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Analysis of Poverty-Environmental Degradation Nexus among Arable Crop Farmers in Plateau State, Nigeria.

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Abstract
The study analysed the poverty-environmental degradation nexus among arable crop farmers in Plateau State, Nigeria. Using multi-stage sampling technique, 265 farming households were randomly sampled from 9 communities spread across three Local Government Areas of the three agro ecological zones in the State. Primary data generated from farming household heads through well-structured questionnaires were used. The household's income, expenditure and information on factors that lead to environmental degradation dominated the bulk of the data. The data were analysed using Foster, Greer and Thorbecke (FGT) index and probit regression model. The monthly mean per adult equivalent household expenditure (MPAEHE) was ₦3,940. A poverty line of ₦2,627 was estimated, based on this poverty line, the FGT measures show that 42% of the farming households in the study area were poor. The probit regression result revealed that the quantity of wood collected, number of animals allowed to graze and length of time they graze were significant ($P<0.01$). A unit increase in any of these variables would lead to the probability of an increase in the poverty depth of the farmers. Knowledge of natural resource conservation was significant ($P<0.05$) and farm size was significant ($P<0.10$). Increasing any of these variables by a unit, would result to the probability of decreasing poverty among the households. Hence the hypothesis that there is a strong and direct relationship between these phenomena of poverty – environment trap thesis is accepted. It is recommended that there is the need for policy makers and managers of poverty alleviation programmes to identify the poor at community levels so as to direct poverty programmes and projects towards them. Also environmental aid should be introduced to abate environmental degradation.
Keywords: Poverty, Degradation, Nexus, Arable

1. Introduction

The poor have traditionally taken the brunt of the blame for causing society's many problems including, more recently, environmental degradation. There is a general consensus that poverty is a major cause of environmental degradation. For example, in one of the conclusions of the Bruntland Commission Report, which incidentally has been accepted as the blue print for environmental conservation, it was explicitly stated that, poverty is a major cause of environmental problems and amelioration of poverty is a necessary and central condition of any effective programmes addressing the environment (World Commission on Environment and Development, 1987). The poor are the victims of environmental degradation and the perpetrators of the degradation. They are basically short-run maximisers; they try to meet the needs of the present at the cost of the future. The poor and hungry often destroy their immediate environment for their survival. They cut down forests; their livestock overgraze grasslands; they overuse marginal lands; and they crowd into congested cities in growing numbers. The cumulative effect of these changes is so far-reaching as to make poverty itself a major global scourge. It is in this context that the first report on Human Development mentioned that "Poverty is one of the greatest threats to the environment" (UNDP, 1990).

The nexus of environment and poverty is especially strong in developing countries. The economic well-being of many (especially rural) households directly depends on the quality of the environment and on the availability of natural resources. Especially for low-income countries like Nigeria, a substantial percentage of national income and even larger share of the active population directly depend on agricultural, forestry and fisheries resources (Titilola and Jeje, 2005).

This calls for the need to understand and empirically investigate these links as well as to assess the impact of the conditioning factors; these are the issues this paper dealt with.

2. Literature Review

The link between poverty and environment has often been mentioned in the 'sustainable development' debate and is seldom systematically explored (Lele, 1991). The literature that treats the link usually focuses on the 'vicious circle' between poverty and environmental degradation; the circle is Malthusian in inspiration where farmers pushed by population increase and poverty extend cropping to fragile marginal lands and degrade them. As a result the yield is reduced and this further impoverishes farmers (Pearce and Warford, 1993; Mink, 1993; Dasgupta and Maler, 1994).

