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Socio-economic Variables Associated with Poverty in Crude Oil Polluted Crop Farms in Rivers State, Nigeria

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Abstract: This study focused on the use of socio-economic variables as determinants of poverty in crude oil polluted crop farms in Rivers State, Nigeria. The objectives of this study were to determine the effects of socio-economic variables on the poverty level of farm-households, and to estimate the probability and intensity of poverty among the farmers in crude oil polluted and nonpulluted farms. A multistage sampling technique was use to collect data for this study. A total of 340 questionnaires were distributed within 17 local government areas of the state, out of which 296 questionnaires were found suitable for analysis using tobit censored regression analysis. This study found out that extent of income diversification reduced poverty drastically by 9.8 times in crude oil polluted farm-households and 12.7 times in non-polluted farm-households. Other variables that also reduced poverty in all categories of farms studied include land ownership by inheritance (2.9%) and years of farming experience. Some variables that reduced poverty in crude oil polluted farms though marginally, were access to extension services (0.48%) and farm labour. All the socio-economic variables estimated showed that the probability of poverty will decrease in many farm-households up to 11.20% as in the case of farm income if there is a 10% increase in these variables, while the intensity of poverty will also decrease in many farm–households up to 7.63% using the same variable (farm income).

Key words: Socio-economic variables, crude oil polluted farms, tobit regression analysis, poverty, Rivers State Nigeria

INTRODUCTION

Severe damage to the mangrove swamps and rain forests in the Niger Delta region of Nigeria had been reported with adverse effects on the soil fertility, animals, forest resources, fish and invertebrates in the area. The most offensive damage is the constant pollution of the land, air and sea of the Niger Delta area with crude oil and oil products (Onwuka, 2005; Edwin-Wosu and Kinako, 2004; Essien and Antai, 2005; Akeredolu *et al.*, 2005; Akaninwor and Okeke, 2006; Onweremadu and Eshett, 2007; Njoku *et al.*, 2008; Chikere *et al.*, 2009; Patrick-Iwuanyanwu *et al.*, 2010).

Falode *et al.* (2006) stated that the development and distribution of petroleum resources in the Niger Delta area had created significant environmental, social and economic impacts which have resulted into many social conflicts. Hutchful (1986) reported that the environmental dimension of the minorities grievance in the Niger Delta region of Nigeria (Rivers State inclusive) is derived from land alienation; disruption of the natural terrain by the construction of oil industry infrastructure and installations, and pollution. Land alienation has exacerbated demographic stress and recurrent violence in the Niger Delta (Anugwom, 2004; Sampson, 2008). Worse still, Nigeria Law (Nigerian Land Use Act of 1978) permits alienation of land by the oil industry without consultation with the indigenous owners (Kaniye, 2001; Olayiwola and Adeleye, 2006).

The combination of economic and ecological difficulties have decipated the means of livelihood of the mostly peasant occupants of the oil-yielding communities in Rivers State and other ethnicities in the Niger Delta region of Nigeria. Fabig and Boele (1999) supported this view saying the oil rich Ogoni people of Rivers State faced poverty, pollution and environmental degradation as well as repression by the Nigerian government. Therefore, this study examined the socio-economic variables associated with poverty in crude oil polluted crop farms in Rivers State.

There have been irregularities in the major livelihood activities (such as farming, fishing and hunting) of the people of Rivers State due to crude oil pollution. Government policies aimed at mitigating the occurrence and effect of oil spillage have not yielded significant results due to lack of empirical knowledge necessary for providing better damage assessments, and possibilities for the implementation of successful measures, to mitigate the adverse effects of crude oil and gas pollution.

The questions this study therefore asks are: (a) what are the effects of crude oil pollution on crop production and the welfare of the farmers in Rivers State of Nigeria? (b) what are the effects of socio-economic variables as determinants of poverty in crude oil polluted and non polluted crop farms in Rivers State, Nigeria.

Literatures exist that had studied the effects of crude oil and gas pollution on soils and crops in Nigeria (Bello *et al*., 1999; Agbogidi *et al*., 2005; Daniel-Kalio and Tih, 2006; Eriyameru *et al*., 2007; Agbogidi *et al*., 2007; Abii and Nwosu, 2009; Idodo-Umeh and Ogbeibu, 2010) and outside the borders of Nigeria Minai-Tehrani *et al*. (2007). Bello *et al*. (1999) examined the effects of gas flaring on the growth and yield of maize on farms located at some distances from gas flaring point. The experimental findings revealed that crop total leaf area monitored, mean percentage plant survival and grain yield were significantly reduced in all the locations compared with the control. The authors observed that farms located 200 m away from the flaring point failed to produce any yield. Minai-Tehrani *et al*. (2007) studied the effects of different concentrations of light crude oil on the growth and germination of *Festuca arundinacea* (Tall fescue). The results obtained showed that the germination number and dry biomass of the plant decreased by increasing light crude oil concentration in the soil. The length of leaves reduced in higher crude oil concentration in comparison with the control.

