ASUU JOURNAL OF SCIENCE
A Journal of Research and Development
Vol. 6, No. 1 & 2, December, 2019; pp 118-142

Examining the determinants of agricultural-land degradation among farming households in Sokoto Plain, North-western Nigeria

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ABSTRACT

Agricultural land in Nigeria is becoming more vulnerable to degradation due to socio-economic, environmental and political constraints, such as fragmentation through inheritance and lack of inputs such as fertiliser. To ensure that policy decisions align with the needs of farmers, this study examines farmers' perceptions of the extent and causes of agricultural land degradation along the Sokoto Plain. A multistage sampling method was used to sample 360 farming households across administrative and agro-ecological characteristics. A structured questionnaire supplemented with an oral interview was used for data collection. Descriptive statistics, land degradation perception index and ordered probit regression model were used to analyse the collected data. Soil nutrient depletion, erosion, soil structural and ecological changes were the major forms of degradation observed by the farmers in the study area. Majority of farm plots were classified as displaying "moderate" to "severe" degradation based on the perception index parameters. The significant determinants of land degradation include; age of farmer (regression co-efficient -0.0067), educational attainment (-0.0182), household head community status (-0.3246), poverty status that is being non-poor relative to poor households (-0.2404) showed an advantage. The land ownership status that is owned-plot (-0.1818) and number of parcels owned by the

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household (-0.0773) and credit access (-0.0773) decrease the likelihood of severity of land degradation. By contrast, distance of plot from town (0.0419) and plot gradient (1.0673) increase the tendency of severity of land degradation. The study recommends more access to basic inputs and capacity building on sustainable agricultural practices to farmers could raise soil fertility status, productivity and reduces land degradation.

Keywords: Agricultural-Land Degradation; Perceptions, Determinants, Sokoto Plain

INTRODUCTION

Agriculture accounts for most land use and remains the principal means of livelihood for the rural poor. More than 70 percent of the Nigerian labour force is engaged in occupation that is directly connected to land and agriculture (NBS, 2012 and NBS, 2017). Degradation on agricultural lands refers to changes in the quality of soil, water and other characteristics that reduce the ability of land to produce goods and services that are valued by humans or that action on land that decreases sustainable crop production over time (FAO, 2011 and Oyekale, 2012).

Land degradation remains an important global issue in the 21st century because of its adverse impact on agronomic productivity, the environment, and its effect on food security and the quality of life (Eswaran and Reich, 2001and Oyekale, 2012). Productivity impacts of land degradation are due to a decline in land quality on site where degradation occurs (e.g. erosion) and off site where sediments are deposited. The productivity of some lands in Africa has been reported to have declined by 50% as a result of soil erosion and desertification (Dregne, 1990). Yield reduction in Africa due to past soil erosion may range from 2 to 40%, with a mean loss of 8.2% for the continent (Lal, 1995). Annual reduction in total production for 1989 due to accelerated erosion was 8.2 million tons for cereals, 9.2 million tons for roots and tubers, and 0.6 million tons for pulses. If accelerated erosion continues unabated, yield reductions by 2020 may be 16.5% (Eswaran and Reich 2001).

The extent and severity of the effects of land degradation on crop production in Nigeria have not been fully established neither the rate of progression properly documented. However, it has been estimated that generally, soil losses ranging between 3 and 10 tonnes/ha/year from cultivated lands in Nigeria far exceed the soil tolerance level, beyond which sharp drop in soil productivity occurs (Babalola and uZagal, 2000). More than 90% of Nigeria's soils have suffered from variable degree of degradation (Babalola and Zagal, 2000) and between 50 % and 75 % of Bauchi, Borno, Gombe, Jigawa, Kano, Katsina, Kebbi, Sokoto, Yobe, and Zamfara States in Nigeria are being affected by desertification {Federal Ministry of Environment, Nigeria (FMEN), 2006}. It is against this background this study seeks to assess perception and examine the determinants of agricultural land degradation among farming households in Sokoto Plains of Nigeria.

MATERIALS AND METHOD

The study area

The study was carried out along the Sokoto plains in the North-Western Nigeria. Sokoto Plain is located between latitudes 100 30′ N and 130 21′ N and longitude 30 30′ E and 50 55′ E, it cut across Sokoto, Kebbi and Zamfara States with very small portion of Katsina State. Sokoto Plain is characterized by a savannah type climate with alternating wet and dry seasons. The Annual Rainfall Range along the Plain is between 400 to 900 mm and Annual Temperature Range of 21 to 43 oC with a prolonged dry season of 6 to 9 months. Agricultural production along the plain as in many parts of the country is largely rain-fed, while irrigated farming is also much practiced in the fadamas.

