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Effects of Land Degradation on Poverty among Farmers in Southern Parts of Borno State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author AMB designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author ASSU managed the literature searches and analyses of the study. Author BGS supervised and edited the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The study analyzed the effects of land degradation on poverty among farmers in Southern Part of Borno State, Nigeria. Using multistage sampling technique, 120 farming households were sampled from 20 villages spread across five Local Government Areas in Southern part of the State. The households' expenditure, value of free natural resources, causes of land degradation and information on the household livelihood-related factors dominated the bulk of the data. The data were analyzed using Foster, Greer and Thorbecke (FGT) model and Probit regression model. A poverty line of ₦8588.48 was estimated and was enough to provide households with basic requirements per month for existence (food and non-food). Based on this poverty line of ₦8588.48, the FGT measure showed that 64% of the farming households in the study area were poor; the average depth of the poor households from the poverty line was 48% of the poverty line, while 22% of the poor farming households were severely poor. The probit regression revealed that quantity of fire-wood collected (0.061), duration of grazing (0.010), burning of crop residues (0.023), soil erosion (0.091) and flooding (0.051) were all positive and significant. On the other hand, fallowing period (-0.032) and knowledge of conservation (-0.087) were both negative and significant. The

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study therefore recommended that policies should be geared up towards minimizing fuel wood consumption through establishing alternative energy sources such as technologies that utilizes ample solar and wind energies.

Keywords: Land degradation; poverty; farmers; Borno State.

1. INTRODUCTION

Poverty is a pronounced level of deprivation that encompasses shortfalls or inadequacies in basic human needs; it can prevent people from achieving internationally acceptable levels of wellbeing [1]. These basic needs include access to food, clothing, health care services and shelter. Poverty also refers to the inability of an individual to spend 1.9 dollar per day [2]. It is estimated globally that about 889 million people fall below the absolute poverty line (living on less than 1.9 U.S Dollar daily), 43.8% of whom are found in the Sub-Saharan Africa, followed by South Asia with 34.8%, East Asia and Pacific with 16.5% and Latin America and the Caribbean, Europe and Central Asia with 4.9% [3].

Central African Republic with 78% of its population living below the poverty line has the highest poverty level in sub Saharan Africa followed by Burundi (75%) and Democratic Republic of Congo (72%) which are ranked second and third Africa's poorest countries respectively [3]. Nigeria is one of the countries in Sub-Saharan Africa where poverty is being experienced, especially in rural areas where up to 69% of the population lives below the poverty line and engaged in agricultural enterprises [4]. Worried by the continued rise in poverty, successive government in Nigeria has formulated one policy or the other in order to alleviate poverty. These policies include the National Poverty Eradication Programme (NAPEP), Subsidy Re-Investment Programme (SURE-P), Family Support Programme (FSP) and Better Life Programme (BLP). Despite these efforts, the poverty level has continued to raise. Focusing on the 1996 – 2010 data, the national poverty incidence was 65.6% in 1996 and declined to 54.4% in 2004. In 2010, the national poverty incidence has however surged higher to 69% [5]. This increase in poverty profile was as a result of many factors, among which are land degradation, households' socioeconomic characteristics, ill-health/diseases [6].

Poverty is linked to land degradation [7]. Land degradation is any reduction or loss in the biological or economic productive capacity of the land resource base. It is generally caused by human activities, exacerbated by natural processes, and often magnified by and closely intertwined with climate change and biodiversity loss [8]. Agricultural production over time has been a major factor in ecological degradation. The outcome of uncontrolled land use and intensification of agricultural production often result in alarming loss of biodiversity of plants and pockets of reserved areas and as well as reduction in soil fertility in Nigeria [9]. In addition, weak property right limits farmers' ability to engage in improved land use practices such as terracing, planting of trees, and resistant vegetation and blocking of soil erosion outlets, which could enhance the productivity of farmers. In other words, this factor act as disincentive for environmental conservation and often result in a fundamental process of causing land degradation, poverty and under development [10].

Like in many parts of Nigeria, people in Southern part of Borno depend much on the land for their livelihood. Fuel wood is still being collected from forests on a large scale by these residents; livestock continue to graze uncontrolled and the vegetation cover which is to protect the soil continues to disappear. In addition, poor soil management practices, increase in soil erosion, and deforestation are decreasing the productive capacity of land that is already over cultivated [11]. The overall effect of these is the increase in food insecurity and poverty among agricultural communities where the average household income is less than US$1/ day [12]. To achieve poverty reduction in the study area, it became necessary to empirically measure the poverty status and examine the effects of land degradation on poverty among the farming households. This study therefore aimed at exposing this information. The objectives of the study were to determine the poverty status of the farmers and estimate the influences of land degradation on their poverty status. The study hypothesizes that land degradation does not affect poverty.

