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The Food Challenge: Impact of Oil Spillage on the Welfare of Cassava Farmers in the Niger Delta Region of Nigeria

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Abstract

The study made use of the economic efficiency of cassava farmers in Bayelsa, Delta and Rivers States in analysing food shortage, oil spillage and the future of farmers in the Niger Delta of Nigeria. Five hundred and forty (540) cassava farmers were used in a multistage sampling procedure. Data analysed used descriptive statistics and a stochastic frontier model. The findings were that cassava farmers are relatively educated and relatively vibrant. Stochastic frontier results (Maximum Likelihood Estimates) revealed farm output increases with size, hired labour, family labour and planting material but decreases with herbicide. A mean economic efficiency of 61 per cent implied room for improvement in efficiency by 39 percent with present technology. Economic efficiencies were significantly different between OS and NOS groups. Most farmers in NOS locations (92.0%) had higher welfare than those in OS locations (25.0%). Oil spill reduced Per Capita Household Expenditure of cassava farming households in OS locations by N45. 861:.00. Oil spillage reduced the economic efficiencies in cassava farming as well as the welfare of their households in the Niger Delta region of Nigeria. Policy option requires efficient utilisation of resources.

Keywords: Cassava farmers, environmental pollution, food shortage, oil spillage.

Introduction

Environmental pollution is a major human-driven challenge closely tied to climate change, and addressing it is vital for protecting our planet's future. (Magnano et al, 2023). Adeola et al, (2022), in their work, stated that it is unfortunate that after more than 5 decades of oil and gas exploration in Nigeria, no sustainable resources have been added to its coffers. The bane of the country's economy has been the near-complete reliance on crude oil, which has led to a shift from other sectors' growth and development. Today, a move from a dependence on agriculture to

crude oil petroleum has hurt agriculture and the communities where this crude oil is produced (Sharma and Shrestha, 2023). This has equally led to food shortages, access to food, unemployment, and so on, as crude petroleum is not a resource that lasts forever. Liquid petroleum products are generally noted as oil and are made up of hydrocarbons. Its release into the ecosystem is termed an oil spill (Danny & Jacob, 2022). The leakage of pipelines due to long usage, activities of oil thieves, and improper use of equipment are the main causes of oil spillage. It has been recorded that oil spills could be caused by deliberate acts like sabotage, oil bunkering, and lack of maintenance of engineering equipment. (Chika & Ndidi, 2022). According to Ocholi (2022), oil spills can also occur through natural occurrences, earthquakes and hurricanes.

The history of oil spills in Nigeria is shocking and appears to be one of the worst on earth (Odesa *et al*, 2024). The oil industry whose confine is within the Niger Delta region has added so much value to the economy of Nigeria and this fact has not been controverted, but the crude oil exploration business has made the Niger Delta region one of five severely degraded ecosystems in the world, (Nnadi *et al*, 2022).Efficiency measurement relies on the application of a production function which represents the maximum output obtained from a given level of inputs (Martin and Riley, 2025). Measurement of smallholder resources has important consequences for the growth or development of agriculture in Nigeria. Hence, a very crucial factor of productivity, especially in countries where resources are minimal and chances for production/ application of better technologies have been reduced (Abiri *et al,* 2023).

Cassava, our crop of focus, is accepted in many tropical African countries where it plays a bigger role in the food industry (Adebayo, 2023). The ability of a farmer to keep the roots in the ground outside the harvest for two years or more until their market value improves makes this crop more competitive than other root crops (International Institute for Tropical Agriculture, 2020). This advantage over similar food crops makes planting more attractive to rural farmers. According to Immanuel *et al.* (2022), cassava has five major advantages over other food crops, including a reserve crop during famine, a rural food staple, a cash crop for local and foreign consumption, industrial usage and for realizing money from overseas