Sampling Procedure and Sample Size

A multistage sampling method was employed in sampling 360 farming households. In the first stage, three major States of the Plain were purposively chosen for the study, namely: Sokoto, Kebbi and Zamfara States as they occupy over 90% of the plain. The second stage involved the purposive selection of two Local Government

Areas and three farming communities/villages from each LGA based on the State level expert assessments of community agro-ecological status. In the third stage, a proportionate random sampling of farming households across the selected farming communities was carried out. The sampling plan is presented in Table 1.

Table1: The sampling plan for the study

State	Local Govt Area	Community Agro - ecological Status	Selected community	Number of farming Households [1]	Sample Size (Household)
	Bunza		Zunguru/Bunza	458	25
Kebbi		Bright Spot	Tilli	330	18
		(Wetter zone)	Gwade / Chakawa	366	20
	B/Kebbi	Hot Spot	Makera	348	19
		(Drier zone)	Ambursa/Zauro	641	35
			Gulumbe	476	26
	Tureta	Bright Spot	Tureta	439	24
Sokoto		(Wetter zone)	Loffa	275	15
			Tsamiyya	238	13
	Kware	Hot Spot	Marabawa	183	10
		(Drier zone)	Sabon Birni	201	11
			Durbawa	220	12
	Tsafe	Bright Spot	Keta	366	20
		(Wetter zone)	Yankuzo	474	26
Zamfara			Bilbis	513	28
	Zurmi	Hot Spot	Gurbin Baure	275	15
		(Drier zone)	Dauran	330	18
			Moriki	460	25
Total	6		18	6590	360

[1] Source: Computed using the ADP VLS estimate, 2014

Method of Data Collection

Structured questionnaire was used for data collection. The questionnaire featured socioeconomics and demographic information of the households, land use and management practices - crop combination and diversification; households perceptions on the causes of land degradation as well as plot level characteristics.

Analytical Techniques

Combinations of analytical techniques were employed for data analysis. These include descriptive statistics in the form of frequency and percentage, Land degradation perception index and ordered probit regression model. Factor rating of perceived land fertility, severity of soil erosion features, plot gradient and management practices were further used for the construction of land degradation perception index and classification of plots in land degradation severity classes following Genene and Wagayehu (2010) and Abdullahi (2014). The perception index is specified as:-

$$PI = \frac{\Sigma PWPS}{AWP} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . (1)$$

Where:

PI = Perception Index; PWPS = Parameter Weighted Perception Score; AWP = Aggregate Weighted Point of parameter descriptors and Σ = Summation sign

$$PI = \frac{(P1 \times 4) + (P2 \times 2) + (P3 \times 2) + (P4 \times 2)}{4+2+2+2} \ldots \ldots \ldots \ldots \ldots$$

Where:

P1= Parameter rating for soil characteristics in terms of richness in organic matter, scaled from 1 to 4 and weighted 4

P2 =Parameter rating for degree of erosion on the farm plot, scaled from 1 to 4 and weighted 2

P3 =Parameter rating for degree plot gradient (sloppiness), scaled from 1 to 4 and weighted 2

P4 =Parameter rating for application of external inputs (fertilizer and or manure), scaled from 1 to 4 and weighted 2

The Aggregate Weighted Points for the parameter descriptor (AWP) = 4+2+2+2 =10 ....(3)

The expected minimum index is 1 and a maximum of 3.6, thus the index ranges from 1 to 3.6. The index is further grouped to classify the perceived agricultural land degradation status, thus an index of:

1.00 - 1.25 = Slightly degraded,

1.26 - 2.00 = Moderately degraded,

2.10 - 2.90 = Severely degraded and
3.00 - 3.60 = Extremely degraded

Ordered Probit Regression Model

Ordered probit regression model was used to examine the determinants of land degradation in the study area. The model is built around a latent variable as specified by Maddala (1989) and Greene (2000), given by:

$$Y^* = \beta' X_i + X_i \qquad (i = 1, 2, 3, \ldots, n) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where:
Y* is unobserved latent variable for level of land degradation, which is ordered. β' is a vector of coefficient of explanatory variables (Xi) estimated. The parameter estimates β' represent the effect of explanatory variables on the underlying order of land degradation severity. ε i is disturbance term.
The dependent variable Y is observed in j number of categories, in this case Y takes the level of land degradation. Y = 0, (Slightly degraded); Y = 1, (Moderately degraded); Y =2, (Severely degraded) and Y = 3, (Extremely degraded) plot.
The explanatory variables in this case are:
Agei = Age of the household head (years)
HSZi = Number of family members
HEdui= Number of years of formal education completed by the household head
PovStat = Household poverty status (Dummy variable where: poor, 1 and non-poor, 0)
TLUi = Total livestock holding of the household (Tropical Livestock Unit)
PLTOwni = Plot ownership status, dummy (1, if own plot; 0,Otherwise)
NoPloti = number of farm plot managed by the household
PlotAreai = Size of land own (Ha)
Distown = Average distance of plot to residence (Km)

