THE EFFECT OF OIL SPILLAGE ON CROP YIELD AND FARM INCOME IN DELTA STATE, NIGERIA

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ABSTRACT

Environmental degradation of the oil-rich Niger Delta region has been wanton and continuous with dire health, social and economic consequences for its peoples, for over three decades. Using a sample of 262 crop farmers drawn randomly from 10 communities and 5 LGAs in the oil producing agro-ecological zones of Delta State, the negative impact of oil spill on crop production was accentuated. Oil spill reduced crop yield, land productivity and greatly depressed farm income as a 10 percentage increase in oil spill reduced crop yield by 1.3 percent while farm income plummeted by 5 percent. In order to halt the continual degradation of the Niger Delta environment, the authors recommend the enactment and enforcement of stringent environmental laws to protect the area as well as the implementation of policies to reduce the crushing level of poverty and guarantee a better livelihood for the people.

KEYWORDS: small-scale farmers; oil spills; natural resource degradation; low crop yield; land productivity

JEL CLASSIFICATION: O13, Q10, Q12, Q28, Q52.

INTRODUCTION

Delta State which is one of the nine (9) States in the Niger Delta region of Nigeria, is greatly endowed with abundant natural resources and a weather which supports all year round agricultural production. According to [8], about 50 percent of the active labour force is engaged in one form of agricultural activity or another, with yam, cassava, plantain, maize, cocoyam and vegetables as the predominant food crops in the area. However, owing to the hydrographic conditions of the State only a fraction of the land size is cultivated with crops.

Cropping patterns are mainly sole cropping, mixed cropping and intercropping, while farming practices are traditional, and the use of crude implements such as hoe and cutlasses predominate. Agricultural production is on a small and subsistence scale, with small farm holdings. Mechanisation is on a very low scale and the use of modern farming inputs such as fertilizers and pesticides is limited because farmers hardly have access to it, since it is nationally distributed by the Federal Government.

Although the level of agricultural production in the State is somewhat low given the abundant resource endowment, Delta State is the largest crude oil producing State in Nigeria located in the Niger delta region, the base of the Nigerian oil and gas industry which generates over 90 percent of the nation's foreign exchange earnings. Paradoxically, in spite of the increasing revenue from crude oil exploitation, the communities from which this resource flows in the Niger Delta continue to live in conditions of social deprivation and abject poverty.

All stages of oil exploitation impact negatively on the environment, and the greatest single intractable environmental problem caused by crude oil exploration in the Niger Delta region is oil spillage. According to [6], over 6000 spills had been recorded in the 40 years of oil exploitation in Nigeria, with an average of 150 spills per annum. In the period 1976 – 1996, 647 incidents occurred resulting in the spillage of 2,369,407.04 barrels of crude oil. With only 549,060.38 barrels recovered, 1,820,410.50 barrels of oil were lost to the ecosystem (Table 1).

The environmental consequences of oil pollution on the inhabitants of Delta State are enormous. Oil spills have degraded most agricultural lands in the State and have turned hitherto productive areas into wastelands. With increasing soil infertility due to the destruction of soil micro-organisms, and dwindling agricultural productivity, farmers have been forced to abandon their land, to seek non-existent alternative means of livelihood. Aquatic life have also been destroyed with the pollution of traditional fishing grounds, exacerbating hunger and poverty in fishing communities.

[4] in a study on the effect of oil spill on crop production in the Niger Delta, reported that oil spill on crops causes great damage to the plant community due to high retention time of oil occasioned by limited flow. The oil hamper proper soil aeration as oil film on the soil surface acts as a physical barrier between air and the soil. In fact, oil pollution affect the physicochemical properties of the soil such as temperature, structure, nutrient status and pH. Oiled shoots of crops like pepper and tomatoes may wilt and die off due to blockage of stomata thereby inhibiting photosynthesis, transpiration and respiration. In fact, germination, growth performance and yield of these crops stifled by oil spillage [2].

