NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 56, Number 1, April 2025, Page 267-290
Available online at: http://www.ajol.info/index.php/naj
https://www.naj.asn.org.ng

Analysis of Economic Cost of Agricultural Land Degradation in Southeast Nigeria

Nwofoke, C.
Department of Agricultural Economics, Management, and Extension
Ebonyi State University, Abakaliki, Nigeria
Corresponding author's email: nwofoke.christian@ebsu.edu.ng

Abstract

This study aims to analyze the economic cost of agricultural land degradation and determine the constraints to the use of agricultural land degradation control measures in southeast Nigeria. Southeast Nigeria is the study region. All of southeast Nigeria's registered crop farmers make up the study's population. The sample size of 300 farmers was determined based on Cochran's formula for an infinite population. A multistage purposive and random sampling process was used to choose the study's respondents. Data were collected from primary sources using a questionnaire augmented with a face-to-face interview in 2023 and analysed using percentages, mean score, economic cost method, and factor analysis. Results showed that a farmer had a loss of about ₦11,973.04/ha, approximately (US$16.179/ha), to agricultural land degradation. The major constraint to the practice of agricultural land degradation control measures was economic constraints. The study recommends that, since most of the farmers use nutrient replacement as agricultural land degradation control measures, the government should subsidize the cost of fertilizer to increase usage by farmers. Our research is unique in the field of environmental degradation since many authors dwelled on geophysical erosion, soil loss, gully erosion, productivity loss and soil wash erosion, our study assessed economic cost of agricultural land degradation using replacement cost method (cost of replacing destroyed plants; cost of establishing conservation measures and cost of seeds and seedlings replacement and use of labour hours lost). Also, this study considered the degree of consciousness of the farmers to sheet/soil wash erosion as it affects the study area, while most other studies considered the geophysical aspect. The findings of this research will inform policymakers on how loss in productivity can affect the prospects of growth in the national output. To the farmers, it will help them identify the economic cost of agricultural land degradation per hectare of land. To the government, the cost of land degradation will be known, and this will help them in their plans. To the general public, constraints to the use of agricultural land degradation control measures will be known and work hard to eliminate it, and to researchers and scholars, this will serve as a reference material for further research.

Keywords: Economic cost, Degradation, Nutrient replacement, Southeast, Nigeria

Introduction

A detailed analysis of the costs and advantages of taking action versus doing nothing to address agricultural land degradation needs to be the foundation for stepping up efforts, attracting more investment, and boosting policy commitment. Consistent with this, this study analysed the economic cost of agricultural land degradation in the southeast region of Nigeria. Agricultural land degradation has an adverse impact on the livelihoods and food security of billions of people worldwide, particularly in southeast Nigeria. The threat is frequently observed throughout large areas of several nations, especially in regions with hot, dry climates like the southeast region of Nigeria, and it has led to significant economic, social, and environmental losses.

It is obvious that the first step in dealing with agricultural land degradation and its impacts is to accurately grasp the cost and its effects on various factors by identifying the pertinent methods and approaches in this regard. A phenomenon affecting agricultural lands that can result in the loss of the land's economic and ecological quality is known as agricultural land degradation (Mirzabaev, Strokov, and Krasilnikov, 2023). Agriculture land degradation is defined by ELD Initiative & UNEP (2024) as a decline in the economic value of ecosystem services and goods derived from agricultural land. According to the Food and Agriculture Organization (FAO), land degradation is the sustained loss of ecosystem productivity and function. Therefore, agricultural land degradation is the reduction in economic and biological value of agricultural land as well as goods derived from it as a result of erratic climatic factors or anthropogenic activities.

Southeast Nigeria's terrain is reported to be low-lying, which exposes surface regions to flooding, coastal erosion, and sheet erosion, leading to the removal of the topsoil (Okenmuo, Ibeh, & Obalum, 2023). The physical damage to agricultural land in Southeast Nigeria by agents of degradation poses a great threat to the lives and properties of the citizens, causing a decline in food production in the area.

Reports have shown that amongst the southeastern States in Nigeria, Anambra has the highest number of gullies, followed by Enugu, Imo, Abia, and Ebonyi states, respectively (Johnbosco, Egbueri & Igwe 2021). The performance of the agricultural sector concerning its contribution to national output has decreased, and this change has been attributed to the effects of agricultural land degradation, which is one of the factors that is eroding the gains of the agricultural sector (Owan, Ebehung, Owan-Enoh, Agbor, and Egere 2024). Agricultural land degradation is much more serious in the southeast region than in other parts of the country due to the prevailing climate conditions and intrinsic characteristics (Nwofoke & Azizi, 2024). Land degradation, poverty, and food insecurity are pervasive and interconnected, and, left uncontrolled, future access to rural land for agriculture will be precarious in the region. There are both on-site and off-site consequences of agricultural land degradation, and one of the most detrimental on-site effects is yield drop caused by losses in land productivity (Abdulle, Hussein, Mohamed, Mohamud, Osman, Mohamuud & Idiris 2022). This research measured agricultural land degradation in southeast Nigeria using the replacement cost method.

Relative to other regions of Nigeria, “the southeast region, particularly in Abia, Anambra, Ebonyi, and Imo states, has soil erosion as one of the predominant means of agricultural land degradation" (Aja, Ugwoke, Anyoha, Okereke-Ejiogu, & Onyezi, 2023). The soils are structurally unstable and therefore prone to gully and sheet/soil wash erosion (Andebutop, Ebong & Danbaba 2023). The region is known for its long-standing customs of bush burning, continual farming, and mining on sloppy hills. (Oyim, Osayi, Okaforocha & Nwokoye 2023). Severe ecological consequences arising from the significant loss of soil in the area include food insecurity, a decrease in agricultural output, loss of soil structure, and depletion of soil fertility (Ota, Mohan Udume, Olim, Okolo, 2024).

The menace of soil erosion in this region has made agricultural practices in the area more challenging" (Kayode, Aizebeokhai, Odukoya, 2019). Prices for agricultural land have increased rapidly, nearly doubling in the Southeast region of Nigeria, as a result of the sheet and gully erosion incidents that have been documented in the area. These erosion incidents have removed 45 to 90% of the total sediment output on agricultural lands in the region. (Chude, Ezendu, Ugadu, and Adiaha, 2024). Therefore, an analysis of the cost of agricultural land degradation in Southeast Nigeria becomes imperative.

Furthermore, it is crucial to consider the degree of consciousness of the farmers to sheet/soil wash erosion, as it affects the study area, since most studies considered the geophysical aspect. The awareness ranges from observations on local loss of agricultural production, increased use of fertilizer, low quality produce, and effects of extensive deforestation on the local climate, and prospective stakeholder interests in reacting to degraded agricultural land.

Again, this analysis of the economic cost of agricultural land degradation in the southeast region of Nigeria has been prompted by the rising price of agricultural produce, which translates to increased product prices. Land degradation persists as the value of agricultural land rises, and investments to stop it are lagging. This lack of investment to prevent agricultural land degradation may primarily be a result of a lack of knowledge on the costs related to land degradation. However, it might be challenging to understand the whole cost of land degradation. To estimate the economic cost of agricultural land degradation in the southeast of Nigeria, this research focused primarily on the use of evidence from farmers' observations of the soil (primarily soil degradation), plants growing on the soil (soil productivity), and the cost of replacing damages.

Numerous studies have been done on the subject, including Cost of land degradation and improvement in Eastern Africa (Kirui & Mirzabaev, 2016), Nigeria's sustainable economic development and environmental degradation: a theoretical perspective (Ogboru & Anga, 2015), Environmental degradation: reasons for it and its effects (Tyagi, Garg & Paudel, 2014), Farmers' perceptions of how soil degradation affects agricultural activities in the Nigerian Delta State local government area of Ethiope East (Akinnagbe & Umukoro, 2011), Assessing the effects of agricultural land degradation on poverty in Ghana using a multi-market model at the national level (Diao & Sarpong, 2011), Review of Nigeria's environmental issues (Isife, 2012); Sustainability and environmental degradation in Nigeria: The Need for

Environmental Education (Asaju, & Arome, 2015), An analysis of the factors contributing to environmental degradation in southeast Nigeria (Chibuzor, Okoyeh, & Egboka, 2017), Cost of environmental degradation in the Kingdom of Morocco (World Bank, 2003) and The Economic Cost of Environmental Degradation: A Case Study of Degradation of Agricultural Land in Ghana (Kwame, 2014).

