nigeria*, held at Port-Harcourt Nigeria, 26th -29th November. Pp 89-104.

[32] Oyekale, A.S. (2012). Intensive land use, land management and efficiency of food production in the Niger Delta region of Nigeria. *Electronic Journal of Environmental, Agricultural and Food Chemistry,11*(3), 188-204.

[33] Preston, S. (2003). Intercropping principles and production practices. Agricultural Systems Guide. Appropriate Technology Transfer for Rural Areas (ATTRA) [Online] Available: http://attra.ncat.org/attra-pub/PDF/intercrop.pdf. (June 5th, 2010).

[34] Rugege, D., Bob, U., Moodley, V., Mtshali, S., Mutanga, O. &Mthembu, A. (2007). *A literature review for the Baseline Survey on Communal Land Rights Act in KwaZulu-Natal.* Submitted to the Department of Land Affairs, Pretoria.

[35] Sherbinin, A. (2003). The Role of Sustainability Indicators as a Tool for Assessing Territorial Environmental Competitiveness. A paper presented at the International Forum for Rural Development held in Hotel Grand Bittar, Brassilia, Brazil from 4-6 November 2003.

[36] Titilola S.O. & Jeje, L.K. (2008). Environmental degradation and its implications for agricultural and rural development: The issue of land erosion. *Journal of Sustainable Development in Africa,* 10 (2), 116-146.

[37] Tsue, P.T., Lawal, W.L. &Ayuba, V.O. (2013). Productivity and Technical Efficiency of Catfish Farmers in Benue State, Nigeria.*Advanced Journal of Agricultural Research, 1*(002): 020-025.

[38] Udoh, E. J. (2000). *Land management and resource use efficiency among farmers in South-Eastern Nigeria* (Unpublished Ph.D thesis).University of Ibadan, Ibadan, Nigeria.