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Poverty and Stochastic Dominance Comparison Using Educational Status of Crude Oil Polluted Crop Farms in Rivers State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author OTP designed the study, managed the literature searches, performed the statistical analysis and wrote the first draft of this manuscript. Authors VOO and BTO managed and supervised the statistical analysis of this study and were also involved in the literature searches and editing of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

This study focused on poverty and stochastic dominance comparisons using educational factors in crude oil polluted and non-polluted crop farmer households in Rivers State, Nigeria. Data were collected using multistage sampling technique, via 296 questionnaires from crop farmers in selected 17 local government areas (LGAs) of the state. Analytical tools used were FGT poverty measures and stochastic poverty dominance. The results of this study showed that incidence of poverty (P_0) were higher in crude oil polluted crop farmer households (58.8% - 100%) as compared to non-polluted crop farmer households (40.1% – 66.7%), significant at 1%. The results also indicated that poverty gap (P_1) in crude oil polluted category was slightly higher (6.3% - 13.9%) as compared to

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7.3% - 13.4% in non-polluted crop farmer households (significant at 5%). The range of poverty severity (P_2) in crude oil polluted was higher (0.9% - 4.6%) as compared to 0.7% - 4.1% in non-polluted crop farmer households (significant at 1%). The stochastic poverty dominance results confirmed that there was high rate of incidence of poverty (P_0) in Rivers State, Nigeria as all educational sub-groupings first order stochastic dominance (FSD) conditions failed. However, the results revealed, there was higher poverty gap (P_1) and poverty severity (P_2) experienced among crude oil polluted crop farmer households than in non-polluted, as majority of the distribution curves were unambiguous at the second (SSD) and third order stochastic dominance conditions (TSD). In conclusion, there was high level of headcount poverty in the state. However, there was more high level of poverty (at P_0, P_1, P_2 measures) in crude oil polluted than in non-polluted crop farmer households as at time of survey in 2003 using the educational variables applied in this study. This could have been as a result of crude oil pollution on crop farms.

Keywords: Stochastic poverty dominance; FGT measures; educational sub-groupings; crude oil pollution; crop farmer households; Rivers State Nigeria.

1. INTRODUCTION

Niger Delta, Nigeria's oil belt, is home to oil and gas industry, with proven reserves. However, oil and gas have not brought the prosperity, better living conditions and governmental attention and development desired by the indigenous population of Niger Delta [1]. Rather, the industry has been accompanied by instability, insecurity, conflict, violence, crime and social tensions [2,3]. This region is characterized by the absence of infrastructure, social services, non-oil industries and even the petroleum products produced in the area. Infact, there is widespread neglect, social and economic under development in the zone. Educational facilities are inadequate in the rural communities of the Niger Delta. There is economic poverty in this region and other parts of the country [1,4] inspite of the huge revenue accruing from the petroleum industry into Nigerian economy.

Poverty is a persistent challenge to infrastructural development in Nigeria and other developing countries. According to [4] about 92.4% of the Nigerian population live in poverty on less than $2 per day, while 70.8% of the populace in Nigeria suffer extreme poverty, living on less than $1 per day [4,5]. Studies on Niger Delta region have shown that crude oil and gas exploration, exploitation and production activities have adversely affected agriculture and natural resources, more especially land and soil resources, aquatic lives and fisheries, crops, water resources, livestock, forests and vegetation [6,7,8,9]. Therefore, crude oil and gas exploration in Nigeria has generated a lot of environmental problems and poverty in the Niger Delta region. The Niger Delta region lies at the southern tip of Nigeria and is occupied by the following states: Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo, and Rivers States.

Education has the effect of enabling households in accessing and conceptualizing information on good farming methods, accessing better paying rural labour market and capable of profitably, combining various enterprises. Education provides important indicators of household welfare and that raising poor household's access to education is likely to have beneficial effects on poverty alleviation and income distribution over the long run, especially among small holder farmers in Kenya [10]. Education is an asset for adoption of decisions. Thus, increased education was associated with increased adoption of farm technologies in Imo State, Nigeria [11].

Kurosaki and Hussain [12] in their study on the potential of human capital in over coming two symptoms of poverty (low income and vulnerability to income risk) in Pakistan found that education played an important role in overcoming the two symptoms through expanded opportunities of non-farm employment. According to [13], literacy of household head, and years of education of adults are significant determinants of household welfare and thus potential pathways for reducing poverty. They further said that for expansion of cultivated land, particularly irrigated land, universal literacy, and an extra school year for adults, all helped to reduce poverty in small holder agriculture in Ethiopia.

Therefore, the problem of this study is to compare poverty levels in crude oil polluted and non-crude oil polluted crop farms in Rivers State, Nigeria using the educational status of household heads. Statistical tools to be used to achieve this

aim are the stochastic dominance analysis and poverty measurement indexes.

There is dearth in literature on stochastic poverty dominance comparison using educational status of crude oil polluted and non-polluted crop farmer households in Rivers State, Nigeria. However, there are literature on educational statistics comparing adult, youth, primary and secondary schools literacy rates among the different zones of Nigeria, with specific reference to south-south (Niger Delta) zone, as oil and gas producing area [1,4]. Also, the use of educational variables in poverty comparison in Nigeria had been studied by [14,15]. Other studies using education to compare poverty include [16,17,18,19,20]. There are studies on poverty measures and stochastic dominance analysis using educational variables [21,22,23,24].

None of these articles cited above, had worked on this research topic of measuring poverty and using stochastic dominance tests to compare the level of poverty in crude oil polluted and non-polluted crop farmer households in Rivers State, Nigeria. Therefore, there is the need for this study to be investigated.

The main objective of this study is to measure and compare poverty and stochastic dominance analyses using educational status variables in crude oil polluted and non-polluted crop farmer households in Rivers State, Nigeria. The specific objectives include to:

(i) Measure and compare poverty among crop farmer households in crude oil polluted and non-polluted areas in Rivers State Nigeria, using their educational status.
(ii) Estimate and compare stochastic poverty dominance in crop farmer households, focusing on their educational status, in crude oil polluted and non-polluted areas of Rivers State, Nigeria.
(iii) Suggest policy recommendations on how crop farmers could ameliorate the detrimental effects of crude oil pollution on their crop farms.

An appraisal of the adequacy of the farm support services offered host communities by petroleum producing companies in Niger Delta with focus on Rivers State, Nigeria was studied by [25]. It was observed that the farm support services rendered to the host communities were not adequate enough to ginger higher farm productivity and income. Similarly in assessing the development efforts made by oil companies as perceived by rural households in selected crude oil producing communities of Rivers State, Nigeria [26] found out that 50% of their respondents agreed that developmental efforts were inadequate and ill – distributed to meet the expectations of the people, while about 90.8% of these same respondents disagreed that the host communities were highly satisfied with these oil and gas companies developmental efforts, hence the spread of poverty despite the abundance of crude oil in Rivers State, Nigeria.

In examining the crippling poverty situation existing side-by-side with Corporate Social Actions (CSAs) of oil and gas corporations in the Niger Delta region of Nigeria, [4] showed that poverty indicators were worse in the Niger Delta area (south – south zone), where petroleum oil corporations claim to embark on corporate social actions (CSAs) than in other geo-political zones of the country, where there is no oil exploration activities. Using education as a parameter, [4] observed that the Niger Delta trailed behind the south-west and south-east in access to, net enrollment and completion rates in primary and secondary schools education, despite the presence of CSAs in the region. The results were similar in the assessments of youth and adult literacy parameters.