2. METHODOLOGY

2.1 Study Area

The study was carried out in Southern part of Borno State, Nigeria. It has an approximate land area of about 20, 661 square Km and lies between latitudes 10°00` and 11°30` North of the equator and longitudes 11°30` and 14°00`East [13]. It is projected to have a population of 1.79 million in 2018 using annual growth rates of 3.6% [14]. It shares borders with Gombe State to the South, Adamawa State to the East and Yobe State to the West. The average annual rainfall ranges from 600 mm-1200 mm and the average annual temperature ranges between 23°C-37°C. The vegetation consists of shrubs interspersed with trees and woodland. The study area has three agro ecological zones namely; Southern Guinea Savanna, Northern Guinea Savanna and the Sudan Savanna Zones. Agriculture and trading constitute the major economic activities of the area. The agricultural activities in the area can be categorized into cropping activities and animal husbandry [11]. The major crops grown are maize, sorghum, cowpea, groundnut, rice and soybean and the animals reared are cattle, sheep, goats, pigs and poultry [11].

Farmers in the study area are mostly small scale farmers characterized by small farm size and make use of hand tools and other simple implements. During the rainy seasons, cattle are mainly grazed communally on the mountain tops while during dry seasons they graze in valleys and on farm lands after harvest. Other livestock such as sheep and goats are grazed intensively during raining season and communally during the dry seasons.

2.2 Sampling Procedure

Multistage sampling procedure was used in drawing samples for the study. Southern part of Borno State consists of nine Local Government Areas (LGAs) namely; Askira Uba, Bayo, Biu, Chibok, Damboa, Gwoza, Hawul, Kwaya-Kusar and Shani. In the first stage, five (5) LGAs were purposively selected because they are among the more secure areas being least affected by the insurgency in the state. The selected LGAs are Bayo, Biu, Damboa, Hawul and Kwaya-Kusar. The second stage involved proportionate selection of twenty (20) communities among the five (5) selected LGAs in the first stage. The third stage involved random selection of 3% of farmers from each of the selected twenty (20) communities in the second stage. This makes a total of 120 respondents that were used for this study. The sampling frame is list of functional registered farmers in the selected communities which was obtained from Borno State Agricultural Development Programme (BOSADP).

2.3 Sources of Data

Primary data were collected through administration of structured questionnaire to gather information on causes of land degradation (such as quantities of fire wood collected, duration of livestock grazing, fallowing period, method of land clearing, experience of soil erosion on farm lands, experience of flooding on farm land and knowledge of natural resource conservation) and poverty status related information (such as household income and expenditure). Secondary information were obtained from related publications such as journals, proceedings of annual conferences, text books and relevant websites.

2.4 Analytical Techniques

Combination of two analytical tools was used in the analysis of the study. They are Foster, Greer and Thorbeck (FGT) index, and Probit regression model.

2.4.1 Foster, greer and thorbeck (FGT) index

The FGT weighted poverty index [15] was used to determine the poverty status of the farmers. The poverty index is defined mathematically as follows:

$$P_{\propto}=\frac{1}{n}\sum_{i=1}^{q}\left[\frac{(Z-Yi)}{Z}\right]^{\propto} \quad (1)$$

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 Monthly Mean per Adult Equivalent Household Expenditure (MPAEHE) of the household in which individual i^{th} lives.

The P–alpha (P_α) measures used in analyzing poverty relate to different dimensions of the indices of poverty, P_0, P_1 and P_2 was used for headcount, depth and severity of poverty respectively. The measure accomplished this through the choice of poverty aversion parameter α (alpha). The larger the α, the greater the weight given by the index to the severity of poverty. The three measures are all based on a single

formula, but each index puts different weights on the degree to which a household or individual falls below the poverty line. In defining the measures, the consumption or household expenditures was arranged in ascending order, from the poorer Y_1, next poorest Y_2... with the least poor Y_q.

