

Impacts of Environmental Degradation on Profitability of Cassava Production in Southeast, Nigeria

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Abstract
This paper examines the impacts of soil erosion on profitability of cassava production in Enugu State, Nigeria. The study specifically compared the costs and returns of the farmers operating on eroded and non-eroded farms and explicitly analyzed the factors influencing profitability of cassava farming enterprise using partial budgetary technique and regression analysis. A multistage sampling procedure was used to select 200 cassava farmers for the study. Primary data were collected on respondents' age, sex, educational background, farm size, as well as on quantities and prices of inputs and outputs using pre-tested questionnaire. Partial budgetary analysis showed that farmers operating on eroded farms recorded lower crop yield resulting in a significant difference ($p<0.05$) between the average gross margin earned per hectare on non-eroded (₦185, 553) and eroded (₦152, 312) farms. Regression model estimates showed that farm size, labor, input-usage and access to extension services positively and significantly influenced profitability of cassava farming enterprise; whereas incidence of soil erosion and large household size have negative effects on profitability of cassava farming enterprise in the study area. Cassava farmers in the study area could substantially increase their profit if farmers have access to more land, credit to purchase farm inputs and extension services geared towards good agricultural practices and soil conservation methods. It is also pertinent for government to design and implement special schemes to control and mitigate the effect of soil erosion in order to forestall continuous degradation of arable lands.
Keywords: Profitability; Budgetary technique; Multiple regression; Soil erosion; Cassava farmers.

1.1 Introduction:

The world's population is expected to continue expanding well into the next century with much of the growth in developing countries (Barbier, 1997). An inevitable consequence will be the demand for new crop land for commercial and subsistence agriculture. Unfortunately, current evidence suggests that much of the existing as well as potentially productive agricultural land in developing countries had been lost through the process of land degradation (Titilola, 2001).

Land degradation is a major problem facing developing countries and is projected to become an even more severe constraint into the future (Barbier, 1990; Pimentel *et al*., 1995). Several studies have shown that nearly 80% of range land and dry land forest areas, 30% tropical forest and around 50% of all irrigated crop land in developing countries are classified as degraded while agricultural productivity is estimated to have declined significantly by approximately 16% due to land degradation (Leonard, 1989; Oldeman, 1994; Abegunde *et al.,* 2006). According to the World Bank (1990), soil erosion affects 50 million people and lead to a huge loss of GNP (US$3000 million per year) relative to other environmental problems.

Given that land is an essential input in farming, the impact of land degradation and depletion of soil resources has profound socio-economic implications for low income countries and poor rural regions of the world (Barbier, 1997). Iheke (2005) and Asogwa *et al.* (2006) reported that soil erosion accounts for variations in the productivity which invariably affects income generating potentials of the farms. This is especially true in Africa where agricultural production is crucial to development and livelihood of the rural population who depend on this primary sector. Although Nigeria's soils were once considered to be among the most fertile in the tropics, the problem of soil nutrient depletion, erosion, and other manifestations of land appear to be increasing (Adeniji *et al*., 1997).

Soil erosion is very prominent in southeastern Nigeria and it is responsible for the destruction of arable land, contamination of water supply, isolation of settlement and migration of communities (Abegunde, 2003; Egboka, 2004). Abegunde (2006) stated that more than 1,000 erosion sites exist in Southeastern Nigeria with Anambra and Enugu States being the worst hit as a result of the topography and nature of the soil (hydromorphic soils). It has widely been observed that erosion has caused loss of forest cover, environmental hazard; reduce farm production and profitability, water contamination among other things. Soil erosion increases the cost of crop production, reduces yields, and causes potential environmental hazards as well as human suffering (Scherr, 2000).

However, empirical studies on the impact of soil erosion on agricultural productivity in Nigeria are scanty. The few ones available studies focused mainly on qualitative measurement and management costs of soil erosion to a farm enterprise (Okoye, 2009; Abegunde *et al.,* 2006). With the rapid rates of soil degradation in many parts of Nigeria, it becomes imperative to investigate the effects of soil erosion on the profitable production of crops, particularly cassava which is a major crop produced in Nigeria. This raises pertinent research questions that need to be addressed:

(i) What are the costs and net returns (profit) to eroded and non-eroded farms?
(ii) How does soil erosion affect the profitability of farms in the eroded and non-eroded farms?
(iii) What are various factors affecting the profitability of cassava production in the eroded and non-eroded?

1.2 The Study area

The study was carried out in Enugu State, located in the South Eastern part of Nigeria. Enugu State was purposefully selected for this study because of high incidence of erosion in the State. Enugu is a mix tropical rain forest zone with a derived savannah; its physical features change gradually from tropical rain forest in the south to open wood-land and then derived savannah towards the north. The State shares boundary with Abia and Imo States to the South, Ebonyi State to the east, Benue State to the northeast, Kogi State to the northwest and Anambra State to the west. The mean temperature in Enugu State in the hottest month of February is about 36.20 °C, while the lowest temperatures occur in the month of November, reaching 20°C. Rainfall is entirely seasonal and most of it falls between May and October.