However, it seems none focused on the analysis of the economic cost of agricultural land degradation in south-east Nigeria. Major issues which are often not addressed include assessment of economic cost of agricultural land degradation using replacement cost method (cost of replacing destroyed plants; cost of establishing conservation measures and cost of seeds and seedlings replacement and use of labour hours lost) as many authors dwelled on geophysical erosion, soil loss, gully erosion, productivity loss and soil wash erosion. Based on this background, the study seeks to investigate the farmers' awareness level on agricultural land degradation; examine the extent of agricultural land degradation; estimate the economic cost of agricultural land degradation in southeast Nigeria; and determine the constraints to the use of agricultural land degradation control measures in southeast Nigeria. Therefore, the null hypothesis, Economic cost of agricultural land degradation does not significantly differ across different locations of the study area, was tested.

Literature Review

In Nigeria, evidence indicates a deteriorating human-land interface and relationship in which negative changes in landscape quality keep lowering both the productivity and aesthetic quality of the natural environment, with serious effects on the economy due to erosion (Turyasingura, Ayiga & Benzougagh, 2022). The situation of erosion is particularly pronounced in the ecologically vulnerable areas of southeastern Nigeria, where population densities and the least land per capita rank among the highest in rural Africa (Verere Balogun, Andrew, Onokerhoraye, 2022). The menace of soil erosion, especially gully in no doubt a major ecological challenge facing most states in Nigeria, especially Anambra, Imo, Ebonyi, Abia, and other states in the humid tropical regions of southeast Nigeria (Nwosu & Nweke, 2024). Being a nation where more than 6,000 km2 of the land base suffers from erosion, with almost 3,400km2 vulnerable (Merem, Twumasi, Wesley, Alsarari, Fageir, Crisler et al., 2019). "Soils of the southeast Nigeria have high soil erodibility and are classed as structurally unstable" (Abisoye, Ojo, Nwosu, Oshunsanya, Ayantayo–Ojo, & Aladele, 2023); therefore, erosion forms a major type of soil degradation in the area. In southeastern Nigeria, the soils are naturally prone to erosion due to their fragile nature and ease of leaching, being mainly ultisols and alfisols (Ubuoh, Onwughara, Odey, 2020). As a result, the impact of the most common form of human-induced soil degradation caused by land use activities in the case of Nigeria consists of deforestation, bush burning, and biodiversity depletion (Sobere, 2024). Given the impacts on natural habitats, deforestation in the Eastern rainforest zone opens the land to forces driving soil degrading catalysts (water erosion and flooding) in a way that accelerates the washing away of the fertile topsoil and leaching. According to Igwe, Ajadike, and Ogbu (2023), the Eastern zone is a typical gully region in Nigeria where over 90% of the land area suffers from sheet, rill, and gully erosion. Both physical, socioeconomic, and anthropogenic factors, as well as deficient agricultural production practices, are believed to have aggravated and exacerbated the high erodibility of the soils in the region. According to Igwe, Ajadike, and Ogbu (2023), the presence of gully sites is one of the hazardous features that characterize the southeast zone. The formation of gullies has become one of the greatest environmental disasters facing many towns and villages in southeast Nigeria (Nwosu & Nweke, 2024). The type of erosion that is predominant in the southeast zone is gully erosion. Chude et al. (2020) concurred that gully erosion is most predominant in the region and is considered an environmental degradation with a lot of disastrous consequences caused mainly by floods as a result of high precipitation, which is a fallout of climate change. The development of gullies causes the loss of a great amount of soil and can be considered as one of the principal causes of geo-environmental degradation in Southeast Nigeria. Researches previously conducted in Imo, Abia, and Anambra States show that gully incidences generate between 4.2 and 10 m 3/ha/year of sediments, which constitute about 45–90% of total sediment production on agricultural lands (Okenmuo, Ibeh, & Obalum, 2023). Erosion predominates in areas which have been subjected to bush burning, continuous cultivation, and mining on hillside slopes, all of which are common and long-term traditional practices in southeast Nigeria (Aja et.al., 2023). Oyim et.al. (2023) had estimated over 1970 gully sites in Imo and Abia states.

Theoretical Framework

The theory of social cost: Pigou (1920) is credited with developing the notion of social cost and recognizing the connection between private and social cost (Watcher, 1992). The idea is that factors of production will not be allocated efficiently if economic agents do not bear the full (social) consequences of their activities, if there exist externalities, and the assumption is that the market cannot resolve the externality problem on its own (Wachter, 1992). The theory of social cost claims that the use of practices that cause externalities by farmers, such as pollution of river bodies, erosion, and encroachment of biodiversity habitat without bearing the full cost of their actions, is the major factor that encourages inappropriate production practices and is the cause of land degradation (Wachter, 1992).

The theory of collective goods: Since externalities are a component of collective goods, the theory of collective goods and the idea of social cost are closely related (Wachter, 1992). Three characteristics define a pure collective good: non-excludability (no one can be barred from consumption, ensuring that everyone benefits), non-rivalry in consumption (consumption by one person does not harm consumption by another person), and externalities (the possibility of free-riding because of non-excludability) (Wachter, 1992). Numerous environmental benefits have communal good characteristics, especially non-excludability and externalities. However, when non-rivalry is no longer present, environmental issues become more prevalent (Wachter, 1992). This idea states that environmental issues like land degradation occur when people can take advantage of scarce environmental resources like grazing grounds without helping to maintain or conserve them (Wachter, 1992). Because the advantages of conservation are shared by all users, no one is motivated to preserve the land (Wachter, 1992).

Process of estimating the cost of land degradation

The act of quantifying or assigning a monetary value to the effects of environmental degradation, which often entails evaluating reductions in soil production, is known as cost estimation. Estimating the consequences of erosion both on- and off-site is done to determine the cost of soil loss. The main effects are a decrease in soil quality brought on by the removal of the nutrient-rich top layers of the soil and a decrease in the ability of many eroded soils to retain water. When soil is separated by accelerated water or wind erosion and moved over great distances, off-site consequences result. Water erosion's primary off-site effect is the introduction of silt and agricultural contaminants into waterways. This may cause drinking water contamination, silting up of dams, and alteration of lake ecosystems. In some circumstances, the decreased ability of degraded soil to absorb water may also contribute to higher downstream floods. However, the study will primarily concentrate on on-site impacts using replacement cost analysis because data on off-site erosion-induced soil loss are not readily available. Economic theories have been utilized to create models that calculate the expenses of these types of environmental deterioration as well as the advantages of protecting these natural resources in order to quantify the costs related to land degradation. For instance, changes in prices and productivity result from soil degradation (erosion) (i.e., both the demand and supply side). The total cost of soil degradation/erosion is the summation of both on-site and off-site erosion, expressed as: Dc.' = Dc. On-site + Dc. off-site. The impact on the soil's characteristics and the impact on agricultural output are the two main techniques used to value erosion's local consequences. Additionally, a number of valuation methodologies, such as the Universal Soil Loss Equation (USLE), can be applied to the assessment of soil deterioration in agriculture. However, USLE is not applicable for investigations in regions where relevant factor values are not available. The Erosion-Productivity Impact Calculator (EPIC) is another method, but it requires huge data sets, which are infrequently available in developing nations, especially when the work spans a long time. Another method used to value the on-site consequences of erosion deals with the readiness to accept payment or pay for the advantages of reduced erosion and is known as contingent valuation and hedonic pricing. Hedonic pricing, however, assumes that people take into account erosion-induced degradation in making decisions about whether to buy or rent a piece of land, but neither of these conditions is met in the majority of developing countries. Instead, hedonic pricing uses land prices to estimate the economic value of soil erosion, and the use of land prices to estimate the cost of erosion also requires data on land prices and a well-developed market for agricultural land. The productivity loss approach is another method that is used to value on-site costs by calculating the opportunity cost. Another method is the replacement cost method. However, in order to calculate the cost of agricultural soil degradation, the study used replacement cost approaches. The availability of data and other pertinent information is a major factor in its adoption, as these techniques can generate broad-brush estimations that can be applied to macroeconomic research. Researchers and other middle-level managers of public organizations can make use of the theoretical foundation because it is comparatively easy to understand and implement. The drawback of this approach is that estimates are mostly focused on local effects, i.e., how it affects only the farmers. Although the majority of experts concur that soil erosion is a serious issue, Van Baren and Oldeman (1998) stated that there is no agreement among scholars about the impact of soil erosion on agricultural production and soil productivity. Since there is no correlation between erosion and productivity, estimating the impact of a unit of soil loss on a crop's production is difficult (Perrens et al, 1984; Erenstein, 1999).