In a study of the socio-economic impact of oil pollution, [14] stated that crude oil exploitation has had adverse environmental effect on soils, forests and water bodies in host communities in the Niger Delta. Farmers have lost their lands, and are consequently forced to emigrate to other communities in search of livelihood exerting additional pressures on natural resources in such areas. According [13], 67.7 percent of 797 respondents interviewed on the socio-economic impact of oil pollution identified farmland degradation as a major problem.

Although the impact of oil pollution in the Niger Delta are enormous, the objective of this study is to examine the effect of oil spill on crop production. Specifically, the study aims to ascertain the effects of oil spill on crop yield, land productivity, and farm income in the study area.

MATERIALS AND METHODS

Area of Study

Five Local Government Areas (LGAs) including Isoko South, Isoko North, Ughelli South, Ughelli North and Udu which are home to several oil producing communities is the area of study; and its a leading source of on-shore crude oil production in Delta State. Delta State lies approximately between longitude 5^0 00´ E and 6^0 45´E of the Greenwich Meridian, and latitude 5^0 00´N and 6^0 30´ N of the Equator. It is one of Nigeria's extremely southern states, and covers an area of 17,001 km^2 [5]. The inhabitants of communities in this area are mainly crop farmers, and cases of incessant oil spillages have been reported there.

Sampling Procedure and Data Collection

Multistage sampling techniques was used to draw samples for the study. The study area comprising the aforementioned five (5) LGAs was purposively selected because of the high level of oil production activities in the area, and the fact that agricultural production is the

Table 1: Oil Spills in Nigeria (1976 – 1996)

Year	Number of Spills	Quantity Spilled (barrels)	Quantity Recovered (barrels)	Net loss to the Environment (barrels)
1976	128	26157.00	7135.00	19021.50
1977	104	32879.25	1703.01	31176.75
1978	154	489294.75	391445.00	97849.75
1979	157	64117.13	63481.20	630635.95
1980	241	600511.02	42416.83	558094.19
1981	238	42722.50	5470.20	37252.30
1982	257	42841.00	2171.40	40669.60
1983	173	48351.30	6355.90	41995.40
1984	151	40.209.00	1644.80	38564.20
1985	187	11876.60	1719.30	10157.30
1986	155	12905.00	552.00	12358.00
1987	129	31866.00	6109.00	25358.00
1988	108	9172.00	1955.00	7207.00
1989	118	5956.00	2153.00	3830.00
1990	166	14150.35	2092.55	12057.80
1991	258	108367.01	2785.96	105912.05
1992	378	51187.90	1476.70	49711.20
1993	453	8105.32	2937.08	6632.11
1994	495	35123.71	2335.93	32787.78
1995	417	63677.17	3110.02	60568.15
1996	158	399036.67	11838.07	387198.60
Total	**4,647**	**2,369,470.04**	**549,060.38**	**1,820,410.50**

Source: Department of Petroleum Resources, 1997.

major occupation of the people. Two (2) communities each that have suffered oil spillages between 2001 and 2004 were selected randomly from the five LGAs, making a total of ten (10) communities. Out of these ten (10) communities, 30 small-scale farmers were selected randomly from them to make a total sample size of 300 farmers used for the study. The communities are Olomoro and Uzere in Isoko South LGA, Owhe-Ologbo and Otor-Iyede in Isoko North LGA, Ukpiovwin and Otor-Udu in Udu LGA, Otor-Ughievwen and Okpare in Ughelli South LGA, and Afiesere and Eruemukohwarien in Ughelli North.

The data set for the study covers the years 2001 – 2004. This was based on the assumption that farmers will be able to recollect their input and output levels before and after possible oil spillages during this time. Primary data for the study were obtained with the aid of questionnaires administered personally to the respondents in their own languages. Data collected included crop yield, land area cultivated, labour and capital input utilised, farm income as well as incidence of spills, and the farmers perception of their effect on agricultural production. Information on social characteristics of the farmers were also obtained.