Abii and Nwosu (2009) studied the effect of oil spillage on the soil of Eleme in Rivers State of Nigeria on two sites (Ogale and Agbonchia) as study area while a geographically similar but unaffected area (Aleto) served as control. The results indicated that oil spill adversely affected the nutrient level and fertility status of the Eleme soil. Idodo-Umeh and Ogbeibu (2010) investigated the values of Total Petroleum Hydrocarbon (TPH) and heavy metals in soils, plantain fruits and cassava tubers harvested from farms impacted with petroleum and non-petroleum activities in Delta State, Nigeria. The results showed that the values of heavy metals were higher in the cortex of cassava tubers, epicarp and mesocarp of plantation fruits harvested from petroleum impacted soil than from non-petroleum impacted soils.

There is scarcity of scientific data on the use of socio-economic variables as determinants of poverty in crude oil polluted crop farms. The socio-economic variables said to be associated with poverty in crude oil polluted crop farms under consideration include: farming experience, farm income, non-farm income, extent of income diversification, farm size, land ownership by inheritance, farm labour and access to extension services. However, literature exists on the use of socio-economic factors in determining the levels of poverty on farms and farm-households. They include Ellis *et al*. (2003), Ellis and Mdoe (2003), Fan and Chan-Kang (2005), Krishna (2006), Nasution (2008), Oseni and Winters (2009), Zhu and Luo (2010).

The analytical tool chosen for data analysis is tobit regression analysis. Literature exists on the use of tobit in analyzing socio-economic characteristics as determinants of poverty on farm households generally (Gardebroek *et al*., 2004; Kimhi, 2006; Akpoko, 2007; Kilic *et al*., 2009). Researchers that have studied the socio-economic variables as determinants of agricultural production include Uddin and Hiroyuki (2006), Sanni and Doppler, (2007), Ekunwe and Orewa (2007), Onduru *et al*. (2007), Armagan (2008), Oseni and Winters (2009), Pfeiffer *et al*. (2009), Hertz (2009), Kakahashi and Otsuka (2009), Subejo and Matsumoto (2009). None of these studies mentioned above had treated this topic: Socio-economic variables associated with poverty in crude oil polluted crop farms in Rivers State, Nigeria using tobit regression analysis.

The main objective of the study is to determine the effects of socio-economic variables on poverty in crude oil polluted and nonpulluted crop farms in Rivers State Nigeria. The objectives were to:

- Determine the effects of socio-economic variables on farm-households poverty in crude oil polluted and non polluted crop farms in Rivers State, Nigeria
- Estimate the elasticity of probability and intensity of poverty among farmers in crude oil polluted and nonpulluted crop farms in the state

Ellis *et al*. (2003) provided a critical view point on livelihoods and rural poverty reductions in Malawi using qualitative and quantitative information. The reports showed that poor rural Malawians confronted constraints that can only be addressed by raising agricultural productivity, diversifying farm output to reduce risk and shift toward higher value outputs, and diversifying livelihoods towards non farm enterprises. Ellis and Mdoe (2003) utilized research on rural livelihoods to derive policy on poverty reduction in rural areas in Tanzania. The research findings showed that rural poverty was strongly associated with lack of land and livestock, as well as inability to secure non-farm alternatives to diminishing farm opportunities.

Fan and Chan-Kang (2005) reported that a positive relationship exists between farm size and labour productivity (and therefore income). Promoting diversification in the production of high value commodities can play an important role in raising the small holders' income. They further said that policies that facilitate urban-rural migration and promote the development of the rural non-farm sector are essential to help alleviate poverty among small farm-households and among the rural poor in general. Krishna (2006) explained that escaping poverty and falling into poverty are responsive respectively, to different sets of factors. Factors such as diversification of income sources and land improvement are most closely related with escape from poverty in some 36 Indian villages studied.

Uddin and Hiroyuki (2006) focused their study on the patterns of farm and off-farm employment, considering the gender structure and incomes earned from different sources in Bangladesh. The study further revealed that unemployment decreased with the increases in farm size and farmers practicing integrated farming had few families labour surplus compared to the conventional farmers. Onduru *et al*. (2007) in a study carried out in Kiambu district of Kenya, explored the effect of household socio-economic factors on farm nutrients balances and agro-economic performance in crop-diary (mixed) farming system. The results showed that family earnings (sum of net farm income and off-farm income) accounted for 61% of family earnings of the studied households.

Owuor *et al*. (2007) studied the determinants of rural poverty in Africa using the small holder farmers in Kenya as a case study. The results of the probit analysis showed that access to micro credit, education, participation in agricultural seminars, livestock assets and location in high potential areas significantly influence the probability of households existing chronic poverty. On the other hand, female gender and distance to the market, increases the probability of persistence in chronic poverty. Sanni and Doppler (2007) studied the identification of socio-economic characteristics influencing the decision of households on fertilizer use intensity in maize-based production systems in the northern guinea savannah of Nigeria. The results of logit analysis revealed that households fertilizer use intensity is significantly influenced by previous year's income, land ownership, engagement in off-farm activities and years of experience in maize farming. Ekunwe and Orewa (2007) examined the socio-economic characteristics of yam producers in Kogi State of Nigeria. Results from the study showed that the mean age of farmers was 53 years, average farming years experience was 25 years and the farmer's average farm size was 0.97 ha.