PLTSlopei = Slope of the field as a proxy of erosion potential (Dummy variable, flat = 0, slopy =1)
Landusei = Land use type (Dummy variable, where: 1 if the plot used for arable crop production; and 0, if the land used for fadama crop production)
CDIi= Crop Diversification Index (Herfindel Index, ranges from 0 to 1)
NIIi = Nutrient Intake Index (Index ranges from 1 to 7)
Cstati = Household head community status (Dummy variable, where: 1, if holds position in community administration either group, religious or traditional; 0, otherwise)
CRDAccess = Household credit access, amount of loan obtained in Naira per annum
Mktacess = Market Access, distance to the nearest urban market (metres)

A priori Expectations on the Determinants of Land Degradation

Age of the household head (Agei): Serves as a proxy variable for farming experience. Thus, age of the household and the perception on land degradation are expected to relate positively (Feder *et al.,* 1985, Pender and Kerr, 1998).

Household size (HSZi): The existence of large number of family members with limited resource could affect land degradation as it may bring about land fragmentation. Therefore, household size is hypothesized to affect land degradation positively.

Education of the household head (Hedui): Education may increase households understanding on the causes and impact of land degradation. Education may increase household's access to credit, thus helps to finance purchase of physical capital and agricultural inputs. Despite this, more educated households may be less likely to invest inputs or labour-intensive land management practice, since the opportunity cost of investing inputs or labour-intensive investments and capital may increase through education. Therefore, the direction of the relationship between education and land degradation is indeterminate a priori.

Livestock holding (TLU): The livestock holding of the household is an indicator of wealth.

Those farmers who have large number of livestock may have more animal dung to improve the fertility of the soil and more capital to invest in soil conservation practice. This may affect the use of soil fertility measures positively (ILRI, 2003), and affect land degradation negatively.

Poverty Status of the households (PovStat) Poverty is expected to affect land degradation positively going by the downward spiral hypothesis.

Plot ownership (PLTown): Plot ownership arrangement influence farmers' land management, Farmers who plough their plots fill better secured than sharecropped or rented. When the farmer fills insecure, the household operating the plot may have less incentive to invest in land improvement (Feder *et al.*, 1988, Baidu-Forson, 1999). Therefore it is hypothesized as the ownership changes from own to rent-in/sharecropped land degradation severity increases.

Slope of the plots (PLTSlope): Slope of the field is the only indicator used as a proxy for the erosion potential (Ervin and Ervin, 1982 and Hurni, 1987). Thus the slope of the plots is hypothesized to directly affect severity of land degradation

Distance of the plot from the residence (Distown): Plots that are nearer to town may receive organic matter to substitute soil nutrient loss and soil conservation structure to minimize soil erosion. Therefore distance is more likely to affecting land degradation positively.

Number of plots (NoPloti): Land fragmentation may undermine farmer's interest in undertaking some type of land management. In dispersed and distant plots, the cost of hauling manure or organic materials may not be worth. The larger the number of parcels of plots a farmer owns and manage, the greater is the amount of time loss in travelling from plots to plots and the lower will be the amount of time left for manuring and soil conservation activities. Therefore, number of plots managed is expected to affect land degradation positively.

Farm Plot area (PlotAreai): considering all other things the same (equal) adoption of SLM, especially cow dung is a function of the area of a plot. Soil conservation structure may take some area especially that would have been used for cultivation. Farmers who managed larger size plots can allocate some part of the land for soil conservation than those who have smaller farms (Wagayehu and Drake, 2003). On the other hand, large plot size may demand higher labour, capital, credit, and fertilizer. Labour, capital or other constraints may limit the ability of farmer to invest on large plot size area than small plot area. Therefore, the effect of plot size is indeterminate.

Land-use (Landusei): Land-use refers to the purposes for which human exploit the land and its resources. According to (Hurni, 1987 and Girma, 2001), land degradation is different from plot to plot-based on land-use and land-cover of the plot. The degree of land degradation is different from plot to plot based on its use. Therefore, land-use is hypothesized to have a positive effect on land degradation.