Model Specification and Estimation

In order to estimate the effect of oil spill on crop production, the following econometric models relating crop yield, land productivity, and farm income with the under listed explanatory variables were specified and subsequently estimated:

$CRP_{YD} = f\ (\ LND_{SZ}, LBR_{NT}\ PLT_{MT}, FRM_{XP}\ CPT_{NT}, OIL_{SP}, \varepsilon)$.....(1)

$LND_{TY} = f\ (LBR_{NT}\ PLT_{MT}, FRM_{XP}\ CPT_{NT}, OIL_{SP}, \varepsilon)$..(2)

$FRM_{NC} = f\ (CRP_{YD}, MKT_{PZ}, OIL_{SP}, \varepsilon)$.....(3)

Where CRP_{YD} is annual household crops yield

LND_{TY} is land productivity measured as the ratio of crop yield to land size

FRM_{NC} equals the returns after deducting or costs of production

LND_{SZ} is land size cultivated measured in hectares

LBR_{NT} is labour cost per cropping season

PLT_{MT} is cost of planting materials

CPT_{NT} is the depreciation cost of capital inputs

FRM_{XP} is farming experience measured as number of years in crop farming

OIL_{SP} is oil spill dummy (oil spillage = 1, no spillage during cropping year = 0)

MKT_{PZ} is average market price for the basket of crops produced

ε is the error term.

Because economic theory does not indicate the precise mathematical form of the relationship among the variables, different functional forms of the above models including the linear, semi-logarithm, logarithm and exponential functions were fitted. However, the lead equations were chosen on the bases of economic, statistical as well as econometric criteria [11], [12]. The semi-logarithmic, exponential, and logarithmic functions were fitted for crop yield, land productivity and the farm income models respectively as follows:

$$CRP_{YD} = \ln \vartheta_0 + \vartheta_1 \ln LND_{SZ} + \vartheta_2 LBR_{NT} + \vartheta_3 \ln PLT_{MT} + \vartheta_4 \ln FRM_{XP} + \vartheta_5 \ln CPT_{NT} + \vartheta_6 OIL_{SP} \quad (1a)$$

$$\ln LND_{TY} = \varphi_0 + \varphi_1 LBR_{NT} + \varphi_2 PLT_{MT} + \varphi_3 FRM_{XP} + \varphi_4 CPT_{NT} + \varphi_5 OIL_{SP} \quad (2a)$$

$$\ln FRM_{NC} = \ln \gamma_0 + \gamma_1 \ln CRP_{YD} + \gamma_2 \ln MKT_{PZ} + \gamma_3 OIL_{SP} \quad (3a)$$

where the variables are as defined earlier in equations (1) to (3) above. The Ordinary Least Squares (OLS) technique was used to estimate the regression parameters.

RESULTS AND DISCUSSION

Socio-economic Analysis

The socio-economic characteristics of the farmers surveyed are presented in Table 2. The results indicate that 80 percent of the farmers had ages ranging between 45 – 71 years, with an average age of 52 years. With such an aged agricultural work force agricultural productivity is bound to be low. Rural-urban migration of able-bodied young men and women, as well as land resource degradation occasioned by incessant oil spills in the area, are implicated for the relatively old age of the farmers.

A relatively large household size was found in the study, with a mean size of 11 persons per household. About 40 percent of the households have a family size that ranged between 13 – 20 persons, thus supporting the preponderance of large family sizes among the poor in rural areas of Nigeria [7]. Though a very large family size may constitute a social burden, larger families use their labour input to an advantage in farming and forest products exploitation. In fact, the intensity of agricultural production has been found to have a direct relation to household size [1].

A major proportion of the crop farmers sampled had no formal education (40.1 percent), while 38.5 percent of them had only primary education. On the whole about 60 percent of the respondents had some form of formal education, an observation which tends to refute the alarming rate of illiteracy prevalent in rural communities. The mean level of educational attainment is 2.00 and the implication of this is that on the average, every farmer in the oil producing areas in Delta State had primary education.

The size of farm holdings in the area are also presented in Table 2. The average farm size is 0.91 hectare. However, 23 percent of the respondents have farms ranging between 0.5 – 0.7 hectare. Such land fragmentation due to traditional ownership structure is antithetical to agricultural growth, because it does not support mechanised and commercial farming.