In the works of Bello *et al,* (2024), the efficiencies of the farmers in the Niger Delta region have been dwindling over the years and this has resulted in low productivity growth as well as a fall in output. Agricultural production in the Niger Delta zone which happens to be the major oil-producing area of Nigeria is affected by several environmental challenges of which oil pollution is most common because of the activities of crude oil prospectors. (Okonfua*et al*, 2023). Oil spillage has been a serious challenge in the country especially in areas where there are many oil exploration activities since crude oil was found in Oloibiri, from 1976 and the 1990s, an estimated 4,647 spills produced about 2,369,470 barrels of crude oil into the Niger Delta ecosystem, (Akaegbobi et al, 2024). Available records show that about nine out of ten villagers in Niger Delta communities are poor and insecure in terms of means of livelihood, with the exploration of crude oil since 1956 and subsequent large-volume exploration to date (Raji, 2023).

Today, the fortunes of the region farmers under the new 'oil economy' are not very clear. The oil industries have hurt the agricultural sector further and prove to be an anathema to the farming population, who are the majority of the region's rural dwellers. Oil spills or contamination have displaced populations, and wildlife, damaged water sources and have tremendous implications on the income and welfare of the rural population. This has affected major staple food crop production yields, such as cassava, in the oil-producing region of the country. (Ayibakari & Ebisine, 2022).

Governments, industries, researchers and relevant stakeholder interventions have not done much in the Niger Delta region. This, therefore, calls for a total effort to improve on production of this crop, including efforts to reduce the problem of oil spillage in its production in the Niger Delta region. (Ayibakari & Ebisine 2022).

Research Questions

From the foregoing, the study addressed the following research questions:

1. What are the socio-economic characteristics of cassava farmers?
2. How is the economic efficiency of farmers affected by oil spillage?
3. To what extent does oil spillage impact the welfare of cassava farmers?

Objectives of the Study

The overall objective of the study is to determine the extent of the food challenge/impact of oil spillage on the welfare of cassava farmers. The specific objectives are:

1. To describe the demographic features of the farmers.
2. To ascertain the economic efficiency levels of farmers affected by oil spillage.
3. To estimate the impact of oil spillage on the welfare of the cassava farmers.

Research Hypothesis

H_0: The economic efficiency of farmers in oil spillage areas is not significantly different from that of farmers in non-oil spillage areas.

Materials and Methods

Study Area

Niger Delta Region of Nigeria (NDRN) is home, to over thirty million people, representing approximately 25% of the country's population (The World Bank, 2014). This region includes 186 local government areas within nine states (Shaibu and Weli, 2017). Specifically, it comprises all Nine states from three geopolitical zones Akwa Ibom, Bayelsa, Cross River, Delta, Edo, and River, Ondo, Abia and Imo. Recognizing the diversity and cultural richness of these areas is essential for promoting their development and ensuring that the voices of millions are represented (United Nations Development Program; Ukhurebor and Abiodun, 2018; Chinedu and Chukwuemeka, 2018; Munir, 2020).

Sampling and Data Collection

The multi-stage sampling procedure was used. The first stage was a purposive selection of three States chosen from the four (4) major oil producing States in the Niger Delta (states that have suffered oil spillage in the last ten years, and include Bayelsa, Delta and Rivers States. (Odesa et al, 2024) The Second stage involved the purposive selection of four Local Government Areas (LGAs) chosen from Delta State, two from Bayelsa State and three from Rivers State. These selected Local Government Areas from each of the chosen states have a record of farmlands that have been affected by oil spillage as well as farmlands not affected by oil spillage. The third stage involved the proportionate selection of twenty communities in Delta State, ten communities in Bayelsa State, and fifteen communities in Rivers State. The fourth and final stage involved the random selection of three cassava Farming households from each community in Delta State, three in Bayelsa State and two from Rivers State that farmed in oil spilt location. Also, eight cassava farming households in Delta State, nine cassava farming households in Bayelsa State and seven cassava farming households in Rivers State were chosen from locations where there is no oil spillage incidence proportionate to the size of the population. A total of 475 cassava farming household heads were used for this work, out of which only 450 cassava farming household heads were suitable for analysis. The survey was conducted from 15th January to 31 July 2024.

Method of Data Analysis

Research tools applied in this work for analysis of survey data include Descriptive statistics i.e., percentage distribution, frequency tables, mean, and standard deviation.

