DETERMINANTS OF FARMERS ADOPTION OF SOIL DEGRADATION PREVENTIVE MEASURES IN ABIA STATE, NIGERIA

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ABSTRACT
This study examined the determinants of farmers adoption of soil degradation preventive measures in Abia State, Nigeria. Primary data used in this study were collected using questionnaire that was administered to 120 randomly selected farmers in the study area. Descriptive statistics and Ordinary Least Squares regression method were used in analyzing the data. The result of the study showed that the major causes of soil degradation in the study area were: deeply excavated subsoil and overburden with materials, extremely eroded due to deforestation and loss of biodiversity leading to attendant soil loss. The impact of soil degradation on the income of farmers showed that 82.8% of the farmers responded to poor soil fertility; 81.08% responded to low farm income; 70.2% on loss of crop output/fruit trees; 66.6% on loss of farmlands and forest biodiversity. The various measures adopted by the farmers for the prevention of soil degradation in the study area with the cost implications of such adoptions were the use of organic manure with total cost incurred as ₦777,100 and average cost of ₦9,963 per farmer; planting of leguminous/cover crop with corresponding total cost incurred as ₦380,750: use of inorganic fertilizer and planting of trees with the corresponding average costs by individual farmers as ₦15,869 and ₦8,225, respectively. The determinants of adoption of soil degradation adaptation measures were income, education level, farming experience, extension contact, and age. Inadequate knowledge on how to cope with soil degradation, and limited income were the major constraints in remediating soil degradation. The study recommended the need for agricultural programme that will involve educating and empowering farmers on reducing soil degradation activities, government intervention in the remediation of soil degraded areas as this will reduce the high cost incurred by farmers in the use of soil conservation techniques.

KEYWORDS: Adoption, Soil Degradation, Preventive, Measures

1. INTRODUCTION
Soil constitutes the foundation for agricultural development, essential ecosystem functions and food security and hence is key to sustaining life on earth (United Nations, 2013). Food and Agriculture Organisation (2015) defined soil as the natural medium for the growth of plants. Soil has also been defined as a natural body consisting of layers (soil horizons) that are composed of weathered mineral materials, organic material, air and water (Gomiero, 2016). The impact of human activities and natural phenomenon has led to the degradation of soil and impinges on its capacity to support life especially though agricultural production. Soil degradation is one of the most serious ecological and environmental problems in South East Nigeria (Kouelo *et al.*, 2015). FAO (2015) defined soil degradation as a change in the soil health status resulting in a

diminished capacity of the ecosystem to provide goods and services for its beneficiaries. Therefore, soil degradation represents a major threat to food production and environmental conservation, especially in tropical and sub-tropical regions. Soil degradation, therefore, refers to a broad spectrum of changes in soil characteristics because of natural or anthropogenic factors that alter their structure and quality, including deforestation and the removal of natural vegetation, agricultural activities, overgrazing, overexploitation of vegetation for domestic use, and industrial activities (FAO, 2015; DeLong *et al.*, 2015; Karlen and Rice, 2015).

Soil degradation can occur through the following processes: physical (i.e., erosion, compaction), chemical (i.e., acidification, salinization) and biological (i.e., loss of soil organic matter, loss of biodiversity) (Gomiero, 2016). The factors that determine the kind of degradation are as follows: soil inherent properties (i.e., physical, chemical), climate (i.e., precipitation, temperature), the characteristics of the terrain (i.e., slope, drainage) and the vegetation (i.e., biomass, biodiversity) (Lal, 2015; Okorafor *et al.*, 2017). The causes that lead to soil degradation are complex and can be of a different nature: biophysical (i.e., land use, cropping system, farming practices, deforestation), socioeconomic (i.e., institutions, markets, poverty), and political (i.e., policies, political instability, and conflicts) (Lal and Stewart, 2013; Barrett and Bevis, 2015; FAO, 2015).

The danger in the physical damages to soil that rages from structural degradation to actual loss of the soil through various processes, has continued to attract the interests of environmentalist. This may have consequences in the quality changes relevant to crop production arising from land degradation (Binie *et al.*, 2002). In the south east of Nigeria, the lands are highly susceptible to three common soil degradation including physical, chemical and biological (Uchegbu *et al.*, 2017). The physical involves removal of surface layers of soil through water erosion, destabilization of the aggregate structure in the surface soil that may give rise to cervices, landslides, deforestation through mass movement of sandy soil, cracks in the earth crusts that encourages run off water thereby widening the gulley that can result to deep land sliders (Okorafor *et al.*, 2017).