Armagan (2008) determined the extent by which conventional dummy variables such as age, education and farming experience can explain efficiency level with logistic regression model in agricultural enterprises. The findings indicated that conventional dummy variables such as age, education and farming experience were not significant factors in explaining efficiency level in this case study. Nasution (2008) addressed the factors that influenced the farm development in poverty alleviation and rural development in Kulon Prongo regency of Yogyarkarta Special Province of Indonesia. In contrary to common belief the significant role of land ownership has a positive impact to influence rural poverty, where the 1% increasing size of land ownership raised 0.177% poor rural inhabitants. The regression model results showed that land ownership positively affected rural poverty.

Oseni and Winters (2009) examined the effect of participation in non-farm activities on crop expenses and in particular on payments for hired labour and inorganic fertilizers. The results of the analysis showed that participation in non farm activities appeared to induce more hiring of labour. The results supported the hypothesis that non farm participation helped relax liquidity constrains of farmers.

Pfeiffer *et al*. (2009) explored the effect of off-farm income on agricultural production activities in Mexico. The study found that off-farm income has a negative effect on agricultural output and the use of family labour on the farm, but a positive impact on the demand for purchased inputs. Hertz (2009) documented the relationship between non-farm income and agricultural investment in Bulgaria, specifically expenditures on working capital and investment in livestock. The results showed that the use of non-farm income for farm investment was consistent. Kakahashi and Otsuka (2009) attempted to identify the effects of the increasing non-farm income on the use of tractors and threshers and on the employment of hired labour as a substitute, for family labour in central Luzon. The study found that the increased non-farm income positively affected the ownership of factors and also led to the increased use of hired labour, thereby releasing family labour to non-farm jobs.

Zhu and Luo(2010) examined the impact of rural-to-urban migration on rural poverty and inequality in a mountainous area of Hubei province of China. The results showed that, by providing alternatives to households with lower marginal labour productivity in agriculture, migration led to an increase in rural income. The authors states that households facing binding constraints of land supply are more likely to migrate and poorer households benefit disproportionately from migration.

Gardebroek *et al*. (2004) used a tobit regression analysis to explain the impact of different socio-economic factors on the size of the threshold between positive and negative investments. Akpoko (2007) used tobit analysis to determined factors influencing adoption of intermediate farm tools and equipment. The results revealed that farm size and use of biological factors and chemicals were highly significant determinants of the adoption.

Kimhi (2006) used two stage estimation with two sided tobit analysis to examine the relationship between maize productivity and plot size in Zambia. The results showed that the endogeneity of plot size was very important in the analysis. When considering plot size as an exogenous explanatory variable, they found a monotonic positive relationship between the yield of maize and plot size, indicating that economies of scale are dominant throughout the plot size distribution. Kilic *et al.* (2009) analyzed the over all impact of household non farm income generating activities on rural farm households in Albania using tobit instrumental variables. The results showed that Albanian rural households utilized their non farm earnings not to invest in time-saving efficiency-increasing technologies, but to move out of crop production. This present study will analyze the effects of socio-economic variables on poverty levels of Rivers State crop farmers in crude oil polluted and nonpulluted crop farms in the state using maximum likelihood estimates of tobit censored regression analysis.

MATERIALS AND METHODS

This study was conducted is Rivers State which is located in the Niger Delta region of Nigeria, between 2002 and 2003. The state is geographically located approximately between latitudes 6^0E - 7^0E and longitudes 4^0N and 6^0N. Data were collected from both primary and secondary sources. The primary data were collected through personal interviews and observations with the crop farmers, and structured questionnaires distributed among crop farmers in crude oil polluted and non-crude oil polluted areas of Rivers State. Types of data on socio-economic characteristics collected include area of farmland cultivated, area of farmland acquired for crude oil exploration and exploitation, area of farmland spilled by crude oil a year before the survey and within the years of survey period. Other information collected include value of crops lost, family and hired labor, farm income and non-farm income generated, access to extension services, land ownership by inheritance, extent of income diversification and commercialization of crop output. The data provided the base to carryout this comparative study on the effects of socio-economic variables in determining the poverty levels of the crop farmers in crude oil polluted and non-crude oil polluted farms.

A multistage sampling procedure was used to collect data for this study. The first stage involved the selection of 17 local government areas (LGAs) out of the existing 23 LGAs in Rivers State, Nigeria. These 17 LGAs were selected based on the fact that they were more crop farming inclined than others, i.e, these are areas where crop farming was an important occupation. The second stage involved the stratification of farmland in an LGA into two sampling units namely crude oil polluted and non-crude oil polluted. This stratification of the farmland into two sampling units was based on the fact that information were needed from both crude oil polluted and nonpulluted areas. The third stage involved the random sampling of 10 crop farms from crude oil polluted areas in a selected LGA and a corresponding number of 10 crop farms from non-crude oil polluted farmland in the same locality (community) in the given LGA. This summed to 20 crop farms investigated per selected LGA which gives a total of 340 crop farms sampled in the 17 LGAs of the state.