A new dimension to the link between poverty and environmental degradation was brought out in 1995 when Reardon and Vosti introduced the concept of 'investment poverty' and related the same to other measures of poverty (Reardon and Vosti, 1995). The notion of poverty was examined by them in the context of categories of assets held and categories of environment change with particular focus on farm household income generation and investment strategies as determinants of the links. According to them the strength and direction of the poverty-environment links in rural areas are to differ (even invert) depending on the composition of the assets held by the rural poor and the types of environmental problems they face. One of the major findings of their study is that the level of poverty conditions the links. People having incomes above an established welfare poverty line can still be too poor in key assets and thus overall cash and human resources to be able to make critical investments on soil conservation or follow key land use practices to maintain or enhance their natural resource base. They might thus be better off than the 'welfare poor' but still be 'investment poor'. Finally they opined that the links between poverty and environment in a given setting depend on the level, distribution and type of poverty and environmental problems.

The above discussion on the various studies conducted worldwide reveal that there is a two-way linkage between poverty and environmental degradation. Degradation of environment caused either by the poor or the rich has both direct and indirect impacts not only on the cost of production but also on the productivity of crops and thus on the income of the people. The poor get more affected than the rich and become poorer due to environmental degradation manifested through destruction of forest for fuel wood, timber, cultivation; degradation of land and water through the use of chemical fertilizer, pesticide, etc in modern farming; and pollution of air due to consumption of biomass fuel. Thus a vicious link is established between poverty and environmental degradation. Each becomes the cause and effect of the other. This study attempts to quantify the magnitude of both poverty and environmental degradation over time and verify empirically the link between them. Though estimates are available on poverty for both rural and urban areas of Nigeria and the nature of environmental degradation in rural and urban areas, the present study is confined to farming communities only.

3. Methodology

3.1 The Study Area

The study was carried out in Plateau State, located in central Nigeria. The State derives its name from the geographical landscape that predominates in this part of the country. The state lies between latitudes 8^{o} N and 10^{o}N, and longitude 7^{o}E and 11^{o}E of the prime meridian (GTZ, 2010). The altitude ranges from around 1,200 meters (about 4000 feet) to a peak of 1,829 metres above sea level in the Shere Hills range near Jos. The state has a land mass covering nearly 30,913 km^2 (11,935.6 sq mi) and ranked as the 12^{th} out of the 36 states in Nigeria. The state has a population of 3,206,531 based on the 2006 census (NBS, 2009). The projected population by 2011 stands at 3,681,299 people going by a population growth rate of 2.8% per annum.

The state comprises 3 political senatorial zones and 17 administrative Local Government Areas, viz: The northern senatorial zone consisting of Bassa, Barkin Ladi, Jos East, Jos North, Jos South and Riyom Local Governments. Bokkos, Kanke, Mangu, Kanam and Pankshin Local Government Areas make up the central senatorial zone. The local governments of Langtang North, Langtang South, Mikang, Qua'an Pan, Shendam and Wase make up the southern senatorial zone.

3.2 Sampling Procedure and Sample Size

A multi stage sampling was used to select respondents for the study. One local government area was purposively selected from each of the three senatorial zones of the state. The purposive sampling ensures that the researcher does not end up with a sample concentrated in one ecological and or senatorial zone. Qua'an Pan was selected from the southern zone while Bokkos was selected from the central zone. Bassa from the northern zone brought the total number of the local governments to three (3). These LGAs have been shown to be engaged in intensive crop cultivation (PADP, 2000). From each of these LGAs, three communities were randomly selected, making a total of nine communities. The farming communities are; from Qua'an Pan – Namu, Kwalla and Kwande; from Bokkos – Bokkos, Manguna and Mushere while from Bassa – Jengere, Jebu-Bassa and Kwall were selected. The sampling frame was made up of a list of farming households obtained from PADP found in the communities. The simple random sampling method was used to draw at least 10% from the list to constitute the sample size. The

total number of the sample size was 265. These were selected by the use of the table of random numbers.

3.3 Data Collection and Analysis

Primary data were collected using questionnaires. The questions were structured to elicit answers on the objective of the study. The data collected include information on both quantifiable and non-quantifiable factors affecting income and household expenditure pattern and environmental utilization variables as it pertains to the use of land and forestry resources. The tools used for data analysis to achieve the objective of the study include Foster Greer and Thorbeck (FGT) index and Probit regression model.