Enugu state has 17 Local Government Areas (LGAs) and three agro-ecological zones; Zone A (Enugu North), Zone B (Enugu East) and Zone C (Enugu West). Two of the Zones (i.e, A & B) are not affected by soil erosion while Zone C is seriously affected by soil erosion. Economically, the state is predominantly rural and agrarian, with a substantial proportion of its working population engaged in farming, trading and services. Cassava is a very important staple food cultivated in the State.

1.3 Data collection

Primary data were used for this study. Data were collected from cassava farmers using a set of pre-tested structured questionnaires. Information sought include respondents' socio-economic characteristics such as age, gender, educational level, marital status, farm size, as well as on quantities and prices of inputs and outputs for cassava production in 2011/2012 planting session. Respondents were also asked to provide detailed information on incidence and management costs of erosion on their farms.

A multi-stage sampling procedure was used to select respondents. In the first stage, following State's agro-ecological classification, two local governments were selected from zones A and B while four local government areas were selected from Zone C based on their prominent positions in cassava production and incidence of soil erosion.

Secondly, one village/community that is known for high cassava production were selected in each local government areas. Finally, twenty five cassava farmers were selected from each village to give a total sample of 200 respondents.

1.4 Empirical model

The economic effects of soil erosion can be appraised through the use of budgeting analysis. Budgeting analysis was used to capture the profit accruable to cassava farmers operation on eroded and non-eroded farms. Various inputs used in the production and their cost were identified. The data that are important in the production of cassava include: total output per hectare, cost of fertilizer used, seed, labour use, transportation cost, processing cost, cost of soil maintenance and price per basket of the output (i.e, cassava).

The arithmetical relationship used to capture the gross profit made by the farmers is expressed as:

Gross Margin (GM) = $\sum P_iQ_i - \sum PjQj$ (1)

Where;

P_i = Price of cassava basket (₦).

Q_i = Output of the farmer producing cassava per hectare (kg).

Pj = Unit cost of variable input (fertilizer, labour cost, farm, cost of land clearing, ridging, planting materials, weeding and harvesting), money spent to initiate soil erosion control measures.

Qj = Total quantity of variable input used per hectare (kg).

1.5 Multiple regression analysis

Multiple regressions were used to analyze the effect of respondents' socio-economic and farm level characteristics on the profitability of cassava production in eroded and non-eroded farms.

The implicit form of the regression model is presented as:

$Y = f(X_1, X_2, X_3, X_4 - - - X_n)$ (2)

This is explicitly expressed as:

$Y = ß_0 + ß_1X_1 + ß_2X_2 + - - - ß_nX_n + e$

Where:

Y = gross margin (₦/ha)

X_1 = farm size (ha)
X_2 = household size (No of person)
X_3 = education (years)
X_4 = labour (mandays)
X_5 = age (years)
X_6 = sex (male, 1; female, 0)
X_7 = incidence of soil erosion (Dummy: non-eroded, 1; eroded, 0)
X_8 = membership in association (Dummy: member, 1, non-member, 0)
X_9 = cost of inputs (e.g. fertilizer and other agrochemicals) (₦).
X_{10} = extension contact (Dummy: contact, 1; Otherwise, 0)
β_i = parameters to be estimated
e = disturbance or random error term

Three functional forms of the regression model were used: linear, semi-log and double-log. The functional forms are expressed as:

Linear: $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + e$

Semi-log: $Y = \beta_0 + \beta_1 \log X_1 + \beta_2 \log X_2 + \ldots + \beta_n \log X_n + e$

Double-log: $\log Y = \log\beta_0 + \beta_1 \log X_1 + \beta_2 \log X_2 + \ldots + \beta_n \log X_n + e$ (3)

The choice of any functional form depends on the magnitude of the R^2, the significance of t- and F-value, and the *a priori* theoretical expectations of the sign and size of the regression coefficients (Koutsoyiannis, 1979; Gujarati, 2006). R^2 is the coefficient of determination, which measures the goodness of fit of the model. It measures the joint contribution of the explanatory variables ($X_1 \ldots X_n$) towards explaining the observed variability of the dependent variable (Y). The t-value tests the significance of the individual regression coefficients, while the F-ratio tests the significance of the entire regression relationship.