Bello et al. [14] had indicated that the level of education of the inhabitants of Asa and Ilorin West LGAs of Kwara State determined their level of enlightenment in line with what they do for a living and realization of the importance of different government policies.

In investigating the effects of education on farm and non-farm productivity in rural Pakistan [27] allowed the effects of education to differ from each level of education attained. The results showed that returns to male education were significantly positive in outside labour markets for non-agricultural work, with acceleration in reward as the education level goes up; the effects of primary school education on crop productivity were significantly positive but with no additional gain from higher education. These results implied that more educated household members had comparative advantages in non-farming.

The impact of growth on poverty was analyzed by [17] and the results showed that primary education played a more important role in improving welfare of farmers in urban than in rural areas of Ethiopia. Similarly, [18] showed

that the probability of being poor in 2002 for households whose head had attended primary school reduced by 11% compared to those whose head had no education in Malawi. Multi dimensional measurements of poverty in sub-Sahara Africa were estimated by [19] and the results showed that decomposition of poverty by dimension indicated that lack of schooling was the key contributor to multidimensional poverty.

In analyzing pathways in breaking the poverty trap in Ethiopia [13] observed that literacy of the household head and years of education of adults were some significant determinants of household welfare, thus potential pathways for reducing poverty. Their findings called for simultaneous investments in education as a policy support measure for reducing poverty in small holder agriculture in Ethiopia.

The Foster-Greer–Thorbecke (FGT) class of decomposable poverty measures were reviewed by [28] saying subsequent researches had concluded that the indices were closely linked to stochastic dominance and provided a unifying structure linking poverty, inequalities and well being. The authors said the measures have become the standard for international evaluations of poverty and are the basis for a growing statistical literature on stochastic dominance and multi-dimensional dominance tests. The FGT paper contributed to poverty measurement by developing a parameter class of measures having certain desirable characteristics, and one that policy makers could understand. Furthermore, they said a stochastic dominance approach to poverty has been developed to understand when poverty comparisons agree over a range of poverty lines, or when many different poverty measures agree.

Stochastic dominance is a term which refers to a set of relations that may hold between a pair of distributions [29]. In order to determine whether a relation of stochastic dominance holds between two distributions, the distributions are first characterized by their cumulative distribution function, or CDFs. In [22] stochastic dominance was applied to a series of regionally representative Kenya household survey data to compare distribution of welfare levels across groups overtime testing the robustness of changes in poverty. The study found out that first order poverty dominance (FSD) held for the years 1994 and 1997 meaning that poverty in 1994 was lower than in 1997. The authors noted that given the findings of first order dominance, there was no need to search for second or third order dominance since a finding of any degree implies that higher degrees of dominance must also hold.

Characterizing weights in the measurement of multidimensional poverty using Cameroonian data, [30] results showed that the stochastic dominance tests indicated that the principal components analysis (PCA) dominated the multiple correspondence analysis (MCA) meaning that overall poverty (headcount) index based on PCA was less than the other indices.

Robust multidimensional poverty comparisons were made in the Democratic Republic of Congo [21] and the results revealed that children were educationally deprived upto 22.62%. This implied that 22.62% of the children aged 6 through 17 years had never attended school and did not go to school as at 2007. The situation was dire for female children living in the rural arrears. Indeed, there was at least 7.71% difference between the percentages of female children education deprived than male children in the rural areas.

Poverty measures and stochastic dominance tests were used to estimate growth and distribution in Tanzania [23]. The authors stated that whether an individual is literate or illiterate was an important attribute that influenced the level of welfare in Tanzania. A literate individual is relatively in a better position to be exposed to new ideas of doing things and becoming more productive. Thus, it is more likely that a literate individual will be better off than an illiterate one. Poverty indices results showed that households headed by literate individuals are relatively well off compared to households headed by illiterate individuals. The headcount index for heads decreased substantially from 50% in 2000 to 37% in 2007. Their results further indicated that poverty decreased with higher level of education. They concluded that the difference in poverty indices between primary education and higher education was very large.

In their study of robust estimates of changes in poverty and inequality in post – independence Namibia, [24] applied the framework of stochastic dominance test. The results revealed a significant decrease in the poverty headcount over the period. There was a strong inverse relationship between the level of education of head of household and the incidence of poverty. Poverty levels remained highest among

individuals in households where the head had no formal education (61%) or only primary education (45%). Among households where the head had completed secondary education, the incidence of poverty was much lower (19%), and among those who had completed tertiary education, poverty was almost non – existent (2%).

2. MATERIALS AND METHODS

2.1 Data Collection

This study was conducted in Rivers State, Nigeria, for about nine months (from August 2002 to April, 2003). The state is located in the southern tip of the Niger Delta region of Nigeria and is characterized by two distinct seasons; wet and dry, which favour the production of many tropical crops. Total precipitation ranges from about 3000 mm in the north to 5000 mm at the coast [31]. This gives rise to a high degree of run-off which results in severe flooding during the rainy season [32]. In case of oil spillage at this period, the crude oil could spread to many areas of the state in no time, devastating farmland, forests, mangroves, rivers, seas and estuaries.

Data were collected from both the primary and secondary sources. Primary data collection was through personal interviews and observations with the crop farmers, and structured questionnaires which were distributed among crop farmers in crude oil polluted and non-crude oil polluted areas of an affected community in Rivers State, Nigeria.

The sampling techniques used in obtaining data for this study was the multistage sampling procedure. Crude oil production, exploration and exploitation activities are wide spread throughout the 23 Local Government Areas (LGAs) of Rivers State. The first stage of the multistage sampling procedure involved the selection of seventeen (17) LGAs out of the existing 23 LGAs in the state. The reason for the selection of these 17 LGAs was because they were more crop production inclined than others. The second stage involved the stratification of crop farms in selected LGAs into two sampling units, namely crude oil polluted and non-crude oil polluted, so as to obtain necessary information.

The third stage was the random sampling of ten (10) crop farmers from crude oil polluted areas in a selected LGA and a corresponding number of ten (10) crop farmers from non-crude oil polluted areas in the same locality or community in the chosen LGA. This gives a total of 340 crop farmers interviewed and/observed in the selected 17 LGAs of Rivers State, Nigeria. However, due to difficult terrain, the politicking of crude oil pollution issues, youth restiveness in the state as at the time of the survey and some questionnaires being inconsistent with the set objectives of the study, only 296 questionnaires were retained as suitable for analysis of which 169 questionnaires where retrieved from the crude oil polluted crop farms and 127 from the non-polluted crop farms.

Table 1 showed the distribution of interviewed respondents, and questionnaires of respondents found consistent with the set objectives of the study.

Table 1. The distribution of sample size among the sampled LGAs in Rivers State, Nigeria

S/no	Local government area selected	Sample size
1	Abua/Odual	20
2	Ahoada East	20
3	Ahoada West	20
4	Andoni	20
5	Asaritoru	16
6	Degema	10
7	Eleme	17
8	Emohua	20
9	Etche	20
10	Gokana	20
11	Ikwerre	19
12	Khana	18
13	Obio/Akpor	14
14	Ogba/Egbema/Ndoni	20
15	Omuma	11
16	Oyigbo	15
17	Tai	16
	Total	296

Source: Field survey, 2003

2.2 Methods of Analysis

The following methods of analysis were used in the study. Measurement of poverty and stochastic poverty dominance analysis.

2.2.1 Measurement of poverty

This study in measuring poverty focused on the three main measures, all of which are members of the class of measures proposed by Foster,

Greer and Thorbecke [33]. They are: The headcount index [H], the poverty-gap index (PG), P_2 measure (severity of poverty). This FGT paper has played a central role in several thriving literatures, and has contributed to the design, implementation, and evaluation of prominent development programmes [28]. However, rather than treat these as alternative measures, they had been interpreted as measures of three different things; the headcount index is a measure of the prevalence of poverty (P_0), the poverty-gap index is a measure of the depth of poverty (P_1), while the P_2 measures the severity of poverty [22,24,34].