Three components of the FGT index are:

1. Suppose α =0: This equals the headcount ratio, the index measures no aversion to poverty:

$$P_0=\frac{1}{n}\sum_{i=1}^{q}\left[\frac{(Z-Yi)}{Z}\right]^0=\frac{q}{n}=H \quad (2)$$

2. Suppose α = 1: the P_α is the headcount times the average expenditure shortfall:

$$P_1=\frac{1}{n}\sum_{i=1}^{q}\left[\frac{(Z-Yi)}{Z}\right]^1=\frac{q}{n}I=HI \quad (3)$$

P_α= Headcount × average expenditure shortfall.

It measures the depth of poverty (the proportion of the expenditure shortfall from the poverty line). It is otherwise called the poverty gap between the i^{th} poor farming household and the poverty line.

3. For α ≥ 2, it weighs the poverty of the poorest individual more heavily than those just slightly below the poverty line by Squaring the gap between their expenditure and the poverty line in order to increase its weight in the overall poverty measure:

$$P_2=\frac{1}{n}\sum_{i=1}^{q}\left[\frac{(Z-Yi)}{Z}\right]^2 \quad (4)$$

This measure, unlike the first two P_α measures is sensitive to the distribution of expenditure among the poor. Here, the P_α is the weighted sum of individual expenditure shortfalls where income gaps themselves are the weights. Thus, the expenditure gap ratios of poorer households weigh more importantly in the calculation of P_α than the expenditure gap ratios of less poor households.

Different standards can be used in setting up a poverty line. For instance, the food poverty line of 3000 kilocalories per day for an equivalent adult can be used as recommended by World Health Organization. However, for this study, the standard of living of households used in measuring the poverty level in the study area was based on total monthly consumption expenditure (food and non-food expenditure). The focus was on consumption goods, such as food (value of own produced food items consumed and those purchased from the market), non-food items (expenditure on clothes, health, education, transportation and farm inputs). Other sources of household expenditure that were considered are the values of the free environmental resources (fire wood, wild animals, wild fruits/vegetables, medicinal plants and fish) consumed. The value of natural resources consumed by a household was estimated by asking the amount (quantity/unit) utilized or collected for subsistence. The estimated quantities of extracted free natural resources were then multiplied by their prevailing market prices. The computed values were then summed up to arrive at the total value of free natural resources consumed by a household. Each household's total expenditure was then obtained by summing up their expenditures on food items, non-food items and natural resources.

Table 1. Nutritional (calorie based) equivalent scales

Age in years	Male	Female
0-1	0.27	0.27
2-3	0.45	0.45
4-6	0.61	0.61
7-9	0.73	0.73
10-12	0.86	0.78
13-15	0.96	0.83
16-19	1.02	0.77
20 and above	1.00	0.73

Source: FOS 2004

Each of the household's total expenditure was divided by the number of members in a given household to get the per capita expenditure as used by [16]. This was further converted into per adult equivalent expenditure using the scales provided by [17] as contained in Table 1. This was done by multiplying each of the household's per capita expenditure by number of household members that fall in any of the age distribution by sex. The converted per adult equivalent expenditure for each group by age and sex are then summed up for each household to obtain the monthly per adult equivalent household expenditure (MPAEHE). The MPAEHE of all the households were then ranked and divided into equal increments. For this study, the divisions was based on deciles or 10% increments such that the first decile represents the bottom 10% of the sampled households in terms of consumption

expenditure (or presumably the poorest) and the highest or the 10th decile was that increment which represents the highest 10% of the sampled households in terms of consumption expenditure (or presumably the richest). The MPAEHE of all the deciles were then summed up and divided by ten to get their mean. Two-third of the mean was then computed to arrive at the MPAEHE which served as the poverty line for the study.

2.4.2 Probit regression model

Probit regression model was used to analyze the influence of land degradation on poverty status. The model is expressed in equation 5:

$$P=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+e_i \quad (5)$$

Where;

- P = Poverty index of households (such that P = 1 if household's expenditure is below the poverty line and P = 0 if otherwise).
- β_0 = Constant (autonomous poverty)
- X_1 = Quantity of fire wood collected in (bundles)
- X_2 = Duration of grazing (hrs/day)
- X_3 = Number of years farmland is allowed to lay fallow (Number)
- X_4 = Burning of crop residues on farm lands (burn crop residues on farms = 1, 0 = if other wise)
- X_5 = Soil erosion (1 = if a farmer had experienced soil erosion on farm land, 0 = if other wise)
- X_6 = Flooding (1 = if a farmer had experienced flooding on farm land, 0 = if other wise)
- X_7 = Knowledge of natural resource conservation (1= if source of information is formal, 0 = if otherwise)
- $\beta_1 - \beta_7$ = Coefficients of the independent variables
- e_i = Random disturbances