1.6 Results and discussion

Costs and returns (₦) to cassava production among eroded and non-eroded farms

The result of costs and returns to cassava production in Enugu State are presented in table 1 below. Farmers were categorized into two groups; with eroded and non-eroded farms. Table 1 revealed that cassava production in Enugu State returns positive gross margin with the value of ₦152,312 and ₦185,553 per hectare among eroded and non-eroded farms respectively. Out of the various inputs considered however, labour cost was the highest. The results showed that the mean yield of cassava output was about 14 and 17 tonnes per hectare while the revenue generated per hectare was ₦199,247 and ₦223,094 among eroded and non-eroded farms.

Results from the pooled estimates showed that farmers' revenue from cassava production was ₦211,171 There was however, a significant difference ($p<0.01$) between the total revenue earned by farmers with eroded farms (₦199,247) and those with non-eroded farms (₦223,094). This implied that higher revenue was earned by farmers with non-eroded farms. The total variable cost (TVC) in generating the revenue earned by farmers among eroded showed that labour cost constitutes the largest component of TVC (₦17,239.94) accounting for about 36.73 percent while soil erosion control measure costs (cost of seed, cost of establish conservation, labour spent in repairing damaged ridges and mounds) was about 16.25 percent of the total cost.

However, among non-eroded farms labour cost also constitute the largest component of TVC (₦16,153.99) accounting for about 43% of the total cost. This result agrees with Osemeobo (1992) who found out that labour was the main cost absorbing larger percentage of the total cost. TVC accounted for 19.91 percent of TR in the pooled sample estimates, and 23.56 percent and 16.83 percent for farmers on eroded and those on non-eroded farms respectively. This means that, total variable costs account for more than 20 percent of the total revenue generated from cassava production in the study area. However, a significant difference was established between costs incurred and net profit among eroded and non-eroded farms.

The gross margin earned per hectare was ₦168,932.11 in the pooled estimates which accounts for about 80 percent of TR, while the gross margin of farmers on eroded farms (₦152,312) and those on non-eroded land (₦185,553) accounted for 76.44 percent and 83.17percent of TR respectively. In addition, there was a significant difference ($p<0.01$) between the gross margins of cassava producers among two groups of respondents due to extra cost spent on eroded farms.

Table 1: **Costs and returns (₦) to cassava production in eroded and non-eroded farms per ha.**

Item	Pooled (₦)	% Revenue & Cost	Eroded (₦)	% Rev. & Cost	Non-eroded (₦)	% Rev. & Cost	t-value
Revenue							
Total revenue	211171		199247		223094		1.03*
Variable cost							
Cost of planting materials	2826.65		2976.5		2676.8		
Cost of fertilizer	12108.03		12540.5		11676		
Labour cost	16696.97		17239.94		16154		
Cost of transportation	6792.78		6551.54		7034.01		
Control erosion	4251.33		7627		0		
Total variable cost	42,238.90	19.9	456,935.50	23.6	37,540.80	16.8	2.2**
Gross margin	168,932.30	79.9	152,311.00	76.4	185,552.70	83.2	1.5**

***, **, and *** at 10%, 5% and 1% significant levels.**

1.7 Regression coefficient of determinant factors influencing the profitability of eroded and non-eroded farms

The regression results of various factors influencing the profitability of eroded and non-eroded cassava farmers in the study area are shown in Table 2. The estimates showed R^2 of 0.70 and 0.75 on eroded and non-eroded farms respectively which implies that 70% and 75% change in gross revenue was jointly accounted for by the independent variables included in the model. Also, result from the pooled estimates showed an R^2 of 0.91 which means that 91% change in gross revenue was jointly accounted for by the independent variables included in the model. In addition, based on the significance of the t- and f- values at the 1% level of probability, the regression model is considered to be a good fit.

The results revealed that farm size, household size, labour, incidence of soil erosion and value of inputs significantly influenced gross revenue of cassava farmers on eroded farms at different levels of probability. In addition, farm size, labour and costs of inputs were positively signed while household size, incidence of soil erosion and membership of association were negatively signed. In the same vein, labour, membership of association, value of inputs, and extension contact significantly influenced gross revenue at different level of probability among non-eroded farms. While labour, value of inputs, extension contact was positive; membership of cassava association is negative.

In another dimension, all the variables of pooled data except education and sex significantly influenced gross revenue at different level of probability. Farm size, labour, age, value of inputs, extension contact were positively signed while household size, incidence of soil erosion, membership of association were all negatively signed. The significant and positive coefficient of farm size shows that further unit increase of farm size could lead to an increase in gross revenue by 24 percent on eroded farms. Also for pooled data, a unit increase of land size could lead to 12 percent increase in gross revenue, this means that profit increased as farm size increased. Onyebinama and Onyejelem (2010) noted that increase in farm size, will cause an increase in farm output, hence farm income is expected to increase.

The negative and significant coefficient of household suggests that for every unit increase in household size of cassava farmers, profit realized will be reduced by 10% and 20% for pooled and eroded farms respectively. This implies that the larger the household size, the less amount of money the farmer realized from the sales of cassava. This shows that value of farm produce that could have been sold is consumed directly by household. The result agrees Okike (2000); Echebire and Ukoha (2006)) who reported that family size had a negative influence on productivity.