The headcount has $\propto$ = 0, while $\propto = 1$ is for PG and $\propto$ = 2 for P_2. For both the poverty – gap index P_1 and P_2, the individual poverty measure is strictly decreasing in the living standard of the poor (the lower the standard of living the poorer you are deemed to be). Furthermore, P_2 has the property that the increase in your measured poverty due to a fall in standard of living will be deemed greater the poorer you are.

The FGT formula that is normally, used to measure overall poverty is shown in equation (1) in discrete terms, [22,28,34,35]

$$P\alpha = \frac{1}{N}\sum_{i=1}^{q}\left(\frac{z - yi}{z}\right)^{\alpha} \quad i = 1, 2, \ldots\ldots\ldots, q \ \ldots\ldots \quad (1)$$

Where,

- $P\alpha$ = weighted mean poverty index
- q = the number of households in poverty
- y = the per adult equivalent expenditure of household.
- z = the poverty line
- α = 0, 1, 2 (i.e. the degree of concern for the depth of poverty).
- N = Total number of households surveyed (296 samples).

We can now demonstrate the decomposable property of $P\alpha$ as this study considered educational sub-groupings. We considered the population split into m sub-groups with populations ni, where i = 1, ….,m

The authors [36] observed that

$$n = \sum_{i=1}^{m} ni \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

where,

- n = total number of respondents sampled
- ni = number of respondents in each sub group
- m = number of sub-groupings.

The FGT class of measures can be written [34]

$$P\alpha = \sum_{i=1}^{m} \frac{P\alpha i\, ni}{n} \ldots\ldots\ldots\ldots\ldots \quad (3)$$

where,

- Pα = weighted mean poverty index, α = 0, 1, 2.
- $P\alpha i$ = weighted mean of the sub-group poverty index

The index $P\alpha i$ gives, for each sub group i containing n_i persons, the measure described in equation (3)

$$P\alpha i = \frac{1}{n_i}\sum_{j=1}^{q\ j}\left(\frac{z - y_{ij}}{z}\right)^{\alpha} \ldots\ldots\ldots \quad (4)$$

where,

- $z - y_{ij}$ = the poverty gap for the jth household in the subgroup i.
- qj = the number of households in sub-group in poverty.
- j = 1,2, ……., qj.

Thus, by an appropriate choice of α, the measure confirmed to satisfy the desired axioms when aggregate poverty is decomposed by subgroups.

2.2.2 Stochastic poverty dominance

Stochastic poverty dominance testing is a power tool for assessing whether poverty has increased overtime as a result of some policy reform. The test is robust to many of the measurement problems that routinely confound such poverty assessments [28]. In stochastic dominance continuous distributions, first we define the three poverty measures. The cumulative distribution function is defined by [29,34] and modified by this study as:

$$F(y) = \int_{o}^{y} f(x)dx \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

which is the probability of observing someone with a standard of living less than y (where f(x) is the probability of observing a living standard indicator with the value x). Letting z denote the poverty line, the general class of FGT poverty measures can be written in the form:

$$P\alpha(z)=\int_0^z (I - x/z)\ \alpha\ f(x)dx \quad \ldots\ldots \quad (6)$$

The headcount index $P_{0\ (z)}$ is then obtained when $\alpha = 0$, when α = 1, equation (6) becomes the poverty – gap index, $P_{1\ (z)}$, while when $\alpha = 2$, it is the distribution sensitive measure $P_{2\ (z),}$ etc.

Suppose we do not know the poverty line z, but we can be sure that it does not exceed $Z^{max.}$, nor do we know the poverty measure, but we can identify some desirable properties for such a measure, including the additivity property. Then it can be shown that poverty will unambiguously fall between the two groups of crop farms, if the poverty incidence curve (the cumulative distribution) for the group of crop farms B (unpolluted) lies no where above that of the other group of crop farms A (polluted), up to Z^{max}. This is the First Degree Stochastic Dominance condition (FSD) as applied to poverty.

When we plot the cumulative frequency distribution (cumulative percentages of the population below various consumption expenditure levels) in group of crop farms A and B, we find that the curve for A (polluted crop farms) is everywhere above that of B (unpolluted crop farms, poverty is higher in group of crop farms A than in B, no matter what is the poverty line or measure.

If the curves intersect (and they may intersect more than once), then the ranking is ambiguous. Then we know that some poverty lines and some poverty measures will rank the distributions differently to others. We need more information. One can restrict the range of poverty lines, or one can impose more structure on the poverty measure.

If one restricts attentive measures which do reflect the depth of poverty such as P_1 and P_2 (but excluding the headcount index) then we can use a Second Degree Stochastic Dominance condition (SSD). A fall in poverty then requires that the poverty deficit curve, given by area under the cumulative distribution, is no where lower for the group of polluted crop farms (A) at all points up to the maximum poverty line, and at least somewhere higher.

When this test is inconclusive, one can further restrict the range of administrative poverty measures. If one is content to rely solely on distribution sensitive measures such as P_2 (but excluding P_0 and P_1), then a Third Degree Stochastic Dominance condition (TSD) can be tested. An unambiguous poverty comparison for all poverty lines then required that the poverty severity (P_2) curve is everywhere higher in one of the two situations being compared. If necessary, one can go on to test higher degree dominance (P_3) though the interpretation of the increasingly restricted class of measures becomes less clear. Amongst the FGT class, the fourth degree dominance test restricts attention to $P\alpha$ measures for values of α =3 or higher [34] and that was observed in this study.

3. RESULTS AND DISCUSSION

3.1 Measurement of Poverty by Educational Status of Household Head

The educational status of a household head affects the poverty level of a household. It is expected that the lower the educational attainment of the household head, the higher the family's likelihood to be poor. Table 2 presents the measures of poverty by educational status of household heads decomposed as: no schooling (illiterate), primary school attempted and/or completed, secondary school attempted and/or completed, National Certificate of Education (NCE), Ordinary National Diploma (OND) Certificate holders, first degree holders Bachelor of Science (B.Sc) / Arts (B.A), Bachelor of Education, (B.Ed) and Higher National Diploma (HND) Certificate and Postgraduate degree holders in all crop farms surveyed, crude oil polluted crop farms and non-crude oil polluted crop farms in Rivers State, Nigeria.

The results on Table 2 showed that in all crop farms surveyed category, majority of the poor households were those respondents who were illiterates (no schooling), primary and secondary schools attempted and/or completed groups. These constituted 40.2% out of the 57.09% of the poor households. Also shown on Table 2 are the results of different FGT measures of poverty and their contributions to overall poverty incidence (P_0), depth (P_1) and severity (P_2). The headcount proportion showed that poverty was prevalent in all groups of educational status identified in this study. The secondary school attempted and/or completed group had the lowest P_0 value of 53.2% but contributed more than 35% of the overall poverty and was significant at 1%. The postgraduate educational status grouping had the highest P_0 value of 66.1% but contributed only 2.43% of overall

poverty (significant at 5%). The NCE/OND equivalent grouping had a P_0 value of 59.6% but contributed significantly to the overall poverty, 25.10% (significant at 1% level,) while the B.Sc /B.Ed/HND educational grouping had a P_0 value of 54.3% (second lowest value) but contributed up to 19.23% to the overall poverty (statistically significant value at 1%).