Crop diversification index (CDI): Crop diversification will capture the cropping pattern adopted by the households. The index is expected to be negatively related to the extent of land degradation (Spio, 1996).

Nutrient Intake Index (NII): It is expected to be negatively associated with output and similarly to land degradation status (Mandal and Mitra, 1990)

Credit access (CRDAccess): Access to credit may enable farmers to purchase inputs or acquire physical capital, thus contributing to technology adoption and increased capital and input use intensity in agriculture (Feder *et al.,* 1985, Pender and Kerr, 1998). On the contrary, according to (Pender *et al.*, 2001; Bekele and Holden, 2002) provision of credit for fertilizer has a negative effect on incentive to conserve land and this causes erosion rates to be higher when credit is provided. Credit may reduce labour-intensive land management practices. Therefore the effect of use of agricultural credit on land degradation is indeterminate a priori.

Market access (MARKDIS): In areas closer to market, intensification, growing of higher value crops and high level of use of external input is expected. Farmers in the remote area will seek to be self-sufficient in production; off-farm employment opportunities are limited and lower wage prevailing (Berhanu, 1998). Moreover better access also may increase non-farm opportunities and thus reduce farmland management (Angelsen, 1999). Therefore, market access is hypothesized to affect land degradation positively.

Social position of the household head (Cstat): It is expected that households who are involved in different position may have good understanding about the problem of land degradation and may have access to information on a different strategy to minimize the impact of land degradation. Therefore, it is expected that this variable will have a negative correlation with land degradation.

RESULTS AND DISCUSSION

Commonly Observed features of Agricultural Land Degradation

Table 2 presents the commonly observed agricultural land degradation in the study area. The results show about 71 percent of the households experienced soil fertility decline and was identified as the most common form of agricultural land degradation across the sampled localities. This is followed by water erosion (58.89%), wind erosion (34.44%), vegetation drying up (16.67%) and salt and or alkaline build up (11.67%) that occur commonly on Fadama land.

Table 2 Distribution of commonly observed degradation

Degradation Type	Sokoto		Kebbi		Zamfara		*All States combined* (N=360)	*Rank*
	Kware (n=33)	*Tureta (n=52)*	*B/kebbi (n=80)*	*Bunza (n=63)*	*Zurmi (n=58)*	*Tsafe (n=74)*		
Wind erosion	21 (63.64)	20 (38.49)	64 (80.00)	6 (9.52)	11 (11.97)	2 (2.70)	124 (34.44)	3rd
Water erosion	6 (18.18)	35 (67.31)	49 (61.25)	36 (57.14)	24 (41.38)	62 (83.78)	212 (58.89)	2nd
Vegetation drying up	7 (21.21)	12 (23.09)	12 (15.00)	12 (19.05)	6 (10.34)	11 (14.86)	60 (16.67)	4th
Soil fertility decline	29 (87.88)	36 (69.23)	50 (62.50)	49 (77.78)	28 (48.28)	62 (83.78)	254 (70.56)	1st
Salt/Alkaline build up	14 (42.42)	20 (38.46)	0 (0.00)	4 (6.35)	0 (0.00)	4 (5.41)	42 (11.57)	5th
Observation Extent								
very Recent	5 (15.15)	4 (7.70)	11 (13.75)	12 (19.05)	1 (1.72)	3 (4.05)	36 (10.00)	4th
Last 5 years	5 (15.15)	6 (11.54)	37 (46.25)	10 (15.87)	20 (34.48)	12 (16.22)	90 (25.00)	3rd
Over 5 years	8 (24.24)	9 (17.31)	15 (18.75)	11 (17.46)	18 (31.03)	31 (41.89)	92 (25.56)	2nd
About 10 years	10 (30.30)	19 (36.54)	17 (21.25)	30 (47.62)	18 (31.08)	26 (35.14)	120 (33.33)	1st
Over 10 years	5 (15.15)`	14 (26.92	0 (0.00)	0 (0.00)	1 (1.72)	2 (2.70)	22 (6.11)	5th

Figures outside parenthesis are frequencies while in parenthesis are percentages (source)

The result further presents the households proclaimed extent of observation for noticeable degradation in the community. About 33% of the households observed the degradation features in the community for about 10 years, while 25.56 % had the observed for over 5 years, 25% observed the features for the last 5 years and 10%

attested the degradation features observed occur very recently. The results implied agricultural degradation was long observed phenomenon in the study area, since overwhelming majority of the households had observed the degradation feature for between 5 and 10 years. This finding was further supported by historic comparison of crop yields that clear reflects farmers' of medium to long term trends in their production processes (Abdullahi, 2014).

