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COMPARATIVE ANALYSIS OF LAND DEGRADATION AND ITS EFFECT ON RICE PRODUCTION: A CASE STUDY OF AYAMELUM LOCAL GOVERNMENT AREA OF ANAMBRA STATE, NIGERIA

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AUTHORS' CONTRIBUTIONS

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ABSTRACT

This study examined land degradation and its effect on rice production. This was achieved by investigating the effect of land degradation on the total factor productivity of rice farmers in Omor, Ayamelum Local Government Area (LGA), Anambra State, Nigeria. Three research questions and three hypotheses were formulated for the study. A descriptive survey research design was employed in the study. The population for the study was delimited to all rice farmers who are members of the rice producers' cooperative society in the Omor community in Ayamelum LGA, Anambra state with a sample size of hundred (100) rice farmers selected from the population using a multistage sampling technique after grouping the farmers in clusters in cooperatives and those attached to the government's Agricultural programs with regards to their villages. The study relied on primary sources of data which were obtained through surveys from first-hand interactions and the application of questionnaires to rice farmers in the Omor community. The Ordinary Least Square (OLS) regression analysis was employed to test the hypotheses. The study revealed a significant effect of Tillage degradation and Bush burning degradation. Water degradation was not significant. Consequent to the findings, the study, therefore, recommends amongst others that Bush burning is a major factor that reduces the quality of the soil. Hence, bush burning on the farmland should be restricted by state and federal law and properly monitored to ensure compliance in the area.

Keywords: Land degradation; soil; fertility; factor productivity.

1. BACKGROUND

1.1 Introduction

Food is a basic necessity for life and economic development. However, the rising cost of food and agricultural produce over the last decade has raised concerns regarding the root cause of food scarcity. The major finger pointing to the impairment of soil quality resulting in poor yield [1]. This consistent process whereby the state of the biophysical environment is affected by a union of natural and human-induced processes acting upon the soil is known as Land degradation [1]. It is also the washing away of the natural quality of soil components of any ecosystem [2]. This had been a major global issue

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since the 20th century and it has remained high on the international agenda in the 21st century. Land degradation can also be viewed as any change or disturbance to the land perceived to be deleterious or undesirable [3].

Historically, land degradation has been a contentious issue [4,5]. "The causes and effects differ based on location, mainly in terms of localized intensity, as well as programs to solve problems of land degradation, which also vary regionally as a function of ecosystem characteristics, culture, economics, and political will. However, some cases of similarities in causes and consequences have been reported to exist" [6].

The major causes of land degradation include land clearance through poor farming practices, overgrazing, inappropriate irrigation, urban sprawl, commercial development, land pollution including industrial waste, oil spillage, quarrying of stone, sand, and minerals. Land degradation is thus along-recognized environmental issue, which straddles both physical and social sciences. Land degradation has been acknowledged in the policy cycle through Agenda 21 and the signing of the United Nations Convention to Combat Desertification (UNCCD) in 1994.

Land degradation is a serious environmental threat in Nigeria with its associated problems. The country has made several efforts to address this problem but the result is insignificant [7]. Although, several studies on land degradation and farm productivity have been carried out globally and locally such as Graves et al, [8] in the UK; Egbetokun, Omonona, & Adedeji, [9] in Nigeria; and Costantini & Lorenzetti, [10] in Italy. Most studies in Nigeria that considered other degradation indices such as water and tillage degradation was carried out in Western and Northern Nigeria. As in Ojo, Ojo, Ajani, Oseghale, & Busari, [11] carried out in Ogun state, Nigeria and [12] carried out in Kaduna. There is, therefore, a need to carry out a similar study in Eastern Nigeria with consideration to Omor, Ayamelum LGA, Anambra state which is a community of rice farmers well-known in Anambra state, Nigeria.

Also, most of the prior studies in Nigeria focused only on Autoregressive techniques [13]; Tobit regression [11], and descriptive statistics [9,12]. However, there is a need to explore other techniques for data analysis such as ordinary least square (OLS) regression, Generalized Method of Moments (GMM), etc. Hence, the current study is carried out to advance the body of knowledge to cover land degradation and farm productivity in Anambra state, Nigeria while considering the OLS regression technique.