The overall effects of soil degradation pose a major threat to food security especially in poor regions. All the adverse impacts on agronomic productivity and environmental quality are respectively due to a decline in soil quality. FAO (2015) highlights that there is a strong positive correlation between soil degradation and poverty. Therefore, this study is very apt for Nigeria with burgeoning rate of poverty. Poverty in Nigeria is said to be mainly a rural phenomenon where up to 80% of the population live below the poverty line (Edoumiekumo and Karimo, 2014; Adigun *et al.*, 2015). Runsewe (2017) stated that Nigeria was projected to be the poverty capital of the world in 2018 according to the world poverty clock.

According to Nkonya *et al.* (2011) and Tesfaye (2017), the world's population is growing and is projected to exceed 9.2 billion by 2050 and in order to feed this growing population it will be necessary to boost the production of food. However, land degradation is extensively increasing, covering approximately 23% of the globe's terrestrial area, increasing at an annual rate of 5-10 million hectares, and affecting about 1.5 billion people globally (Gnacadja, 2012).

Programmes of soil restoration have become necessary to assist the soil to recover productivity. The adoption and investment in sustainable soil management is crucial in reversing and controlling land degradation, rehabilitating degraded lands and ensuring the optimal use of land resources for the benefit of present and future generations (Akhtar-Schuster *et al*., 2011). Adoption of these measures play critical role in increasing productivity, achieving food security, household income and poverty reduction through reducing soil erosion and improving soil fertility (Lal and Stewart, 2013; Zucca *et al*., 2014; Iheke and Nwaru, 2014).

From the foregoing rural dwellers depend solely on the soil for livelihood and soil degradation is a major threat to food security. Also given that adoption of measures aimed at preventing soil degradation would lead to reduction in poverty and increased productivity, this study examined the determinants of farmers adoption soil degradation prevention measures in Abia State, Nigeria. Specifically, the study identified the causes of soil degradation prevalent in the area; estimated the loss in income of farmers as a result of soil degradation; identified the various measures used by farmers in preventing or reducing soil degradation and the cost incurred; estimated the determinants of adoption of soil degradation adaptation measures; and identified the constraints of farmers to preventing soil degradation in the study area.

2. RESEARCH METHODOLOGY

This research was carried out in Abia State, Nigeria. The State is in the South-East region of Nigeria. It lies between latitudes of $4^0$40' and $6^0$14' North of the Equator and longitudes $7^0$10' and 8^0 10' East of the Greenwich Meridian. It has a population density of 580 persons per square kilometer and a population of 2,845,380 persons and projected population of 3,727,300 in year 2016 (National population Commission-NPC, 2006; National Bureau of Statistics, 2016) and occupies an area of about 6420 km^2 with about 2.6 percent of the country's population. It has an average population density of 364 persons per square kilometer with 63 percent of the people involved in agricultural production because of the rich soil which stretches from the northern to the southern part of the State and has an average household size of 6 persons per family (NPC, 2006). It has three Senatorial Zones namely: Abia North, Abia South and Abia Central, with 17 Local Government Areas, grouped into 3 Agricultural Zones which are Umuahia, Ohafia and Aba Zones.

The climate of the State is a tropical one and usually humid all year round, with two seasons, the rainy season and dry season. The State is low lying with a heavy rainfall of about 2400mm which is evenly distributed between months of April through October, while the dry season starts from November and end February/March. The rest of the state is moderately high plain. The state is located within the forest belt of Nigeria and the temperature ranges between 20^0C and 36^0C. As a result of the climatic condition of the State, Nigerian Environmental Study/Action Team (NEST) (2011) reports major environmental damage caused by heavier rains to include flood, erosion especially in Aba and Ohafia Agricultural Zones of the State. The major crops grown are maize, yam, cassava, rice, vegetables etc, while livestock includes goat, sheep, poultry, pigs, etc. Plantain, oil palm, cocoa and rubber are some of the cash crops produced by the people.