3.3.1 FGT Weighted Poverty Measure

The Foster, Greer and Thoebecke (Foster, *et al.,* 1984), weighted poverty index were used for the quantitative poverty assessment is defined mathematically as follows:

$$\boldsymbol{P}_{\propto} = \frac{1}{n}\sum_{i=1}^{q}\left[{}^{(z-y_i)}/_{z}\right]^{\propto} \quad (1)$$

Where

α = the FGT index and takes values 0, 1 or 2

n = total number of households

q = number of households below the poverty line

Z = poverty line

Y_i = the MPAEHE of the household in which individual i^{th} lives

3.3.2 The Probit Model

The common solution to the deficiencies of the LPM model as estimated via OLS is to adopt a different model specification. The Probit model constrains the estimated probabilities to be between 0 and 1, and relaxes the constraint that the effect of independent variables is constant across different predicted values of the dependent variable. In common parlance, the probit model assumes an *S*-shaped response curve such that in each tail of the curve, the dependent variable, (P*r*(Y_i = 1), responds slowly to changes in the independent variables, while towards the middle of the curve, i.e, towards the point where P*r*(Y_i = 1) is closest to .5, the dependent variable responds more swiftly to changes in the independent variable.

The probit model assumes that while we only observe the values of 0 and 1 for the variable Y, there is a latent, unobserved continuous variable Y* that determines the value of *Y*. We assume that Y* can be specified as follows:

$Y_i^* = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \ldots + \beta_k x_{ki} + \mu_i$ (2)

and that:

$Y_i = 1$ if $Y_i^* > 0$

$Y_i = 0$ otherwise

where $x_1, x_2, \ldots, x_k$ represent vectors of random variables, and μ represents a random disturbance term.

Now from equation 1,

$Pr(Y_i = 1) = Pr(\beta_0 + \beta_1 x_1 i + \beta_2 x_{2i} + \ldots + \beta_k x_{ki} + \mu i > 0)$ (3)

Rearranging terms,

$Pr(Y_i = 1) = Pr(\mu_i > -(\beta_0 + \beta_1 x_1 i + \beta_2 x_{2i} + \ldots + \beta_k x_{ki})$

$= 1 - Pr(\mu_i < -(\beta_0 + \beta_1 x_1 i + \beta_2 x_{2i} + \ldots + \beta_k x_{ki})$

$= 1 - F(-\beta_0 + \beta_1 x_1 i + \beta_2 x_{2i} + \ldots + \beta_k x_{ki})$ (4)

where F is the cumulative density function of the variable μ. If we make the usual assumption that μ is normally distributed , we have:

$Pr(Y_i = 1) = 1 - \Phi(-(\beta_0 + \beta_1 x_1 i + \beta_2 x_{2i} + \ldots + \beta_k x_{ki})$

$= 1 - \Phi(-X_i\beta)$

$= \Phi(X_i\beta)$ (5)

where Φ represents the cumulative normal distribution function.

Using maximum likelihood techniques, we can compute estimates of the coefficients (βs) and their corresponding standard errors that are asymptotically efficient. However, these estimates cannot be interpreted in the same manner that normal regression coefficients are. These coefficients give the impact of the independent variables on the latent variable *Y**, not *Y* itself. To transfer *Y** into a probability estimate for *Y* we compute the cumulative normal of Y*. Because of this transformation there is no linear relationship between the coefficients and P*r*(Y_i = 1). Hence the change in P*r*(Y_i = 1) caused by a given change in x_{ji} will depend upon the value of all the other *xs* and their corresponding coefficients, or more precisely on the value of the sum $X_i\beta$, as well as the change in x_{ji}. The model can be presented as:

$$\Phi^{-1}(Pi) = Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_{6+\mu} \quad (6)$$

where the *pi* are defined in terms of the parameters β_0, β_1,... β_6 and the known values of the predictor variables. This has to be maximized with respect to the parameters. The parameters to be investigated will include:

P = poverty index of households (where P =1 if household's income is above the poverty line and P = 0 if otherwise).