The process of implementing the replacement cost: The replacement cost method estimates the cost for replacing the soil nutrients lost in each planting season. These include what it will cost a farmer to replace every damage caused by erosion and any other agent of agricultural land degradation per hectare of land.

Methodology

Southeast Nigeria is the study region. One of Nigeria's six geopolitical zones, it includes the states of Abia, Anambra, Ebonyi, Enugu, and Imo. Its entire area is roughly 78612 km^2, and it is located in the tropical rain forest zone of Nigeria between latitudes 4047'35"N and 707'44"N and longitudes 7054'26"E and 8027'10"E. Its population is about 16.4 million, the majority of whom are Igbo (NPC, 2006).

Sampling procedure

All of southeast Nigeria's registered crop farmers make up the study's population. A multistage purposive and random sampling process was used to choose the study's respondents. First, the states of Anambra, Ebonyi, and Enugu were purposively chosen based on the intensity of land degradation in the area and its topographic peculiarity (Okorafor, Akinbile & Adeyemo 2017; Nwaiwu *et al.*, 2013). The second stage was the purposive selection of two agricultural zones from each of the selected States (Aguata and Awka in Anambra, Ebonyi North and Ebonyi South in Ebonyi State, and Enugu North and Enugu-West in Enugu State) because of their high involvement in agriculture and intensity of land degradation (Okpalla & Nwofoke, 2018). The third stage was a purposive selection of one local government area from each of the agricultural zones (Aguata and Aniocha in Anambra, Abakaliki and Afikpo North in Ebonyi, and Udenu and Udi in Enugu) because they are more involved in agricultural land degradation (Bolarinwa, Aiyedun, Odulate, & Odugbemi, 2021). The fourth stage was a purposive selection of one community from each of the selected L.G.A.s (Mkpologwu in Aguata and Obeledu in Anaocha), (Amagu in Abakaliki and Amasiri in Afikpo North), and (Igboeneme in Udenu and Eke in Udi) because of their level of agricultural activities and land degradation. The last stage was a random selection of 50 crop farmers from each of the communities previously selected, making a total of 300 respondents who were used for this study. The sample size was determined based on Cochran's formula (Cochran, 1977) for an infinite population. Cochran's formula is considered appropriate in situations with large populations. The Cochran formula is:

$n = \frac{Z^2pq}{e^2}$;

Where n is the sample size, Z is the selected critical value of the desired confidence level, p is the estimated proportion of the population that has the attribute in question, q = 1 – p, and e is the desired level of precision. The z value is found in a z table. To determine the sample size (n), it was assumed that the proportion of farmers in the population was 50% (p = 0.5), the desired level of precision was 5% (e = 0.05) at a 95% confidence level (z = 1.96), and a response rate of 95%.

Therefore, $n = \frac{\left((1.96)^2(0.5)(0.5)\right)}{(0.05)^2} = 385$

A total of 385 respondents were expected to be used for the study, but due to non-response (incomplete questionnaires/unreturned forms), 300 responses (78%) were retained. So, a random sample of 300 crop farmers in our target population should be enough to give the confidence levels we need. Hence, the calculated sample size for the study was approximately 300 farmers. Nzeadibe, Egbule, Chukwuone, and Agu (2011) used a 65% response on their research on climate change awareness and adaptation in the Niger Delta region of Nigeria. There is currently no consensus on the acceptable level of response rate for a survey (Sataloff and Vontela, 2021) but an ideal range should be around 40% to 75% in all field researches (Reinisch et al., 2016; Story & Tait, 2019) therefore, the response rate for this study can be considered as acceptable. This was used by Janatu, Aiah and Richard (2021) to determine the sample size in the work: predicting the adoption of improved cassava varieties in Sierra Leone; Mousaei (2021) use it to determine the sample size in the work: the effect of farm counselling on farmers' beliefs and motivation in sustainable environmental protection (case study: wheat farmers in Behbahan city, Iran). Simeneh (2015) also used it in a work: perception of farmers toward physical soil and water conservation structures in Wyebla watershed, northwest Ethiopia; and Telle, Melo, Righetto, Didoné, Barbosa, (2022) also used it to determine the sample size in the work: soil management practices adopted by farmers and how they perceived conservation agriculture.

Model Specification

Model for estimation of the economic cost of agricultural land degradation

The model is specified thus, as adopted and modified from Okoye (2009),

Net income = Revenue – total expenses

Where Total expenses = initial expenses + economic cost

Economic cost = cost of labour hours lost (number of hours spent repairing damaged ridges, mounds, and other seed beds and replacing destroyed plants measured in man/days); cost of establishing conservation measures; cost of seeds and seedlings for replacing erosion-damaged/removed ones; cost of nutrient replacement(fertilizer).

Therefore, Expected net income = net income + economic cost.

Results

State of Farmers' Awareness of Agricultural Land Degradation in Southeast Nigeria

Awareness of the farmers on agricultural land degradation was assessed based on their response to the relevant questions on awareness and the results presented in Table 2. The farmer' awareness of land degradation on their farms is displayed in Table 2. The findings indicate that all farmers knew about the agricultural land degradation on their farms. This outcome indicates that farmers are aware of soil degradation. The low level of land productivity, high cost of fertilizer for replacement, and widespread erosion or gullies on the farm or in the surrounding area may all be contributing factors to the high rate of awareness (Amangabara, Njoku, Iwuji, 2017). This concurs with the findings of Okoye (2009), which revealed a high level of awareness of the threat of soil erosion and other forms of degradation of agricultural lands in southeast Nigeria.

The extent to which Degradation of Agricultural Land occurs in Southeast Nigeria

The level of degradation of agricultural land in Southeast Asia was assessed, analyzed, and the results are presented here. The result of the analysis is presented in Table 3. How one or more of the land resources (soil, water, vegetation, rocks, air, climate, relief) have deteriorated is shown in Table 3. The majority of these changes were noticed by the emergence of certain indicators of land degradation, such as field erosion, tree loss, etc. It is important to emphasize that some changes to farms and factories brought on by the rising prevalence of agricultural land degradation are typically site-specific. The result displays the numerous indications of land degradation that farmers have observed on their fields and in the nearby plants. They include field erosion (X = 2.9), total removal of the soil with stone appearance (X = 2.8), tree reduction (X = 2.8), water scarcity (X = 2.9) and terrace slide (X = 2.5), were all accepted as it was observed by the farmers as evidence of agricultural land degradation while appearance of tree roots (X = 2.0) and increased ant-hill (X = 2.4) though were also accepted to have been observed by farmers but at a lower significant level. This indicates that the farmers' perception of the level of observed agricultural land degradation included human, geology, and climate influences. The outcome is consistent with those of Amangabara, Njoku, and Iwuji (2017), Nwaiwu (2016), who argued that a variety of factors, including climatic conditions and human activity, contributed to soil degradation. However, the grand mean of (X = 2.6) suggests that the farmers in the research area were significantly aware of all the characteristics of agricultural land degradation stated in Table 3.

Duration of Awareness of Degradation of Agricultural Land in Southeast Nigeria

This duration by farmers was assessed, and the result is presented in Table 4. Table 4 shows that a greater percentage of the respondents (52.0%) noticed agricultural land degradation a long time ago (11-20years). This was followed by a relatively high percentage of the respondents (29.3%) who became recently aware of agricultural land degradation (10 years and below), while only 18.7% of the farmers had noticed the phenomenon a very long time ago (11 - 20years and above). This finding implies that agricultural land degradation is not a new problem in the study area and that the 18.7% of the respondents who noticed it recently could be because their years of farming experience are small. This is in line with the study of Amangabara, Njoku, and Iwuji (2017) and Osabuomen and Okoedo-Okojie (2011), who reported that soil deterioration has been a problem worldwide for many years.

