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AGRICULTURAL LAND USE PRACTICES AND INTENSITY OF ENVIRONMENTAL DEGRADATION IN NORTH CENTRAL NIGERIA'S ARABLE FARMING LANDSCAPE

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ABSTRACT
Arable land is the most important agricultural production input. Land use, coupled with management practices is the key instrument for achieving environmental security, increase in yield and productivity. This study examined the agricultural land use practices and intensity of environmental degradation among arable farming households in North central Nigeria. A survey of 356 households was used to generate household level data using a well-structured questionnaire. The data collected were analyzed using both descriptive and inferential statistics like means and ordered logistic regression analysis (Ologit). Results showed that land is cultivated intensely and on a continuous basis with mixed-cropping and complete tillage commonly practiced by 83.2% and 67.4% of the farmers, respectively. On the average, arable farmers perceived environmental degradation as having high intensity (2.46) on their farmland. Agricultural land use practices like complete tillage, more frequent weeding, land conflicts, farming on sloppy farmlands increased the intensity of environmental degradation while practices like herbicide use reduced it. The study concluded that improving land use practices is, therefore, a pre-requisite for sustainable agriculture, which is itself a necessary condition for environmental conservation. Hence, extension agents should organize proper teaching of farmers in rural areas on the best ways to cultivate and harvest crops and to take due caution in the choice of equipment for land clearing as well as the technique of land clearing in order to minimize injury to the environment.

Keywords: Arable land use practices, Environmental degradation, Intensity, North central Nigeria, Ordered logistic regression

INTRODUCTION
Nigeria is one of the most developed economies in Africa with the petroleum industry providing 95% of foreign exchange earnings and about 80% of budget revenues. Yet, agriculture is still the main source of revenue for two-thirds of the population (National Technical Working Group, 2009). Agriculture has always played a key role in the nation's economy, it contributed about 42% to Gross Domestic Product as against 13% for oil and gas in 2009 and 40% in 2010 (National Bureau of Statistics and Federal Ministry of Agriculture and Rural Development, 2012). Also, the agricultural sector is pivotal to attainment of national food security as it is the sole provider of the largest proportion of the national total food consumption requirement. The Nigerian agricultural landscape is basically dominated by small-scale farmers who form about 90% of the farming population. The bulk of farms are both physically small (less than two hectares of good arable land) and operated at the household level using, for the most part, family labour.

The use of land for agricultural production remains one of the strongest influences affecting environmental quality in North-central Nigeria. According to the Intergovernmental Panel on Climate Change 9[IPCC, 2007), most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas (GHG) concentrations. Agricultural activities including indirect effects through deforestation and other forms of land conversion account for about one third of total global warming potential from GHG emissions today. Therefore, reducing the direct and indirect emissions from agriculture is an essential part of the larger effort to slow the pace of environmental degradation (High Level Panel of Experts, 2012). Environmental change processes lead to changes in the biophysical life support system including land surface (vegetation), water resources, soil and atmosphere which constitute the elements that support the long-term sustainability of life on earth (Iheke & Oliver-Abali, 2011).

Land use does not necessarily lead to environmental degradation, not even intensive land use. Proper short term investments in inputs (water, fertilizer, seeds) and long term investments in structures and equipment (pumps, tractors, dams, terraces) can conserve soil and water, while allowing productive and sustainable agricultural land use. However, if conditions are such that farmers cannot invest in these inputs and structures, human activity will continue to degrade natural resources and peoples livelihoods, unless some adaptation strategies can help provide food and income without destroying the natural resource base.

Despite the perceived importance of land in rural food productivity and maintenance of environmental quality, little empirical evidence exists on the effects of arable land use practices on the environment (Lubowski, *et al.*, 2006). Precisely, the actual dynamics of how arable land use practices at the household level affects degradation of the environment in Northcentral Nigeria has not been clearly studied (Bamire, 2010). It is however, important to investigate the implications of different arable land use on environmental degradation.