A multi-stage sampling technique was used for this study. The first stage involved the purposive selection of two Local Government Areas (LGAs) each from the three Agricultural Zones namely, Aba, Ohafia and Umuahia making it a total of 6 LGAs. The selection was based on the prevalence of soil degradation. In the second stage, 2 communities were randomly selected from the 6 LGAs, making it a total of 12 autonomous communities while in the third stage, two villages were randomly selected from each of the selected communities making a total of twenty-four (24) villages. In the last stage, five (5) farmers were randomly selected from each of the village to have a total of one hundred and twenty (120) farmers.

Data for this study were collected from primary source. Preliminary visits were made to the study locations before actual commencement of data collection. This helped the researcher to familiarize herself with the study locations and to pre-test the data collection instrument. Data collected using structured questionnaire and interview schedules were analyzed using descriptive and inferential statistical tools. The causes of soil degradation, the effects of soil degradation, the various measures used by farmers in preventing soil degradation and the constraints faced by the farmers towards preventing soil degradation respectively, were realized using descriptive statistics such as means and percentages. The determinants of adoption of soil degradation adaptation measures was realized using Ordinary Least Square regression analysis. The model is specified implicit as:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}) \qquad 1$$

Where Y is adoption score measured as Y = (U/V)*100, with U as the participatory score of the respondent household on the number of measure adopted and V being the overall score of all the measures adopted by the farmer; X_1 = sex (1 = male, 0 = female); X_2 = marital status (Married = 1; otherwise = 0); X_3 = age (years); X_4 = household size (number of persons living together); X_5 = farm size (ha); X_6 = educational level (years); X_7 = net farm income (naira); X_8 = farming experience (years); X_9 = extension contacts (number of visit); X_{10} = Number of soil degradation experienced, (number of occurrences); X_{11} = Membership of cooperative group (Yes = 1, otherwise = 0); and X_{12} = Topography of land (Dummy: plain/flat land= 1, sloppy = 0).

Four functional forms of the model namely, Linear, exponential, Double log and Semi log model were fitted and the best fit model chosen as the lead equation. The lead equation was chosen based on some statistical and econometric criteria such as number of significant factors, the conformity of the signs borne by the coefficients of the variables to *a priori* expectations, the magnitude of the coefficient of determination (R^2) as well as the significance of the F – ratio.

3. RESULTS AND DISCUSSION

3.1 Causes of Soil Degradation

The causes of soil degradation based on farmers opinion is presented in Table 1

Table 1. Distribution of farmers based on the opinion on the causes of degradation

Causes	Mean Score	Rank	Remark
Deeply excavated subsoil and overburden with materials.	3.58	1	Accepted
Loss of soil productivity and quality chemical due to processes	3.57	2	
Socio-economic factors e.g. tenure system, farmers' health status, poverty etc.	3.20	3	Accepted
Refuse dumpsites producing leaching	3.12	4	Accepted
Extremely eroded due to deforestation and loss of biodiversity leading to attendant soil loss/ structural decline of the soil	3.08	5	Accepted
Rain run-off due to land slope, terrain and landscape position	3.06	6	Accepted
Compaction of soil due to footpath or animal grazing	3.05	7	Accepted
Leaching/Salinization/Acidification	3.05	7	Accepted
Soil inherent properties from parent materials	2.71	8	Rejected
Lack of soil and crop management e.g tillage, drainage, use of organic or inorganic fertilizer	2.68	9	Rejected
Inappropriate land use/soil management and cropping systems	2.66	10	Rejected
Drainage density	2.61	11	Rejected
Grand mean	3.03		Rejected

Source: Field survey data (2019).

The mean ratings of the opinions of the farmers based on their perceived causes of soil degradation in the study area is presented in Table 1. Deeply excavated subsoil and soil overburden with materials and loss of soil productivity and quality due to chemical processes. erosion were ranked first and second as major causes of degradation. This reduces the productivity of the soil. According to Gomiero (2016) deeply excavated subsoil and overburden with materials, extremely eroded due to deforestation and loss of biodiversity leading to attendant soil loss which causes soil degradation can occur through physical and biological processes such as erosion, compaction, mining activities, loss of soil organic matter, loss of biodiversity.