Indicators used by farmers for identifying degraded crop land

Farmers were asked for some indicators used in identifying degraded crop land. Table 3 show the highest proportion (61.10%) judge degradation in crop land by decline in crop yields especially the cereals crops. This is follows by the changes in soil type, soil colour, soil depth and noticeable ease of tillage as well as surface sealing and crusting. However, about 21% and 15 % identified degraded land through the intensity of weed growth and weed types respectively. These features help them to interpret changes on indicators of soil and land degradation and to make decisions about specific actions.

Table 3 Distribution of indicators use in identifying degraded crop land

Land degradation indicator	Sokoto		Kebbi		Zamfara		*All States*	*Rank*
	Kware (n=33)	*Tureta (n=52)*	*B/kebbi (n=80)*	*Bunza (n=63)*	*Zurmi (n=58)*	*Tsafe (n=74)*	*combined* (N=360)	
Soil colour	17 51.52	15 28.85	55 (68.75)	4 (6.35)	9 (15.52)	18 (24.32)	118 (32.78)	2nd
Soil depth	0 (0.00)	6 (11.54)	35 (43.75)	26 (41.27)	18 (31.03)	15 (20.27)	100 (27.78)	3rd
Ease of tillage	7 (21.21)	6 (11.54)	35 (43.75)	14 (22.22)	5 (8.62)	27 (36.48)	94 (26.11)	4th
Intensity of weed growth	11 (33.33)	11 (21.15)	1 (1.25)	13 (20.63)	11 (18.97)	28 (37.84)	75 (20.83)	5th
Weed type	6 (18.18)	14 (26.92)	2 (2.50)	0 (0.00)	5 (8.62)	26 (35.14)	53 (14.72)	7th
Surface sealing/ crusting	27 (81.82)	17 (32.69)	6 (7.50)	7 (11.11)	1 (1.72)	0 (0.00)	58 (16.11)	6th
Change in soil type	22 (66.67)	12 (23.08)	46 (57.50)	30 (47.62)	13 (22.41)	12 (16.22)	144 (40.00)	1st
Decline in cereal crops yield	9 (27.27)	11 (21.15)	0 (0.00)	2 (3.45)	0 (0.00)	0 (0.00)	22 (6.11)	8th

Figures outside parenthesis are frequencies while in parenthesis are percentages (source???)

The features of land degradation identified by the households are however, upheld by great deal of literature that supported the idea indigenous knowledge to address land degradation (Chambers et al., 1989; Fujisaka, 1989; Critchely et al., 1994 and Kruger et al., 1995). Such local classifications of soils have been found to correlate well with scientific measures of soil quality (Bellon and Taylor, 1993, Talawar and Rhoades, 1998).

Perceived Plot Level Land Degradation Parameters

Table 4 presents the households rating or perception on some land degraded parameters. Farmers' views about land degradation parameters are based upon their observations, values, and experiences. The results show the perceived fertility status across the plots. About 16% of the plots are perceived by the household as very fertile whereas 34.19, 37.04 and 12.82 % were classified as fertile, medium and low fertility statuses respectively. On the degree of erosion problem about 50 percent of the plots showed no appreciable signs of erosion, whereas, 31.12 percent were rated as having low degree of erosion that is they shown minimum symptoms of soil erosion. About 15 % of the plots were perceived to belong to the medium degree of erosion that is the plots were exposed to erosion in the form of sheets and finally 4.77 percent are rated as having high degree of erosion in the form of severe rill or gully. The distribution depicted a normal spread across the fertility classes with the majority falling in between fertile and medium fertility status.

Farmers' perception on the erosion and fertility status across farms concur with Stocking and Murnaghan (2000) scientific explanation of erosion induced loss of soil productivity that loss of nutrient and organic matter in eroded sediment reduce the total stock of nutrients in the remaining soil that will be available for future crops.