The poverty gap (P_1) measure showed that poverty was deep among the post graduate household heads (16.9%), though not statistically significant and contributed only 3.53% to overall poverty. The NCE/OND and equivalent certificate holders had a P_1 value of 12% and contributed about 29.14% of overall poverty (statistically significant at 1%) to the depth of poverty.

At the P_1 measure, the secondary school group had a value of 8.7% with a contribution of 33.07% (significant at 1%).

The severity of poverty (P_2) was shown to be high among the post graduate household heads with a value of 7% though its contribution to overall poverty was the lowest in this measure (5.28%) and was not statistically significant. The highest contributions to overall poverty in P_2 measure were from the NCE/OND and equivalent certificate holders (33.87%) and secondary school certificated household heads with a value of 31.89% (both statistically significant at 1%). Comparing the poverty levels in the educational groupings, the secondary school and NCE/OND equivalent household heads contributed more to the overall poverty level in all FGT measures studied (i.e. from 31.89% - 35. 22% and 25.10% - 33.82%) respectively.

Table 2 further showed that in crude oil polluted crop farm households category, the percentage frequency of poverty affecting household heads with various levels of education attained was about 64.55%, while 35.45% were not poor. The proportion of concentration was highest in the secondary school (27.56%), primary school (11.02%) and no schooling (illiterates), 7.87%, all accounting for about 46.45% out of the total of 64.55% for this category of crop farms. For the poverty headcount measure (P_0), there was absolute poverty value of 100% at the post graduate grouping of the household heads, though they contribute only 4.80% of overall poverty (significant at 1%).

Illiterate grouping had headcount of 62.5% dominance in poverty (significant at 1%). The P_0 ratio results also showed that 67.3% of the secondary school leavers were prevalent in poverty and contributed 42% of the overall poverty in this measure and category of crop farms (statistically significant at 1%). About 63.5% of the primary school leavers, 61.1% of the B.Sc/B.Ed/HND graduates had incidence of poverty, with 22.0% as its contribution to overall poverty (statistically significant at 1%).

At the P_1 measure, 13.9% of the post graduate household heads were deep in poverty, though contributed only 4.44% of the overall poverty (significant at 5%). The NCE/OND graduates household heads had 11.1% depth in poverty and they contributed 20.16% of overall poverty. The highest contributor to overall poverty was the secondary school leavers (45.31%) while about 10.9% of them were deep in poverty (P_1) in crude oil polluted crop farms.

Poverty was more severe (P_2) in the NCE/OND graduate household heads (4.7%), with contributions of 29.16%, significant at 10%. The severity of poverty (P_2) value showed that about 3.2% of the secondary school leavers were severely poor (significant at 1%) in the crude oil polluted crop farms. However, these contributed the highest quota of 45.58% to the overall poverty in the P_2 measure. Again, the secondary school leavers and NCE/OND equivalent graduands were the highest contributors to overall poverty (i.e. from 42.0% - 45.58% and 16% - 29.16% respectively), and had the highest percentage of members held in incidence, deep and severe poverty conditions when compared to other educational status used in crude oil polluted crop farms category.

In the non-polluted crop farms category, the results on Table 2 showed that 51.48% of the respondents were categorized as poor, while 48.52% were non – poor. Out of these poor household heads, about 35.5% of the 51.48% were secondary, primary school and illiterate household heads. In the headcount (P_0) measure, no schooling group had 66.7% of its members held in incidence of poverty contributing 8.26% to overall poverty. The primary school leavers household heads had 58.6% of its respondents engulfed in incidence of poverty (both were statistically significant at 1% level). The highest contributions were made by secondary school leavers (28.51%) and NCE/OND graduates (28.10%) and both were statistically significant at 1% level.

Table 2. Measure of poverty using educational status of household head in Rivers State, Nigeria

Educational status of household head	Percentage frequency of poverty			Head-count of poverty	Contribution to overall P_0 (%)	Poverty Gap (P_1)	Contribution to overall P_1 (%)	Poverty severity (P_2)	Contribution to overall P_2(%)
	Poor	Non-poor	Total						
All crop farms surveyed									
No schooling (Illiterate)	10.14	5.41	15.55	0.630***	5.87	0.110***	5.93	0.032***	6.18
				(0.71)	(1.14)	(0.021)	(1.48)	(0.010)	(2.22)
Primary school	10.47	6.76	17.23	0.588***	12.15	0.090***	10.65	0.020***	8.30
				(0.069)	(2.19)	(0.015)	(2.37)	(0.004)	(2.37)
Secondary school	19.59	17.22	36.81	0.532***	35.22	0.087***	33.07	0.023***	31.89
				(0.048)	(3.88)	(0.012)	(4.83)	(0.005)	(6.34)
NCE/OND Equivalent	9.12	8.45	17.87	0.596***	25.10	0.120***	29.14	0.039***	33.87
				(0.068)	(3.82)	(0.022)	(5.33)	(0.010)	(7.59)
B.Sc/B.Ed/HND	6.76	5.07	11.83	0.543***	19.23	0.087***	17.68	0.020***	14.48
				(0.084)	(3.82)	(0.019)	(4.35)	(0.007)	(5.13)
Postgraduate	1.01	0.00	1.01	0.667**	2.43	0.169	3.53	0.070	5.28
				(0.273)	(1.69)	(0.118)	(3.12)	(0.056)	(5.00)
Total / Average	57.09	42.91	100	0.563***	100	0.098***	100	0.027***	100
Crude oil polluted crop farms									
No schooling (Illiterate)	7.87	4.74	12.61	0.625***	4.00	0.093**	3.95	0.035	5.03
				(0.122)	(1.31)	(0.041)	(2.01)	(0.024)	(3.77)
Primary school	11.02	6.30	17.32	0.636***	11.20	0.095***	11.12	0.026**	10.22
				(0.103)	(2.97)	(0.028)	(3.96)	(0.012)	(5.38)
Secondary school	27.56	13.39	40.95	0.673***	42.00	0.109***	45.31	0.032***	45.58
				(0.065)	(5.78)	(0.020)	(7.97)	(0.009)	(12.16)
NCE/OND Equivalent	7.87	5.51	13.38	0.588***	16.00	0.111**	20.16	0.047*	29.16
				(0.120)	(4.61)	(0.045)	(8.08)	(0.028)	(14.11)
B.Sc/B.Ed/HND	8.66	5.51	14.17	0.611***	22.00	0.063***	15.02	0.009***	7.38

Educational status of household head	Percentage frequency of poverty			Head-count of poverty	Contribution to overall P_0 (%)	Poverty Gap (P_1)	Contribution to overall P_1 (%)	Poverty severity (P_2)	Contribution to overall P_2(%)
	Poor	Non-poor	Total						
				(0.115)	(5.64)	(0.017)	(5.11)	(0.003)	(3.47)
Postgraduate	1.57	0.00	1.57	1.000***	4.80	0.139**	4.44	0.024*	2.63
				(0.000)	(3.29)	(0.049	(3.44)	(0.014)	(2.42)
Total/Average	64.55	35.45	100	0.648***	100	0.097**	100	0.029*	100
Non-polluted crop farms									
No schooling (Illiterate)	11.83	5.92	17.75	0.667***	8.26	0.127***	8.51	0.033***	8.47
				(0.086)	(1.96)	(0.024)	(2.34)	(0.009)	(2.83)
Primary School	10.06	7.10	17.16	0.586***	14.05	0.134***	17.39	0.041***	20.16
				(0.091)	(3.35)	(0.028)	(4.59)	(0.012)	(6.31)
Secondary School	13.61	20.12	33.73	0.404***	28.51	0.086***	32.85	0.026	37.26
				(0.065	(5.18)	(0.018)	(6.51)	(0.07)	(8.48)
NCE/OND Equivalent	10.06	10.65	20.71	0.486***	28.10	0.084***	26.33	0.020***	23.86
				(0.085)	(5.63)	(0.019)	(6.28)	(0.005)	(6.80)
B.Sc/B.Ed/HND	5.33	4.73	10.06	0.529***	18.60	0.073***	13.81	0.014**	9.91
				(0.121)	(5.40)	(0.022)	(4.97)	(0.006)	(4.68)
Post Graduate	0.59	0.00	0.59	0.401	2.48	0.082***	1.11	0.007***	0.34
				(0.590)	(2.44)	(0.010)	(1.11)	(0.000)	(0.34)
Total/Average	51.48	48.52	100	0.493***	100	0.091***	100	0.024***	100