Other causes of degradation as identified by the farmers were socio-economic factors e.g tenure system, farmers' health status, poverty etc; extremely eroded due to deforestation and loss of biodiversity leading to attendant soil loss; refuse dumpsites producing leaching; barren landscapes with little or no vegetation; compaction of soil due to footpath or animal grazing; leaching, salinization and acidification; rain run-off due to land slope, terrain and landscape position with mean scores greater than the 3.00 which was the cut-off mean. Lal (2015) reported some factors such as chemical process like acidification, salinization; because of some factors such as soil inherent properties (i.e., physical, chemical); climate (i.e., precipitation, temperature), the characteristics of the terrain (i.e., slope, drainage) and the vegetation (i.e., biomass, biodiversity) causes soil degradation. Some researchers Lal (2013); Ogwo and Ogu (2014); FAO (2015) reported that factors like biophysical (i.e., land use, cropping system, farming practices, deforestation), socioeconomic (i.e., institutions, markets, poverty), and political (i.e., policies, political instability, conflicts) are all contributing factors that cause soil degradation.

Observations from the study location and oral reports from farmers showed that erosion, sloppy terrain and landscape position, continuous cultivation of land due to scarcity of farmland were the major cause of degradation. In agreement to these findings Lal (2015) reported that poor management of agricultural land induces soil erosion that leads to reduced productivity (which must be compensated with the addition of fertilizers), or, in extreme cases, to the abandonment of the land. Intensive conventional agriculture makes soils highly prone to water and wind erosion, which worsen when situated on a slope. Pimentel and Burgess (2013) reported mild to severe soil erosion is possibly affecting about 80% of global agricultural land. Soil erosion has been estimated to reduce yields on about 16% of agricultural land, especially croplands in Africa and Central America and pasture in Africa (Wood *et al.,* 2000).

Compaction of soil due to footpath or animal grazing as reported by Lal (2015) is a worldwide problem and can reduce crop yield by 20% – 55%. Nutrient depletion is another significant process of soil degradation, with severe economic impact on a global scale. To cover the losses, more land would have to be converted to agriculture and more inputs used to replace the reduced soil fertility. Nnabude (1995) reported that refuse dumpsites can cause chemical soil degradation were associated with salinization, leaching, nutrient imbalance and fertility depletion. According to Ademoroti (1996), accumulation of toxic substances of industrial and urban origin could contribute to chemical soil degradation. He also reported that in some intensively cultivated areas where the use of fertilizers and pesticides are high, chemical soil degradation was due to nutrient leaching, resulting in groundwater pollution and eutrophication of lakes. Some socio-economic activities such as continuous cropping of land to earn a living, cutting down of trees for wood resulting to deforestation, are linked to the cause of soil degradation and decline soil fertility which affect soil productivity (Kouelo *et al.,* 2015), while Ehikwe and Ugwu (2013) opined that the heterogeneity of the different components of soil, the rotation of farm land at average rate of one and a half yearly periods against the five yearly rotation period considered safer that the first option in the south east has been a causative factor to soil degradation.

Factors that cause of soil degradation as shown in this study include the removal of surface layers of soil though water erosion which was prevalent in the study area, destabilization of the aggregate structure in the surface soil that may give rise to crevices, deforestation through cutting down of trees and mass movement of sandy soil. Others include, cracks in the earth crusts that encourages run off water thereby widening the gulley that can result to deep land sliders, the rotation of farm land at an average of two years leaves the bush without due fallowing process and sufficient length of time, the continuous cultivation of land which is very devastating as most lands do not grow trees but shrubs and the increase in bush burning that has been a remarkable threat to land that homes are even ravaged and devastated, affect crop output, income and livelihood of farmers

3.2 Effects of Soil Degradation

The result of the effects of soil degradation by the respondents is presented in Table 2.

Table 2. Distribution of farmers according to their responses on effects of soil degradation.

Perceived effects	Frequency	Percentage
Poor soil fertility	92	83
Loss of farmlands/forest biodiversity	74	67
Loss of crop output/fruit tress	78	70
Loss of occupation/means of livelihood	42	38
Low farm income	90	81
Increase cost on soil remediation	65	59
Increase in subsistence cropping system	70	63
Increase in poverty status of farmer	73	66
Rural to urban migration	40	36
Change from farming to other occupation	54	49

Source: Field survey data (2019).