In this paper an analysis has been carried out to find a cross sectional relationship between agricultural land use practices and environmental degradation in Northcentral Nigeria. This paper does not include all dimensions and factors of the land use-environment problem but is limited to the following variables:

1. Agricultural Land Use: There is a considerable diversity of opinions about what constitutes agricultural land use. One opinion that has much merit for our purpose is that: agricultural land use refers to the activities of man on land which are directly related to the growing of crops on fields (Harris, Birch and Palmer, 1996). It is conceptualized as the activities carried out on lands which aid the growth of crops. Some of the different land-use categories are: rain fed agriculture, irrigated agriculture, permanent crops, permanent pastures or rangeland and fallow. Generally, agricultural land use involves both the manner in which the biophysical attributes of the land are manipulated and the intent underlying that manipulation for agricultural purposes. An important feature of agricultural land use is regional variations, in particular, in intensity of use. Agricultural land-use refers to all land cover type (e.g., arable, improved grassland, extensive grassland), and management of such land (e.g., cropping patterns, fertilizer inputs, grazing regimes). Other disturbance effects such as erosion and wildfires are a function of both land use and climate.
2. Environment: According to Akinbode (2002), environment is the totality of the places and surroundings in which we live, work, and interact with other people in our cultural, religious, political and socioeconomic activities for self-fulfilment and advancement of our communities, societies or nations. It is within this environment that both natural and man-made things are found. In a broader and more explicit sense, it has been defined by Federal Environmental Protection Agency Act in Section 38 as including water, air, land and all plants and human beings or animals living therein and the inter-relationship that exist among these or any of them. Also, arising from the provisions of Section 20 of the 1999 Constitution of the Federal Republic of Nigeria the term environment means the following:

(a) The water, air and land; (b) Forest and wild life; (c) All layers of the atmosphere; (d) All organic and in-organic matter and living organisms; and (e) The interacting natural systems that include components referred to in paragraph (a) to (d).

3. Environmental degradation: When the environment becomes less valuable or damaged, environmental degradation is said to occur. When habitats are destroyed, biodiversity is lost, or natural resources are depleted, the environment is hurt (Etuonovbe, 2009). Countries all over the world, particularly the developing ones, face severe environmental degradation that appears to be threatening their long-term development prospects. This is so because they rely upon the use of natural resources in their growth and development process. These natural resources are being used up in a manner that appears wasteful and, thereby, forecloses options for development in the future. The World Bank estimated that more than a million people in Sub-Saharan Africa still live in acute poverty and suffer grossly inadequate access to resources required to give them opportunity for economic development. The immediate struggle for basic survival by the poor in various countries undermines the legitimate concerns of environmental protection and leads to consequent pressure on the environment, with attendant pervasive degradations (Hisham, 1993).

Environmental problems of rural Nigeria are of varying nature and degree depending on the physical weather and vegetation characteristics of the area as well as the socio-economic life of its people. There are many forms of environmental degradation, some of which include: deforestation, land or soil degradation, desertification, pollution and drought. The broad objective of the study was to analyze the effect of agricultural land use practices on environmental degradation in Northcentral Nigeria. Specifically, the study sought to:

i. identify land use practices in arable food crop production;
ii. assess intensity of environmental degradation from farmers' perspective; and
iii. determine the effect of arable land use practices on the intensity of environmental degradation.

The effect of the current farming practices adopted by arable farmers on the environment in the study area would provide an empirical guide for the identification of any gaps that may exist in the current farming practices employed and the interventions required towards more sustainable food production. Policy makers, thus, stand to benefit from this work, as it will provide them with sufficient information to articulate sound and relevant policies to the alleviation of the poverty and hunger problems among rural farmers.