Source: Field survey, 2003. *Asterisks indicate significance levels. ***1%, **5%, *10%. Figs. in parentheses are standard error*

In the poverty gap (P_1) measure, the primary school leavers (13.4%) and illiterates accounted for 12.7% of members who were deep in poverty (both statistically significant at 1%). The highest contributory groups to the depth of poverty were the secondary school leavers (32.85%) and NCE/OND graduates (26.33%), both significant at 1% level, respectively.

Analyzing poverty severity measure (P_2) the results showed that more of the primary school leavers were severely poor (4.1%), followed by no schooling group (3.3%), both statistically significant at 1% respectively. The highest contributions to poverty were made by secondary school leavers (37.26%), though not statistically significant, followed by NCE/OND equivalent graduands (23.86%), statistically significant at 1% while primary school leavers contributed 20.16% (statistically significant at 1% level) in non-polluted crop farm category. The secondary school leavers and the NCE/OND certificate holders had contributed most (i.e. from 28.51% - 37.26% and 23.86% - 28.10% respectively) to the overall poverty situation in the P_0, P_1, P_2 measures in the non-polluted crop farms category.

These results obtained in this study on no schooling grouping were similar to the results of [15,19,21,23,24]. However, the results were quite higher compared to the result of [5]. The values of results obtained in this study on primary and secondary schools decomposed groups indicating levels of incidence, depth and severity of poverty were similar to those of [18,23,24]. The results also obtained in this study favourably compares with the results of [13,24,27] on higher education and their contributions to decline of poverty at the incidence (P_0), poverty gap (P_1) and poverty severity (P_2) levels.

Comparing the levels of poverty in crude oil polluted and non-polluted crop farmer households in Rivers State, Nigeria, the results on Table 2 showed that poverty was generally higher at the headcount (P_0) level in crude oil polluted crop farmer household than in non-polluted crop farmer households. The results showed that incidence of poverty ranged from 58.8% to 100% (absolute poverty), in crude oil polluted crop farms, while in non-polluted crop farms, incidence of poverty (P_0) ranged from 40.1% to 66.7%. The absolute poverty occurrence (100%) among the post graduate certificated household heads (significant at 1%) was a surprise result, though the reasons could be due to the severity of crude oil and gas pollution on their crop farms [1,6,8] and secondly, it could be due to the fact that these group of crop farmers must have started crop farming newly as a business.

The results on Table 2 further indicated that poverty was slightly deeper and more severed in crude oil polluted crop farmer households than in non-polluted crop farmer households. The results analyzed showed that poverty gap (P_1) in crude oil polluted crop farm households ranged from 6.3% to 13.9%, while in non-polluted crop farmer households, the range was slightly lower. The range of severity of poverty (P_2) in crude oil polluted crop farmer households was from 0.9% to 4.6%, while in the non-polluted crop farmer households, the range was 0.7% to 4.1%.

These results go to say that there was high level of poverty among crop farmer households in Rivers State, Nigeria during the period of survey in 2003. Secondly, there was higher level of poverty at all poverty measures studied (P_0, P_1, P_2) in crude oil polluted crop farmer households than in non-polluted crop farmer households using educational status of household heads in Rivers State, Nigeria at the period of survey. Hence, crude oil pollution on crop farms was detrimental to the crops which leads to loss of revenue, damage to properties, health and hence poverty [4,6,8,9].

3.2 Stochastic Poverty Dominance Using Educational Variables

Stochastic poverty dominance testing was used in assessing whether poverty was more in the crude oil polluted crop farmer households than in non-crude oil polluted crop farmer households in Rivers State, Nigeria using educational variables.

Considering the three poverty measures namely P_0, P_1 and P_2 discussed in section 3.1 above. The stochastic poverty dominance distribution curves were traced out as one plots P_0 on the vertical axis and the poverty line on the horizontal axis, allowing the latter to vary from zero to the maximum consumption expenditure of N7,500 (US $62.50) using the exchange rate of N120 per US $1.00 tenable during the survey in 2003. This results in the cumulative distribution function (CDF) which is equivalent to the headcount incidence (P_0) with each point on this curve giving the proportion of the population consuming less than the amount given on the horizontal axis (first order stochastic poverty dominance).

If the area under this curve was calculated up to each point, then the poverty gap (depth) P_1 curve results (second order stochastic poverty dominance). Each point on this curve is simply the value for the headcount (P_0) times the poverty line (Z) which was N4068.19 (US $33.40). If again the area under the poverty gap (poverty deficit curve) was calculated at each point then a new curve is obtained, which is termed the poverty severity (P_2) curve (third order stochastic poverty dominance) and P_3 which can be termed a fourth- order stochastic poverty dominance can be attained subsequently [22,23,28]. The results of stochastic poverty dominance in crude oil polluted and non polluted crop farms using educational status of the household heads in Rivers State, Nigeria are presented in Figs. 1-7.

Fig. 1 showed the stochastic poverty dominance among the illiterate household heads sub-group in the crude oil polluted and non-polluted crop farms categories. The results show that the first order stochastic dominance (FSD) was inconclusive as the curves crossed each other up to four times before the maximum z score value. For this reason, more information was needed to determine where poverty dominates among these groups of crop farmer households, hence Fig. 2 was traced.

Fig. 2 showed that the second order stochastic poverty dominance (SSD), third order stochastic poverty dominance (TSD), and even the fourth-order stochastic poverty dominance (at P_3) also did not hold because at the early stage severe poverty among the crude oil polluted crop farmer households was higher than among the non – polluted crop farmer households. Then, latter the results changed as the curves crossed at higher poverty lines (z) to show that extreme poverty among the non – polluted crop farmer households was worse than among the crude oil polluted household heads. Therefore, stochastic poverty dominance amongst the illiterate household heads was ambiguous in the crude oil polluted and non-polluted farms categories. This confirms the illiterate sub-group results shown on Table 2 of section 3.1 (at poverty measures Pα = 0, 1, 2) respectively. It is necessary to note here that the results of stochastic poverty dominance might not necessarily be the same with that of poverty measures estimated in Table 2 [37].

The stochastic poverty dominance among household heads who attained primary school certificate was traced (though not presented) and the results showed that there was no poverty dominance between the crude oil polluted and non-polluted crop farms at P_0 (i.e. the first order stochastic poverty dominance, FSD failed). Fig. 3 showed that SSD condition held at P_1.