X_1 = Quantity of wood collected in (kg)

X_2 = Number of cattle that graze on farmland

X_3= Number of years farmland is allowed to lie fallow

X_4 = Knowledge of natural resource conservation (dummy where 1 = if source of information is formal, 0 = otherwise).

X_5 = Duration of graze per week (hrs)

X_6 = Size of farm land owned as personal property (ha)

4. Results and Discussion

4.1 Poverty Profile

The poverty profile of the farming households which include poverty headcount or incidence (P_0), poverty gap or depth (P_1) and squared poverty gap or severity (P_2) were calculated. The P_0 for the entire farming households was 0.42. The relative smallness of this figure when juxtapose by the findings by Yusuf (2000) who reported a poverty incidence of 52% in Kwara State; Omonona (2001) who reported a poverty incidence of 58% in Kogi State; Bandabla (2005) who reported a poverty incidence of 50% in Ibadan metropolis, Oyo State and Patrick (2006) who reported a poverty incidence of 62% in Borno State may not be unconnected to the report by the NBS (2009) that Plateau State had the least unemployment rate of 7.1% among the states of the federation in 2008. This means that 42% of the farming households in the study area were poor (Table 1). The result shows that 3.4% of the total households sampled were below core poverty level (i.e people who could not spend more than ₦1,313 a month to buy the basic necessities of life). These were considered as the extreme poor. The result also shows that 27.6% of the households were moderately poor. Their monthly consumption per person was below the poverty line of ₦2,627, but more than ₦1,313. In all, the analysis showed that 42% of the sampled households were relatively poor and could not attain the minimum standard of living; this leaves 58% of the total households sampled to be non – poor. These were the households with per capita monthly expenditure equal or higher than ₦2,627. Although the poor are conventionally defined as the population that fall below a certain poverty line, it is assumed that even individuals above the poverty line may suffer from "investment poverty" (Reardon and Vosti 1995).

The poverty gap index (P_1), usually referred to as the depth of an average poor person from the poverty line was 21%. This implies that 21% of the poverty line (₦552) was required to bring an average poor person in the study area to the poverty line. The poverty index (P_2) which measures the distance of each poor person to one another was found to be 0.11. This means that among the poor households, 11% were severely poor. This shows that the poor households were not equally poor but they vary in their degree of poverty.

4.2 Relationship between Poverty Level and factors that lead to Environmental Degradation

The result showed that five out of the six listed regressors had significant influence on the poverty depth of the farming household's head. The variables that had significant co-efficient are the quantity of wood collected (X_1), number of cattle that graze on farm lands (X_2), knowledge of natural resource conservation (X_4), duration of graze per week (X_5) and size of farm land (X_6). The only variable that was not significant is number of years farm land is allowed to lie fallow (X_3).

The result of the analysis indicated that the coefficients of the quantity of wood collected is 0.0404 and significant ($P<0.01$). This implies that a percentage increase in the quantity of wood collected would result to a probability of an increase in the poverty depth of the farmers by 4.04%. This agrees with *apriori* expectation that the indiscriminate felling of trees makes the farmlands prone to degradation. This finding is consistent with the findings by Okwi *et. al*. (2006) and Dasgupta (2003). It is also in conformity with the findings of Lal and Okigbo (1990) to the effect that deforestation and wood harvest (for fire wood) is a major source of human induced environmental degradation, accounting for nearly 15% of the total land degradation in Africa. Kareem *et al.* (2009) stated that Nigerians consume from 1.9kg to 4.0kg per day per capita of firewood depending on household size. When applied to the country's population currently put at about 150 million people, the country consumes about 285 million kilogrammes of firewood daily. Maiangwa *et. al*. (2007) also reported that fuel wood is the dominant form of cooking energy for all rural farmers in Nigeria. Poverty constrained options may induce the poor to deplete resources at rates that are incompatible with long term sustainability (Holden *et. al.,* 1996). In such cases, degraded resources precipitate a "downward spiral," by further reducing the income of the poor (Durning, 1989; Pearce and Warford, 1993). In summary, this result supports the downward spiral