The main thrust of the study is therefore to investigate the effect of land degradation on farm productivity in Omor, Ayamelum LGA, and Anambra states. Specifically, the study examines the following:

i. The effect of water degradation on total factor productivity in Omor, Ayamelum LGA, Anambra state.
ii. The effect of tillage degradation on total factor productivity in Omor, Ayamelum LGA, Anambra state.
iii. The effect of bush burning degradation on total factor productivity in Omor, Ayamelum LGA, Anambra state.

1.2 Land Degradation

Land degradation is without a doubt one of the most complex environmental issues facing the Nigerian Agricultural sector and communities worldwide [1]. It is also one of the least understood. According to Boer and Hannam [1], land and its primary constituent element, the soil, form the basic terrestrial foundation of human development and survival, physically sustaining societies around the world through agriculture, grazing, forestry, and the maintenance of water sources. The human link to the Obasohan and its soils is an inherent part of global and national culture and heritage. Soil bodies are large and readily identifiable ecosystems and are the fundamental components of terrestrial biodiversity.

It can be viewed as any act on land that changes it from its natural ecological state and makes it unfit for effective use. Furthermore, land degradation is the deterioration of soil, vegetation, and water resources both in quantity and quality.

The cause of land degradation is largely human and it is affected by economic, socio-cultural, policy, and institutional circumstances of the people [14]. Other causes of land degradation include production on the steep slope and fragile soils with inadequate investment in soil conservation and vegetative cover, erratic and erosive rainfall patterns, declining use of fallow, intensive tillage, intensive farming, limited recycling of dung and crop residues to the soil, limited application of external sources of plant nutrients, bush burning, deforestation/logging, and overgrazing. Underlying these proximate causes include many factors like population pressure, poverty, high cost and limited access to agricultural inputs and credit, low profitability of agricultural production low conservation practices, high risks [of crop failure] facing farmers, fragmented land holdings, and insecure land tenure, dearth of information about appropriate alternative farming technologies.

Affecting many of these factors are government policies relating to infrastructure development, market development, input and credit supplies, land tenure, agricultural research and extension, conservation programs, and land use regulation [15].

1.2.1 Water degradation

Inappropriate irrigation and wrong usage of water practically bring about a fall in the economic value of soil. According to Ojo et al., [11], this leads to loss of vegetation, reduced drainage density of water runoff, reduced slope gradient, reduced runoff water storage, increased climate change, and increased land fragmentation. This negative impact of water loss had in most cases accounted for the problem of poor factor productivity for the farming period [16].

1.2.2 Tillage degradation

Tillage degradation as considered by Ojo et al., [11] refers to the loss of soil value that arises from tillage activities. The activities had been observed to reduce organic matter content of the soil, slope gradient of soil, terracing for land management practice, and ultimately destroy soil structure. These activities by farmers over time reduce land quality thereby reducing the land output quality [16].

1.2.3 Bush burning degradation

Bush burning degradation refers to the loss of quality of soil arising from the activity of bush burning [11]. To measure the effect of bush burning on land degradation, four indicators as used by different researchers [16,17] were used by constructing the following formula $vi \sum_{i=1}^{4} Xi \frac{X_{LM}+X_{LV}+X_{LM}+X_{CC}}{4}$.

From the formula, there is an indication that the mean indicator represented the bush burning degradation index as in Ojo et al., [11] with due consideration to "loss of moisture-retaining capacity"; "loss of vegetation"; "loss of microbes embedded in the soil" "colour change".

Fig. 1. Land degradation in Eastern Nigeria
Source: Premium Times Nigeria, 2021

Fig. 2. Bush burning in Delta State, Nigeria
Source: yourcommonwealth.org (2014)

1.2.4 Total factor productivity

Total Factor Productivity (TFP) refers to the productivity of all inputs taken together which is to say that it is a measure of productive efficiency. TFP is a measure of the output of an industry or economy relative to the size of all of its primary factor inputs. When the growth of a nation's economic output over time is compared with the growth of its labour force and its capital stock (inputs) it is usually found that the former exceeds the latter. This is due to the growth of TFP, that is, the ability to combine the factors (labour and capital) more effectively over time. This can be due to changes in qualities (more appropriate skills or embedded technologies) or to better methods of organization. TFP represents any effect in total output not accounted for by inputs. It addresses the real driver of output growth, not contributed by growth in productivity or inputs such as capital stock and the labour force. TFP can be interpreted as growth through technological innovation and efficiency achieved by enhanced labour skills and capital management.