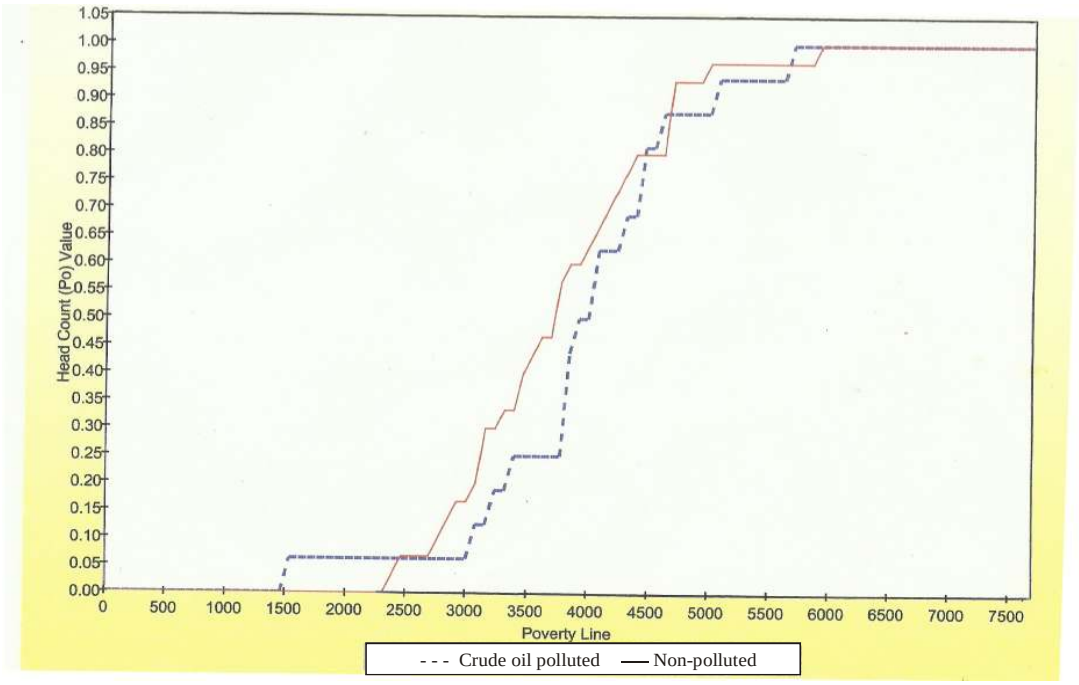

Fig. 1. Stochastic poverty dominance among illiterate crop farmer households at P_0

The graph depicted that the stochastic poverty dominance condition was unambiguous as crude oil polluted crop farms distribution curve completely lies below the non-polluted crop farms distribution curve at poverty gap (P_1) level. This means (from P_1 level onwards) poverty was more in non-polluted crop farmer households than in crude oil polluted crop farmer households in this category of primary school educational status, while it was ambiguous at P_0 level. This result is similar to the results on Table 2 on primary school sub-groupings.

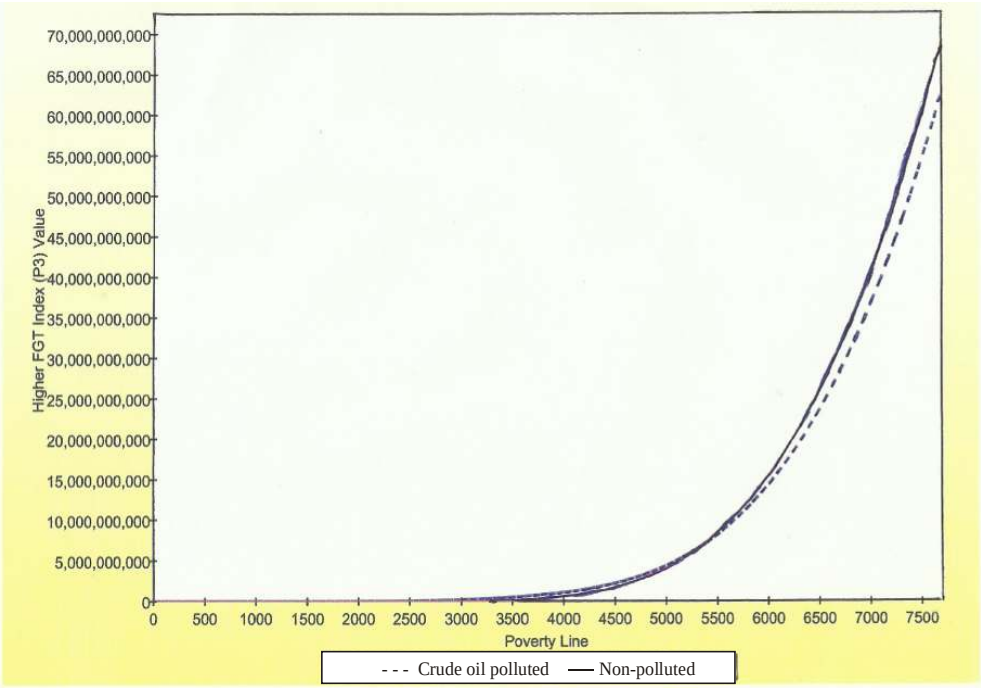

Fig. 2. Stochastic poverty dominance among illiterate crop farmer households at P_3

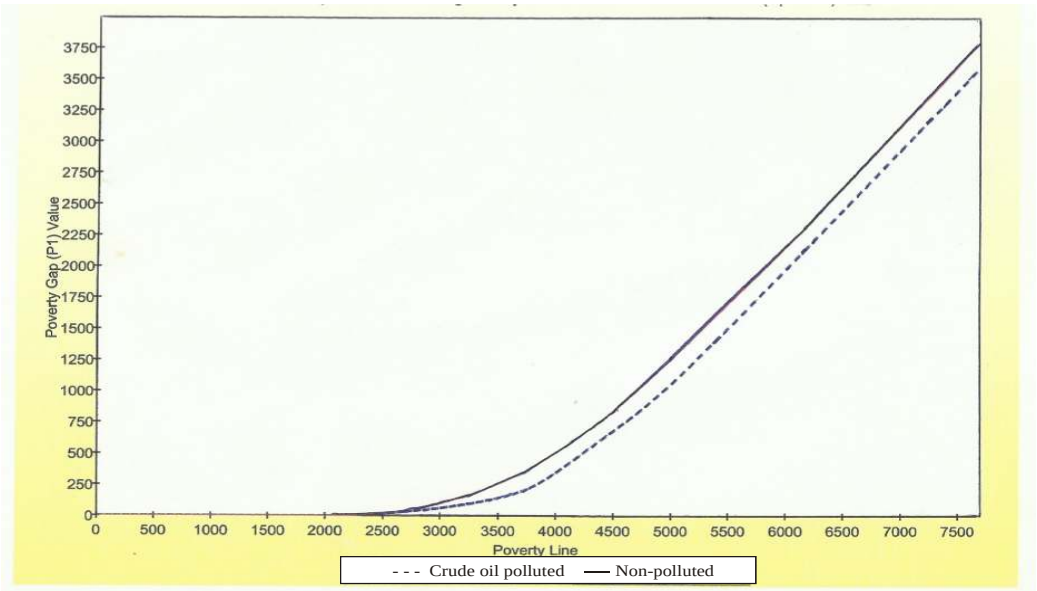

Fig. 3. Stochastic poverty dominance among primary school attained crop farmer households at P_1

The stochastic poverty dominance graph for secondary school leavers among the crude oil polluted and non-polluted crop farmer household heads was drawn and the first order stochastic dominance (FSD) did not hold (Fig. not presented).

Because FSD was inconclusive, this study sought for more information and tested for SSD at P_1 as shown in Fig. 4. These results on Fig. 4 showed that depth of poverty was unambiguously higher among the crude oil polluted crop farmer households than was experienced among the non-polluted crop farmer households, as the earlier distribution curve completely lies above the latter.