Objective 2: The stochastic Frontier Production function was used to analysethe economic efficiency of cassava farming households. Variables like cassava yield and farm inputs were used. A Stochastic Frontier Production Model (SFPM) in line with the original models of Aigner*et al*. (1977) is given as:

$$Y_i = F(X_i : \beta)\exp(V_i - U_i), \qquad i = 1, 2, _ \ldots . N \tag{1}$$

Where,
Y_i= output of cassava farm
X_i = real input used by cassava farm
β =vector of parameters estimated
$Vi - U_i$ = is a double error term Aigner*et al*. (1977) such that
V = Random variable independently and identically distributed N (O, δ^2) and independent of U
U = Random variable that accounts for technical inefficiency independently distributed as truncation of the normal distribution with mean μ and variance $\sigma^{2.}$ Whereas values of Vi represent occurrences that are outside the control of cassava farmers, values of Ui, however, show the technical inefficiency of cassava production. Coefficients (β) represent the parameters of the model that are to be determined. The ratio between the standard deviation of errors of technical inefficiency (U) and the standard deviation of model specification errors (V) is represented by λ). This ratio is expressed as:

$$\delta^2 = \delta_v^2 + \delta_v^2 \quad and \quad \gamma = \frac{\delta_v^2}{\delta^2} \tag{2}$$

The values of γ ranges from 0 to 1, such that value of 0 with traditional average response function for which nonnegative random variable, μi , is absent from the model, i.e. perfect efficiency. Value one shows all deviations from frontier are due to technical inefficiency i.e. random error on production is zero. Maximum likelihood estimation of conditions stated on the statistical distributions of v and u, makes it possible to calculate conditional mean of ui:

$$e_i = v_i + u_i \tag{3}$$

Measuring Economic Efficiency

Stochastic Frontier Production Model using a Cobb-Douglas function for cassava-producing farmers as:

$$lnY = \beta_0 + \beta_1 lnX_{1ij} + \beta_2 lnX_{2ij} + \beta_{3ij} lnX_{3ij} + \beta_4 lnX_{4ij} + \varepsilon i \tag{4}$$

Where ij refer to ith observation on jth farmer
In = logarithm to base e;
Y = total quantity of cassava cultivated in kilograms
X_1 = the area under cassava produced (hectares)
X_2 = labour in man-days
X_3= Material inputs of cassava stocks
X_4 = fertiliser applied in kilograms
εi = error term ($V_i - U_i$)

Dual cost frontier production function used in evaluation of total cost in production by (Ogundari, 2008; Maurice, 2012) is specified as follows:

$$LnC = \alpha_0 + \alpha_1 LnP_1 + \alpha_2 LnP_2 + \alpha_3 LnP_3 - \alpha_4 LnP_4 - a_5 Y_I + v_i + u_i \quad (5)$$

Such that:

C = Total input cost of production of the cassava farm (₦)

α_0 = intercept or constant

$\alpha_1 - \alpha_5$ = parameters to be estimated

Ln = natural logarithm

P_i = unit price of land (rent) per hectare (₦)

P_2 = unit price of labour in man- days (₦)

P_3 = unit price of cassava stocks per kg. (₦)

P_4 = unit price of fertiliser applied (₦)

Y_i = Is frontier output of cassava of the ith farm (kg)

A multiple regression model based on Stochastic Frontier Cost Function was employed to determine economic efficiency and its determinants of cassava farmers. It applied a single-stage maximum likelihood function estimation procedure of Stata 14. Frontier functions (production and cost) were computed through maximum likelihood methods. It should be noted that this computer programme estimates cost efficiency (CE), which is estimated initially as a reverse of equation 5. Hence, farm-level economic efficiency was derived using:

$$Economic\ Efficiency = \frac{1}{Cost\ Efficiency} \quad (6)$$

The Economic inefficiency model is explicitly specified as:

$$U = \gamma_0 + \gamma_1 Z_1 + \gamma_2 Z_2 + \gamma_3 Z_3 + \gamma_4 Z_4 - \gamma_5 Z_5 - \gamma_6 Z_6 + \gamma_7 Z_7 + \gamma_8 Z_8 \quad (7)$$

Where U is inefficiency indices, Z_1 = Age of farmers in years, Z_2 = Household size, Z_3 = Years of formal Education, Z_4 = Years of farming experience, Z_5 = Household head Status, Z_6 = Access to Extension, Z_7 = off-farm income, Z_8 = Association Membership. It is, however, expected that the entire included explanatory variable should have a direct effect on the inefficiency level of cassava farmers.