Extent of Agricultural Land Degradation in Southeast Nigeria

During the field work component of this study, the respondents were asked to indicate the extent of ALD in the study area. The result showed that indicators of degradation of farmland manifested at a very high extent, while some occurred slightly. The result is presented in Table 5. Table 5 describes the intensity of agricultural land degradation in southeast Nigeria using a Likert-type rating scale categorized as slightly degraded, moderately degraded, highly degraded, and very highly degraded. Some forms of agricultural land degradation considered in this study include loss or decrease in soil fertility, deforestation, and desertification, among others. It is necessary to note that most of these forms of land degradation parameters are location-specific. The result in Table 5 illustrates the various forms of farm land degradation based on the intensity of its effects on farmers' production activities. They include continuous decrease in the productive capacity of the land (X = 3.2), this implies that continuous decrease in the productive capacity of the land occurs at a great extent in the study area and needs urgent attention by adopting a control measure as continual decrease in the productive capacity of the land will increase cost of production and cost of control also. This is in line with the report of Land Degradation Neutrality (LDN) from Nigeria and the UNCCD Global Mechanism (2018), which opined that “the resultant impact of land degradation includes loss of productive capacity of the soils for present and future usage”. Loss or change in vegetative cover (X = 2.3) was also observed to a great extent in the study area based on the farmer's response and has affected both the farmer's environment and yield, as it has exposed the soil surface to erosion and runoff and has contributed to nutrient loss. The control of this menace will go a long way in curbing loss in productivity and also reducing the cost of setting up a farm and the economic cost of agricultural land degradation. Another observed agricultural land degradation indicator was loss or decrease in soil fertility (X = 3.4), which implies that the cost of production has increased in the study area by the purchase of fertilizer and other manure to increase yield. This cost may be reduced by the use of cultural practices such as shifting cultivation. Decreased soil regenerative ability (X = 3.1), which implies that the rate at which the soil in the study area renews its nutrients after it has been used has decreased and should be controlled before it worsens. Poor drainage (X = 2.5) is also a problem in the study area and should be enhanced to help control some land degradation indicators like erosion. Deforestation (X = 2.5) was also observed, implying that the rate of deforestation in the study area was high and should be controlled, as this also increased the extent of agricultural land degradation. Flooding (X = 2.7) was another agricultural land degradation indicator observed in the study area, as it has contributed to soil loss, crop failure, nutrient loss, among others. Loss of range of species or ecosystem (X = 2.2) was also observed, implying that there was a loss of range of species both in plants and animals in the study area, and has also affected both the ecosystem services to the farmers and production itself. Breakdown of soil structure (X = 2.0), to a great extent, the soil structure has also changed and affected both the cropping patterns, nature of crop, and cropping activities in the study area; this calls for urgent attention to salvage the farmers from loss through the use of adequate control measures. Most of these indicators of agricultural land degradation manifested in the study area to a significant extent as reported by the farmers while desertification (X = 1.6), change in soil texture (X = 1.8), change in soil type (X = 1.7) and reduction in soil water (X = 1.8) also occur in the study area but not at significant level therefore were rejected. This implies that agricultural production, sustainability, as well as management for food security alongside sustenance have been threatened by the menace posed by agricultural land degradation indicators in the study area. This corroborates the study of Chude, Ezendu, Ugadu, and Adiaha (2020) and Okorafor, Akinbile, and Adeyemo (2017), who opined that farmland availability for development and agricultural production has significantly decreased as a result of the loss of agricultural land to land degradation in southeast Nigeria. However, the grand mean of (X = 2.4) implies that the farmers observed most of the various forms of degradation in the area, some to a significant extent, others to an insignificant extent. This also corroborates the study of Aweda et.al. (2024), who reported that soils of southeast Nigeria are inherently vulnerable to degradation since they are mostly ultisols and alfisols, which are brittle and easily leached. Making erosion and other forms of land degradation prevalent in the area.

Estimating the economic cost of agricultural land degradation in the study area

The study adopted the replacement cost methods in estimating the cost of agricultural land degradation in the study area. The replacement cost method estimates the cost for replacing the soil nutrients lost each year, the cost of replacing every damage caused by erosion, and any other agents of agricultural land degradation in the study area. Table 6 shows the estimation of the economic cost. This result showed that the on-site cost of agricultural land degradation is the cost in the long-run net profitability of the farming system from investing in soil conservation, provided, of course, that such an investment is an economically worthwhile alternative. This implies that for every hectare of staple crop (yam, cassava, rice, maize) farmed in southeast Nigeria, the farmer loses an average of ₦11371.04 to agricultural land degradation. This result is supported by the findings of Barbier (1996), who estimated the on-site cost of soil erosion to be around US$50.1/ha, which is approximately (₦37,074/ha). Also, Cruz, Francisco, and Conway (1988) reported about (US$19.39/ha), which is approximately (₦14,348.6) as nutrient replacement cost due to agricultural land degradation.

Duncan's Multiple Range Test

A comparison test method called Duncan's multiple range test can be used to measure the substantial variations in the economic costs of agricultural land degradation in various areas. To assess the economic costs of agricultural land degradation in various research areas, Duncan's test was employed to test hypothesis II. At a 5% probability level, Table 7 compares the economic effects of agricultural soil degradation in various farm locations. Means and standard deviations in the same column with different superscripts are significantly different. Mean separation was done using the Duncan test at a 5% level of significance ($P<0.05$). The result of the ANOVA test, as presented in Table 4.6, shows that the economic cost of agricultural land degradation differs across the study locations. The annual farm income of Enugu state, with the lowest mean value (₦ 157,710.00±75771.23), significantly differs ($p < 0.05$) from that of Ebonyi state (₦309,390.00±192792.23) and Anambra (₦274,560.00±162013.67), which have higher mean values. Meanwhile, the initial cost of setting up a farm in Ebonyi state with the highest mean value (₦158280.00±102223.17) was significantly different ($p< 0.05$) from that of Anambra (₦77480.00±27606.35) and Enugu state (₦79350±43079.06). Finally, the cost of establishing conservation measures among farmers in Anambra (₦24289.00±14965.77) recorded the highest mean value and differed significantly ($p < 0.05$) from those of farmers in Ebonyi State (₦18246.40±13692.81) and Enugu State (₦18527.10±14365.57). As a result of this, the null hypothesis II, which states that 'economic cost of agricultural land degradation does not significantly differ across different locations in the study area', was rejected, and the alternative hypothesis was accepted that economic cost of agricultural land degradation significantly differs across locations in Southeast Nigeria. This implies that compared to all other states in Southeast Nigeria, Anambra's economic impact of agricultural land degradation is much higher. This data is consistent with the study by Aweda et.al. (2024), which found that Anambra had a higher cost of agricultural land degradation than other states in Southeast Nigeria. It also met the a priori expectation. The study by Nwosu and Nweke (2024), which claimed that Anambra in southeast Nigeria had an unfair share of gully erosion that had a higher economic effect on the local farmers due to the nature of the land degradation, is also consistent with this. Again, the study by Chude et.al. (2024) revealed a large economic effect of erosion on farmers' income in Anambra compared to other states in Southeast Nigeria.

Constraints to the use of mitigation strategies on agricultural degradation in southeast Nigeria

The obstacles that prevent farmers from using management techniques on degraded land in southeast Nigeria were identified using factor analysis. Factor analysis uses mathematics to summarize how variables and factors relate to one another. The factors were given names based on the variables that had high loading in each component matrix. Variables with a coefficient of 0.40 or higher have high loading and can be used to name a factor, according to Kaiser's (1958) rule of thumb. Nwibo, Eze, Nwofoke, Mbam, and Umeh (2019); Ezeh and Okorie (2013). This rule has been generally applied. To name the constraints in this analysis, only variables with factor loadings of 0.40 and eigenvalues >1 variance were considered. Table 8 presents the results in a summarized form. The result of the varimax rotated matrix on the barriers to farmers using agricultural land degradation control techniques is shown in Table 8. Three (3) factors—institutional factor (Factor I), information/knowledge factor (Factor II), and economic factor—were discovered and extracted based on items that clustered and loaded highly (Factor III). These three reflect the main impediments and obstacles that prevent farmers from using agricultural land degradation control methods.

