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Original Article

Effect of oil-spill on farmland degradation and mitigation response employed by farmers in Niger Delta region of Nigeria

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ABSTRACT

This paper evaluated the mitigation practices employed by rural farmers in degraded farmlands in the Niger Delta region of Nigeria. The study focused on three states: Delta, Edo, and Ondo, which were purposively selected. Communities were chosen using a simple random sampling technique from a list of oil spill-affected areas documented by the Ecology Department of the Ministry of Environment, resulting in a sample size of 197 farmers. Data were collected using a structured and validated questionnaire. Descriptive statistics, such as frequency counts and percentage tables, were used to analyze the data, while a binary logistic regression model was applied to draw further conclusions. The results showed that 31% of the sampled farmers reported severe degradation of their farmlands due to oil spills, while another 31% perceived the degradation as moderately serious. The study identified leakages from vandalized oil pipelines and explosions at oil well terminal stations as the primary causes of oil spills, accounting for 20% and 19% respectively. The Logit Regression Model indicated that off-farm employment opportunities, compensations to farmers by government intervention agencies and multinational oil companies, and farmers' cooperative societies were significant negative determinants of not employing mitigation practices, despite mitigating the effects of oil spills. The marginal effect analysis revealed that, on average, a 1 percent increase in the utilization of off-farm employment opportunities, compensation to farmers, access to cooperative societies, and implementation of various Niger Delta intervention programs decreased the probability of employing mitigation practices by 0.50%, 0.45%, 0.005%, and 0.72% respectively. The study recommended enhancing off-farm economic activities to supplement the meager income from degraded farmlands.

HIGHLIGHTS

- Mitigation practices in Niger Delta farms are studied
- Oil spills cause severe farmland degradation
- Off-farm jobs lessen land mitigation efforts
- Economic support aids rural farming resilience

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1. Introduction

Crude oil may be regarded as a complex bio-organo-mineral system where minerals, water, air, organic matter (O.M.), and microorganisms interact across a range of scales, from nanometers to kilometers (Alexander, 2014). There are practices that degrade productive soil, reduce crop yield, and diminish producers' profit. These practices are typically poor agronomic practices, resulting in soil that does not function to its full capacity. Changes in many physical, biological, and soil properties can be indirectly measured by its low productivity, which, in turn, reflects in low profitability for farmers.

In another development, land degradation can occur due to factors unrelated to management practices, such as oil spills caused by pipeline vandalization, explosions at oil ring terminals, spills from modular artisanal refineries, drilling of oil wells, and corrosion of oil pipelines (Shell Petroleum Development Company of Nigeria, SPDC, 2016). Some definitions of land degradation that appear in the literature include the reduction in the land's actual potential uses and the diminution or complete loss of the soil's productive potential for current and future use (Blaike and Brookfield, 1987).

Nigeria possesses one of the worst environmental records in the world. Deforestation is a serious problem, leading to one of the highest rates of forest loss (3.3 percent) globally (Butler, 2005). Since 1990, the country has lost approximately 6.1 million hectares, or 35.7 percent of its forest cover (Butler, 2005). In the Niger Delta region, the primary livelihoods of the people are farming and fisheries. The incessant oil spills have led to a loss of livelihood, with most rural households adopting alternative livelihood strategies to mitigate the impact of oil spills on their farms, thereby reducing their crop yield and producer profit, especially among small-scale farmers who mainly reside in rural areas.

The paradigm shift now involves engaging in both farm and off-farm livelihood strategies not only to mitigate the effects of oil spills but also to augment meager incomes. Farmers in the study area have abandoned the traditional system of relying solely on one type of farming enterprise, instead employing multiple livelihood

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strategies, such as non-farm livelihood activities and on-farm processing, among others.

The Niger Delta region remains a challenging place for farmers due to a fundamental lack of basic infrastructure in many areas, poverty, lack of off-farm employment opportunities, widespread criminality, and other factors such as oil spills and gas flaring, all contributing to the social and economic crises in the region.