Objective 3: In analysing objective three, the study made use of the estimated results of the Cobb-Douglass production model in objective two. The mean economic efficiency of the oil spillage and non-oil spillage groups was used as a baseline that separates cassava farmers who are efficient and those farmers not efficient. The impact of oil spillage on the economic efficiency of cassava farmers was estimated using propensity score matching methods. Propensity score matching examined the impact of farming in oil spillage cassava enterprise on economic efficiency. The method compares the economic efficiency of oil-spillage-affected cassava enterprise households with their counterfactual group that farmed in no - oil-spillage-affected locations.

The propensity scores are estimated with the probit model (Rosenbaum 2023). Predicted propensity scores estimated treatment effect. According to Guo et al, (2020), the average

treatment effect on treated (ATT) is a notable variable in the propensity score matching model. Hence, we employ the ATT to estimate the effects of farming oil spillage affected farmlands on economic efficiency. ATT is calculated as:

ATT= E (T/1=1) = E(Y/1)/D=1) - E (Y (0)/D=1 (8)

Where E(Y/1)/D=1 represents the expected economic efficiency outcome of cassava farmers that farmed in oil spillage-affected farmlands, and E (Y (0)/D denotes the alternative economic efficiency of non-oil spillage-affected cassava farmers. First and foremost, the study generated the economic efficiency results from objective 2 and then profiled the groups of farmers into low efficiency and high-efficiency status using the mean of the economic efficiency. (See Table 4). Results from these tables were then applied for propensity score matching using nearest neighbour and kernel-based matching approach. Matching methods with replacement were employed, which matched each treated observation i, to the control observation j with similar characteristics. The study went further to match the units of variables or covariates using the propensity scores. In doing this, we had to drop 18 observations as stated in Table 6.

Oil spills on cassava farming household welfare were estimated using per capita household expenditure. There are several ways of measuring per capita expenditure which is taken as a proxy for welfare. Following the works of Haughton and Khandker, (2009), per capita expenditure can be estimated as:

$$Per\ Capita\ Household\ Expenditure = \frac{\sum T.E}{N_i} \quad (9)$$

Where T.E is the total expenditure of household i,

N_i is the total number of household members in the adult equivalent scale

$\sum$ represents the sum

The adult equivalent scale (ES_i) was computed following Cockburn (2001)

$$ES_i = 1 + 0.7(Z_i - 1 - K_i) + 0.5 * k_i \quad (10)$$

Where

Z_i represents a number of adults in household i, K_i represents the number of children. Children are defined as persons less than 15 years old, while adults are above 15 years. The welfare baseline is then a measure that divides the low and high welfare status. Using the expenditure approach, two-thirds of mean per capita expenditure separates the population of low welfare status from the rest of the population.

Results and Discussion

Socio-Economic and Demographic Characteristics of Farm Households in Niger Delta

Age distribution of cassava farmers in Table 1 showed that 33.93% of the cassava farmers in oil spill locations were between the age brackets of 50 -54 years, while 14.27% were less than 50 years. Therefore, these age brackets indicate that the majority of the farmers are not young and strong, since they are not in their prime age and will be less productive (Daudu et al, 2023). The sex distribution of the cassava farming population in the oil spill-affected area revealed that 55.4% of the farmers were female, while 44.6% belonged to the male category as shown in Table 2. This gender ratio has further confirmed that both males and females were actively engaged in cassava farming. The result agrees with the work of Udiji et al., (2019), who observed that female farmers contributed significantly to agricultural production in the region. The profile of

respondents by size of household members is shown in Table.3, revealed that the majority of households in oil spill (65.2%) and non-oil spill (68.6%) locations had relatively large household sizes between 5 to 8 persons. Sibhatu and Qaim (2017) stated that although large household size amounts to taking more money for food and clothing from income realised from the farm, they equally provide family labour during planting and harvesting season.