Table 2 showed that 83%, 81%, 70%, 67%, 66%, and 63% of the respondent noted that poor soil fertility, low farm income, loss of crop output/fruit trees, loss of farmlands and forest biodiversity; increase in poverty status of farmer, increase in subsistence cropping system, respectively were the result of soil degradation, while 59%, 49%, 38% and 36% indicated increase cost of soil remediation, changing from farming to other occupation, loss of occupation/means of livelihood and rural to urban migration as factors that resulting from soil degradation.

Most farmers interviewed perceived a decline in soil fertility, loss of farmlands, and crop yield. This decline in soil fertility and consequently of crop yields was most important indicator of soil degradation mentioned by farmers in the study affecting their income. This agrees with the study of Baba (2017) who reported similar situation in his study location (Kano State). Soil degradation in these sites has negative impacts on the communities due to diminishing level of soil fertility, loss of farmlands and forest biodiversity. These negative impacts have led to loss of arable farmlands, occupation, and means of livelihood with attendant economic hardship, and consequently increased rural-urban migration in the area.

The population structure during study location visits for the collection of data showed that the villages consisted more of aged people and children, indicating that the young people have migrated to the cities. Ehikwe and Ugwu (2013) reported that the immediate impact of soil or land degradation is the abandonment by members of the communities, forcing automatic or emergency migration on the people or their means of livelihood. This implied that soil degradation had a negative impact on their income which could affect their livelihood negatively. From the result of the study, farmers have their own perception in evaluating the impact of soil degradation affecting their income levels.

The findings are results in consonance with Bekele and Drake (2003); Gebremedhin and Swinton (2003). They noted that soil degradation is perceived by farmers through soil erosion and soil fertility depletion to affect their income and output, while Awoyinka *et al.* (2005) reported that 69% of the farmers experienced a low level of crop loss to soil degradation as a result of erosion. According to FAO (2015), soil degradation represents a major threat to food production and environment conservation, especially in tropical and sub-tropical regions (where most of the future population growth will take place). The negative impacts have led to loss of occupation and means of livelihood, income, and consequently increased rural-urban migration especially the young people. These negative impacts if not checkmated could increase soil bulk density, soil infertility, reduce soil porosity and infiltration of water into the soil as well as increase flooding and surface runoffs with attendant gully erosion.

3.3 Measures Used by Farmers in Preventing Soil Degradation and Various Cost Incurred

The result on the measures used by farmers in preventing soil degradation and cost incurred is presented in Table 3. The result showed the various measures adopted by the farmers for the reduction or prevention of soil degradation in the study area alongside the cost implications of such actions. Majority (70.2%) of the farmers adopted organic manure (poultry faeces, animal dung etc) with total cost incurred as ₦777,100 and average cost of ₦9,963 per farmer, followed by 65.7% of the farmers that adopted planting of leguminous/cover crop and corresponding total cost incurred as ₦380,750 while 41.4% and 36.04% used inorganic fertilizer and planting of trees with the corresponding average cost incurred by individual farmers as ₦15,869 and ₦8,225, respectively.

About 40.54% of the farmers adopted drainage construction and flood barriers and construction of diversion ditch with corresponding total costs incurred as ₦234,000 and ₦246,000, respectively. On the other hand, liming and water harvesting recorded the least in terms of adoption as only 14% of the farmers adopted them with the attendant costs of ₦85,600 and ₦26,000, respectively. Result further showed that an average of ₦295,325 was the total cost incurred by the farmers in adopting soil degradation prevention/reduction measures. These findings are in line with the results of Ogwo and Ogu (2014) who reported the measures employed by rural communities to combat soil and land degradation impacts to be bush fallow system as a measure of soil remediation in the areas, use of sand filled bags, use of isolated clumps of bamboos, terraced farming, alley cropping as vegetation strip and water harvesting practices, prevention of farming within specific distance (about 300m) from gully and the use of stones arranged to prevent flooding as the major remediation measures in the areas.