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% of the country's total land area (NBS, 2008). There are six states in the zone and the Federal Capital Territory, Abuja. 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% (NPC, 2006). The major ethnic groups of the study area are the Gwari, Baruba, Bargana, Nupe, Tiv, Yoruba, Igala, Idoma, Angas and Birom. Rainfall in the zone is largely seasonal and highly variable from year to year, with mean annual rainfall of between 1500 mm and 1800 mm in north and south, respectively. Agricultural activities depend mostly on rainfall, with rain-fed agriculture accounting for more than 90 percent of the production systems (Food and Agriculture Organization [FAO], 2001). Agriculture is the mainstay of the zone's economy.

Sampling Procedure

Multi-stage random sampling technique was used to select a sample size of 360. In the first stage, a random selection of three States from North-Central Nigeria which comprised Niger, Kwara, Kogi, Benue, Nassarawa and Plateau States was made. 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 (LGAs) 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 (LGA) 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 Kogi States, respectively, giving a total of 356 respondents analyzed for the study.

Method of Data Collection

Data for this study were collected mainly from primary sources. The primary data were collected from the arable crop farmers in North-central Nigeria using a well-structured and pre-tested questionnaire.

Analytical Framework

The data collected were analyzed using both descriptive and inferential statistics. Objectives i and ii were analyzed using mean while objective iii was analyzed using ordered logistic regression analysis (Ologit). Furthermore, the null hypothesis was tested using z-test as embedded in the Ologit model for estimation.

1. Rating Scale Technique: To compute the intensity of environmental degradation, 15 indicators/variables were used for measuring this intensity. They include: biodiversity loss, soil erosion, desertification, deforestation, and loss of fertile land, disease/pest infestation, weed infestation, hailstorm, high rainfall, low rainfall, high temperatures, low temperature, and quick loss of soil moisture, frequent flooding, and run-off (water pollution). The 4-point rating scale was graded as Very High = 4; High = 3; Low = 2 and Very Low = 1. The mean score of respondents based on the 4-point rating scale is given as: 4 + 3 + 2 + 1 = 10/4 = 2.50

Using the interval scale of 0.05, the upper limit cut-off point is 2.50 + 0.05 = 2.55; the lower limit is 2.50 – 0.05 = 2.45. Based on these limits, mean scores below 2.45 (MS < 2.45) were ranked as 'Low intensity' of environmental degradation; those between 2.45 – 2.54 (2.45 ≥ MS ≤ 2.54) were considered as "high intensity" of environmental degradation, while mean scores that are greater or equal to 2.55 were considered "very high intensity" of environmental degradation.

2. Ordered logistic regression model: According to Greene (2003), the ordered logit model (also ordered logistic regression or proportional odds model), is a regression model for ordinal dependent variables. It can be thought of as an extension of the logistic regression model that applies to dichotomous dependent variables, allowing for more than two (ordered) response categories. The model only applies to data that meet the proportional odds assumption, that the relationship between any two pairs of outcome groups is statistically the same. This means that the coefficients that describe the relationship between, say, the lowest versus all higher categories of the response variable are the same as those that describe the relationship between the next lowest category and all higher categories, etc. Because the relationship between all pairs of groups is the same, there is

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only one set of coefficients. The model cannot be consistently estimated using ordinary least squares; it is usually estimated using maximum likelihood.

Examples of multiple ordered response categories include bond ratings, opinion surveys with responses ranging from "strongly agree" to "strongly disagree," levels of state spending on government programs (high, medium, or low), the level of insurance coverage chosen (none, partial, or full), employment status (not employed, employed part time, or fully employed) (Greene, 2003). Suppose the underlying process to be characterized is:

$$y* = x'\beta + \epsilon, \qquad \ldots(1)$$

where;
y^* = the exact but unobserved dependent variable (perhaps the exact level of agreement with the statement proposed by the pollster); **x** is the vector of independent variables, and β is the vector of regression coefficients which we wish to estimate. Further suppose that while we cannot observe y^*, we instead can only observe the categories of response as:

$$y = \begin{cases} 0 & \text{if} \quad y^* \leq \mu_1, \\ 1 & \text{if} \quad \mu_1 < y^* \leq \mu_2, \\ 2 & \text{if} \quad \mu_2 < y^* \leq \mu_3 \\ \vdots & \\ N & \text{if} \quad \mu_N < y^*. \end{cases} \qquad \ldots(2)$$