2. THEORETICAL REVIEW

2.1 Social Cost Theory

"The social cost school is originally credited to Pigou, [18] and his recognition of the relation between private and social cost" (Watcher, 1992). "The argument is that if economic agents do not bear the full (social) costs of their actions; if there are externalities, factors of production will not be optimally allocated and the assumption is that the market cannot cope with the externality problem by itself" (Wachter, 1992). "The theory of social cost explains land degradation as the result of farmers' use of practices for which they do not bear the full costs; for example, downstream costs of water pollution or erosion), or of positive externalities (related for instance to protective functions or biodiversity values) that cannot be transformed into income and so force-land users to adopt inappropriate production practices" (Wachter, 1992).

2.2 Review of Empirical Studies

Adeleye et al., [13] investigated "the impact of environmental degradation (proxied by carbon emissions) and non-renewable energy on Agro-productivity in Nigeria. They employed time-series data from 1980 to 2018, the study engaged the Johansen cointegration and Impulse Response Functions (IRFs) techniques within the Vector Autoregressive (VAR) framework. The study revealed that carbon emissions significantly reduce Agro-productivity by 0.23% while non-renewable energy boosts Agro-productivity by 5.38%, on average, *ceteris paribus*. Other results reveal that domestic credit, rural population, and arable land exert asymmetric effects. These outcomes are consistent and align with a priori expectations".

Adewuyi and Baduku [12] identified "the recent consequences of land degradation in the peri-urban area of Kaduna metropolis to improve the environment and the socio-economic status of the inhabitant. A random sampling method was employed to collect data from the field for observation and measurement while the snowball sampling technique was adopted for the selection of farmers through semi-structured interviews, which were analyzed using descriptive statistics". "The findings of the study revealed that there are three new recent consequences of land degradation in the area; namely, socio-economic constraints which include (continuous cropping or grazing) spending more time on the same parcel of land, energy, and an increase in the cost of farming; the second being poisonous chemicals found in waste buried in the soil which is non-biodegradable, while the third is the permanent presence of much non-degraded wastes in the soil" Adewuyi and Baduku [12].

2.3 Gaps in Knowledge

Most studies in Nigeria that considered other degradation indexes such as water and tillage degradation was carried out in Western and Northern Nigeria. As Ojo et al., [11] carried out in Ogun State, Nigeria while few studies were carried out in Kaduna [12].

The studies carried out in Nigeria mainly focused on Autoregressive techniques, [13]; Tobit regression [11] and descriptive statistics [9,12]. The current study is therefore carried out to advance the body of knowledge to cover land degradation and farm productivity in Anambra state, Nigeria while considering the OLS regression technique.

3. METHODOLOGY

3.1 Research Design

The study adopted the *Descriptive Survey* research design based on the fact that the study seeks to carry out a qualitative inquiry. A survey method is one in which a group of people or items is studied by collecting and analyzing data from only a few people or items considered to be representative of the entire group. It specifies how such data will be collected and analyzed. This method is chosen for data collection because it enables the researcher to solicit information that might not be available on the pages of the textbook.

3.2 Population of the Study

The entire population of the study include farmers from the four villages (quarters), Orenja, Akanator, Aturia, and Amike who were further divided into clusters according to their sub-villages and according to cooperatives of the Agricultural Development Programme (ADP) and River Basin and Rural Development Authorities (RBRDAs) programs which are government-sponsored aimed at supporting farmers.

3.3 Sampling Techniques

The study employed multistage, purposive, and random sampling techniques to choose 100 farmers from Omor Community in Ayamelum Local government area of Anambra state. Stage I involved a purposive selection of the four villages/quarters (Onenja, Akanator, Arturia, and Amikwe). Stage II involved a random selection of twenty-five farmers belonging to rice producer's cooperative societies either in their sub-village, village, or government-owned programs from each of the four selected communities to arrive at 100 respondents that were used for the study.

3.4 Sources of Data

Data used in this study were obtained from Primary sources. The primary data was collected through structured surveys directly administered to the respondents as questionnaires and an index was built based on the responses of farmers. Primary data refers to statistical material, which originates from first-hand inquiries, experiments, and observations (Akindele, Nassar, & Owolabi, 2008).