Against this backdrop, the study seeks to address the following research questions:

i. What are the socio-economic characteristics of the respondents in the study areas?
ii. What are the causes of oil spills in the study area?
iii. What mitigation responses are employed by farmers in the study areas?

The study objectives are to describe the socio-economic characteristics of farmers in the study area, identify the causes of oil spills, and examine the coping strategies employed by farmers in the study area. The apparent paucity of information, as reflected in the little or no research done on the effects of oil spills on the livelihood choices of rural households in the Niger Delta region of Nigeria, necessitated the need to undertake this study. The study seeks to fill relevant gaps by providing quantitative data that previously did not exist. Including Edo State, a minor oil-producing state, and Ondo State, an outlying state, further adds credence to the study. The study has contributed to knowledge by highlighting the profile and characteristics of farmers in the study area. The identification and quantification of coping factors relevant to the ability of farmers in this region to be resilient were also documented.

Table 1. Summary of Sampled Communities and Respondents in the Study Areas

State	LGAs	Community	Respondents
Delta	Ika-South	Agbor	10
		Igbodo	10
	Oshimili-South	Asaba	10
		Igbuzor	10
	Sapele	Sapele1	10
		Amukpe	10
	Ethiope-East	Isikolo	10
		Ogharefe	10
	Udu	Oto-Udu	10
		Emadaja	10
	Ndokwa-West	Kwale	10
	Kwale	Odode	10
	Sub-Total		120
Edo	Oredo	Ogba	10
		Amagba	10
	Ovia South-West	Iguorhiakhi	10
		Agbonvbonba	10
	Orhionmwon	Ugo	14
		Abudu	14
	Sub-total		68
Ondo	Ese-Odo	Imogbini	10
		Abokiti	10
	Ilaje	Aboto	10
		Akata	10
	Sub-Total		40

2. Methodology

2.1. Study Area

The study was conducted in the Niger Delta region of Nigeria. This region comprises nine crude oil-producing states in the Niger Delta area and eastward. The Niger Delta Development Commission (NDDC) estimates the size of the Niger Delta at 112,000 square kilometers, inhabited by more than 3,000 settled communities (SPDC, 2012). The population in this oil and gas-producing region is constantly rising. In 1991, there were approximately 20.5 million people; today, there are about 30 million, and this figure is projected to rise to 46 million by 2020 (NDDC, 2012). The primary livelihoods of the people in this region are subsistence farming and fishing. The ecosystem is particularly sensitive to changes in air and water quality, such as increased acidity.

2.2. Sampling Techniques

The study area is made up of three States of Niger-Delta region based on having the distinctive features of Niger-Delta region. The states are Delta, Edo and Ondo states, they were purposively selected based on; Delta State was selected from the four (4) major oil producing states while Edo state was selected from the three (3) minor oil producing states while Ondo State was selected from the two (2) outlier states outside the core south-south states. In the second stage, proportionate sampling techniques was used to select six (6) L.G.As from Delta State; three (3) L.G.As from Edo State and two (2) L.G.As from Ondo State. In the third stage, Random sampling technique was used to sample 2 communities from each states selected L.G.As. Thus, giving us 22 oil-spilled communities for representativeness from the list of oil spill affected rural communities from Ecology Department in the Ministry of Environment of each states, finally ten cassava farmers were randomly selected from the list of registered Agricultural Development project based cassava farmers and interviewed with the structured questionnaire, thus giving sample size of one hundred and ninety seven (197) farmers whose data were useful and collected between February and march, 2019. The table below indicated sampled L.G.As; sampled communities and sampled farmers respectively. However, the sampling frame could not be secured because it was a classified document.

2.3. Data Collection and Analysis

Primary data were used for the research, the questionnaire was used to collect data on the severity of environmental degradation noticed in the area and measures deliberately put in place to mitigate effect of oil spillage on farmlands livelihood and if they promote mitigation practice or not. The data were analyzed using descriptive statistics and logit model.