I. ***Institutional factors****:* From the result in Table 8, institutional factors constraining the use of agricultural land degradation control measures were: Lack of awareness of available conservation strategies (0.580), this implies that some institutions, like the extension service providers are not meeting up with the responsibility of creating awareness of the available conservation strategies to farmers. Not enough soil conservation training offered (0.494) according to the respondents, training on soil conservation is not enough since there are new soil conservation strategies on a daily basis emanating from research, but mostly do not get to them from the extension service providers. Lack of effective exposure to extension services (0.594), access to extension service demonstration plots is not always available for proper understanding of the measures due to the failure of the government agency responsible for that. Poor health (0.751), most of the farmers are old and suffer from one form of ill health or the other, the health institutions have continued to fail in the rural areas in the provision of health services. No access to land (0.678), the land fragmentation nature in the study area has hindered the use of capital-intensive land degradation control measures in the study area. Rise in population (0.637), absence of birth control by responsible institutions, and other population control measures have reduced the available lands and may not allow some erosion control systems, such as shifting cultivation. This is a pointer to the fact that agricultural land degradation control measures have not received adequate attention from the responsible institutions. This finding is in line with that of Thanh, Hung, Nam, Phuoc, Phuong, Khanh, and Giang (2024), who identified institutional constraints as one of the constraints to sustainable land management adoption among smallholder farmers in the uplands of Vietnam.

II. ***Information/knowledge factors****:* The specific information/knowledge factors hindering the farmers from the use of agricultural land degradation control measures were: insufficient information on proper use (0.592) the farmers reported lack of information on the proper use of the conservation processes as a constraint to practice of agricultural land degradation control measures in the study area. Inefficient technical information (0.580) from the respondents, there is also inefficient information on the proper use of land degradation control measures, and required more information to aid adaptation. Requires a huge amount of labour (0.454). The respondents also reported high labour requirements of conservation measures as a constraint to their practice. This also confirms the view of Deressa (2010), who reported that lack of information was among the factors limiting farmers' adaptation to climate change in the Nile basin region of Ethiopia. For example, a lack of information on coping strategies to the agricultural land degradation menace could be attributed to the fact that control measures for agricultural land degradation options have not been strengthened in the area, and thus, information is lacking on it. In a similar study, Nzeadibe, Egbule, Chukwuone, and Agu (2011) assessed farmers' perception of climate change governance and adaptation constraints in the Niger Delta region of Nigeria. They also reported inadequate information as a factor limiting knowledge on adaptation measures.

III. ***Economic factors:*** Another constraint to adoption of agricultural land degradation control measures in the study area was economic constraint due to factors that loaded high, the economic factors limiting the use of agricultural land degradation control measures among the farmers were: high cost of adoption (0.728) and lack of access to credit (0.490) the cost of adoption and practice of agricultural land degradation control measures is high and access to credit is very low according to the respondents and these has been a constraints to practice of agricultural land degradation control measures. Lack of investments (0.600), most of the farmers do not invest in agricultural land degradation control measures because of their cost and labour intensity. Not aware of the total cost of soil conservation (0.897), the cost of most of the conservation measures is not known to the farmers, and this is a constraint to the practice. Not patient for the long-term benefit (0.588), the reward to investing in agricultural land degradation control measures takes a long time, and this is a constraint to its use. This finding is in line with previous studies, which reported that access to credit positively correlates with technology adoption (Dimo, Maina, & Ndiema, 2022). Credit is thus a vehicle for enhancing the adoption of technology. In agreement with this, Obisesan, Amos, and Akinlade (2016) reported that farmers' access to credit facilities increased adoption levels in Southwest Nigeria. This is because credit increases the farmers' economic power to practice the best of the control measures for agricultural land degradation. Consequently, the inability of farm households to access credit hinders their capacity to adopt land degradation control measures. The finding again agrees with that of Nwosu and Nweke (2024), who reported that a lack of money hinders farmers' adaptation to climate change in the Nile basin region of Ethiopia. Furthermore, Verere and Onokerhoraye (2022) in a study of adaptation measures to climate change by crop farmers in the southeast rainforest zone of Nigeria also observed lack of credit as the reason for their inability to purchase and adopt improved innovations for cushioning the negative impacts of climate change.

Therefore, Institutional, information/knowledge, and economic factors constrained the use of agricultural land degradation control measures in southeast Nigeria. Hence, the persistence of these factors will continue to increase constraints on the use of agricultural land degradation control measures.

Discussion

This study investigated the state of farmers' awareness of agricultural land degradation in Southeast Nigeria. From the findings of the study, it was observed that all the farmers are aware of one form of land degradation or the other. This is evident in the reduced productivity of the land and increased input requirements in the farm as farmers now use more fertilizers and compost manure, keep spare grains for replacement in eroded areas, thereby increasing production cost. This finding is in line with that of Nwosu and Nweke (2024), which revealed a high level of awareness of the threat of soil erosion and other forms of agricultural land degradation in southeast Nigeria.

This implies that the farmers will be willing to know the actual cost of agricultural land degradation and ways to avert it. It is important to note that knowing the actual financial value of agricultural land degradation will assist in decision-making about control measures. Also, more research is needed on the adoption of control measures.

The study again analyzed the extent the which farmers were able to observe agricultural land degradation in Southeast Nigeria, and the findings showed a grand mean of (X = 2.6), which implies that the farmers in the study area observed to a great extent the features presented as indicators of agricultural land degradation. Practically, the farmers observed these signs at an early stage of their appearance and could not apply control measures since they were not so sure it was an indicator of land degradation, and continued to apply those human factors that increase land degradation until the effects were felt in their production. This finding provided a valuable insight to farmers and the general public on the signs of agricultural land degradation. This finding is in line with those of Amangabara, Njoku, and Iwuji (2017) and Nwaiwu (2016), who reported total removal of the soil with stone appearance, tree reduction, scarcity of water on the farmland, among others, as indicators of agricultural land degradation.

The findings of the study on the duration of awareness of agricultural land degradation in Southeast Nigeria also showed that the majority of the respondents observe these features of agricultural land degradation long enough over 11 to 20 years. This implies that agricultural land degradation is not new in the study area and needs research on the cost of land degradation to guide the farmers on the best control measures to adopt. These findings are consistent with those of Amangabara, Njoku, and Iwuji (2017), who opined that soil erosion has been a problem in most agricultural land for a long period of time.

The findings on the extent of agricultural land degradation in the study area showed that the majority of the land in southeast Nigeria is highly degraded, with a grand mean of (X = 2.4). This is evident in the increased farm input and reduced output. This implies that a study on the economic cost of agricultural land degradation in the area is highly necessary. Also, it means that the rate at which the soil in the study area renews its nutrients after it has been used up has decreased and should be controlled before it worsens. Also, agricultural productivity, sustainability, and management for food security/sustenance have been highly reduced by agricultural land degradation indicators in the study area. This corroborates the study of Chude, Ezendu, Ugadu, and Adiaha (2020), who reported that the productivity of farmlands in southeast Nigeria has been greatly reduced by agents of agricultural land degradation.

The study also estimated the economic cost of agricultural land degradation in the study area using the on-site method and found that a farmer loses an average of N11,973.04/ha, which is approximately (16.179/ha), to agricultural land degradation as of the time of this study. This figure gave an insight into the financial value of what a farmer stands to lose due to land degradation. With this knowledge, farmers will make good decisions in land conservation, and to the general public, who cannot easily value land degradation, it will help them determine the best use of the land to avoid degradation and the alternative cost of land degradation. These findings corroborate with that of Cruz, Francisco, and Conway (1988) who reported about (US$19.39/ha), which is approximately (N8051.43) as nutrient replacement cost due to agricultural land degradation.

Analysis on constraints to the use of agricultural land degradation control measures in southeast Nigeria also showed that most of the constraints are institutional, information, and economic, with factors like lack of awareness of available conservation strategies, insufficient information about proper use, and lack of access to credit loading high. This implies that responsible institutions still have a lot to do to ensure land conservation, more information is still needed by farmers on land conservation, and credit should also be made available to farmers, especially for land conservation.