3.5 Method of Data Analysis

The research paper made use of *descriptive* and *inferential* statistics in analyzing the data. The multiple regression method was adopted in validating the hypotheses. The ordinary least square analysis was specifically used to determine the independent variables' ability to explain the dependent variables' variance [19]. The multiple regression model employed in the study is therefore given thus:

$$TFP = \eta_0 + \eta_1 WDI + \eta_2 TDI + \eta_3 BBDI + + \mu \quad (1)$$

Where:
η_0 = Constant
$\eta_{1\text{-}3}$ = Coefficients of slope parameters.

The anticipated signs of the coefficients are such that $\eta 1$ is greater than 0; while, η_2, and η_3 are less than 0.

Table 1. Description of variables

Label	Description	Measurement	Source
WDI	Water Degradation Index	Water degradation is an index measured from a structured index where it is 1 if true and 0 if otherwise. $\sum_{i=1}^{5} Xi/5$	[11]
TDI	Tillage Degradation Index	Tillage degradation index is measured from a structured index where it is 1 if true and 0 if otherwise. $\sum_{i=1}^{4} Xi/4$	[11]
BBDI	Bush Burning Degradation Index	Bush burning degradation index is measured from a structured index where it is 1 if true and 0 if otherwise. $\sum_{i=1}^{4} Xi/4$	[11]
TFP	Total Factor Productivity	Total factor productivity is measured from a structured index where it is 1 if true and 0 if otherwise. $\sum_{i=1}^{6} Xi/6$	[11]

Source: Researcher's compilation, (2022).

4. DECISION THRESHOLD

The decision threshold for accepting or rejecting our null hypotheses is relative to the sign and significance

level of the computed *t-statistic* from the least square regression output. The study has a significance threshold of 0.05. Hence, the null hypothesis is rejected if our probability value is less than 0.05 and accepted if otherwise.

4.1 Summary Statistics

The summary statistics show the measures of dispersion and central tendencies given the observations, min and max values of the selected variable [20-22].

From the Table 2, the average of each variable shows the measure of central tendency which represents the mean value of the variables; while, the standard deviation is the measure of the average distance between the values of the data in the set and the mean. A low standard deviation indicates that the data points tend to be very close to the mean; while a high standard indicates that the data points are spread out over a large range of values.

The summary statistics also depict the skewness and kurtosis which reports on the normality of the data. The normality test result revealed a negative skewness of -0.137006. The normality test also reveals a kurtosis of 2.870270. The skewness and kurtosis threshold upholds those values between -2 to +2 and -7 to +7 are reported as a normal distribution (George & Millery, 2010; Bryne, 2010) is therefore indicative that the data for the study is normal.

4.2 Test of Hypotheses

4.2.1 Hypothesis I

H_{01}: Water Degradation has no significant effect on Total Factor Productivity in Omor, Ayamelum LGA, Anambra state.

The ordinary least square regression output is shown above with three independent variables, as follows: Water Degradation Index (WDI), Tillage Degradation Index (TDI), and Bush Burning Degradation Index (BBDI). The overall R-squared is 0.965143. The probability value of the F-statistic is > .05. Which interprets that the model is significant. The variable of interest also revealed a significance and coefficient value of (0.2205) and the *t-statistic* (-1.233). Based on this negative insignificant result, the null hypothesis is thereby accepted. Therefore, we conclude that the water degradation index has a statistically significant effect on total factor productivity in Omor, Ayamelum LGA, Anambra state.

4.2.2 Hypothesis II

H_{01}: There is no significant effect of Tillage Degradation on Total Factor Productivity in Omor, Ayamelum LGA, Anambra state.

Table 3 reveals the ordinary least square regression output with three Independent Variables, as follows: Water Degradation Index (WDI), Tillage Degradation Index (TDI), and Bush Burning Degradation Index (BBDI). The overall R-squared is 0.965143. The probability value of the F-statistic is > .05. Which interprets that the model is significant. The variable of

Table 2. Summary statistics of dependent variables

WDI		BBDI		TDI		TFP	
Ave	0.495	Ave	0.415	Ave	0.6175	Ave	0.558333
Std Error	0.0158831	Std Error	0.018876	Std Error	0.017572	Std Error	0.016305
Median	0.5	Median	0.25	Median	0.75	Median	0.666667
Mode	0.5	Mode	0.25	Mode	0.75	Mode	0.666667
Std Dev	0.15883096	Std Dev	0.188763	Std Dev	0.17572	Std Dev	0.16305
Kurt	-0.46239597	Kurt	-0.94954	Kurt	-0.36233	Kurt	1.32338
Skew	0.016013	Skew	0.658463	Skew	-0.96008	Skew	-1.5497
Range	0.5	Range	0.5	Range	0.5	Range	0.5
Min	0.25	Min	0.25	Min	0.25	Min	0.166667
Max	0.75	Max	0.75	Max	0.75	Max	0.666667
Sum	49.5	Sum	41.5	Sum	61.75	Sum	55.83333
N	100	N	100	N	100	N	100