Economic efficiency of cassava farmers in an oil spill and non-oil spill affected. Maximum likelihood estimates in stochastic cost function used in the computation of economic efficiency are presented in Table 4. In oil spill-affected farms, the price of land (rent), fertilizer and planting material were statistically significant at one percent degrees. It therefore implies these factors are important determinants of total cost associated with cassava production. Among variables inputs that were significant, the price of land (rent), fertilizer and price of planting materials were all positively significant. The result means that an increase in the price of these inputs will lead to an increase in total production cost. This result agrees with the work done by Guan *et al.* (2023) who

Table 1: Age Distribution of Household Heads

	Oil Spill Affected Farmers				Non-oil Spill Affected Farmers			
Age of House hold Heads (years)	**Frequency**	**Percentage (%)**	**Mean**	**Standard deviation**	**Frequency**	**Percentage (%)**	**Mean**	**Standard deviation**
≤ 35- 39	0	0	55.75	6.41	6	1.77	49.77	5.59
40- 44	3	2.67			65	19.23		
45- 49	13	11.60			112	33.14		
50-54	38	33.93			87	25.74		
55-59	21	18.75			43	12.72		
60-64	28	25.00			23	6.80		
65-69	9	8.05			2	0.60		
Total	112	100.0			338	100.0		

Source: Computed from field Survey, 2024

Table 2: Sex distribution of household heads

Sex of household heads	Oil spill affected farmers		Non- Oil spill affected farmers	
	Frequency	**Percentage (%)**	**Frequency**	**Percentage (%)**
Male	50	44.6	191	56.5
Female	60	55.4	147	43.5
Total	**112**	**100**	**338**	**100**

Source: Computed from field Survey, 2024

Table 3: Distribution of Household Heads by Household Size

	Oil Spill Affected Farmers				Non-oil Spill Affected Farmers			
Household size (Members)	**Frequency**	**Percentage (%)**	**Mean**	**Standard deviation**	**Frequency**	**Percentage (%)**	**Mean**	**Standard deviation**
1 – 4	29	25.8	6.29	5.7	102	30.2	2.26	1.99
5 – 8	73	65.2			232	68.6		
9 – 12	5	4.5			1	0.3		
13 – 16	5	4.5			3	0.9		
Total	112	100			338	100		
Total								

Source: Computed from field Survey, 2024

Table 4: Analytically-derived Stochastic Frontier Cost Function

	Oil Spill Affected Farms	Non-oil Spill Affected Farms
Variable	Coefficient	Coefficient
Production factor		
Constant	0.0232	0.0016
Price of land (rent)	0.5005	0.6461
Price of labour (wages)	0.0713	0.1208
Price of Planting Material	0.3215	0.1404
Price of fertilizer	0.1067	0.0927
Output (adjusted frontier output)	0.8868	0.9630

Source: Computed from field Survey, 2024.

stated that these factors increased the cost of production of cassava in South West and South East regions of Nigeria. In non-oil spill-affected farms, the price of land(rent), price of fertilizer, and planting materials were statistically significant, which therefore implies that these factors are important determinants of the total cost of cassava production. The frequency distribution of economic efficiency estimates of the oil spill and non-oil spill-affected cassava farmers computed as the inverse of cost efficiency is presented in Table 5. Economic efficiency estimates of oil spillage affected cassava farmers ranged from 0.51 to 0.61. The mean economic efficiency of cassava farmers affected by oil spills is estimated at 0.57, suggesting significant room for improvement specifically, a potential increase of 43% in their economic efficiency. In contrast, non-oil spill-affected cassava farmers exhibit economic efficiencies ranging from 0.54 to 0.65. With an average efficiency of 0.60, these farmers have the opportunity to enhance their economic performance by 40%. As detailed in Table 4, the maximumlikelihood estimates from the cost frontier model illustrate these findings. The parameters for production costs and input prices were carefully derived using relevant input price variables, emphasizing the robustness of these insights.