Then the ordered logit technique will use the observations on y, which are a form of censored data on y^*, to fit the parameter vector β. However, since the dependent variable (y) is categorized, the following model is specified as:

$$p(Y \leq i) = p_1 + \ \ldots + p_i \qquad \ldots(3)$$

$$odds(Y \leq i) = \frac{p(Y\leq i)}{1-p(Y\leq i)} = \frac{p_1+\cdots+p_i}{p_{i+1}+\cdots+p_{k+1}} \qquad \ldots(4)$$

$$logit(Y \leq i) = \ln\left(\frac{p(Y\leq i)}{1-p(Y\leq i)}\right), \quad i = 1, \ldots, k \qquad \ldots(5)$$

The cumulative logistic model for ordinal response data is given by:

$$logit = (Y \leq i) = \alpha_i + \beta_1 X_1 + \cdots + \beta_m X_{im}, \quad i = 1, \ldots, k\,. \qquad \ldots(6)$$

It follows then that the cumulative odds are given by

$$odds(Y \leq i) = \exp(\alpha_i)\exp(\beta_1 X_1 + \cdots + \beta_m X_m), \quad i = 1, \ldots, k \qquad \ldots(7)$$

Ordinal logistic regression model is sometimes referred to as the constrained cumulative logit model originally proposed by Walker and Duncan (1967) and later called proportional odds model by McCullagh (1980); Ananth & Kleinbaum (1997); Hosmer & Lemeshow (2000) and Agresti (2007). Dong (2007) applied the models for ordinal response study, a self-efficacy in colorectal cancer screening. Adepoju and Adegbite (2009) also used ordinal logistic model to study the relationship between staff categories (as outcome variable) Gender, Indigenous status, educational qualification, previous experience and age as explanatory variables. Adeleke and Adepoju (2010) applied ordinal logistic regression to model the three major factors viz., environmental (previous cesareans, service availability), behavioral (antenatal care, diseases) and demographic (maternal age, marital status and weight) that affected the outcomes of pregnancies (livebirth = 0, stillbirth = 1 and abortion = 2). Tsue *et al.* (2014) modelled farm and farmer-specific characteristics and land use factors influencing household vulnerability (less vulnerable = 3; vulnerable = 2 and highly vulnerable = 1,) to environmental degradation in North-central Nigeria.

This study therefore, applied ordinal logistic regression to model agricultural land use factors influencing intensity of environmental degradation (very high intensity = 1, high intensity = 2 and low intensity = 3).

Ordered logit regression model was employed to achieve objective iii. The model is specified as follows:

$$Y(\leq j) = \ln\left(\frac{p(Y \leq j|X)}{p(Y > j|X)}\right) \qquad \ldots(8)$$

It then means that:

$$\Pr(Y \leq j) = \ln\left(\frac{\sum pr(Y \leq j|X)}{1-\sum pr(Y \leq j|X)}\right) = \alpha_j + \beta_1 X_1 + \cdots + \beta_{15} X_{15} \qquad \ldots(9)$$