Source: Authors computation, 2022

Table 3. Ordinary least square regression output

Target (y) variable: TFP				
Var	**Coeff**	**Std. Error**	**t-Stat**	**Probability**
C	-0.074836	0.022358	-3.347177	0.0012
WDI	-0.025967	0.021058	-1.233136	0.2205
TDI	0.972495	0.022354	43.50512	0.0000
BBDI	0.109657	0.021501	5.100144	0.0000
R^2	0.965143	Mean dependent var		0.558333
Adjusted R^2	0.964054	S.D. dependent var		0.163050
Std error of the regression	0.030914	Akaike info criterion		-4.076068
Sum squared residual	0.091742	Schwarz criterion		-3.971862
Log-likelihood	207.8034	Hannan-Quinn criter.		-4.033894
F-stat	886.0337	Durbin-Watson stat		0.242559
Probability (F-stat)	0.000000			

Source: E-views Ver. 9.0

interest also revealed a significance and coefficient value of (0.000) and the *t-statistic* (43.505). Based on this positive significant result, the null hypothesis is thereby rejected and alternate, accepted. Therefore, we conclude that tillage degradation has a statistically significant effect on total factor productivity in Omor, Ayamelum LGA, Anambra state.

4.2.3 Hypothesis III

H_{01}: There is no significant effect of bush burning degradation index on total factor productivity in Omor, Ayamelum LGA, Anambra state.

The ordinary least square regression output is shown above with three IVs, as follows: Water Degradation Index (WDI), Tillage Degradation Index (TDI), and Bush Burning Degradation Index (BBDI). The overall R-squared is 0.965143. The probability value of the F-statistic is > .05. Which interprets that the model is significant. The variable of interest also revealed a significance and coefficient value of (0.000) and the *t-statistic* (5.100144). Based on this positive significant result, the null hypothesis is thereby rejected and alternate, accepted. Therefore, we conclude that Bush Burning Degradation Index have a statistically significant effect on Total factor productivity in Omor, Ayamelum LGA, Anambra state.

5. CONCLUSION AND RECOMMENDATION

The major point of emphasis of this paper is the effect of land degradation on rice production with a primary focus on Omor, Ayamelum LGA, Anambra State, Nigeria. This is premised on the information that the ball-point areas and farming settlements where land degradation and its effect on productivity have received a considerable measure of attention by scholars and Agric professionals. Related studies were reviewed and the current study was discussed from the social cost perspective pointing out that land degradation can be linked to farmers' activities. The hypotheses tested showed a statistically significant effect of land degradation on the efficiency of farmers and the agricultural industry. The study, therefore, makes the following recommendations:

i. Although the study found an insignificant effect of water degradation on factor productivity, the farmers in the industry should yet form cooperative societies among themselves for ease in tackling the water degradation menace, accessing government and non-governmental technical and financial support.
ii. It is highly recommended that reforestation programs should be embarked upon to reclaim the degraded land to forestall escalation. Partnering with international organizations that focus on policies that enhance sustainable land management should be promoted thereby increasing farmers' productivity in the area.
iii. Bush burning is a major factor that reduces the quality of the soil. Hence, bush burning on the farmland should be restricted by state and federal law and properly monitored to ensure compliance in the area.

5.1 Contribution to the Knowledge

The study has several academic contributions to the literature and more broadly to land degradation. Firstly, it developed links between land degradation and its effect on productivity considering the various degradation index employed in the study which can be beneficial to Agric managers in understanding the actual effect of soil quality loss as a result of various wrong activities of farmers and other players in the agricultural environment. It also provides additional evidence from the southeast which is at a developing stage about large-scale farming in Nigeria.

5.2 Suggestions for Further Studies

Future studies may consider a comparative analysis of other sources of land degradation outside water, tillage, bush burning, etc., and their effect on rice production while considering the distinction between large and small Agric businesses. The reasons for this result should therefore constitute an area of future research. Moreover, analysis of the effect of land degradation on factor productivity can be extended to neighbouring economies in West Africa.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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