The stochastic poverty dominance results among the NCE/OND and equivalent certificate holders were tested and were inconclusive at FSD and SSD levels respectively (Figs. not shown). The inconclusive nature of the graphs showed that this study needed more information using poverty severity (P_2) measure (TSD), which held (Fig. 5). Fig. 5 gave the needed clearer position on poverty dominance among the NCE/OND and equivalent certificate holders, which showed that NCE/OND and equivalent certificated holders in crude oil polluted crop farmer households distribution curve lies completely above that of the non-polluted crop farmer households distribution curve.

This means that the NCE/OND and equivalent certificate holders in the crude oil polluted crop farms were severely poorer than those in the non-polluted crop farms category.

Comparing the stochastic poverty dominance results among the B.Sc/B.Ed/HND graduate households, this study found out that the FSD and SSD tests were inconclusive, therefore are said to be ambiguous (Figs not presented). Therefore, this study needed further information to test the TSD at poverty severely (P_2) level and it held (unambiguous) as in Fig. 6. Fig. 6 indicated that there was more severity of poverty among non-polluted crop farmer households than it was experienced among the crude oil polluted crop farmer households. This was because the distribution curve for non-polluted crop farmer households lies everywhere above that of the distribution curve of the crude oil polluted crop farmer households at P_2 level of poverty measure.

The households whose heads had postgraduate degrees had their stochastic poverty dominance tested at first order stochastic dominance (FSD) condition which did not hold.

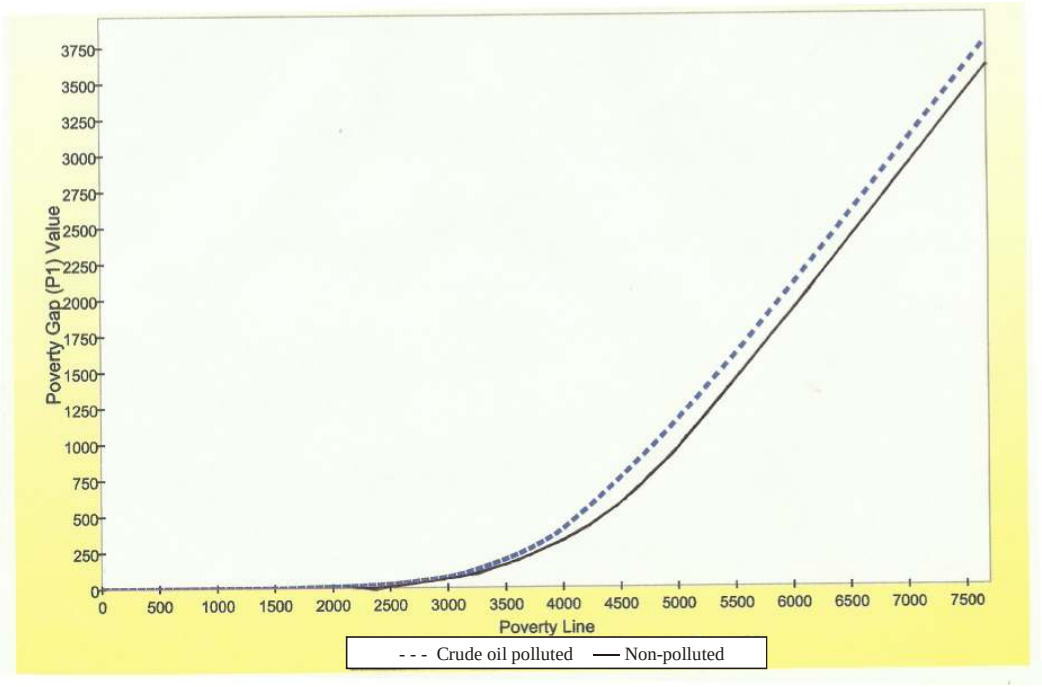

Fig. 4. Stochastic poverty dominance among secondary school attained crop farmer households at P_1

Therefore, more information was sought to reach a conclusive poverty dominance point, which was obtained at the poverty depth (P_1) level (SSD) as in Fig 7. In Fig. 7 it was clear that the post graduate degrees holders household heads in non-polluted crop farms were less deep in poverty than those in crude oil polluted crop farms, because the crude oil polluted crop households distribution curve was everywhere above that of the non-polluted crop farmer household distribution curve.

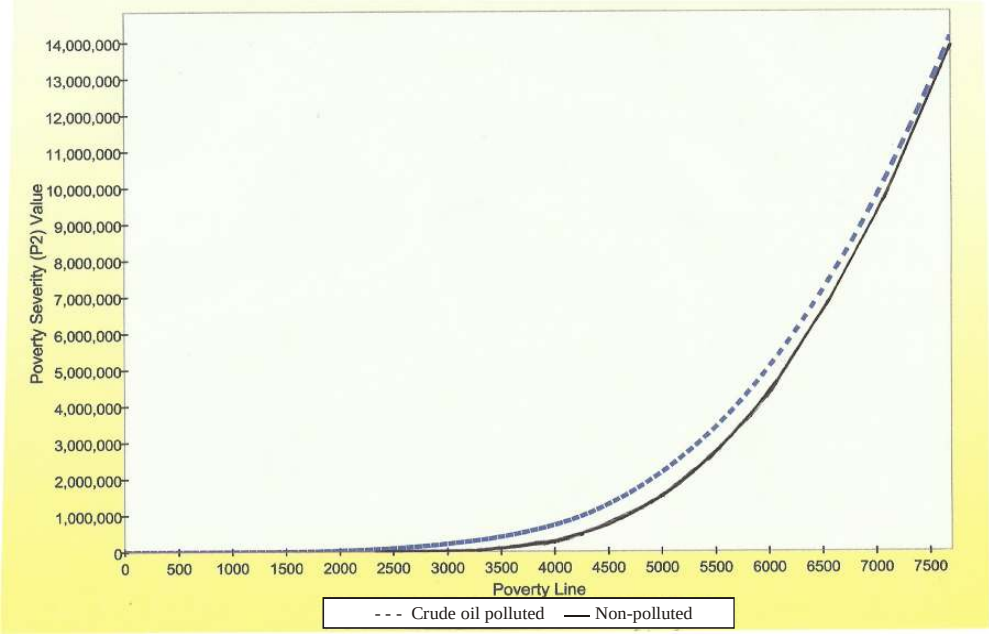

Fig. 5. Stochastic poverty dominance among NCE/OND Certificate crop farmer households at P_2

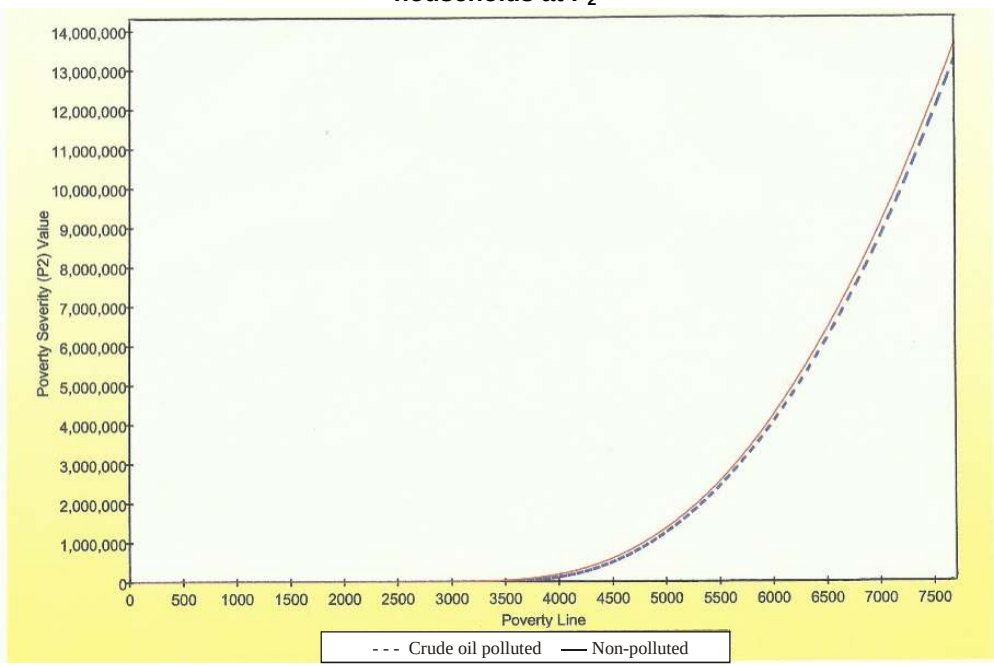

Fig. 6. Stochastic poverty dominance among B.Sc/B.Ed/HND graduate crop farmer households at P_2