Table 5: Frequency distribution of Economic Efficiency of farmers

Economic Efficiency Level (%)	Oil Spill Affected Farms	Non-oil Spill Affected Farms
≤ 50	0 (0.00)	0 (0.00)
51 – 60	111 (99.11)	256 (75.74)
61 – 70	1 (0.89)	82 (24.26)
71 – 80	0 (0.00)	0 (0.00)
81 – 90	0 (0.00)	0 (0.00)
91 – 100	0 (0.00)	0 (0.00)
Total	112 (100.00)	338(100.00)
Mean	56.72%	59.76%
Minimum	51.74%	54.14%
Maximum	61.05%	65.07%

Source: Computed from field Survey, 2024

Note: Figures in parenthesis are percentages

Test of Mean Efficiency Difference between Farmers. The test of the mean efficiency difference between cassava farmers in the two areas was accomplished using a t-test of mean difference and the results are presented in Table 6. The test was based on the hypothesis that there is no significant difference between the economic efficiency of the group's oil spill-affected and non-oil spill-affected crop farmers.

Table 6: Summary of test of means for Economic Efficiency.

Group	Observation	Mean	Standard error	t-value
Non-Oil spill	338	59.76	.0009	14.80
Oil spill	112	56.72	.0019	
Combined	450	59.08	.0010	
Difference		.0303	.0028	

Source: Computed from field Survey, 2024

Distribution of cassava farmers by economic efficiency level

In arriving at the groupings of the farmers into the categories of high economically efficient and low economically efficient, the results generated from objective two were used. The mean of economic efficiency of the two groups of farmers was used to determine those farmers who were highly economically efficient and low economically efficient. Table 7 shows the distribution of farmers by economic efficiency level. It revealed that only 17% of the cassava farmers in the oil spillage-affected group had high economic efficiency while the remaining 83% of the farmers had low economic efficiency. Contrary to cassava farmers in the oil spillage group, Table 7 revealed that 67% of the cassava farmers in the non-oil spillage group had high economic efficiency while the remaining 33% of the farmers had low economic efficiency.

Table 7: Distribution of farmers by economic efficiency level

Parameter	Oil Spill Affected Farmers		Non-Oil Spill Affected Farmers	
	Frequency	Percentage (%)	Frequency	Percentage (%)
High Efficiency	19	16.96	228	67.46
Low Efficiency	93	83.04	110	32.54
Total	**112**	**100**	**338**	**100**

Source: Computed from field Survey, 2024

Distribution of cassava farmers by welfare level using mean per capita expenditure. Per-capita expenditure was used as a proxy for welfare in this study. This approach has been used by several researchers and institutions (Ul Mustafa, 2022) as a measure of welfare. Based on this, the welfare threshold was constructed as two-thirds of the mean per-capita expenditure of all farming households following work by Adepoju and Obayelu, (2013). Thus, the computed welfare threshold is ₦136,204 These results are in tandem with the findings ofYamou ((2024) who inferred that farmer in the oil spillage-affected areas suffered poor yield and low income which ultimately affected their welfare status.

Table 8: Distribution of farmers by welfare level

Parameter	Oil Spill Affected Farmers		Non-Oil Spill Affected Farmers	
	Frequency	Percentage	Frequency	Percentage
High Welfare	28	25	310	92
Low Welfare	84	75	28	8
Total	112	100	338	100

Source: Computed from field Survey, 2024

Impact analysis of oil spillage on economic efficiency and welfare of cassava farming households

Table 9 shows propensity score which was estimated through a probit regression was 0.2478. In estimating propensity scores, data collected on covariates were fitted into the probit model and gradually reduced the number until the desired good match was obtained. Finally, influential covariates determining program participation were retained. A common support condition (Fig.4.1) was then imposed and a balancing property was set.