Conclusion

Due to inherent characteristics and the prevailing environmental conditions, agricultural land degradation is far more severe in the southeast region of Nigeria than in other regions. To calculate the cost of agricultural land degradation, the study used a replacement cost technique. The price of soil degradation affects net farmer income levels as well, and it has a significant negative effect on poverty reduction in the economy, particularly for rural poor people in southeast Nigeria, where agricultural soil degradation is most severe. Though there were constraints (institutional, information/knowledge, and economic constraints) to the practice of agricultural land degradation control measures in southeast Nigeria, it is evident that the benefits outweigh the problems; hence the need to encourage the use of agricultural land degradation control measures by farmers to achieve the twin goal of food security and environmental sustainability. The study therefore, recommends Establishment of effective monitoring and evaluating systems that assesses and enforces regulations on activities that result in negative environmental externalities at the expense of the welfare of society; Since most of the farmers use nutrient replacement as agricultural land degradation control measures, government should subsidize the cost of fertilizer to increase usage by farmers; Extension agents should encourage farmers to always include land degradation control measures in their farm budget to control loss due to land degradation and ensure sustainable environmental practices.

References

Abdulle, Y. A., Hussein, M. F., Mohamed, A. M., Mohamud, A. H., Osman, A. F. I., Mohamuud, B. A., & Idiris, F. H. (2022). Effects of soil erosion on crop productivity in Afgoye, Lower Shabelle-Somalia. *International Journal of Plant, Animal and Environmental Sciences*, 12(1), 115–122.

Abisoye, O. O., Ojo, Nwosu, N. J., Oshunsanya, S. O., Ayantayo-Ojo, V. I., & Aladele, S. E. (2023). Impacts of soil conservation techniques on soil erodibility on an Alfisol. *Heliyon*, 9(3), e14574. https://doi.org/10.1016/j.heliyon.2023.e14574

Adekalu, K. O., Olorunfemi, I. A., & Osunbitan, J. A. (2007). Grass mulching effect on infiltration, surface runoff, and soil loss of three agricultural soils in Nigeria. *Bioresource Technology*, 98(4), 912–917. https://doi.org/10.1016/j.biortech.2006.02.044

Aja, O. O., Ugwoke, F. O., Anyoha, N. O., Okereke-Ejiogu, E. N., & Onyezi, S. A. (2023). Adoption of sustainable land management practices among farmers under the Third National Fadama Development Project in Imo State, Nigeria. *African Journal of Agricultural Research*, 20(1), 52–58. https://doi.org/10.5897/AJAR2023.16544

Akinnagbe, O. M., & Umukoro, E. (2011). Farmers' perception of the effects of land degradation on agricultural activities in Ethiope East Local Government Area of Delta State, Nigeria. *Agriculturae Conspectus Scientificus*, 76(2), 135–141.

Amangabara, G. T., Njoku, J. D., & Iwuji, M. C. (2017). People's perception of soil erosion and its impact in Imo State, Nigeria. *International Journal of Research in Applied, Natural and Social Sciences*, 5(12), 77–88.

Andebutop, S., Ebong, D. E., & Danbaba, K. L. (2023). Impacts and mitigation strategies for gully erosion: The Nigerian perspective. *World News of Natural Sciences*, 51(2), 112–132.

Asaju, K., & Arome, S. (2015). Environmental degradation and sustainability in Nigeria: The need for environmental education. *American Journal of Social Sciences*, 3(3), 56–61.

Assen, Y. A., & Ashebir, M. (2023). Factors affecting the adoption of sustainable land management practices in Semen Bench District, Southwest Ethiopia. *International Journal of Sustainable Development Research*, 9(3), 43–50. https://doi.org/10.11648/j.ijsdr.20230903.11

Aweda, E. D., Okhimamhe, A. A., Obateru, R. O., Schürmann, A., Teucher, M., & Conrad, C. (2024). Assessing the impacts of migration on land degradation in the Savannah region of Nigeria. *Sustainability*, 16(18), 8157. https://doi.org/10.3390/su16188157

Barbier, E. B. (1996). The economics of soil erosion: Theory, methodology and examples. Paper presented at the *Fifth Biannual Workshop on Economy and Environment in Southeast Asia*, Singapore.

Bolarinwa, O. K., Aiyedun, J. O., Odulate, L. O., & Odugbemi, J. A. (2021). Effects of environmental degradation on the profitability of cassava production in Southeast, Nigeria. *Research Journal of Agricultural Economics and Development*, 1(1), 1–10.

Chibuzor, S. I., Okoyeh, E. I., & Egboka, B. C. (2017). Evaluation of the causes of environmental degradation in parts of Southeast Nigeria. *International Journal of Innovative Research and Advanced Studies (IJIRAS)*, 4(11), 407–411.

Chude, V. O., Ezendu, C. O., Ugadu, M. E., & Adiaha, M. S. (2020). A review of the menace of soil erosion in Nigeria with specific reference to the Southeastern States. In *Proceedings of the 44th Conference of the Soil Science Society of Nigeria* (pp. 405–414). DOI: 10.36265/colsssn.2020.4455

Cochran, W. G. (1963). *Sampling techniques*. Wiley.

Cruz, W., Francisco, H. A., & Conway, Z. T. (1988). The on-site and downstream costs of soil erosion in the Magat and Pantabangan watersheds. *Journal of Philippine Development*, 15(1), 85–111.

Deressa, T. T., Hassan, R. M., & Ringler, C. (2010). Perception of and adaptation to climate change by farmers in the Nile Basin of Ethiopia. *The Journal of Agricultural Science*, 149(1), 23–31. https://doi.org/10.1017/S0021859610000687

Diao, X., & Sarpong, D. B. (2011). Assessing the effects of agricultural land degradation on poverty in Ghana using a multi-market model at the national level. *IFPRI Discussion Paper 01086*.

Dimo, J. C., Maina, S. W., & Ndiema, A. C. (2022). Access to credit and its relationship with information and communication technology adoption in agricultural extension among peasants in Rangwe Sub-County, Kenya. *Asian Journal of Agricultural Extension, Economics & Sociology*, 40(10), 97–105.

ELD Initiative & UNEP. (2015). *The value of land: Prosperous lands and positive rewards through sustainable land management*. The Economics of Land Degradation. Available at: www.eld-initiative.org

Erenstein, O. C. A. (1999). *The economics of soil conservation in developing countries: The case of crop residue mulching* [Doctoral dissertation, Wageningen University].

Ezeh, A. N., & Okorie, A. (2013). Determinants of cooperative societies as sources of agricultural credit among farmers in Enugu State, Nigeria. *International Journal of Food and Agricultural Economics*, 1(2), 43-54.

Igwe, P. U., Ajadike, J. C., & Ogbu, S. O. (2023). Assessment of factors influencing gully erosion for its remediation in Eastern Nigeria. *African Regional Journal of Environment*, 6(1), 8–16.

Isife, B. I. (2012). Review of Nigeria's environmental issues. *Journal of Environmental Science and Technology*, 5(6),