hypothesis and by implication, alleviating absolute poverty would likely reduce poverty-induced deforestation. Number of cattle allowed to graze on farmlands and the duration of graze per week were significant (P<0.01). This implies that a percentage increase in the number of cattle allowed to graze and the duration of weekly graze would lead to a probability of increasing the poverty level of the farmers by 25% and 14% respectively. Again, this agrees with *apriori* expectation. Oldeman *et. al.* (1991) and Batjes (2001) showed that overgrazing account for 49% of the degradation witnessed in Sub Saharan Africa (SSA). IAR (1996; 1998) reported that the unavailability of designated grazing lands makes animals to graze uncontrollably (free range), this consequently leads to overgrazing. The average number of cattle owned by households in the study area is 5. Because the prevalent land tenure arrangement in the study area is communal, households that have interest in land allowed these animals to graze uncontrollably thus, conforming to the theory of "tragedy of the poor".

Overgrazing results when more animals than a piece of land can support are allowed to graze in that area. This can cause serious damage to the land. When too many animals are allowed to graze on a piece of land they eat the plants that hold the soil in place. Too many animals may mean that the grass is eaten down to the roots faster than it can grow back. This in turn leads to overgrazing. Overgrazing can cause and accelerate soil erosion and with it a loss of soil fertility. When large herds are concentrated around one particular area the animals compact the soil by trampling on it resulting in the soil being unable to retain as much moisture as it needs. Once the animals have overgrazed an area it is often left barren with no protection and the wind blows away the topsoil. This is accentuated by the fact that most of the households are poor consequent upon which they cannot afford supplemental feeding.

Knowledge of natural resource conservation was negatively significant (P<0.05), implying that a percentage increase in the knowledge of natural resource conservation would lead to the probability of a decrease in poverty by 46% among the farmers. The lack of knowledge about environmental conservation has been shown to be a big problem in Africa. Barbier (1998) argued that the conventional approach to land conservation in Africa has been to encourage farmers to adopt limited range of improved farming systems and crop production techniques and packages, not necessarily those which are compatible with conservation objectives. Some authors have also argued that, often, the appropriate land management technologies exist but that information about their use has not reached the end users because of deficiencies in extension and education (Anderson and Thampapillai, 1990; Reganold *et. al.,* 1990). Farmers will therefore need to be educated on sustainable management practices such as the right tillage practices and the harmful effects of bush burning.

Finally, size of farm land was significant (P<0.10), which implies that a percentage increase in the size of farmland would lead to a probability of a decrease in poverty by 4% among farmers in the study area. This agrees with the *apriori* expectation that the larger the farm size, the lesser the incidence of poverty. This is expected because, all things being equal, an increase in farm size will raise the output level and consequently income.

The study agrees with the hypothesis that there is a direct relationship between poverty and environmental degradation. The aim of the study was to empirically test the bi-directional relationship between rural poverty and environmental degradation. The results provide evidence in consonance with the dominant view in the literature that poverty spurs environmental degradation since five of the environmental variables exhibit a significant relationship with poverty depth of the households in the study area. From the empirical result of this study, it could be stated that the poverty-environmental degradation nexus is a one way traffic as is been suggested by the Brundtland report and a host of others such as Barbier and Burgess (1992); Pimentel *et. al*., (1995); Cleaver and Schreiber (1992); Barbier (1997) and Barbier (1998).

These however contrast with the findings by Broad (1994) as well as Reardon and Vosti (1995) that "not all environmental degradation in developing countries is linked to poverty; for example, pollution as an externality of the agriculture of richer farmers or forest or commons overexploitation by large and capital-intensive lumber and cattle operations can ravage the environment without the poor's lifting a hand".