Table 9: Predicted Propensity Score (P score)

Variable	Observation	Mean	Standard Deviation	Minimum	Maximum
P score	417	0.2478	0.1993	0.0146	0.9455

Source: Computed from field Survey, 2024

Table 10: Propensity score match showing treatment assignment and common support

Treatment assignment	Off support	On support	Total
Untreated	16	322	338
Treated	2	110	112
Total	18	432	450

Source: Computed from field Survey, 2024

Table 11: Distribution of observational bias

Sample	Pseudo R^2	LRχ2 (ρ-value)	Mean bias
Unmatched	0.186	94.19 (0.000) ***	31.0
Matched	0.016	4.77 (0.782)	7.1

Source: Computed from field Survey, 2024

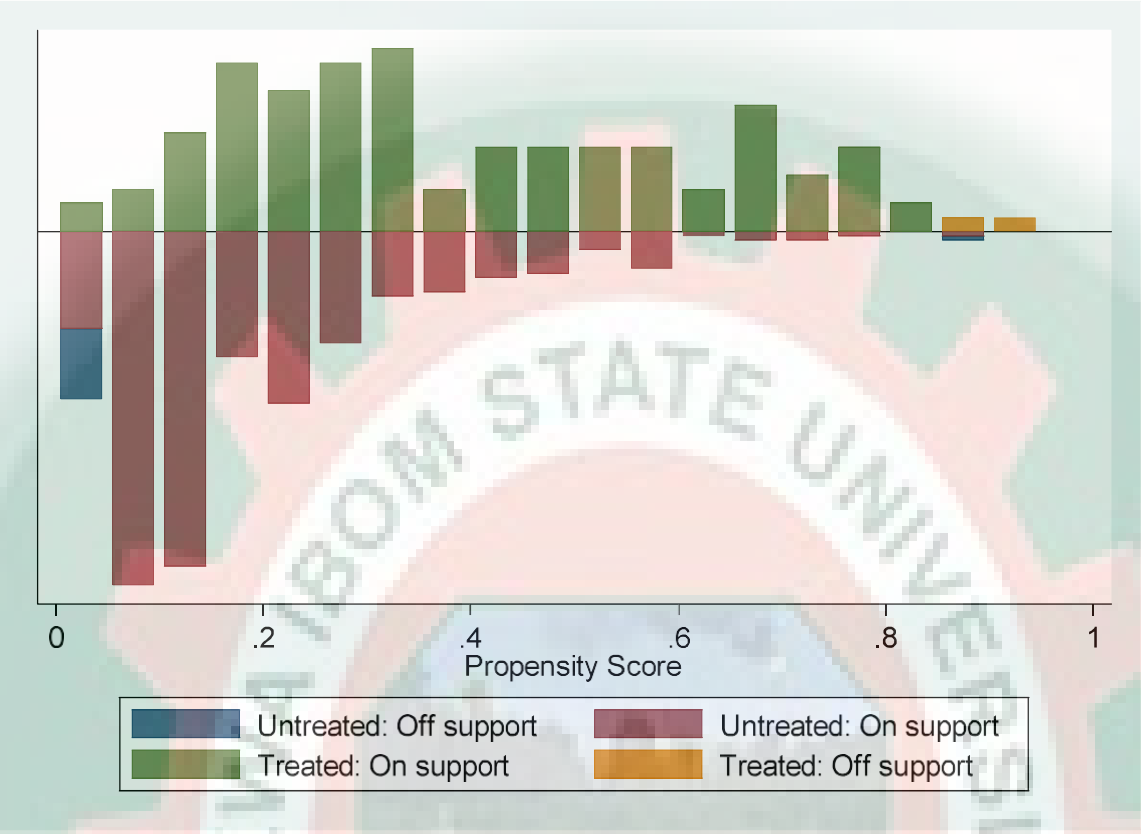


Figure 1. Common Support for Propensity Score Match (p score)
Source: Computed from field Survey, 2024

The last test carried out was common support as shown in (Figure 4.1) above. It is a visual representation of propensity scores. The above graph shows density distributions of propensity scores for oil spillage-affected farmers and non-oil spillage-affected farmers. There was a considerable (good) overlap which shows that the matching estimate was good. The three criteria used in assessing the quality of the match thus confirm that the match was good. Thus, the next stage is to evaluate the impact of economic efficiency and welfare of cassava farmers having similar observed characteristics. The outcome variables are the economic efficiency and welfare indexes of farmers in both oil-spilled locations and those not affected by oil spills.