453-462.
Janatu, V. S., Aiah, L., & Wadsworth, R. A. (2021). Predicting the adoption of improved cassava varieties in Sierra Leone. *Journal of Agricultural Extension and Rural Development*, 13(1), 60–68. https://doi.org/10.5897/JAERD2020.1214
Johnbosco, C. U., Egbueri, J. C., & Igwe, O. (2021). The impact of hydrogeomorphological characteristics on gullying processes in erosion-prone geological units in parts of southeast Nigeria. *Geology, Ecology, and Landscapes*, 5(3), 227–240. https://doi.org/10.1080/24749508.2020.1711637
Kaiser, H. F. (1958). The varimax criterion for analytic rotation in factor analysis. *Psychometrika*, 23(3), 187–200. https://doi.org/10.1007/BF02289233
Kayode, O. T., Aizebeokhai, A. P., & Odukoya, A. M. (2019). Soil characterisation for precision agriculture using remotely sensed imagery in southeastern Nigeria. *Journal of Physics: Conference Series*, 1299, Article 012070. https://doi.org/10.1088/1742-6596/1299/1/012070
Kirui, O. K., & Mirzabaev, A. (2016). Cost of land degradation and improvement in Eastern Africa. In *Economics of Land Degradation and Improvement – A Global Assessment for Sustainable Development* (pp. 327-350). Springer.
Kwame, A. (2014). *The Economic Cost of Environmental Degradation: A Case Study of Degradation of Agricultural Land in Ghana* [Doctoral dissertation, Kwame Nkrumah University of Science and Technology].
Land Degradation Neutrality (LDN) from Nigeria and the UNCCD Global Mechanism. (2018). *National Report on Land Degradation Neutrality Target Setting Programme*. Federal Ministry of Environment, Nigeria.
Merem, E. C., Twumasi, Y., Wesley, J., Alsarari, M., Fageir, S., Crisler, M., ... & Romorno, C. (2019). Regional assessment of climate change hazards in Southern Nigeria with GIS. *Journal of Safety Engineering*, 8(1), 9-27. https://doi.org/10.5923/j.safety.20190801.02
Mirzabaev, A., Strokov, A., & Krasilnikov, P. (2023). The impact of land degradation on agricultural profits and implications for poverty reduction in Central Asia. *Land Use Policy*, 126, Article 106530. https://doi.org/10.1016/j.landusepol.2023.106530
Mousaei, M. (2021). The effect of farm counseling on farmers' beliefs and motivation in sustainable environmental protection (Case study: Wheat farmers in Behbahan city, Iran). *Journal of Research in Agriculture and Animal Science*, 8(6), 40–49.
National Population Census (NPC). (2006). *National Population Commission, Federal Republic of Nigeria Official Gazette*. Abuja, Nigeria.
Nigeria Bureau of Statistics. (2020). *Annual Abstract of Statistics*. Abuja, Nigeria.
Nwaiwu, J. C. (2016). Investigation of the level of arable crop farmers' awareness of soil degradation in Imo State. *Global Journal of Agricultural Research*, 4(1), 18–25.
Nwibo, S. U., Eze, A. V., Nwofoke, C., Mbam, B. N., & Umeh, G. N. (2019). Economic analysis and constraints of irrigation by dry season rice farmers in Ikwo Local Government Area of Ebonyi State, Nigeria. *Indian Journal of Ecology*, 46(1), 18–22.
Nwofoke, C., & Azizi, J. (2024). Using a structural equation modelling approach to investigate factors influencing farmers' choice of agricultural land degradation

control measures in the Southeast Region, Nigeria. SSRN. https://ssrn.com/abstract=4859794 or http://dx.doi.org/10.2139/ssrn.4859794

Nwosu, T. V., & Nweke, I. A. (2024). Erosion potentials of soils under different land utilization types in Anambra State, Nigeria. *Agriculture, Food, and Natural Resources Journal*, 3(1), 101–106. https://doi.org/10.5281/zenodo.13932023

Nzeadibe, T. C., Egbule, C. L., Chukwuone, N. A., & Agu, V. C. (2011). Climate change awareness and adaptation in the Niger Delta Region of Nigeria. *African Technology Policy Studies Network*, Working Paper No. 57.

Obisesan, A. A., Amos, T. T., & Akinlade, R. J. (2016). Factors influencing adoption of improved cassava varieties among smallholder farmers in Southwest Nigeria. *Journal of Agricultural Extension*, 20(2), 68-82.

Ogboru, I., & Anga, R. A. (2015). Environmental degradation and sustainable economic development in Nigeria: A theoretical approach. *Research Journal of Economics*, 3(6), 1–13.

Okenmuo, F. C., Ibeh, K. G., & Obalum, S. E. (2023). The menace of widespread gully erosion in southeastern Nigeria: Litho-anthropogenic history and management and policy issues. In E. C. Igwe, I. Uko, & A. O. Onunwa (Eds.), *Valedictorian Festschrift in Honour of Professor Peter Chinedum Nnabude* (pp. 61–79). Cadventures Press.

Okorafor, O. O., Akinbile, C. O., & Adeyemo, A. J. (2017). Soil erosion in South-Eastern Nigeria: A review. *Scientific Research Journal (SCIRJ)*, 5(9), 30–37.

Okoye, C. U. (2009). Soil erosion control and damage costs in Nigerian small farms: Implications for farm growth and sustainability. *111th EAAE-IAAE Seminar: Small Farms – Decline or Persistence*, University of Kent, Canterbury, UK, 26–27 January.

Okpalla, W. A., & Nwofoke, C. (2018). Exploratory analysis of the economics of soil erosion management practices by crop farmers in Anambra State, Nigeria. *Advances in Bioresearch*, 10(3), 46–58.

Osabuomen, C. M., & Okoedo-Okojie, D. U. (2011). Determinants of farmers' perception of soil degradation in Edo State, Nigeria. *Journal of Sustainable Development in Africa*, 13(6), 1-13.

Ota, H. O., Mohan, K. C., Udume, B. U., Olim, D. M., & Okolo, C. C. (2024). Assessment of land use management and its effect on soil quality and carbon stock in Ebonyi State, Southeast Nigeria. *Journal of Environmental Management*, 358, Article 120833.

Owan, J. O., Ebehung, N., Owan-Enoh, B. E., Agbor, R. I., & Egere, A. I. (2024). The impact of agricultural sector development on employment in Nigeria. *Global Journal of Arts, Humanities and Social Sciences*, 12(7), 51–73.

Oyim, A., Osayi, K. K., Okaforocha, C. M., & Nwokoye, E. S. (2023). Constraints to agricultural productivity in South East Nigeria: Evidence from small-scale farmers in Abakaliki Metropolis. *The International Journal of Research and Innovation in Social Science (IJRISS)*, 7(10), 1–15.

Perrens, S. J., & Trustum, N. A. (1984). Assessment and evaluation of soil conservation policy. *Report, Workshop on Policies for Soil and Water Conservation*, 25–27 January 1983, East-West Center, Honolulu, Hawaii.

Pigou, A. C. (1920). The report of the Royal Commission on the British Income Tax. *Quarterly Journal of Economics*, 34(4), 607–625. https://doi.org/10.2307/1885159

Sobere, N. U. (2024). Impact of deforestation on biodiversity conservation in Nigeria and the legal response. *East African Journal of Law, Policy and Globalization*, 2(1), 27–53.

Telle, T. S., Melo, T. R., Righetto, A. J., Didoné, E. J., & Barbosa, G. M. C. (2022). Soil management practices adopted by farmers and how they perceived conservation agriculture. *Revista Brasileira de Ciência do Solo*, 46(2), 1–13. https://doi.org/10.36783/18069657rbcs20210151

Thanh, N. V., Hung, H. G., Nam, L. V., Phuoc, D. N., Phuong, L. T. H., Khanh, H. L. P., & Giang, M. T. (2024). Determinants of adoption of sustainable land management practices among smallholder farmers in the uplands of Vietnam: An empirical study in Central Vietnam. *International Journal of Sustainable Society*, 16(2), 107–124.

Turyasingura, B., Ayiga, N., & Benzougagh, B. (2022). Re-thinking land degradation and its impacts on the livelihoods of farmers in Kanungu District, Uganda. *Research Square*, 1–23. https://doi.org/10.21203/rs.3.rs-1966742/v1

Tyagi, N. K., Garg, N. K., & Paudel, M. N. (2014). Environmental degradation: Reasons for it and its effects. *Journal of Environmental Science, Toxicology and Food Technology*, 8(1), 01-05.

Ubuoh, E. A., Onwughara, I. J., & Odey, E. (2020). Susceptibility of agricultural land to soil degradation by rainfall using aggregates' stability indices in parts of Abia State, South Eastern Nigeria. *Jordan Journal of Earth and Environmental Sciences (JJEES)*, 11(3), 7.

Van Baren, J. H. V., & Oldeman, L. R. (1998). Human-induced soil degradation activities. *International Agrophysics*, 12(1), 37–42.

Verere, S. B., & Onokerhoraye, A. G. (2022). Climate change vulnerability mapping across ecological zones in Delta State, Niger Delta Region of Nigeria. *Climate Services*, 27, Article 100313.

Wachter, D. (1992). Land titling for land conservation in developing countries? *The World Bank Research Observer*, 7(1), 151-167.

World Bank. (2003). *Kingdom of Morocco: Cost assessment of environmental degradation* (Report No. 25992-MOR). Middle East and North Africa Region Water, Environment, Social and Rural Development Department, The World Bank.