The Logit Model

Following Aldrich and Nelson (1986), the logit model (Equation 1) was employed to identify the determinants of the effects of oil spills. The logit model is based on the cumulative logistic probability function. The dependent variable L is the logarithm of the odds that a particular choice will be made. It serves as an index of the effect of the independent variable on the dependent variable,

$$\log\left[\frac{P_i}{1-P_i}\right] = \Sigma \mathrm{b}_{kX_{ik} \equiv b\prime X_i} \quad (1)$$

$$L\_1 = L\_n\,(P\_1\,/\,(1-P\_1\,)) = \beta\_0 + \beta\_1\,x\_1 + \beta\_2\,x\_2 + \beta\_3\,x\_3 + \beta\_4\,x\_4 + \beta\_5\,x\_5 + \beta\_6\,x\_6 + \beta\_7\,x\_7 + \beta\_8\,x\_8 + \beta\_9\,x\_9 + \beta\_10\,x\_10 + \beta\_11\,x\_11 + E \quad (2)$$

where L_1= logit or log of odds ratio= (1; 0, otherwise), p1 = degradation index (1 practice mitigation; 0 = otherwise), X_1 = Educational level (number of years in school), X_2 = Family size (numbers), X_3 = Farm size (ha), X_4 = off-farm employment (yes = 1 and 0 = otherwise), X_5 = compensation to farmers by government and oil majors in the area, X_6 = Temporary out-migration (yes = 1; and 0 = otherwise), X_7 = Social Safety net Support (membership = 1 and 0 = otherwise), X_8 = Implementation of government policy as destruction if illegal artisanal refinery (yes = 1 and otherwise = 0), X_9 = farmers' co-operative society (membership = 1; and 0 = otherwise), X_{10} = Provision of basic amenities (yes = 1 and 0 = otherwise), X_{11} = Implementation of various Niger Delta intervention programmes (e.g. PAP, NDDC, 13 & Derivation fund and various Niger Deltas' Petroleum and Area Development Commission = (yes = 1 and 0 = otherwise)

combining probabilities within a (0-1) range to address the problem of predicting the odds of an event occurring within this range.

The goodness of fit evaluates the classification of farmers' responses to mitigation measures on land degradation. In this study, the dependent variable is defined as farmers' positive or negative response to the application of mitigation measures to counteract the effects of land degradation. The logit model as used by Kimenta (1986) was used. The estimated model is specified in Equation 2.

In order to know the probability of employing mitigation measures by the respondents, the predicated probability was calculated as indicated by Agada et al (1997) and Abebaw et al. (2001). According to them, the two groups can be compared using predicated probability created through the logit regression, the difference is the estimate of gain due to the application of that particular menace. If the coefficient of a particular variable is positive, it means that a higher value of that variable results in a higher probability of practising land degradation mitigation measures.

3. Results and Discussion

The results of Table 2 indicate that 52% of the respondents were farming on their land. Farmers that rented their lands constituted 35% since the majority (52%) of the respondents farm on their land. It becomes imperative for them to adopt measures that can help intensify their land utilisation, this is to help boost production which in turn can augment the income of farmers since the size of the land on average is small.

Table 2: Distribution of Respondents on Modes of Land Acquisition

Mode of land acquisition	Frequency	Percentage
Inherited land	8	4
Purchase	8	4
Lease	10	5
Rented	69	35
Personal	102	52
Total		100

Table 3: Distribution of respondents based on the level of degradation experienced

Level of degradation	Frequency	Percentage
Very severe	40	20
Severe	50	25
Slightly severe	60	31
Not severe	47	24
Total	197	100

Farmers were required to give the perceptual extent of degradation on their farms. The required responses were very severe, severe, slightly severe and not severe. Table 3 shows that 31% of the respondents expressed their perceived level of degradation to be slightly severe, 25% of the respondents experienced severe level of degradation, while 20% experienced very severe level of degradation on their farm lands. This necessitated the employment of mitigation strategies so as to mitigate the effect of such degradation on the source of livelihood.