Each farm owner of these 340 crop farms observed was administered with a structured questionnaire, resulting in a total of 340 questionnaires distributed to the affected farms in the 17 LGAs of Rivers State of Nigeria. Out of the 340 questionnaires administered, only 326 questionnaires were retrieved due to the difficult terrain of the state and the politicking of crude oil pollution issues in the country. Furthermore, 30 questionnaires were found to be inconsistent with the set objectives of this study. Hence, only a total of 296 questionnaires were retained as suitable for analysis.

Tobit regression model: The tobit regression model is the analytical tool favored in this paper among all the qualitative response models on welfare economics because of its dual purpose of measuring the elasticity of the probability that the farmer whose farmland was affected by crude oil pollution could become poor, as well as intensity of poverty among these crop farmers as stated in objectives 1 and 2.

Tobit regression model is a hybrid of the discrete and continuous models, used to determine the impact of the explanatory variables on the probability of being poor and the intensity of poverty. Following Rahm and Huffman, (1984) the tobit regression model which has a functional form as expressed in Eq. 1 was used:

$$\begin{aligned} Yi &= Xi\beta, \text{ if } i^* = Xi\beta + \mu i > T \\ &= 0; \text{ if } i^* = Xi\,\beta + \mu i \leq T \\ i &= 1, 2, \ldots\ldots\ldots 296 \end{aligned} \quad (1)$$

where, Yi is the dependant variable measuring the probability of crop farmers being poor and the intensity of poverty among these farmers.

$$Yi = 1, \begin{cases} \text{if } i^* > T, \text{ if the farmer is poor} \\ 0, \text{ if } i^* \leq T, \text{ if the farmer is not poor} \end{cases}$$

I* = Non observable latent variable (poverty gap) defined as z - yi/z for poor households where z > yi.
T = Threshold level which can be either a constant or a variable, that is when the poverty line (z) equals the adult equivalent household expenditure (yi), T = 0. The value is z-y = 0, if z = yi for non-poor households. If the non-observed latent variable i* is greater than T, the observed qualitative variable yi that indexes poverty becomes a continuous function of the explanatory variables, and 0 otherwise (i.e., no poverty)
Xi = A vector of explanatory variables which consists of the socio-economic and oil pollution characteristics of the farmer
β = Vector of parameters to be determined
μ = An independently, normally distributed error term with zero mean and constant variance, $б^2$.

The explanatory variables (Xi) specified as variables associated with determining the levels of poverty, used in the analysis were as follows:

X_1 = Years of farming experience
X_2 = Farm income in dollars (US $)
X_3 = Non farm income in dollars (US $)
X_4 = Extent of income diversification. The extent of farm income diversification is given by Herfindahl Index (H) and is expressed as:

$$H = \sum_{i=1}^{n} R^2$$

where,

$$R = Ai / \sum_{i=1}^{n} Ai$$

H = Extent of diversification index
Ai = Gross farm income from crops on the ith farmland in dollars (US $)
R = Gross farm income ratio
n = The number of crops cultivated by the farmers
X_5 = Farm size in hectares
X_6 = Land ownership (dummy = 1, if plots were inherited, 0 if otherwise)
X_7 = Family and hired labour (in man days)
X_8 = Access to extension services (dummy = 1, if yes, 0 if otherwise)

Tobit decomposition framework: Using the tobit decomposition framework suggested by McDonald and Moffitt (1980), it can be shown that:

$$E(Yi) = F(z) \times E(p) \quad (2)$$

where, E(p) is the expected value for Yi for those poor farmers, and F is the cumulative normal, distribution function at (z), where (z) is Xiβ/-б. Differentiating with respect to any element of X gives:

$$\frac{\partial E(Yi)}{\partial Xi} = F(z)\frac{\partial E(p)}{\partial Xi} + E(p)\frac{\partial F(z)}{\partial Xi} \quad (3)$$

Multiplying through by Xi/E(Yi), the relation in Eq. 3 can be converted into elasticity forms:

$$\frac{\partial E(Yi)}{Xi}\frac{\partial Xi}{E(Yi)} = F(z)\frac{\partial E(p)}{\partial Xi}\frac{\partial Xi}{E(Yi)} + E(p)\frac{\partial F(z)}{\partial Xi}\frac{Xi}{E(Yi)} \quad (4)$$

Rearranging Eq. 4 by using Eq. 2:

$$\frac{\partial E(Yi)}{\partial Xi}\frac{Xi}{E(Yi)} = \frac{\partial E(p)}{Xi}\frac{Xi}{E(p)} + \frac{\partial F(z)}{\partial Xi}\frac{Xi}{F(z)} \quad (5)$$

The total elasticity consists of two effects:

- The change in the probability of the expected level of intensity of poverty among the farmers
- The change in the elasticity of the probability of being poor

RESULTS

In estimating the socio-economic variables as determinants of poverty among the farm-households, the maximum likelihood estimates (MLE) of tobit censored regression model consisting of 10 regressors were estimated as in Eq. 1. Table 1 shows the maximum likelihood estimates of the tobit regression for the determinants of poverty in crude oil polluted and nonpulluted farms respectively. The results showed that 100% of the analyzed factors were statistically significant at least at 10% level of significance, sigma and intercept (constant) inclusive in the crude oil polluted farms and 70% of the variables were statistically significant at least at 10% level of significance in nonpulluted farms. This indicates that the model had a good fit to the set of data used in the analysis.