Table 3. Distribution of farmers based on the measures adopted in reducing soil degradation and the cost incurred

Measures adopted by the farmers	**Frequency***	**Percentage**	**Cost incurred (₦)**
Using sand filled bags and stones to prevent flooding and as erosion control measure	43	38.74	131400
Crop rotation	66	59.46	255000
Planting of leguminous/cover crop	73	65.77	380750
Use of organic manure (poultry faeces, animal dung etc)	78	70.27	777100
Use of inorganic fertilizer (e.g NPK)	46	41.44	730000
Use of mulching	42	37.84	46500
Planting of trees	40	36.04	329000
Mixed farming	44	39.64	338000
Liming	14	12.61	85600
Multiple cropping	52	46.85	539000
Water harvesting	14	12.61	26000
Bush fallow	54	48.65	113000
Prevention of farming within specific distances from gullies	18	16.22	25000
Drainage construction/flood barriers	45	40.54	234000
Use of improved varieties of crops	44	39.64	462500
Water harvesting in catchment pits	22	19.82	142000
Construction of diversion ditch	33	29.73	246000
Construction of ridges across slopes	49	44.14	455000
Average	**43.17**	**38.90**	**295,325**

Source: Field survey data (2019). * Multiple responses recorded.

Ehikwe and Ugwu (2013) reported that long-term remediation of degraded soils was only by vegetation establishment through colonization of soil flora and fauna that would induce ecological succession. This could suggest why 36.04% of the farmers practised afforestation. As reported by Obalum *et al.* (2012) vegetation establishment would increase both the structural and functional dimensions of the ecological system. Survey carried out in the study areas indicated that the sites were extremely eroded due to deforestation and the attendant soil loss and productivity. These sites were located at Isukwuato, Bende and Ikwuano LGA, Abia State.

Majority of the farmers also adopted the use of organic and inorganic fertilizers, planting of leguminous crops. However, efficiency of organic or inorganic fertilizer in an eroded soil where the physical properties are degraded alongside chemical nutrients depletion depends, to a large extent, on the dynamic relationship between the level of harm done to the soil's physical condition and the level of progress made in the difficult task of improving it as reported by Ngwu *et al.* (2005), Adama and Quansah (2009) and Obalum *et al.* (2012).

Some situation of soil degradation needs a combination of carefully selected, suitable management practices depending on the shape of the yield reduction function. In Nigeria, for instance, research evidence from eroded alfisols suggests that, rather than inorganic fertilization, application of poultry manure and fallowing with various grass and leguminous species for two years, could improve the soil physicochemical properties and productivity (Salako *et al.*, 2007; Igwe, 2011).Using the study by Oyedele and Aina (1998)in southwestern Nigeria as a reference point, Lal *et al.* (2003) stated that soil chemical properties can account for over 75% of the variation in the yield from eroded soils in Sub Saharan Africa. Thus, soil degradation caused by erosion-induced short-term decline in productivity is more easily compensated by inorganic and/or organic fertilization and supplemental irrigation, drainage construction etc. as opposed to long-term decline in productivity.

3.4 Determinants of Adoption of Measures of Preventing Soil Degradation

Result of the regression estimates of the determinants of the adoption of soil degradation preventive measures is presented in Table 4. The exponential functional form was chosen as the lead equation with respect to econometrics and statistical criteria in terms of the number of statistically significant variables and the significance of F-ratio. The coefficient of determination ($R^2 = 0.620$) showed that 62% of the variations in the farmers adoption level of soil degradation preventive measures was explained by the independent variables ($X_1 – X_{10}$) investigated. The F-ratio which determines the overall significance of a regression model is statistically significant at the 1% level, implying that the model is adequate for further analysis. This implies that the independent variables jointly exerted great influence on the level of adoption of soil degradation preventive measures.

Table 4. Determinants of adoption of measures used in preventing soil degradation

Variable	Linear	Exponential+	Double log	Semi-log
Intercept	169.589	10.096	8.666	5.083
	(5.11)***	(12.31)***	(3.34)***	(2.23)***
Sex (X_1)	69096.750	0.422	0.476	100161.100
	(1.24)	(1.53)	(1.70)	(1.81)
Marital status (X_2)	-18903.020	0.575	0.590	12.956
	(-0.29)	(1.78)	(1.76)	(1.13)
Age (years) (X_3)	-0.005	-0.000	-0.095	-39.273
	(-2.86)***	(-2.90)***	(-3.39)***	(-3.29)***
Household size (X_4)	-8714.774	0.286	0.098	-4.235
	(-0.64)	(0.42)	(0.24)	(-0.42)
Farm size (X_5)	85239.300	0.271	0.059	-0.000
	(1.99)*	(1.19)	(0.80)	(-2.90)***
Educational level (X_6)	9287.135	1.332	0.272	22.423
	(1.41)	(5.92)***	(3.32)***	(1.87)
Net farm income (X_7)	-0.001	0.154	0.0770	-16.861
	(-0.06)	(1.85)*	(4.10)***	(-1.53)
Farming experience (X_8)	6055.290	34549.730	0.125	80920.590
	(1.78)	(2.34)**	(2.25)***	(1.57)
Extension contact (X_9)	1590.400	26.404	0.115	5.189
	(2.28)**	(2.86)***	(2.76)***	(2.14)**
Number of soil degradation	-46318.620	24.217	5.653	-79380.890
experienced (X_{10})	(-0.68)	(1.83)*	(3.41)***	(-1.15)
R – square	0.536	0.620	0.544	0.583
Adjusted- R square	0.455	0.576	0.458	0.536
F – ratio	7.50***	8.71***	7.56***	7.64***