Table 1: Details of Sample Selection (N=300)

States	Agricultural zones	LGAs (One from each AZ)	Communities (1 from each LGA)	No. of respondents (50 from each community)
1. Anambra	Aguata	Aguata	Mkpologwu	50
	Awka	Anaocha	Obeledu	50
2. Ebonyi	North	Abakaliki	Amagu	50
	South	Afikpo North	Amasiri	50
3. Enugu	Enugu-north	Udenu	Igboeneme	50
	Enugu west	Udi	Eke	50

Table 2: State of Farmers' Awareness of Agricultural Land Degradation in Southeast Nigeria (N=300)

Awareness	Frequency	Percentage
Aware	300	100
Not aware	0.0	0.0
Total	300	100

Source: Authors' calculation from the survey result of 2024

Table 3: Distribution of the Farmers by Extent of Observation of Agricultural Land Degradation in Southeast Nigeria (N=300)

Observed soil degradation	VGE	GE	LE	VLE	Total	Mean	Std. dev.	Remarks
Field erosion	98(32.7)	115(38.3)	72(24.0)	15(5.0)	300	2.9	0.8	Accepted
Total removal of the soil with a stone appearance	57(19.0)	138(46.0)	105(35.0)	0(0.0)	300	2.8	0.7	Accepted
Tree reduction	87(29.0)	114(38.0)	55(18.3)	44(14.7)	300	2.8	1.0	Accepted
Appearance of tree roots	16(5.3)	75(25.0)	124(41.3)	85(28.3)	300	2.0	0.8	Accepted
Water scarcity	77(25.7)	152(50.7)	56(18.7)	15(5.0)	300	2.9	0,8	Accepted
Terrace slide	54(18.0)	137(45.7)	42(14.0)	67(22.3)	300	2.5	1.0	Accepted
Increased ant-hill	94(31.3)	56(18.7)	48(16.0)	102(34.0)	300	2.4	1.2	Accepted
Total	483	787	502	328	2100	2.6		Accepted

Source: authors' calculation from the survey result of 2024
VGE = very great extent; GE = great extent; LE = low extent; VLE= very low extent
Numbers in parenthesis are the percentages; Maximum scorer = 4; Minimum score = 1; Accept = ≥2.0, Reject <2.0

Table 4: Distribution of the Farmers by Duration of Awareness of Agricultural Land Degradation in Southeast Nigeria (N=300)

Awareness	Frequency	Percentage
Recently (10years and below)	88	29.3
Long time (11-20)	156	52.0
Very long time (20 years and above)	56	18.7
Total	300	100

Source: Authors' calculation from the survey result of 2024

Table 5: Distribution of the Farmers by Extent of degradation of farmland in Southeast Nigeria (N=300)

Extent of agricultural land degradation	Slight	Moderate	High	Very high	Total	Mean	Std. Dev.	Remarks
Continuous decrease in the productive capacity of the land	0(0.0)	56(18.7)	124(41.3)	120(40.0)	300	3.2	0.7	accepted
Loss or change in vegetative cover	60(20.0)	115(38.3)	94(31.3)	31(10.3)	300	2.3	0.9	Accepted
Loss or decrease in soil fertility	21(7.0)	26(8.7)	54(18.0)	199(66.3)	300	3.4	0.9	Accepted
Decreased soil regenerative ability	31(10.3)	5(1.7)	154(51.3)	110(36.7)	300	3.1	0.9	Accepted
Poor drainage	49(16.3)	104(34.7)	109(36.3)	38(12.7)	300	2.5	0.9	Accepted
Desertification	170(56.7)	81(27.0)	42(14.0)	7(2.3)	300	1.6	0.8	Rejected
Deforestation	59(19.7)	85(28.3)	93(31.0)	63(21.0)	300	2.5	1.0	Accepted
Flooding	83(27.7)	41(13.7)	46(15.3)	130(43.3)	300	2.7	1.3	Accepted
Loss of the range of species or ecosystem	57(19.0)	142(47.3)	82(27.3)	19(6.3)	300	2.2	0.8	Accepted
Change in soil texture	92(30.7)	187(62.3)	21(7.0)	0(0.0)	300	1.8	0.6	Rejected
Change in soil type	153(51.0)	97(32.3)	46(15.3)	4(1.3)	300	1.7	0.8	Rejected
Breakdown of soil structure	50(16.7)	199(66.3)	44(14.7)	7(2.3)	300	2.0	0.6	Accepted
Reduction in soil water	75(25.0)	200(66.7)	24(8.0)	1(0.3)	300	1.8	0.6	Rejected
Total	900	1338	933	729	3900	2.4		Accepted

Source: Authors' calculation from the survey Result of 2024, Numbers in parentheses are the percentages
Maximum scorer = 4, Minimum score = 1, Accept = ≥2.0, Reject <2.0

Table 6: Estimating the economic cost of agricultural land degradation in Southeast Nigeria (N=300)

Items	Procedure	Value
A. Sample size		300
B. Total annual revenue		₦74166000
C. Total hectares		537
D. Average hectare = $\frac{C}{A}$	$= \frac{537}{300}$	1.79
E. Average annual revenue (per farmer) $= \frac{B}{A}$	$= \frac{74166000}{300}$	₦247220.00
F. Initial expenses (initial cost of setting up a farm)		₦31511000
G. Average Initial expenses (initial cost of setting up a farm per farmer) $\frac{F}{A}$	$= \frac{31511000}{300}$	₦105036.67
H. $average\ initial\ expenses\ per\ farmer(ha) = \frac{G}{D}$	$= \frac{105036.67}{1.79}$	₦58,679.70
I. Economic cost (replacement cost)		₦6106250
J. Economic cost per farmer = $\frac{I}{A}$	$= \frac{6106250}{300}$	₦20354.17
K. Average economic cost per farmer (ha) = $\frac{J}{D}$	$= \frac{20354.17}{1.79}$	₦11371.04
L. Average total expenses (per farmer (ha)) = (H+K)	58679.70+11371.04	₦70050.74
M. Average Net income (per farmer(ha)) = (E-L)	247220−70050.74	₦177169.26
N. Average expected net income = (M+K)	177169.26+11371.04	₦188540.3
O. Average Loss per farmer (ha)		₦11371.04

Source: Authors' calculation from the survey results of 2024

Table 7: Duncan's Multiple Range Test of Hypothesis II (H0$_2$: Economic Cost of Agricultural Land Degradation does not significantly differ across different Locations in the Study Area)

Location	N(sample size)	Annual farm income (₦)	The initial cost of setting up farm (₦)	Cost of establishing conservation measures (₦)
Anambra	100	100274,560.00±162013.67[a]	77480.00±27606.35a	24289.00±14965.77b
Ebonyi	100	309,390.00±192792.23[a]	158280.00±102223.17b	18246.40±13692.81[a]
Enugu	100	157,710.00±75771.23[b]	79350±43079.06a	18527.10±14365.57[a]

Source: Authors' calculation from the survey result of 2024

Table 8: Distribution of the Farmers by Constraints to the use of agricultural land degradation control measures in southeast Nigeria (N=300)

Constraints	Factor I Institutional	Factor II Information/knowledge	Factor III Economic
Lack of awareness of available conservation strategies	**0.580**	0.098	0.047
Insufficient information about proper use	0.008	**0.592**	0.005
High cost of adoption	-0.215	-0.033	**0.728**
Lack of access to credit	-0.030	0.225	**0.490**
Lack of interest	0.023	-0.432	-0.158
Lack of environmental concern	-0.004	0.252	-0.353
Inefficient technical information	0.035	**0.580**	0.183
Lack of manpower	0.298	-0.434	0.098
Lack of investments	0.229	-0.070	**0.600**
Not enough soil conservation training is offered	**0.494**	0.115	0.024
Lack of effective exposure to extension services	**0.594**	0.154	-0.027
Not aware of the soil problem	-0.449	-0.509	-0.285
Not aware of the total cost of soil conservation	0.250	0.167	**0.897**
Requires a huge amount of labour	-0.200	**0.454**	-0.187
Not patient for the long-term benefit	-0.470	-0.062	**0.588**
Poor health	**0.751**	-0.081	0.080
No access to land	**0.678**	-0.226	-0.112
Rise in population	**0.637**	0.154	-0.083

Source: Authors' calculation from the survey result of 2024