3. RESULTS AND DISCUSSION

3.1 Poverty Status of the Farming Households

3.1.1 The poverty line

The poverty line used for determining the poverty status of the farming households in the study area is presented in Table 2. The result shows that the sampled households that fell in the first decile or the bottom 10% survived on an average of ₦4,159.91 per month and their share of the total monthly MPAEHE was 3.23% while those in the last decile spent an average of ₦32,968.07 per month and their share of the total monthly MPAEHE was 25.59%. The first decile represented the poorest twelve households from the sampled one hundred and twenty households, while the tenth decile represented presumably twelve richest households of the sample. The poverty line of ₦8,588.48 which was the 2/3 of the means of the MPAEHE was located within the twelve households of the seventh decile.

This poverty line based on 2018 prices was expected to meet the minimum basic requirements (food and non-food) of household per month in the study area. Thus, any household in the study area with per capita monthly expenditure greater than or equal to ₦8,588.48 was considered to be non–poor or rich whereas any household with per capita monthly expenditure below ₦8,588.48 was considered poor.

3.1.2 Poverty profile

The poverty profile of the farming households obtained from the FGT model which includes P_0, P_1 and P_2 are presented in Table 3. The P_0 for the entire farming households was 0.64 which implies that 64% of the farming households were poor or could not spend up to the value of the poverty line (₦8588.48). The proportion of the non-poor farming households on the other hand was 0.36 implying that only 36% of the farming population in the study area can spend up to or above the value of the poverty line. The result further shows an increase in the number of poor in the study area when compared with the findings of [18] who observed the proportion of the food poor and absolute poor in Borno State, Nigeria to be 33.2% and 55.1% respectively.

The value of the P_1 was 0.48 implying that an average poor farming household in the study area requires 48% of the poverty line (₦4122.47) in order to escape poverty. The value of the P_2 which measures the distance of each poor person to one another was found to be 0.22 implying that among the poor households, 22% were severely poor. This shows that the poor households were not equally poor but they vary in their degree of poverty.

3.2 Influence of Land Degradation on Poverty Status of the Farmers

Result of the Probit regression model is shown on Table 4. The pseudo R-square shows that about 21% of the variability in poverty was explained by the set of explanatory variables of the model. The log-likelihood function (-65.062) and the Chi-square (34.59) were both significant at 1% level, implying that the model provide a good fit to the data.

The result showed that all the seven listed variables had a significant influence on the poverty status of the farming household's head (Table 4). The coefficient of quantity of fire wood collected (0.061) was positive and significant (P<0.05) implying that a percentage increase in the quantity of wood collected would result to land degradation and probability of increasing poverty among the farmers by 6% as a result of low yield caused by land degradation. This agrees with the finding of [19] who observed that deforestation had a positive effect on poverty in Katonga Basin, Uganda. [20] also reported that 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.

The coefficient of duration of grazing (0.010) was positive and significant (P<0.05) implying that a percentage increase in time period allocated for free range grazing result in the probability of increasing poverty through land degradation induced by over grazing. [21] also found that overgrazing reduced forage yields by an average of 32%, which has led to associated losses in beef carcass weights and milk production in Niger. Overgrazing resulting from livestock stocking densities that exceed the available fodder supply is also considered to be a cause of degradation of land and forest resources [22]. In addition, overgrazing removes the vegetation cover that protects soil from erosion [23] and degrades natural vegetation that leads to desertification and decrease in the quality of rangelands [24].

Fallowing Period had a coefficient of -0.032 was negative and significant (P<0.05) implying that one year allocated for farm land to fallow results to a decrease in the probability of house holds' poverty by 3% due to high yield obtained from the farm land through bush fallowing. This result is similar with that of [25] who observed that improvement in biomass as a result of bush fallowing increases revenue by 1.04%, and consequently reduces poverty in Kenya.