Source: Field Survey Data (2019). ***, ** and* Significant at 1%, 5% and 10%, respectively. Figures in parentheses are the t-ratios. +Lead equation

The coefficient of age was negatively signed and highly significant at 1% alpha level implying an inverse relationship with use level of soil degradation preventive measures. This is suggestive of the fact that the older the farmer, the less the wiliness to adopt new soil degradation preventive practices. This is because older farmers are less receptive and more conservative to try new and improved farm techniques and are more risk averse. This is in agreement with the result of Okoye *et al.* (2007) that increasing age would make a farmer to be less energetic to work in the farm. Nyssen *et al*. (2009) reported that whereas old people responded better to participate with full interest, while young age farmers were more motivated to participate by the economic reward obtained from participation.

The coefficient of educational level was positively signed and statistically significant at 1% level. This is in line with *a priori* expectation as educated farmers are flexible and can adopt good changes and new improved soil degradation preventive technologies that can enhance their productivity and income. Thus, the more the level of enlightenment, the better the willingness of the farmers to accept farming innovations. This agrees with the findings of Adégnandjou and

Dominique (2018) that improving education and disseminating knowledge is an important policy measure for stimulating local participation in various natural resource conservation and adaptation measures. Contrary to the result obtained in this study Clay *et al.* (1998) found that education was an insignificant determinant of adoption decisions.

The coefficient of farm income was also positively signed and significant at 10% alpha level. This agrees with the findings of Tsefaye (2016), that income gives financial leverage to farmers with the adoption of new technologies. This implies that income encourages the adoption of improved technologies and preventive measures. On the other hand, increase in adoption of improved soil degradation preventive measures could result in increase in yield as well as accruable income. Moreover, International Institute of Tropical Agriculture (IITA, 2009) indicated that economic viability of a technology determines the extent of the adoption. This is because farmers are always ready to adopt any measure or technology that will increase their income from the farm. Equally, the adoption of a given technology or adaptive measures requires some financial commitments. An increase in farm income will enable the farmers to meet these commitments, thereby increasing adoption level.

The coefficient of farming experience was positively signed and statistically significant at 5% alpha level and positively related to adoption of soil degradation preventive measures. It shows that a unit increase in the years of farming experience will lead to an increase in the adoption level of soil degradation preventive measures. This implied that the more experienced a farmer in soil degradation and its effect on crop production, increase of positive attitudinal responses in carrying out activities that will prevent soil degradation. This is in consonance with the results of Frank (2012) and Akeem (2014). Iheke (2010) observed that the longer the years of farming experience, the more efficient the farmer becomes because the number of years a farmer has spent in the farming business may clearly give an indication of the practical knowledge he has acquired. This is an advantage in adopting soil degradation preventive measures will help to boost production in any pre-determined period of farming business.

The coefficient of extension contacts was positively related to the adoption level of soil degradation preventive measures. This implies that the more the number of extension contacts the farmers had, the higher their level of adoption of soil degradation preventive measures and vice versa. In agreement with the study of Iheke and Nwaru (2014) who reported that extension contact provides room for training of farmers which enhances their ability to understand, evaluate and adopt new production techniques which increase soil productivity. Contrary to the result of this study on extension contact, Akeem (2014) reported that there could be negative influence on the participation of extension activities in reducing farmers' attitude in preventing soil degradation because of the quality of the extension service and the areas of priority on which the extension services are based.