Table 1: Maximum likelihood estimates of the tobit censored regression for determinants of crop farmers poverty in rivers state

		Crude oil polluted farms		Nonpulluted farms	
Variables	X_i	Coefficient value	Standard error	Coefficient value	Standard error
Constant	α	0.8202***	0.49E-01	0.3977***	0.53E-01
Years of farming experience	X_1	-0.48E-03***	0.16E-03	-0.51E-03*	0.29E-03
Farm income	X_2	-0.10E-06**	0.45E-07	-0.36E-06***	0.10E-06
Non-farm income	X_3	-0.17E-06*	0.93E-07	-0.40E-06***	0.14E-06
Extent of income diversification	X_4	-9.7971***	2.5416	-12.6577***	3.4921
Farm size	X_5	0.51E-02**	0.20E-02	-0.13E-02	0.31E-02
Land ownership By inheritance (dummy)	X_6	-0.29E-01***	0.50E-02	-0.79E-02	0.93E-02
Farm labour	X_7	-0.14E-03***	0.26E-04	0.70E-04***	0.27E-04
Access to extension services (dummy)	X_8	-0.48E-02**	0.19E-02	0.26E-02	0.73E-04
Log-likelihood function		803.8120	-	559.2115	-
б (sigma)		0.50E-01***	0.88E-02	0.62E-01***	0.13E-01

Source: Field survey, 2003. Asterisks indicate significance level: *** 1%; ** 5%; *10%.

Results of determinants of poverty: The result of the estimated regression coefficient for years of farming experience variable (X_1) in the crude oil polluted farms was -0.48E-03 (-0.00048) and was statistically significant at 1%. In the nonpulluted farms category, the coefficient value for this same variable (X_1) was -0.51E–03 (0.00051) and was statistically significant at 10%. Farm income (X_2) had estimated regression coefficient of -0.10E-06, significant at 5% level in crude oil polluted farms and -0.36E-06, significant at 1% level in the nonpulluted farms. Non-farm income (X_3) variable had a coefficient of -0.17E-06, significant at 10% in crude oil polluted farms category, and -0.40E-06, significant at 1% level in the nonpulluted farms. The results of these three variables (X_1, X_2, X_3) discussed above showed very marginal negative values predicting very marginal reduction in poverty.

The extent of income diversification (X_4) variable coefficient in the MLE results on Table 1 was -9.7991 in the crude oil polluted farms and -12.6577 in the nonpulluted farms and were both statistically significant at 1%. The results showed very significant negative values predicting very significant reductions in poverty. Farm size (X_5) factor had a coefficient of -0.13E-02 (0.0013) in the non polluted farms which was not statistically significant, but was statistically significant at 5% in crude oil polluted farms with a coefficient of 0.51E-02 (0.0051). The variable (X_5) showed positive value on its coefficient in crude oil polluted farms and a negative value in the nonpolluted farms category, though both variables were marginal values.

The land ownership by inheritance (X_6) was a dummy variable with estimated coefficients of -0.29E-01 (-0.029) and -0.79E-02 (-0.0079) in the crude oil polluted and nonpulluted farms respectively, which was statistically significant at 1% in crude oil polluted farms category and not significant in the non polluted farms. The two coefficient values showed negative marginal values.

Farm labour (X_7) include family and hired labour usage on the crop farms. The estimated coefficient values of this factor was -0.14E-03 in crude oil polluted farms and 0.70E-04 in non polluted farms and they were both statistically significant at 1% level respectively. The coefficients had negative marginal value in crude oil polluted farms and a positive marginal value in the nonpulluted farms. Variable (X_8) which represented access to extension services, a dummy variable, had estimated coefficient value of -0.48E-02 (-0.0048) and -0.26E–02 (-0.0026) in crude oil polluted and non polluted farms respectively, significant at 5% level in crude oil polluted farms and not statistically significant in the non polluted farms. The coefficient values were marginal negative values in both categories of farms.

Result of elasticity among farm-households: The effect of changes in the explanatory variables (Xi) on the probability of being poor and the intensity of poverty were obtained as in Eq. 2. Table 2 shows the elasticity coefficients of the probability of a farming household being poor and the intensity of poverty among the households in crude oil polluted farms and nonpulluted farms respectively. The estimates showed that marginal changes in the determinants of poverty among all farms studied increase the probability of poverty. However, most elasticity estimates showed inelastic responses to changes in these determinants.