j = 1, 2, 3
where;
Y = level of intensity of environmental degradation (which is categorized into 3: very high intensity = 1, high intensity = 2 and low intensity = 3)
α = threshold
β_1-β_{15} = estimated parameters
X_1 = land tenure security (inheritance/purchase land = 1, otherwise 0),
X_2 = bush clearing/burning (Yes = 1; No = 0),
X_3 = Tillage (Complete Tillage = 1, Zero Tillage = 0),
X_4 = Weeding Frequency (3 or more times = 1, less than 3 times = 0),
X_5 = practice irrigation (Yes = 1, No = 0),
X_6 = Animals grazing on farm land (Yes = 1, No = 0),
X_7 = mining activity (1 if there is mining activities on respondent's farmland, and 0 otherwise),
X_8 = land conflict (1 if experienced conflict and 0 otherwise),
X_9 = bare farmland (1 if use cover cropping and 0 otherwise),
X_{10} = sloppy farmland (1 if farmland is sloppy and 0 otherwise),
X_{11} = fuelwood harvesting (1 if harvesting and 0 otherwise),
X_{12} = Fallow (Fallow Rotation Index),
X_{13} =Tractor use (1 if use and 0 otherwise),
X_{14} = Herbicide use intensity (l/ha), and
X_{15} = fertilizer use intensity (kg/ha).

RESULTS AND DISCUSSION

Land-use Management Practices

Agricultural land use practices are presented in Table 1. 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 *et al.*, 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 *et al.*, 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 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 by a good percentage (41.3%) of farmers 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 in Northcentral Nigeria. 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 1: Land-use Management Practices by the Respondents (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: Author's Computations (2015)

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Arable Land Use Intensity

The attributes of land use intensification among arable farmers in the study area is presented in Table 2. The average length of fallow was 0.92 years. Consequently, average fallow rotation index for arable farmers was 0.89, indicating that arable farmers in the study area engaged their farmland in permanent and continuous cropping. The short fallow periods found in the study area could be attributed to population pressure and the use of agricultural land for other developmental programmes such as parks, schools, road and estates construction. This supported the assertions of other studies that the changing pattern of land-use affected agricultural production (Aina & Salau, 1992; Awe, 1997). The shortened fallow periods over time and the continuous use of land by majority of the respondents**1**signified the intensification of land-use. This was capable of affecting the soil fertility status and consequently, reduced crop yields. This result was similar to Oyekale (2007) who found an estimated fallow rotation index of 0.71 for farmers in Southwestern Nigeria. Osabuomen and Okoedo-Okojie (2011) also noted that, long periods of bush fallow were no longer practiced commonly by farmers, because of population pressure on available land. Allowing farmlands to fallow for long periods increase soil fertility, crop yield and reduce disease and pest population build up on farmland as well as lowering the rate of soil erosion. The result in Table 2 also showed that farmers had their farm land occupied with food crops for an average of 5.43 months. Average cropping intensity index for the study area was estimated at 0.47 implying that, arable farmers in Northcentral Nigeria could still seek increased production through multiple cropping as the land is averagely not engaged for more than nine months (Dayal, 1978).

Table 2: Land-use Intensity among Arable Farmers (n = 356)

Variable	Frequency	Percentage	Mean
Fallow rotation index (FRI)			0.89 (0.16)
0.33 - 0.65 (Bush fallow)	31	8.7	
>0.66 (permanent/continuous cultivation)	325	91.3	
Years of land under fallow			0.92 (1.33)
0	226	63.5	
1-2	16	4.5	
3-4	61	17.1	
>4	53	14.9	
Crop intensification index (CII)			0.47 (0.24)
< 0.33 (Low)	116	32.6	
0.33 - 0.66 (Medium)	172	48.3	
>0.66 (High)	68	19.1	
Number of crops grown			3.7 (1.5)
Months land occupied by food crops			5.43 (2.53)
Fertilizer use intensity (Kg/ha)			210.8 (162.8)
≤100	86	24.2	
101-200	117	32.9	
201-300	78	21.9	
>300	75	21.1	
Herbicide use intensity (l/ha)			5.4 (4.5)
≤5	201	56.7	
6-10	107	30.1	
11-15	35	9.8	
>15	12	3.4	
Hired labour use intensity (₦/ha)			35715 (3501)
≥50000	268	75.3	
50001-100000	63	17.7	
>100000	25	7.0	
Family labour use intensity (mandays/ha)			2687 (2105)
≤1000	77	21.6	
1001-3000	160	44.9	
3001-5000	72	20.2	
>5000	46	13.2	