The results of the logit regression model presented in Table 5 show that the coefficients for off-farm employment opportunities, compensation to farmers from government and oil majors, farmers' cooperative societies, and the implementation of various Niger Delta intervention programs were significant in mitigating the effect of oil spillage on farmers' livelihoods but had an inverse influence on mitigation practices. This suggests that while increases in these variables offset the effects of oil spillage on farmers' livelihoods, they lower the probability of applying mitigation measures for land degradation caused by oil spillage. The reason is that as respondents receive assistance or support in cash and kind, they often forgo employing mitigation practices. The prohibitive cost necessary to mitigate the land, which resource-poor farmers cannot afford, often leads to this decision. Consequently, farmers are worse off in their income status.

The marginal effect of the independent variables on the dependent variables revealed that, on average, a 1% increase in the utilization of off-farm employment services leads to a 0.50% decrease in the probability of applying land degradation measures in the study areas, holding all else constant. Similarly, compensation to farmers by the government and oil majors, accessing farmers' cooperative societies, and full implementation of various Niger Delta intervention agencies showed marginal effects of 0.45%, 0.05%, and 0.72%, respectively.

4. Conclusion and Recommendations

The study evaluated the mitigation responses employed by farmers to counteract the effects of rampant oil spillage on the farmlands of rural households in the study area. The results indicated that the majority of the farmers owned the land on which they grew crops and reported that the degradation of their farmland was moderately severe. Several factors were found to mitigate the impact of oil spillage on their livelihoods; however, none of these factors influenced the application of mitigation measures on already degraded land due to the associated costs.

The Logit regression results showed that the coefficients for off-farm employment, compensation to farmers by the government and oil companies, utilization of cooperative societies, and the implementation of various Niger Delta intervention programs were significant. However, these factors had an inverse relationship with the use of land mitigation measures, indicating that while they

Table 5. Result of Logit Regression Analysis Showing Variables that Mitigate/Does not Mitigate farming Environment Degradation

Variable	Estimated coefficient	T-ratio	Marginal Effect
Educational level X1	0.620	0.724	0.154
Family size X2	-0.673	-0.897	-0.729
Farm size X3	-0.538	-0.370	-0.167
Off-farm employment opportunity X4	-0.482*	-3.013	-0.509
Compensations by Government and oil majors X5	-0.234*	-2.460	-0.450
Temporary migration X6	NA	NA	-
Social-safety net support X7			-
Implementation of government policy destruction of illegal artisanal refinery X8	-7.903	-0.823	-0.1060
Farmers cooperative society X9	-1.917*	-2.263	-0.0500
Provision of basic amenities X10	0.013	0.141	0.1000
Implementation of various Niger Deltan's interventional programme (e.g PAP, NDDC, 13% Derivation fund and various Niger Deltans petroleum and Gas Areas commission X11	1.166*	1.963	0.7240
Constant	1.230	2.342	0.3400
Log Likelihood	-70.06		
Chi-Square	47.63		

mitigated the effects of oil spillage on livelihoods, they did not promote the use of land mitigation practices.

The other variables were not significant and thus not worth discussing. By inspecting the marginal effects of the independent variables on the dependent variable, it can be seen that, on average, off-farm employment opportunities, the implementation of various Niger Delta intervention agencies, farmers' cooperative societies, and compensation to farmers by the government and oil majors were found to marginally reduce the adverse effects on farmers' livelihoods. The respondents reported that leakages from vandalized oil pipelines, explosions of oil wells/stations, destructive operations of illegal artisanal refineries, and corrosion of oil pipelines were major causes of oil spillage, which in turn led to land degradation.

In conclusion, to ensure that rural farmers remain engaged in farming despite the effects of oil spillage on their farmlands, off-farm employment opportunities should be provided to rural communities to augment their income. Compensation to these rural farmers should be vigorously pursued, and farmers should form or join cooperative societies to gain financial empowerment. Additionally, the government must ensure that Niger Delta intervention programs are implemented to help offset the effects of oil spillage.

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