The coefficient of labour gave a positive sign and significant among cassava farmers in the study area. This implies that, a unit increase in source of labour could lead to an increase in revenue by 27%, 11% and 65% among the pooled, eroded and non-eroded farms respectively. This implies that, adequate supply of labour will affect output which eventually increases farmers' revenue. The result agrees with Onyebinama & Onyejelem (2010) who stated that farmers' income increased as the use of labour and other capital inputs increased.

The coefficient of age was positive and significant at 5 percent level of probability among pooled sample. This indicates that, as respondents age increase by a year, their revenue earning increase by about 13 percent, implying that most of the farmers fall within the active age bracket. The negative and significant incidence of soil erosion suggests that increase in the incidence of soil erosion, would contribute negatively to revenue dropping by 3%. This implies that, as the incidence of soil erosion increases, the level of output reduces which eventually lead to decline in profit status among farmers. This study corroborates Cofie and Penning Devries frits (2002) who reported that the overall effect of soil erosion is that it reduces maximum crop yield; weaken input use efficiency and reduces profit.

With respect to membership of association, the coefficient is negative and significant at 1 percent level. This reduces their revenue potential; every additional membership reduces respondents' revenue earning capacity by 26 percent and 37 percent among pooled and non-eroded farms respectively. This is contrary to *a priori* expectation. However, it may be due to entrance fees charged by these association and at the same time some of these association joined by cassava farmers may not be relevant to their business i.e. most of them prefer to join church and other socio-cultural groups.

In addition, for every unit increase in the value of input, there is corresponding increase in revenue farms by 27 percent and 18 percent among eroded and non-eroded farms respectively. The use of more purchased inputs such as fertilizer, improved cutting, and agrochemicals e.t.c will lead to higher yield levels and consequently revenue will increase as the use of purchased inputs increases, hence, consistent with 'a priori' expectation. In addition, among the pooled sample, the coefficient of extension variable had positive sign and significant. This indicates that revenue increased with extension services.

Table 2: Regression coefficient and the level of significance of independent variables related to eroded and non-eroded farms

Variable	Pooled (n=200)	Eroded (n=100)	Non-eroded (n=100)
Constant	6.233 (3.568)***	5.98 (1.919)	8.164 (3.554)***
Farm Size (ha)	0.121 (1.917)*	0.24 (2.481)***	0.032 (1.537)
House size (No. of person)	-0.109 (-1.686)*	-0198 (-1.83)**	0.061 (0.801)
Education (years)	0.216 (3.387)	0.200 (0.895)	0.034 (0.574)
Labour(Available=1;available=0)	0.271 (4.169)***	0.11(2.13)**	0.650 (8.085)***
Age (years)	0.130 (1.984)**	0.091 (0.839)	0.078 (1.027)
Sex (male=1; female 0)	0.023 (0.350)	0.112 (0.987)	0.048 (0.67)
Incidence of soil erosion (eroded=1;not eroded=0)	-0.112 (-1.691)*		
Association (member = 1; nonmember = 0)	-0.261 (-.09)***	-0.154 (-1.49)	-0.369 (-5.01)***
Cost of inputs (₦)	0.218 (3.219)***	0.269 (2.74)***	0.177 (2.017)*
Extension visit (access= 1; no access = 0)	0.129 (1.79)*	0.97 (1.009)	0.148 (1.69)
R^2	0.909	0.702	0.75
F-value	84.63	9.694	12.84

***, **, and *** at 10%, 5% and 1% significant levels**

1.8 Conclusion

Budgeting analysis and ordinary least square regression were employed to analyze factors affecting profitability of cassava production enterprise in eroded and non-eroded farms in Enugu State, Southeastern geopolitical zone of Nigeria. The result showed that the estimated average cost of ₦46,935.48 was incurred on eroded farms while ₦37,540.8 was estimated to have been spent on non-eroded farms. The mean gross margin among eroded and non-eroded farms was ₦152,311.52 and ₦185,552.7 respectively. The result cassava production is a profitable enterprise in the study area however, soil erosion significantly reduced profit accruable to cassava farmers survey

The results of the multiple regression model showed that farm size, education, cost of inputs and extension contact significantly and positively influenced the profitability of cassava farmers in among the two groups of farms while the pooled sample showed that incidence of soil erosion significantly reduced profitability cassava production in the study area. Hence, cassava farmers in the study area could substantially increase their profit if they have access to more land, credit to purchase farm inputs and extension services geared towards good agricultural practices and soil conservation methods. It is also pertinent for government to operate special schemes to control and mitigate the effect of soil erosion in order to forestall continuous degradation of arable lands in the study area.

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