Table 4: Plot distribution based on perceived land degradation parameters

Parameter	Sokoto Kware (n=219)	Sokoto Tureta (n=258)	Kebbi B/kebbi (n=225)	Kebbi Bunza (n=219)	Zamfara Zurmi (n=201)	Zamfara Tsafe (n=282)	All States combined (N=1404)	X^2 statistics
fertility status								
Very fertile	16 (7.31)	11 (4.26)	7 (3.11)	58 (26.48)	67 (33.33)	65 (23.05)	224 (15.95)	
Fertile	103 (47.03)	112 (43.41)	51 (22.67)	71 (32.42)	37 (18.41)	106 (37.59)	480 (34.19)	
Medium	76 (34.70)	115 (44.57)	126 (36.00)	48 (21.92)	58 (28.86)	97 (34.40)	520 (37.04)	241.27*
Low	24 (10.90)	20 (7.75)	41 (18.22)	42 (19.18)	39 (19.40)	14 (4.96)	180 (12.82)	
Degree of erosion								
No erosion	126 (57.53)	128 (49.61)	47 (20.89)	122 (55.71)	128 (63.68)	140 (49.65)	691 (49.22)	
Low	65 (29.68)	59 (22.87)	93 (41.33)	61 (27.55)	62 (30.85)	97 (34.40)	437 (31.31)	
Medium	15 (6.85)	43 (16.67)	82 (36.44)	20 (9.13)	8 (3.98)	41 (14.54)	209 (14.89)	206.82*
High	13 (5.94)	28 (10.85)	3 (1.33)	16 (7.31)	3 (1.49)	4 (1.42)	67 (4.77)	
Salinity or Alkalinity								
No Salt or/ and Alkaline	198 (90.41)	214 (82.95)	172 (76.44)	155 (70.78)	161 (80.10)	232 (82.27)	1,132 (80.63)	
Low	16 (7.31)	23 (8.91)	50 (22.22)	33 (15.07)	36 (17.91)	30 (10.64)	188 (13.39)	
Medium	3 (1.37)	6 (2.33)	3 (1.33)	23 (10.50)	2 (1.00)	17 (6.03)	54 (3.85)	103.6*
High	2 (0.91)	15 (5.81)	0 (0.00)	8 (3.65)	2 (1.00)	3 (1.06)	30 (2.14)	
Plot gradient								
Flat	131 (59.82)	157 (60.85)	66 (29.33)	116 (52.97)	163 (81.09)	141 (50.00)	774 (55.13)	
Gentle	46 (21.00)	55 (21.32)	107 (47.56)	72 (32.88)	26 (12.94)	96 (34.04)	402 (28.63)	167.66*
Moderately steep	42 (19.8)	31 (12.02)	42 (18.92)	24 (10.96)	10 (4.95)	45 (15.96)	194 (13.82)	
Steep slope	0 (0.00)	15 (5.81)	10 (4.44)	7 (3.20)	2 (1.00)	0 (0.00)	34 (2.42)	
Plot receiving fertilizer								
Yes	147 (67.12)	225 (87.21)	215 (95.56)	160 (73.06)	176 (87.56)	256 (90.78)	1,179 (83.97)	
No	72 (32.88)	33 (12.79)	10 (4.44)	59 (26.94)	25 (12.44)	26 (9.22)	225 (16.03)	104.65*
Plot receiving manure								
Yes	165 (75.34)	206 (79.84)	189 (84.00)	140 (63.93)	115 (57.21)	193 (68.44)	1,008 (71.79)	
No	54 (24.66)	52 (20.16)	36 (16.00)	79 (36.07)	86 (42.79)	89 (31.56)	396 (28.21)	

Figures outside parenthesis are frequencies while in parenthesis are percentage

The perceptions in term of degree of salinity and or alkalinity status of the plots show 80.63 percent had no signs of salt and or alkaline build up. However, few proportion of the plots (3.85% and 2.14 %) exhibit medium and high degree of salt and or alkaline build up respectively. The plots gradient serves as a proxy for erosion potentials and explains the vulnerability of the land to degradation. The result on table 4 further shows 55.13 and 28.63 percent of the plots were relatively flat and gentle slope plots respectively. Whereas, 13.82 and 2.42 percent were on moderately steep and steep slopes plots. These results show about 17 percent of the plots had greater risk of degradation due to erosion as a result of slope gradient features.

Perceived land degradation status

Table 5 present the classified land degradation status, the results show about 22% of the total farm parcels were slightly degraded. About 36%, 39% and 3% of the total farm parcels belong to the perceived moderate, severe and extreme degradation status respectively.