Impact of oil spillage on economic efficiency of Cassava farmers

The impact of oil spillage on economic efficiency was estimated using the two most adopted matching methods, Nearest Neighbour Matching and Kernel-Based Matching (NNM and KBM) in the literature. Results are shown in Table 12.

Impact of oil spillage on the welfare of cassava farming households

Table 13 shows a significant negative impact of oil spillage on welfare. This reflects the average welfare difference between similar pairs of cassava-based farming households with different farming option statuses, underscoring the urgent need to address oil spillage to improve their livelihoods. Specifically, NNM and KBM causal effect of farming on oil spillage affected land

on welfare suggests that welfare of farmers that farmed on oil spilt affected location were lowered by ₦44, 103.55 – ₦45, 861.67 than those farmers not affected by oil spillage. NNM and KBM showed that farming on oil spillage-affected land exerted a negative and significant effect on the probability of welfare through a reduction of per capita household expenditure between

Table 12: Impacts of Oil Spill on Average Treatment on Treated (ATT), Average Treatment on Untreated (ATU) and Average Treatment Effect (ATE) – Economic efficiency

Variable	Sample	Treated	Controls	Difference	Standard Error	T-ratio
Efficiency	Unmatched	0.5672	0.5976	-0.0304	0.0020	-14.80
Index	ATT	0.5669	0.5992	-0.0323	0.0027	-11.73
KBM	ATU	0.5979	0.5627	-0.0353	-	
	ATE	-	-	-0.0345		
Efficiency	Unmatched	0.5672	0.5976	-0.0304	0.0020	-14.80
Index	ATT	0.5669	0.6001	-0.0332	0.0030	-10.90
NNM	ATU	0.5979	0.5665	-0.0315	-	
	ATE	-	-	-0.0319		

Source: Computed from field Survey, 2024.

Table 13: Impacts of Oil Spill on Average Treatment on Treated (ATT), Average Treatment on Untreated (ATU) and Average Treatment Effect (ATE) on Welfare

Variable	Sample	Treated	Controls	Difference	Standard Error	T-ratio
Welfare	Unmatched	145306.13	204672.40	-59366.27	10995.64	-5.40
Index	ATT	146110.94	190214.48	-44103.55	15306.37	-2.88
KBM	ATU	204525.07	136814.15	-67711.55		
	ATE			-61700.26		
Welfare	Unmatched	145306.13	204672.40	-59366.27	10995.64	-5.40
Index	ATT	146110.94	191972.61	-45861.67	15435.67	-2.97
NNM	ATU	204076.07	131035.70	-73040.37		
	ATE			-66135.85		

Source: Computed from field Survey, 2024

₦44. 103.55 and ₦45, 861.67. These results comply with the findings of Ojimba*et al,* (2012). Average growth rates of per capita expenditure of farmers differ significantly among program participants and non-participants of farmers in oil spillage locations and those farmers that farmed in non-oil spillage locations.

Conclusion and Recommendations

It is pertinent to note that the quest to bridge the gap between cassava production and a sustainable environment has been compromised by pollution of farmlands in the Niger Delta region of Nigeria as revealed by this study. This study focused on providing an answer to the question of how much impact oil spillage has had on cassava farming households' economic efficiency and welfare and by extension how oil spillage has contributed to the food challenge in the Niger Delta region of Nigeria. More females should be encouraged into farming in the oil spill-affected location through schemes such as the FADAMA programme. Farmers, through farm input subsidies from the government or bulk purchases from farmers' Cooperative ventures, should be encouraged. Moreover, farmers in affected locations by oil pollution could assess more

land through remediation and farmers in oil-polluted locations should seek additional means of livelihood by diversifying their sources of income.

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