5. Conclusion

Based on the established monthly absolute poverty line of ₦2,627 for the study area, the study observed that about 42% of the farming households were poor. On the average, about 21% of the poverty line (₦552) was required monthly to bring a poor household out of poverty. Result of the probit analysis shows that five of the environmental variables exhibit a significant relationship with poverty depth of the households in the study area, The variables that had significant co-efficient include the quantity of wood collected, number of cattle that graze on farm lands and knowledge of natural resource conservation. Others are the duration of graze per week and size of farm land. It therefore indicates that environmental degradation spurs rural poverty and rural poverty spurs environmental degradation – thereby providing evidence in support of the poverty environment nexus in the study area.

Based on the findings of this study, the following policy measures aimed at reducing poverty are recommended

1. This study revealed that 42% of the farming households lived below the poverty line. There is the need for policy makers and managers of poverty alleviation programmes to identify the poor at community levels so as to direct poverty programmes and projects towards them.
2. There should be strong advocacy on the need for every community to own its woodlot and to embrace agro-forestry. Communities should also be sensitized on the need to come up with simple rules and regulations governing the use of existing adjoining natural forests. This will ensure a systematic harvest and or felling of forest resources
3. It is recommended that environmental aid be introduced to abate environmental degradation. Environmental aid will to a large extent be significant in accelerating economic growth. The aid should be targeted at preserving the environment or facilitating environmental-friendly infrastructural development that will directly benefit the poor people. This should be backed by a strong environmental policy with the political will to enforce it.

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Table 1: Poverty Profile of Households

Index	₦/Percentage
MPAEHE	₦ 3,940
$^2/_3$ (MPAEHE)	₦ 2,627
$^1/_3$ (MPAEHE)	₦1,313
Head Count Index (P_0)	42
- Core Poor (%)	03
- Moderate (%)	27
- Non Poor (%)	58
Poverty Gap Index (P_1)	0.21
Poverty Severity Index (P_2)	0.11

Table 2: Probit Regression showing the Relationship between Poverty Level and factors that lead to Environmental Degradation

Variable	Coefficient (b)	SE	Z-value (b/SE)
Constant	0.75749467**	0.33608819	2.254
Quantity of wood (X_1)	0.04037402*	0.01060034	3.809
Grazing cattle (X_2)	0.25454326*	0.06577105	3.870
Fallow period (X_3)	-0.00057963	0.00091197	-0.636
Knowledge of conservation(X_4)	-0.46295710**	0.19365504	2.391
Duration of graze (X_5)	0.13921086*	0.04049574	3.438
Farm size (X_6)	-0.04097757***	0.02341766	-1.750
Log – Likelihood = -128.6677			
McFadden Pseudo R – Squared = 0.6215161			
P – Value = 0.00011			

***, **, *, = Significant @ 10%, 5% and 1% respectively

Personal details:

First Name:	Sunday
Surname:	Mailumo
Other Name:	Sambo
Profession:	Agricultural Economist
Area of Specialization:	Production Economics & Natural Resource/ Environmental Economics
Current Rank:	Lecturer I/ Research Officer I
Gender:	Male
Date of Birth:	15th December 1974
Local Government Area:	Bassa L. G. A
State of Origin:	Plateau State
Nationality	Nigerian
Marital Status:	Married
Name of Children:	Nathan Ramalon (10th Sept. 2008), Nadab Rumah (14th Jan, 2012

Dates and Institutions Attended

2008-2012	Ahmadu Bello University, Zaria
2002-2006	Abubakar Tafawa Balewa University, Bauchi.
1995-1999	Abubakar Tafawa Balewa University, Bauchi..
1991-1992	Bauchi State Polytechnic, Bauchi.

Qualifications

Ph.D	Agricultural Economics
M. Sc.	Agricultural Economics
B. Tech. (Hons)	Agric Economics and Extension (Second Class Upper Division)
National Diploma	General Agric Technology (Upper Credit)