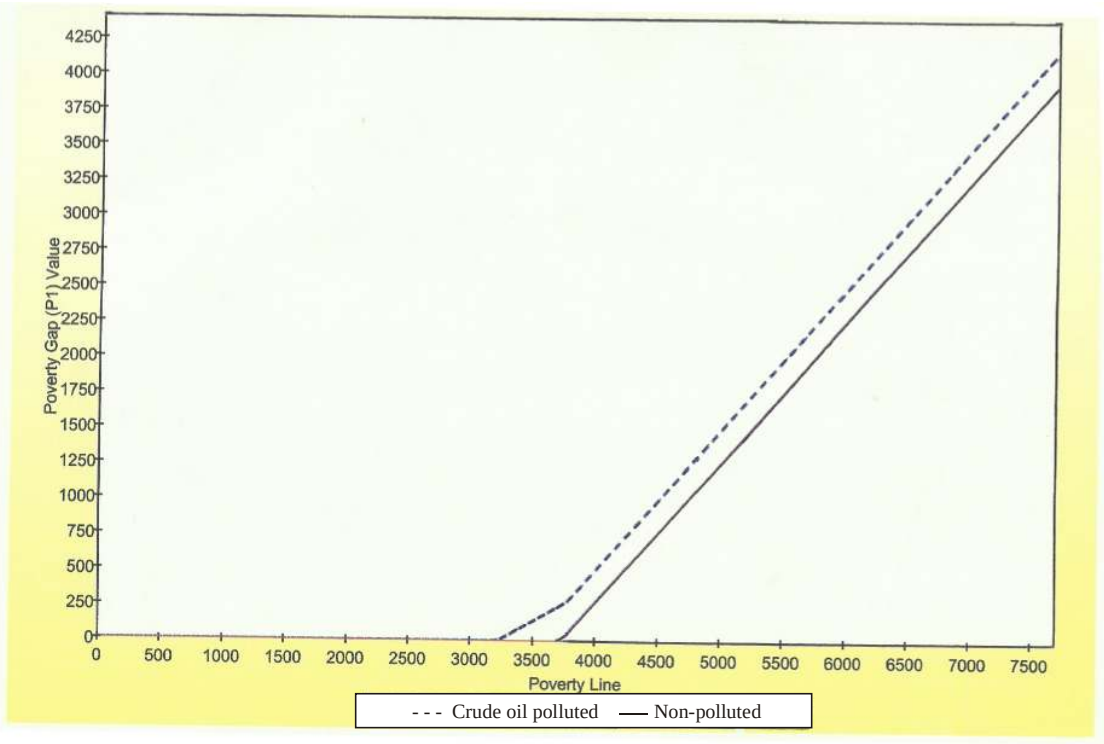

Fig. 7. Stochastic poverty dominance among postgraduate degrees holder crop farmer households at P_1

The stochastic poverty dominance results comparison between crop farmer households in crude oil polluted and non-polluted crop farms using educational sub-groupings showed that poverty existed among crop farmers in Rivers State, Nigeria. These results were similar to the results and arguments of [1,4,15].

The results of this study further revealed that there was deeper and severe poverty experienced in crude oil polluted crop farmer households than it was experienced among the non-polluted crop farmer households. Therefore, crude oil pollution degraded crop farms and was detrimental to crop production, thereby leading to more deep and severe poverty [1,4,8] among the already poor inhabitants of Rivers State, Nigeria.

4. CONCLUSION AND RECOMMENDA-TIONS

4.1 Conclusions

The level of poverty comparisons in this study among crude oil polluted and non-polluted crop farmer households in Rivers State, Nigeria had shown that there was high level of incidence of poverty (P_0) which was generally higher in the crude oil polluted crop farms than in non-polluted crop farms. This study results showed that incidence of poverty (P_0) ranged from 58.8% to 100% in crude oil polluted crop farmer households, while non-polluted crop farmer households incidence of poverty (P_0) ranged from 40.1% to 66.7%.

The results of this study further showed that poverty was slightly deeper and more severe in crude oil polluted crop farmer households than in non-polluted crop farmer households. The results analysis showed that poverty gap (P_1) in crude oil polluted crop farmer households ranged from 6.3% to 13.9% as compared to 7.3% to 13.4% among non-polluted crop farmer households. The range of severity of poverty (P_2) in crude oil polluted crop farms was from 0.9% to 4.6% as compared to 0.7% to 4.1% obtained in non-polluted crop farms category.

Comparing the stochastic poverty dominance results between the crop farmer households in crude oil polluted and non-polluted crop farms, this study revealed that incidence of poverty (P_0) generally existed in Rivers State, Nigeria during

the period of survey in 2003, as none of the educational sub-groupings poverty dominance tests held at the FSD conditions. However, this study results further showed that there was greater poverty gap (P_1) and severe poverty (P_2) experienced among the crude oil polluted crop farmer households than among non-polluted crop farmer households as majority of the distribution curves were unambiguous at the SSD and TSD conditions.

Therefore, this study concluded that here was high level of incidence of poverty among crop farmer households in Rivers State, Nigeria as at the time of this study in 2003. Also using the results of the educational variables studied, there was higher level of poverty (at all poverty measures studied, P_0, P_1, P_2) in crude oil polluted crop farmer households than in non-polluted crop farmer households in Rivers State, Nigeria during the survey.

Hence, crude oil pollution on crop farms degraded and deteriorated farmland, therefore was detrimental to crop production and leads to loss of revenue, caused damages to properties and health risks of crop farmers, thus causing severe and extreme poverty amongst the already poor crop farmer inhabitants of the state.

4.2 Recommendations

The following policy recommendations were made to ensure a better understanding of crop production activities in crude oil pollution prone environment and alleviation of poverty among crop farmers in Rivers State, Nigeria.

(i) This study recommends that current scientific and best farm practices developed by researchers on functional crop farming methods and rehabilitation of soil in crude oil polluted/spilled farmland be disseminated and properly communicated to all crop farmers in the state [38,39,40].

(ii) This could be done using existing agricultural extension and rural development educational programmes in local languages which includes the on – farm training and education programs for crop farmers currently in existence in the Niger Delta Development Commission (NDDC). Also the oil companies operating in the state should set up such training and educational programmes in local languages so as to augment the already existing farming schemes and services being rendered to the local farmers.

(iii) These policies imply that farmers need adequate knowledge and information about farming activities in local languages in a crude oil pollution prone environment, which may improve the crop farmers production capacity, increase their farm income, revenue, and therefore reduce the level of depth and severity of poverty highlighted in this study [14,15,17,18].

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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