Table 5: Distribution of farm plot according to perceived land degradation status

	Sokoto		Kebbi		Zamfara		*All States*	
Degradation Status	*Kware (n=219)*	*Tureta (n=258)*	*B/kebbi (n=225)*	*Bunza (n=219)*	*Zurmi (n=201)*	*Tsafe (n=282)*	*combined* (N=1404)	X^2 *statistics*
Slight	35 (15.98)	42 (16.28)	13 (5.78)	43 (19.63)	61 (30.35)	115 (40.78)	309 (22.01)	
Moderate	115 (52.51)	108 (41.86)	67 (29.78)	91 (41.55)	80 (39.80)	46 (16.31)	507 (36.11)	
Severe	61 (27.85)	94 (36.43)	140 (62.22)	77 (35.16)	57 (28.36)	113 (40.07)	542 (38.60)	193.19*
Extreme	8 (3.65)	14 (5.43)	5 (2.22)	8 (2.84)	3 (1.49)	8 (2.84)	46 (3.28)	

Figures outside parenthesis are frequencies while in parenthesis are percentages (source)

However, Birnin Kebbi the dry exreme of Kebbi had the least percentage (5.78%) while Tsafe the wetter extreme of Zamfara had the highest percentage (40.78%) of slightly degraded lands. The patterns depict that the severity of degradation status increases as one move from the wetter to drier zones. This reflects the agro-ecological dynamics between and along the plain zones. This collaborated with the finding of FMEN (2010) for the rapid extension of desertification processes as one move from the north towards southwards.

Determinants of Land Degradation

Ordered Probit Estimates of Land Degradation Determinants

The Maximum Likelihood Estimates (MLE) and the marginal effects of ordered probit model are presented in Table 6. The model result Chi-square statistics indicates that the parameters included in the model were significantly different from zero at 1 percent level of significance.

The signs of the coefficients indicate the direction of the relationships between the explained and explanatory variables. A positive estimated coefficient in the model implies increase in severity of land degradation with increase in the value of explanatory variable. Whereas, negative estimated coefficient in the model implies decreasing severity with increase in the value of explanatory variable. The marginal effect value provides the impacts that a unit change in the individual independent variable has on different levels of land degradation when all other variables are held at their means.

Based on land degradation classification of the sample farm plots into; slight, moderate, severe and extreme degraded lands, nine variables were found to be significant at different probability levels. The variables include age (age), educational attainment (hheduc) and community status (cstat2) of the household head, poverty status of the household (povstat2), plot ownership status (pltown2) and number of plots owned by household (noplot), distance of plot to town (distown), plot slope (pltslope) and credit amount access by the household (crdamt). However, household size (hhsz), livestock ownership (tlu), farm area (farmarea), plot land usage (pltlus), nutrient intake index (nii), market access (mktacess) and extension access (extaccess) all exhibited positive coefficient with the exception of plot land usage, but were statistically not significant.

On the determinant of land degradation, age as a proxy of experience in farming activities , significantly decreases (-0.0067) the severity of land degradation and increases the probability of the being slight and moderate degraded land by 0.18 and 0.079 % respectively, there by reduces the possibility of holding severe and extreme degraded land by 0.23% and 0.03% respectively. Age serves as a proxy variable for farming experience because farming is an age long activity and means of livelihood in most rural Nigeria. Therefore, experienced farmers tend to manage their land in a better way than the less experienced farmers, as well as perceived and understand the problem of soil erosion and the decline in the fertility of soil and the use of land management practices. Age of the household head and severity of land degradation relates negatively confirmed the priori expectation and also corroborates with the findings of Genene et al., (2009).

Educational attainment above some primary level (above 4 years) decreases the severity of land degradation (-0.0182) enhances the possibility of land holding being slight and moderate degraded by 0.49% and 0.21% respectively. These findings on education - land degradation severity effects and impact relied on the fact that, educational improvement above some primary level appeared to have contributed to several aspect of technology adoption, increasing access to credit that help to finance the purchase of physical capital and agricultural inputs. The findings could be supported with the work of Oyekale (2012) that educated farmers are always in a position to adopt and make use of soil conservation technologies so as to mitigate soil erosion and nutrient depletion.

Community status relatively being community leader rather than ordinary member decreases the severity of land degradation (-0.3246) and increases the possibility of land holding being slight and moderate degraded by 9% and 3.5% respectively. This result conformed with the a priori expectation that household heads who are involved in different social position may have good access to input and information on different strategies to minimise the impact of land degradation.