The elasticity of probability of poverty were estimated using the means of the dependent and independent variables of each category of farms, whereas the elasticity of intensity of poverty were estimated using the conditional means of the dependent and independent variables of each farm category. The total elasticity values were calculated by summing the probability and intensity values together. Elasticity coefficient of probability and intensity of poverty were not computed for dummy variables such as land ownership by inheritance and

Table 2: Tobit total elasticity decomposition for changes in socio-economic factors associated with poverty among crop farmers in rivers state

	Elasticity of		
Variables	Probability of poverty	Intensity of poverty	Total elasticity
Crude oil pollution farms			
Years of farming experience	-0.1708	-0.0850	-0.2558
Farm income	-0.3125	-0.1555	-0.4680
Non-farm income	-0.0771	-0.0384	-0.1155
Extent of income diversification	-0.3097	-0.1541	-0.4638
Farm labour	-0.2960	-0.1473	-0.4433
Nonpulluted farms			
Years of farming experience	-0.1074	-0.0732	-0.1806
Farm income	-1.1199	-0.7625	-1.8825
Non-farm income	-0.1433	-0.0976	-0.2408
Extent of income diversification	-0.4531	-0.3085	-0.7616
Farm labour	0.1256	0.0855	0.2111

Source: Estimated from the result of Tobit censored regression as suggested by McDonald and Moffitt (1980) as in Eq. 2

extension services. The remaining factors were contributory factors, therefore their elasticity coefficients were estimated as in Table 2.

The elasticity of probability of poverty of the years of farming experience in crude oil polluted farms was -0.1708 and -0.1074 in non polluted farms. The elasticity of intensity of poverty was -0.0850 in crude oil polluted farms and -0.0732 in non polluted farms.

The total elasticity for years of farming experience was -0.2558 in crude oil polluted farms and -0.1806 in non polluted farms. The farm income coefficient of elasticity of the probability of poverty in crude oil polluted farms was -0.3125 and -1.1199 in nonpulluted crop farms.

The farm income coefficient of intensity of poverty in crude oil polluted farms was -0.1555 and -0.7625 in nonpulluted farms. The total elasticity for this variables was -0.4680 and -1.8825 in crude oil polluted and nonpulluted farms categories respectively. These results of years of farm experience and farm income showed the possibility of reduction in the probability, intensity and total poverty among the crop farmers households.

The non farm income elasticity of probability of poverty was -0.0771 in crude oil polluted farms and -0.1433 in nonpulluted farms. The elasticity of intensity of poverty in crude oil polluted farms was -0.0384 and -0.0976 in non polluted farms category. The total elasticity for this variable were -0.1155 and -0.2408 in crude oil polluted and nonpulluted farms respectively. The variable extent of income diversification had its elasticity of probability of poverty as -0.3097 and -0.4531 in crude oil polluted and nonpulluted crop farms in the state respectively. It's intensity of poverty coefficients were -0.1541 in crude oil polluted farms and -0.3085 in nonpulluted farms. The total elasticity in crude oil polluted farms was -0.4638 and -0.7616 in non-crude oil polluted farms. The negative values signify that there was the possibility of reduction in poverty.

The farm labour variable's elasticity of probability of poverty in crude oil polluted farms was -0.2960 and 0.1256 in nonpulluted farms. The elasticity of intensity of poverty in the crude oil polluted farms was -0.1473 and 0.0855 in non polluted farms. The total elasticity was -0.4433 and 0.2111 in crude oil polluted farms and nonpulluted farms, respectively.

DISCUSSION

The result of the estimated regression coefficient of years of farming experience (X_1) showed that an extra year increase in the farming experience of the head of the household will lead to very marginal rate of reduction in poverty (0.05%) in all categories of crop farms studied. This could be attributed to the fact that as the years of farming experience increases the age of the farmer also increases, thereby marginally increasing the productivity which marginally reduces the poverty level of the household. Years of farming experience had been shown as a significant factor in increasing agricultural productivity as shown in the earlier result of Sanni and Doppler (2007) and Ekunwe and Orewa (2007). Though in this study it has a similar result, the variable showed marginal increase in productivity which was statistically significant. However Armagan (2008) observed that this variable was not a significant factor in explaining level of efficiency. This is contrary to the findings of the results of this study which showed that the variable was a significant factor in increasing agricultural productivity.

The regression estimates of farm income (X_2) and non-farm income (X_3) showed that increase in these two variables could lead to reduction in poverty though very marginally also. These socio-economic variables had been known to increase agricultural productivity with any level of significant increase in their use and availability. This result is in support of the results of Sanni and Doppler (2007), Oseni and Writers (2009) and Kilic *et al*. (2009). An increase in variables X_2 and X_3 significantly reduces poverty also in household. This was the same view expressed by Fan and Chan-Kang (2005) though in this study these variables reduced poverty marginally. Farm-income and off farm income had become increasingly important in increasing agricultural production as shown by their level of significance as factors used in this analysis. These results are in support of earlier results of Onduru *et al*. (2007), Ellis *et al*. (2003), Ellis and Mdoe (2003), Pfeiffer *et al*. (2009), Hertz (2009), Kakahashi and Otsuka (2009) and Zhu and Luo (2010).