Table 2. Distribution of the monthly MPAEHE by deciles

Deciles	MPAEHE	Expenditure distribution (%)
1st	4159.91	3.23
2nd	5578.39	4.33
3rd	5862.30	4.55
4th	7124.30	5.53
5th	8127.65	6.31
6th	8399.71	6.52
7th	11143.65	8.65
8th	18409.40	14.29
9th	27053.84	21.00
10th	32968.07	25.59
Total	128827.22	
Mean	12882.72	
2/3(MPAEHE)	8588.48	

Source: Field Survey, 2018

Table 3. Poverty profile of the households

Index	Naira/percentage
MPAEHE	₦12882.72
Poverty Line (2/3 MPAEHE)	₦8588.48
Head Count Index (P_0)	0.64
Non-poor	0.36
Poverty Gap Index (P_1)	0.48
Poverty Severity Index (P_2)	0.22

Source: Field Survey, 2018

Table 4. Influence of land degradation on poverty status

Variables	Coefficients	Standard errors	Z-values
Constant	0.160	0.033	-4.91***
Quantity of Fire Wood	0.061	0.749	2.14**
Duration of Grazing	0.010	0.131	2.49**
Fallowing Period	-0.032	0.158	-2.05**
Burning of Crop Residues	0.023	0.270	3.19***
Soil Erosion	0.091	0.649	2.18**
Flooding	0.051	0.449	2.15**
Knowledge of Conservation	-0.087	0.109	-2.05***
LR $Chi^2(7)$ =	34.59***		
Prob>Chi^2 =	0.0003		
Log likelihood =	-65.062***		
Pseudo R^2 =	0.210		

****= Significant at 1% and **= Significant at 5%*
Source: Computed From Field Survey, 2018

Allocation of fallowing period in cultivated and grazed areas helps in promoting environmental recovery and regeneration of vegetation, soil and fauna over long term [26,27,28]. [29] emphasized that fallow land is not an idle land, but is land used for restoring soil fertility and can therefore be considered as a kind of investment which translate into higher productivity.

Burning of crop residues on farm land had a coefficient of 0.023, was positive and significant (P<0.01) implying that a percentage increase in bush burning result to the probability of increasing poverty status by 2%. Farmers do burn vegetation covers during land preparation for weed control and to get rid of crop debris from farm lands [30]. [31] and [32] pointed out that relatively large-scale loss of nutrients and an alteration of soil physical conditions occur after burning. In addition, burning increases soil temperature and deprives land from organic matter there by contributing to low and declining agricultural productivity, and this in turn contributes to worsening of poverty among farmers who depends on the land for their livelihood.

The coefficient of soil erosion (0.091) was positive and significant (P<0.05) implying that farmers who experienced soil erosion on their farm lands are more likely to be poorer by 9%.This agrees with the finding of [33] who observed that at 10% level of significance, households experiencing soil erosion on farm plots are 38% and 26% more likely to be poor in Malawi and Tanzania respectively. Erosion washes away the top most soil which is rich in the nutrients required by crops which is the main source of income for the rural poor. [34] also reported that nutrient depletion is the primary form of soil degradation in sub Saharan Africa, and is leading to a decline in crop productivity, and has been linked to hunger and poverty.

Flooding with coefficient of 0.051 was positive and significant (P<0.05) implying that farmers who experienced flooding on their farm lands are more likely to be poorer by 5%. Flooding affects poverty in wide range of ways. It destroys crops, livestock, houses and other income generation activities [35]. [36] also observed that 48.3% of people in Bangladesh earn an income between Tk. 2001-3000 before flood but only 18.3% of these people earn this same income range after the flood.

The coefficient of knowledge of natural resource conservation (-0.087) was negative and significant (P<0.01) implying that a percentage increase in knowledge of natural resource conservation methods will result in decrease of poverty by 8%. Having knowledge on natural resource conservation helps farmers uses land in a conservable manner there by decreasing land degradation and consequently decreases poverty through high yield obtained from farm land. Awareness raising, promotion, training and financial or material support for best sustainable land management practices can also serve as an indirect means of reducing poverty by improving agricultural productivity [37] and [38].

4. CONCLUSION AND RECOMMENDATIONS

The study concluded that majority of the farming households in the study area were poor and land degradation had effects on poverty status. Specifically, quantity of fire wood collected by households, duration of livestock grazing,

burning of crop residues on farm lands, soil erosion and flooding increases poverty among the farming households. Only fallowing period and knowledge of natural resource conservation decrease poverty among the farming households. Based on the findings of this study, the following recommendations were made;

i. Policies should be geared up towards minimizing fuel wood consumption through establishing alternative energy sources such as technologies that utilizes ample solar and wind energies.
ii. Government should as a matter of policy, establish ranches in all the farming communities. This will encourage sedentary animal production.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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