Table 6 : Ordered Probit Estimate Land Degradation Determinants

			Marginal Effect				
Variable	Coefficient	P[|Z|>z]	Y=0	Y=1	Y=2	Y=3	
age	-0.0067**	0.0250	0.0018	0.00079	-0.0023	-0.0003	50.3038
hhsz	0.0034	0.4670	-0.0009	-0.0004	0.0012	0.0001	13.5464
hheduc	-0.0182***	0.0010	0.0049	0.0021	-0.0063	-0.00076	3.62749
cstat2	-0.3246***	0.000	0.089964	0.034607	-0.1116	-0.0129	0.410997
tlu	0.0026	0.604	-0.0007	-0.0003	0.000896	0.000108	4.82445
povstat2	-0.2404***	0.001	0.062725	0.031177	-0.08287	-0.01103	0.667354
pltown2	-0.1818*	0.073	0.04597	0.025525	-0.06259	-0.00891	0.905842
noplot	-0.0773***	0.000	0.020929	0.009086	-0.02678	-0.00323	4.88591
farmarea	0.0098	0.513	-0.00266	-0.00115	0.003402	0.000411	1.99724
distown	0.0419***	0.005	-0.01133	-0.00492	0.014503	0.001752	2.09601
pltslope	1.0673***	0.000	-0.20208	-0.2015	0.305333	0.098246	0.164261
pltlus2	-0.0705	0.392	0.018752	0.008732	-0.02441	-0.00308	0.778694
nii	0.1261	0.181	-0.03412	-0.01481	0.04366	0.005273	1.83026
crdamt	-1.68E-06***	0.000	4.54E-07	1.97E-07	-5.81E-07	-7.01E-08	18463.9
mktdist	0.0020	0.374	-0.00055	-0.00024	0.0007	8.46E-05	12.2146
extaccess	0.0526	0.436	-0.01433	-0.00606	0.018218	0.002169	0.632302
Threshold parameter for index							
Mu(1)	1.4592***						
Mu(2)	1.1158***						
Mu(3)	3.0046***						
Log likelihood function			-1570.642				
Restricted Log likehood			-1710.142				
Chi – Square			279.00				
Log likelihood index (LRI)			0.0816				
Number of observation			1455				

***, ** and * are significant at less than 1%, 5% and 10% probability level respectively.

Poverty status – being non-poor rather than poor decreases (-0.2404) the severity of degradation and increases the possibility of holding slight and moderate degraded lands by 6.27% and 3.12 % respectively. The possible interpretation of these results is that poor households lack basic inputs to augments the lost soil fertility which adds to the volatility of their land resources to degradation in the form of soil erosion, loss in fertility due to continuous nutrient mining.
Households' ownership of owned-plot rather than on rented or in share cropped reduces degradation severity (-0.1818) thereby

increases the possibility of plot being slight and moderate degraded by 4.6% and 2.6% respectively. This could be attributed to the fact that owned land guarantees future investment for land management and improvement practices compared to borrowed or rented. This corroborated with the findings of Feder et al., 1988 and Baidu-Forson, 1999 that asserted farmers operating on a rent-in or sharecropped lands are unsecured thereby lack incentive to invest in land improvement

Number of parcel holding above the mean holding of 4 parcels decreases land degradation severity (-0.0773) by increasing the possibility of land being slight and moderate degraded by 2.09% and 0.9 % respectively. The result implied that the more fragmented the land, the less the degradation severity, which contradicted the a priori expectation that fragmentation undermine farmers' interest in undertaking some land management practices and more likely to affect severity of land degradation positively.

Distance of plot from town increases the severity of land degradation (0.0419) and increases the possibility of land being severe and extreme degraded land by 1.45 % and 0.18% respectively. This result conformed to the expectation a priori, that plots nearer to town received organic matter more in the form of manure and household refuse to augment the lost soil as well as enhance soil structure to minimise erosion. This finding corroborated with the assertion of Genene et al., 2009 that farm plots around homestead have always supplemented with farm yard manure and better in soil fertility status than fields away from homestead.

Plot gradient (slope) a proxy of erosion potential, relative change of plot gradient from flat to slopy increases the severity of land degradation (1.0673) and increases the possibility of plot being severe and extreme degraded by 30.53% and 9.82% respectively. This result conformed to the a priori expectation and with the finding of Hurni (1987) and Berhanu and Swinton (2003) that plot slope directly affects the severity of land degradation positively.

Credit accessed above the mean amount reduces (-1.68E-06) the severity of land degradation and enhances the possibility of plot being slight and moderate degraded by infinitesimal percentages. This result enable us to settle on the a priori expectation that access to credit enable farmers purchase external inputs that enhance land fertility as well as contribute to improved technology adoption.

CONCLUSION

The paper concludes that there is a prevalence of agricultural land degradation along the Sokoto plain in the forms of erosions, nutrient depletion, soil structure and ecological changes. The degradation perception index parameters put the greater percentage of farm plot to moderate and severely degraded lands. Socioeconomic/demographic, resource endowment and usage factors as well as institutional factors were found to be important determinants of farmers' perception of land degradation. Distance of plot from town, plot gradient was found to be associated with an increase in the severity of land degradation. More access to basic inputs and capacity building on sustainable agricultural practices to farmers could raise soil fertility status, productivity and reduces land degradation.

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