The level of income realised from crop farming by the respondents reveal that farm income are very low. This is not unexpected given the size of land holdings observed in the area, and the fact that crude methods of crop production are employed. Annual farm income ranged between N=19,000.00 – N,=82,000.00, though about 68 percent of the farmers actually earned income of between N=19,000.00 – N=50,000.00 from crop farming operations. The average farm income was N=45,717.20.

Test of Differences of Means

The results of the test of differences of means of important production parameters such as crop yield, land productivity and farm income before and after the incidence of spills are shown in Table 3. The results indicate that oil spill has a statistically significant effect on crop yield, land productivity as well as farm income. The results are similar to those of [3], [9], [10], in studies they conducted in oil producing communities in the Niger Delta region.

Table 2: Distribution of Socio-economic Characteristics of Respondents (n = 262)

Parameter	Frequency	Mean/(Mode)
Age of farmer		
27 – 35	11 (4.2)*	
36 – 44	40 (15.3)	
45 – 53	102 (38.9)	52years
54 – 62	74 (28.2)	
63 – 71	35 (13.4)	
Gender of farmer		
Female	118 (45.0)	
Male	144 (55.0)	(Male)
Educational level		
No formal education (1)	105 (40.1)	2.0
Primary school (2)	101 (38.5)	
Secondary school (3)	48 (18.3)	
Tertiary education (4)	8 (3.1)	
Household size		
5 – 8	57 (21.8)	
9 – 12	101 (38.5)	11persons
13 – 16	72 (27.5)	
17 – 20	32 (12.2)	
Farm size (ha)		
0.5 – 0.7	60 (22.9)	
0.8 – 1.0	154 (58.8)	
1.1 – 1.3	27 (10.3)	0.91
1.4 – 1.6	12(4.6)	
1.7 – 1.9	5 (1.9)	
2.0 – 2.2	4 (1.5)	
Annual farm income (N,= [+])		
19000 – 34000	59 (22.5)	
35000 – 50000	119 (45.4)	45,717.20
51000 – 66000	62 (23.7)	
67000 – 82000	22 (8.4)	

[+] is the Nigerian Naira, N,= 131.00 = US$1.00
* Figures in parentheses ( ) are percentages
Source: Computed from Survey Data, 2005.

Table 3: Test of Differences of Means of Crop yield, Land Productivity and Farm Income

Production parameter	Mean Difference	D.F.	t-value	p-value
Crop yield (kg)	288.862	261	2.825	0.0051**
Land productivity(yield/ha)	771.201	261	7.876	<0.0001**
Farm income(N,=)	15718.72	261	19.088	<0.0001**

** Significant at the 1 % level
Source: Computed from Survey Data, 2005.

Table 4: Factors Affecting Crop Yield and Land Productivity in Oil Producing Areas of Delta State

Variable	Crop Yield Model (semi-log function)			Land Productivity Model (exponential function)		
	Estimated coefficients	t-statistic	p-value	Estimated coefficients	t-statistic	p-value
Land size	703.75	2.11	0.04*			
Labour inputs	-77.29	-0.33	0.74	-0.86E-05	-0.408	0.68
Planting materials	483.27	2.07	0.04*	0.25E-04	2.18	0.03*
Farming experience	310.20	1.65	0.10	0.72E-02	1.06	0.29
Capital input	2076.80	9.81	0.000**	0.35E-03	7.95	0.000**
Oil spill	- 468.94	-2.40	0.02*	-0.16	-2.09	0.04*
	F-statistic =	21.33		F-statistic =		16.59
	DW-statistic =	1.87		DW-statistic =		2.42
	Adjusted R-squared =	0.61		Adjusted R-squared =		0.48
	n =	262		n =		262

* Significant at the 1 % level
** Significant at the 1 % level
Source: Computed from Survey Data, 2005

Table 5: Elasticity estimates of Crop Yield, Land Productivity and Farm Income with respect to Specified Explanatory Variables

Independent Variable	Dependent Variables		
	Crop yield	Land productivity	Farm income
Land size	0.20^{+}	–	–
Labour input	-0.02	-0.04	–
Planting materials	0.13^{+}	0.25^{+}	–
Farming experience	0.09	0.10	–
Capital input	0.58^{+}	0.72^{+}	–
Oil spill	-0.13^{+}	-0.01^{+}	-0.50^{+}
Market price	–	–	0.04
Crop yield	–	–	0.05^{+}

$^{+}$ Independent variables that have statistically significant effects on the dependent variables
Source: Computed from Survey Data, 2005.