Source: Author's Computations (2015)

The result further showed the classification of the farmers on the basis of the fallow rotation and cropping intensity indices using the framework advanced by Rutherburg (1980) and Dayal (1978), respectively. The classification into fallow rotation pattern showed that 91% of the arable farmers engaged their land in permanent and continuous cropping. In addition, the distribution according to the level of cropping intensity showed that land-use in food crop production in North-central Nigeria was characterized by continuous cropping under medium cropping intensity (48.5%). Limited available arable land as shown in the study area probably made shifting cultivation a thing of the past. In this circumstance, the same piece of land was tilled every year. With fragmentation of land by families, land witnesses successively increasing pressure, most likely resulting in the extension of cropping onto marginal lands.

Fertilizer use intensity among arable farmers in the study area showed that on the average, farmers used 210.76 kg of fertilizer per hectare while herbicide use intensity was at 5.35 litres per hectare. The low rate of fertilizer application fell short of the recommended dosage of 300-400 kg/ha, depending on crop type (IART, 1991). These findings were in line with that of Olayemi (1980) that the usage of chemical inputs by farmers in the tropics was minimal. Although, this study had shown the prevalence of continuous cropping in food crop production in the study area, the condition under which this took place fell short of what was advocated for sustainable growth through intensification, as land is been cultivated more intensely under low level of use of modern input.

Hired labour use intensity was on the average ₦35,715/ha. In addition, the use of family labour was found to be 2,687 mandays/ha. This result was expected, given a high household size (nine people) among arable farmers in the study area. Land use intensity increases as land to human population ratio increases.

Intensity of Environmental Degradation from Farmers' Perspective

To ascertain the intensity of environmental degradation in the study area, the level of intensity of environmental problems as perceived by the farmers was examined and presented in Table 3. The following indicators of environmental degradation were perceived as very high intensity by farmers in North-central Nigeria with their mean score 2.55 and above (i.e., MS ≥ 2.55) namely; biodiversity loss (3.31), soil erosion (2.59), deforestation (3.12), hail storm (2.92), high rainfall (2.72), and water pollution (2.69).

Table 3: Mean Scores of Intensity of Environmental Degradation as Perceived by Farmers

Environmental Problem	Mean	Standard deviation
Biodiversity Loss	3.31*	0.624
Soil erosion	2.59*	0.791
Desertification	2.08***	0.891
Deforestation	3.12*	0.766
Loss of fertile land	2.60*	0.918
Disease/pest infestation	2.22***	0.916
Weed infestation	2.52**	0.933
Hail storm	2.92*	0.812
High rainfall	2.72*	0.909
Low rainfall	1.47***	0.725
High temperatures	2.29***	0.994
Low temperatures	2.26***	1.077
Loss of soil moisture	2.01***	0.930
Frequent flooding	2.11***	0.971
Run-off (water pollution)	2.69*	0.854
Total intensity	2.46**	0.341

Note: * = very high intensity; ** = high intensity; and *** = low intensity
Source: Author's Computations (2015)

On the average, arable farmers perceived environmental degradation as having high intensity (2.46) on their farmland. The frequency distribution of respondents by intensity of environmental degradation is presented in Table 4. The result showed that about 35.1 percent of respondents in the study area perceived environmental degradation with very high intensity, 15.7 percent were under high intensity while 49.2 percent of the respondents perceived it as having low intensity.

Table 4: Respondents' Perceived Level of Intensity of Environmental Degradation

Intensity	Frequency	Percentage
Very high intensity (1)	125	35.1
High intensity (2)	54	15.7
Low intensity (3)	175	49.2
Total	356	100.0

Source: Author's Computations (2015)

Effects of Arable Land Tenure and Use Practices on Intensity of Environmental Degradation

The result of the parameter estimates (estimated coefficients along with z values) of the ordered logit regression analysis for the effects of land tenure and land use practices on intensity of environmental degradation are presented in table 6 together with the odds ratios. The test of parallelism is presented in Table 5. The result showed that the assumption of equal location parameters (slope coefficients) was accepted. The χ^2 values of 21.430 was not statistically significant ($p > 0.05$). This implied that the assumption of parallelism was satisfied.