Extent of income diversification (X_4) results disclosed that for a unit increase in income diversification into other productive ventures including off-farm business, poverty drastically reduced by 9.8 times in crude oil polluted farms and 12.7 times in nonpolluted farms respectively. That is, if farmers diversify their sources of income outside farming and fishing, even in crude oil pollution prone environments, poverty will tend to reduced in every farm-household significantly. This result clearly supports the results of Ellis *et al.* (2003), Fan and Chan-Kang (2005), Krishna (2006) and Kilic *et al*. (2009). This however means that, variable X_4 reduced poverty more effectively in the nonpolluted farms in Rivers State, than in crude oil polluted farms category during the period under survey.

Farm size (X_5) estimated coefficients showed that an increase in the farm size by 100% could decrease poverty level marginally in the farm-households by 0.13% in nonpolluted farms but in the crude oil polluted farms, poverty could be increased marginally also by 0.51%. These results are true as the level of output is directly related to the farm size, an increase/decrease in output level leads to an increase/decrease in farm income and productivity. This was the same view shared by Fan and Chan-Kang (2005), Kimhi (2006), Uddin and Hiroyuki (2006) and Akpoko (2007) and consequently leads to an increase or decrease in poverty level of the farm-households.

The variable, land ownership by inheritance (X_6) estimated coefficients showed that a hectare increase in the area of land inherited, owned or improved, could lead to reduction of poverty level in the household by 2.9% in crude oil polluted farms and 0.8% in nonpolluted farms. This could be because money might not be spent to purchase, rent, and/or lease land for agricultural purposes which will decrease the level of poverty in households especially in the crude oil polluted areas where the farmers had been more impoverished. This finding is in support of the findings of Ellis and Mdoe (2003), Krishna (2006) and Sanni and Doppler (2007). This is also in agreement with Onwuka (2005) who said that crude oil pollution on farmland caused poverty among the inhabitants of Niger Delta area of Nigeria. However Nasution (2008) observed that 1% increase in land ownership will raise 0.177% poor rural inhabitants. This view is quit similar to these results as it showed a positive impact on rural poverty.

Farm labour's (X_7) estimated coefficient values signified that for a 100% increase in mandays of labour used in the nonpulluted farms, poverty level increases though very marginally. In the crude oil polluted farms category the poverty level is expected to decrease marginally by 0.014%. In the case of nonpolluted farms, increase in labour leads to insignificant output produced, i.e., decreasing returns to scale. Therefore, continuous increase in farm labour will lead to further reduction in productivity thereby leading to higher level of poverty in such households. However, in crude oil polluted farms, a 100% increase in mandays of labour on the farm reduced poverty level slightly because extra labour is needed most a times to farm an extra plot of land in case of medium and light oil spillages. This extra labour require is the hired labour that will be required to meet up with the timing of farming activities, thereby complementing the efforts of the family labour. This is possible through the use of off-farm income as suggested by Oseni and Winters (2009) and Kakahashi and Otsuka (2009). These results obtained in this study are similar to the results of Fan and Chan-Kang (2005).

Access to extension services (X_8) had estimated coefficients that implied that poverty level will reduce in crude oil polluted farms though marginally. Meaning farm households having contact with extension agents are better informed about new improved farming inputs and technologies available, practices that increase yield, which leads to increase in income, thereby reducing poverty in the households. This view is supported by Owuor *et al*. (2007). It could also mean that farmers with adequate extension knowledge could cope better in crude oil pollution prone environment thereby escaping the poverty associated with oil spillages.

The values of elasticity of probability of poverty of the years of farming experience indicated that if the years of experience were increased by 10%, the probability of poverty will decrease by 1.7 and 1.1% in crude oil polluted and nonpolluted crop farms respectively and the intensity of poverty decreases by 0.85 and 0.73% in crude oil polluted and nonpolluted farms in Rivers State respectively. This means that poverty decreased more in crude oil polluted farms than in nonpolluted farms against expectation. This could be the effect of cumulated experience, acquired over the years in farming in crude oil pollution prone environment; otherwise poverty was expected to be lower in nonpolluted areas.

The farm income elasticity of the probability of poverty in crude oil polluted and nonpulluted farms shows that if farm income is increased by 10% it will lead to a decline in poverty by 3.13 and 11.20% respectively, while the intensity of poverty decreased by 1.56% in crude oil polluted crop farms and 7.63% in nonpolluted farms. The total elasticity of poverty decreased by 4.68 and 18.83% in crude oil polluted and nonpolluted farms respectively for a 10% increase in farm income. These elasticity results showed that an increase in farm income reduced poverty among all the farm-households surveyed as expected though the reductions were more significant in nonpulluted farms. These results are similar to and support the results obtained by Fan and Chan-Kang (2005), Sanni and Doppler (2007), Onduru *et al*. (2007) and Zhu and Luo (2010). This shows that crude oil pollution has a severe effect on farm income of farmers.