The coefficient of number of soil degradation experienced was positively related to the adoption of soil degradation preventive measures. As noted by Frank (2012) and Carlos and Sang (2015) that the knowledge of soil degradation and number of soil degradation experienced by farmers would enable them adopt indigenous coping strategies so as to allocate and utilize resources more efficiently to increase production and farm output.

3.5 Constraints Encountered by Farmers in Preventing Soil Degradation

Constraints encountered by farmers in preventing soil degradation in the study area is presented in Table 5. Constraints encountered in degraded soil remediation among farmers according to the highest ranking were inadequate knowledge on how to cope with soil degradation, limited income, non-availability of credit facilities, high cost of fertilizer/liming materials, and inadequate research extension–farmers linkages. Others include limited trainings on management of soil degradation, non-availability/high cost of inputs, varying topography of farm environment and multiple local cropping patterns among farmers.

Table 5. Constraints encountered by farmers in preventing soil degradation

Constraints	Frequency*	Percentage	Rank
Inadequate knowledge on how to cope with soil degradation	78	70.27	1
Limited income	77	69.37	2
Non-availability of credit facilities	68	61.26	3
High cost of fertilizer/liming materials	66	59.46	4
Inadequate research extension –farmers linkages	65	58.56	5
Limited trainings on management of soil degradation	64	57.66	6
Non-availability/high cost of inputs	62	55.86	7
Varying topography of farm environment	55	49.55	8
Multiple local cropping patterns among farmers	50	45.05	9
Land management problems	49	44.14	10
Non-availability of farm inputs	46	41.44	11
Traditional belief/practice	44	39.64	12
High cost of organic manures	43	38.74	13
Unawareness of soil degradation of farmland	42	37.84	14
Farmers' apathy towards soil degradation control	39	35.14	15

Source: Field survey data (2019). * Multiple responses recorded.

Nwokoro and Chima (2017) opined that these constraints affect the participation of rural farmers in the conservation and remediation of environmental resources while Baba (2017) reported that, soil and land degradation remediation is related to their socio-economic circumstances and to ecological characteristics of their environment, particularly rainfall. Scherr (1999) identified various factors influencing the pace of soil transformation which include: farmer knowledge about the degradation of the degrading resource, incentives for long-term investment, capacity to mobilize resources for land investment, level of economic returns to such investment, factors affecting the formation and function of local groups to help mobilize resources and coordinate landscape-level change.

It is necessary that rural people be empowered through environmental education on resource management, in order to revitalize important traditional resource management practices which they depend on for livelihood. However, Munasinghe (1993) argued that effective participation of local farmers in resource management could be achieved through what he termed 'conservatism' and 'primary environmental care'. These two concepts observe the ways rural people could initiate soil management practices of their own by revitalizing traditional methods of this resource management in their agricultural activities, bearing in mind, the consequences of unsustainable agricultural practices on food security. However, this can only be achieved if appropriate actions are put in place to tackle these constraints inhibiting effective soil resource management in agricultural activities in the rural settings.

According to Jouanjean *et al.* (2014) improvement of the livelihood of the poor and rural farmers will invariably improve attitudes limiting the wasteful usage of their immediate environmental resources. Lack of knowledge of soil degradation on the part of the rural farmers increases chances of indiscriminate use of immediate soil resources. Hence, it should be the priority of government agencies to ensure that environmental education reaches to poor farmers in the rural areas.

4. CONCLUSION AND RECOMMENDATIONS

Farmers in the study area identified deeply excavated subsoil and overburden with materials, extremely eroded due to deforestation and loss of biodiversity leading to attendant soil loss as the major causes of soil degradation. Poor soil fertility was reported by farmers as the major effect of soil degradation in the study area. The major measure adopted by the farmers for the prevention of soil degradation in the study area alongside the cost incurred for such adoption was use of organic manure (poultry faeces, animal dung etc) which was adopted by 70.2% of the farmers, with total cost incurred as ₦777,100 and average cost of ₦9,963 per farmer. The determinants of adoption of soil degradation adaptation measures were income, education level, farming experience, extension contact, and age. The major constraints encountered by farmers in preventing soil degradation was inadequate knowledge on how to cope with soil degradation. Based on the findings of this study, there is need to educate and expose farmers to new technologies and programmes such as climate smart agriculture adaptation programmes and innovations that are easy to practice, cost effective and ensure soil and nutrient conservation for improved productivity.

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