Table 5: Test of Parallelism showing Equal Location of Parameters

Study area	-2log likelihood	χ^2	Df	Sig.
Full sample	630.747	21.430	15	0.124

Source: Author's Computations (2015)

For overall model, the log likelihood statistics indicated by χ^2 (62.96) evaluated the null hypothesis that all coefficients (land use practices) in the model, except the constant equaled zero. The probability greater than chi square (prob > χ^2) was low enough (0.0000) to reject this null hypothesis suggesting that not all factors were equal to zero (Table 6). This implied that land tenure and use factors influenced intensity of environmental degradation in the study area.

This study used the parameter estimates and the odd ratios from ordered logistic regression analysis to interpret the behaviour of land tenure and land use practices on the level of intensity of environmental degradation. Evidence from the models as contained in table 6 showed that, the set of significant explanatory variables varied across the categories in terms of the levels of significance and signs. The positive signs suggested that an increase in the variable was associated with higher category (in this case, low intensity (3)), while a negative and significant parameter means that the independent variable was associated with lower category (in this case, very high intensity (1)). The significant independent variables in the model are discussed as follows:

The coefficient of tillage practice was negative and significant at 1% favouring the lower category. The result of the odds ratio for this variable was 0.46. This implied that farmers who practiced complete tillage were 0.46 time more likely to experience very high environmental degradation than farmers who practiced minimal or zero tillage. Complete tillage may lead to destruction of beneficial soil organisms, loss of organic matter, soil erosion and compaction of soil especially when tractors are used. Minimum tillage or zero tillage as noted by Braide (1986) was an appropriate soil conservation technology in Nigeria as it reduced erodibility. This form of conservation tillage results in long-term maintenance of the soil structure and an increase in water retention and hydraulic conductivity. This result was contrary to Osabuomen and Okoedo-Okorjie (2011) in Edo State that complete tillage did not result in the degrading of the environment, based on the farmers' perception. The result of tillage practice was also found to be negative across all the agro-ecological zones though not statistically significant.

Frequency of weeding farmland increased the likelihood of favouring a lower category (i.e. very high intensity), as the coefficient was negative (-0.96) and significant at 1%. The odds ratio was 0.38. This implied that arable farmers who were in the practice of weeding their farmland more than three times in a cropping season were 0.38 time more likely to experience very high intensity of environmental degradation than those who were weeding less than three times.

Households that experience land conflicts were more likely to experience very high intensity of environmental degradation in the study area. This was confirmed by a negative coefficient (-0.55) which was statistically significant at 5% with the odds ratio of 0.57. This implied that, farmers who experienced land conflicts were 0.57 time more likely to experience very high intensity of environmental degradation. Fasona and Omojola (2005) noted that, the guinea savannah farmer who was already farming close to the margins of cultivation would naturally resist any attempt of invasion of his farmland by the cattle herdsmen who were continually in search of greener pastures that were only in existence within the limit of arable land. These conflicts led to burning and destruction of farms and houses which in turn had tremendous adverse effect on the environment. This result also confirms the findings of Oyekale (2012) that land conflict increased unsustainable land use in Niger Delta region of Nigeria and further noted that where there are land conflicts, investment in sustainable land management practices cannot be promoted.

Farmers with sloppy farmland were more likely to experience very high intensity of environmental degradation. The coefficient of sloppy farmland was negative (-1.09) and significant at 1 % with the odds ratio of 0.33 implying that, farmers who cultivated on steep and sloppy farmland were 0.33 time more likely to experience very high intensity of environmental degradation in the study area. Sloppy areas are prone to erosion and run-offs and farming on such lands makes farmers more vulnerable to agents of degradation.