The non-farm income elasticity coefficients of probability of poverty showed that if the non-farm income is increased by 10%, probability of poverty decreased marginally by 0.77% in crude oil polluted farms and 1.43% in nonpulluted farms, while the intensity of poverty reduced also marginally by 0.38 and 1.0% in crude oil polluted and nonpolluted farms respectively. The total elasticity of poverty reduced by 1.16% in crude oil polluted farms and 2.41% in nonpolluted farms under the same condition of a 10% rise in non-farm income of the crop farmers in Rivers State, Nigeria. These results also help to illustrate that poverty was higher in crude oil polluted crop farm-households than in nonpolluted farm-households. These results obtained are similar to and support the results of Fan and Chang-Kang (2005), Onduru *et al*. (2007), Hertz (2009), Pfeiffer *et al*. (2009) and Zhu and Luo (2010).

The elasticity values of the extent of income diversification showed that for a 10% increase in the variable, probability of poverty declined by 3.10 and 4.53% in crude oil polluted farm-households and nonpolluted farm-households respectively, while the intensity of poverty reduced by 1.54% in crude oil polluted farms and 3.09% in nonpolluted farms. The total elasticity of this variable indicated that for a 10% increase, poverty reduced by 4.64 and 7.62% in crude oil polluted and nonpolluted farm-households. These results showed that the extent of income diversification reduced the probability, intensity and total poverty, though not elastically. The reduction in probability and intensity of poverty were higher in nonpolluted farm-households than in crude oil polluted farm-households. These results were similar to and support the findings of Ellis *et al*. (2003), Fan and Chang-Kang (2005), Krishna (2006) and Kilic *et al*. (2009).

The results of farm labour showed that increasing farm labour (in man days) by 10% reduces the probability of poverty by 2.96% in crude oil polluted farms, while in nonpolluted farms the probability of poverty is increased by 1.26%. A 10% increase in response to farm labour demand reduces the intensity of poverty in crude oil polluted farms by 1.47%, while it increased the intensity of poverty by 0.86% in nonpolluted farms. An increase in mandays of labour used on the farms by 10%, reduced the total poverty in crude oil polluted farms by 4.43% and increased the total poverty by 2.11% in nonpulluted farms. Increase in labour is needed in crude oil polluted farms to supplement the demand, for excess labour needed in cases of replanting, re-fertilizing re-ploughing, re-harrowing and other farming activities necessary after medium or light oil spillages. In nonpulluted farms, extra labour will lead to increase in the cost of farm production and reduction in revenue accruable to the farmer hence possibility of the farmer and his household falling into poverty or even increasing the intensity of poverty in the already poor household. These results support the results of Uddin and Hiroyuki (2006) and Kakahashi and Otsuka (2009).

CONCLUSION AND RECOMMENDATIONS

In conclusion, this study using the tobit regression analysis found out that crude oil pollution on crop farms had detrimental effects, which affected the farmers welfare negatively, thereby making them to be poorer than farmers in nonpolluted areas. This confirms the results of Onwuka (2005). This study also found out that the extent of income diversification by crop farmers in both crude oil polluted and nonpolluted farms had the greatest ability and effect to reduce poverty among the farm-households. Furthermore, this study found out that increase in farm income had the most significant effect to reduce the probability and intensity of poverty in both crude oil polluted and nonpolluted crop farms in Rivers State, Nigeria. Finally, the socio-economic variables used in this study's analysis were significant variables, which clearly showed that poverty existed in the state, though it was higher in crude oil polluted farm-households than in nonpolluted farm-households during the period of survey in 2003.

The results of this study and their implications have brought to limelight some issues to be considered and addressed effectively for policy implications. Therefore, the following recommendations were made that:

- Adequate list of all farmland affected by crude oil pollution should be compiled and commensurate amount of compensations paid to the owners of such farmland promptly in line with economic trends in the country after the correct evaluations of crops and land area lost have been ascertained by experts (Abii and Nwosu 2009). This compensation should be paid by oil companies responsible for theacquisition of farmland for oil and gas exploration activities and/or crude oil spillages

- Farmers in Rivers State living in crude oil pollution prone areas when compensated for their crop losses should seek additional means of livelihood by effectively diversifying their resources and sources of income. (Ellis *et al.*, 2003; Hertz, 2009). This could be done by taking farming as a secondary occupation and seek for greater off farm income (Kilic *et al.*, 2009; Oseni and Winters, 2009). This less dependency on crop farming in crude oil pollution prone areas will help reduce tension and conflicts arising from oil exploration activities in communities in Rivers State, Nigeria (Falode *et al.*, 2006). This will also allow land to be allocated for its best alternative uses (in this case, oil and gas exploration and production). Income diversification is a faster way to reduce or even escape poverty (Krishna, 2006).

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