Regression Results

The results of the OLS estimates of the regression parameters in equations (1a), (2a), and(3a) for crop yield, land productivity and farm income respectively are presented in Table 4. The results indicate that land size, planting materials, capital inputs and oil spill have a statistically significant effect on crop yield in a manner consistent with a prior expectations. However, the impact of labour input on yield was negative but not significant. The negative influence of labour on crop yield may be adduced to the fact that optimum levels of labour supply have been reached, thus further employment of labour exerted diminishing effect on crop yield. The fit of the model was good with an Adjusted R^2 of 0.61; implying that all the independent variables jointly explain 61 percent of the variation in crop yield.

The results of the land productivity model are also shown in Table 4. Similar to the crop yield model, planting material, capital input and oil spill had statistically significant effects on land productivity. The incidence of oil spill impacted negatively on land productivity because yield will reduce due to the poor fertility of the soil and growth performance of crops. Thus with dwindling yield and constant land area, land productivity is bound to fall. However, with an Adjusted R^2 value of 0.48, the explanatory ability of the model is poor compared to that of crop yield.

The estimated regression result for the farm income model (3a), are shown in equation (3b). Although the signs of the independent variables are quite consistent with theoretical expectations, only crop yield and oil spill had

$$\ln FRM_{NC} = 10.30 + 0.051 \ln CRP_{YD} + 0.038 \ln MKT_{PZ} - 0.50 OIL_{SP} \quad \text{.....(3b)}$$

$$t-ratio \qquad (2.16)* \qquad (1.67) \qquad (-16.65)**$$

$$R^2 = 0.52 \qquad DW = 1.95 \qquad F-stat = 96.02 \qquad n = 262$$

**significant at the 5% level* ***significant at the 1% level*

statistically significant influence on farm income, with the effect of oil spillage being very highly significant. This result further accentuated the negative impact of oil spill on crop production as farm income is depressed due to the twin effects of land degradation and poor plant growth.

The elasticity estimates of crop yield, land productivity, and farm income with respect to the explanatory variables for each of the models are shown in Table 5. For crop yield, a 10 percentage increase in land size cultivated and capital input used, will increase crop yield by 2 and 6 percent respectively, while the same proportional change in oil spill will depress yield by 1.3 percent. These are very significant changes given the dearth of fertile arable land in the region; itself a consequence of environmental degradation. The oil spill dummy appeared to exert the greatest impact on farm income, as a 10 percent increase in spillage will decrease farm income by as much as 5 percent.

Conclusion

The impact of oil spill on the degradation of the environment of the Niger Delta region of

Nigeria has raised questions of great concern to stakeholders, particularly oil producing communities who have suffered polluted air, water resources, degraded forests and farm lands, and very high atmospheric temperatures for over thirty years. While a number of studies have been commissioned by oil companies operating in the area on the socio-economic effects of their operation in host communities, independent studies on the environmental impact of oil spill on the health, social and the economic life of the people have not been conducted. Moreover, the wanton and continuous destruction of the ecosystem by oil producing companies is aggravated by the lack of political will by the Federal Government to enact and enforce stringent environmental laws to regulate the environmental consequences of crude oil exploration and exploitation in the Niger Delta.

This paper therefore, considered the effect of crude oil pollution on food crop production using primary data obtained from 262 small-scale crop farmers drawn randomly from 10 communities in 5 LGAs in the oil producing agro-ecological zones of Delta State. The study revealed that oil spill has a negative and statistically significant impact on crop yield, land productivity and farm income in a manner consistent with economic expectation. Therefore, in order to halt the continual degradation of the Niger Delta environment, the Federal Government must play a leading role by enacting and enforcing stringent environmental laws that will protect the oil producing areas, as well as guarantee the people a better livelihood. Deliberate intervention policies must be implemented speedily to embark on massive infrastructural development of the region, as well as address the crushing level of poverty among the peoples of the Niger Delta.

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