Herbicide use per hectare by farmers was found to be positive and significantly related to the higher category of intensity of environmental degradation at 5% with the odds ratio of 1.07. This implied that, increasing herbicide use would likely lower the intensity of environmental degradation by 1.07 times according to the farmers' perception in the study area. This was against *a priori* expectation of this variable as high use of chemicals are likely to cause air pollution, water pollution through run-off, death of beneficial soil organisms and both human and animal health problems.

Though the effects of the other variables were not shown to be statistically significant, land tenure security, irrigation use and fertilizer use intensity were positive favouring low intensity of environmental degradation (i.e. higher category), while clean clearing/bush burning, grazing, mining activity, firewood harvesting and tractorisation were negative suggesting the variables favoured very high intensity of environmental degradation (i.e. lower category) in North central Nigeria.

Table 6: Effects of Arable Land Use Practices on Intensity of Environmental Degradation

Independent variables	Coefficients	Odds ratios
Land tenure security	0.32 (1.33)	1.37
Clean clearing/bush burning	-0.03 (-0.14)	0.97
Tillage practice	-0.78 (-2.67)*	0.46
Frequency of weeding	-0.96 (-3.75)*	0.38
Irrigation use	0.29 (0.81)	1.34
Grazing animals on farmland	-0.20 (-0.75)	0.82
Mining activity	-0.36 (-1.24)	0.70
Land conflicts	-0.55 (-1.92)**	0.57
Bare land	-0.55 (-1.38)	0.58
Sloppy farm land	-1.09 (-3.60)*	0.34
Fuel wood harvesting	-1.06 (-0.86)	0.35
Fallow rotation index	-0.64 (-0.89)	0.53
Tractorisation	-0.41 (-1.32)	0.66
Herbicide use intensity (kg/ha)	0.06 (2.25)**	1.06
Fertilizer use intensity (l/ha)	0.00 1(0.02)	1.00
Cut1	-9.20	
Cut2	-8.45	
Number of observations	356	
LR chi^2 (15)	62.96	
Prob> chi2	0.00	
Pseudo R^2	0.09	
Loglikelihood	-327.20	

Note: * and ** denotes z-test significant at 1% and 5% level, respectively; and values in parentheses represent z-ratios; Cut1, Cut2 = estimated cut points.
Source: Author's Computations (2015)

CONCLUSION AND RECOMMENDATIONS

Arable land is the most important agricultural production input. Land use, coupled with management practices is the key instrument for achieving environmental security, increase in yield and productivity. Land is cultivated intensely and on a continuous basis in the study area. Improving land use practices is, therefore, a pre-requisite for sustainable agriculture, which is itself a necessary condition for economic growth, poverty reduction and environmental conservation. Based on the findings of the study, the following policy recommendations were made:

1. Extension agents should organize proper teaching of farmers in rural areas on the best ways to cultivate and harvest crops (such as minimum or zero tillage, reduction in the frequency of manual weeding, avoidance of cultivating on steep slopes and marginal lands, efficient practice of cropping intensity rather than expansion of land and technical knowhow to manage mechanized farming) and to take due caution in the choice of equipment for land clearing as well as the technique of land clearing in order to minimize hazards of erosion and depletion of fertility through loss of fertile top soil.
2. Furthermore, community leaders and farmers should ensure that communal crises and land conflicts in North-central Nigeria are well handled and managed in a way that do not disrupt the goal of sustainable environmental Management.
3. Appropriate choice of policies, technologies and institutions in order to achieve sustainable environment and development in the study area should be pursued by the

government. Such policies should include; mainstreaming environmental concerns into education system, integrating regional development strategy and environmental management and protection, afforestation policies, fertilizer distribution policies and the development of farm infrastructures like small-scale irrigation schemes.

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