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Soil Erosion Control and Damage Costs in Nigerian Small Farms: Implications for Farm Growth and Sustainability

By

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ABSTRACT

In Nigeria 90% of the agricultural primary produce is in the hands of small holders cultivating between 0.8-4 hectares. Farm size expansion is limited by population pressure, land fragmentation, poor market opportunities and lack of finance. This article presents estimates of soil erosion control(SEC) and soil erosion damage costs (SEDC) in small farmers' fields in Nigeria and examines the contents and direction of the country's agriculture and environment policies vis-à-vis the SEC among small farmers. It was found that 24% of the farmers' spending on tillage/cultural practices was directed at the institution of SEC measures, and that SEC-related defensive expenditures was 3.7 times more than the estimated SEDCs. The capacity of small farmers to respond to soil degradation is severely limited. Most SEC measures deployed derive from non-tradable inputs blurred by incomplete/missing markets for environmental assets. Yet farm development and environmental policies in Nigeria have dwelt on supply-side interventions based on marketable inputs, and have been largely ineffective. Policy and institutional reforms are needed to increase and focus support to farmers to increase defensive expenditures for SEC.

Key Words: Soil erosion, damage costs, farm growth

1. INTRODUCTION

Soil degradation is a serious problem in Nigeria (World Bank, 1990). Deforestation, soil erosion, desertification, soil salinization, alkalinization and water-logging, form different but often interrelated aspects of soil degradation (Karshenas, 1994). In Nigeria, soil degradation affects about 50 million people and leads to the greatest loss of GNP (US $3000 million per year) relative to other environmental problems (World Bank, 1990). By 1964, 47% of the soils of Eastern Nigeria was affected by measurable sheet erosion; 20% from severe sheet erosion (Ofomata, 1976). By 1990, gullies occupied 4% of the land area of Anambra, Imo, Abia and Enugu states (World Bank, 1990).

Most literature on soil erosion (SE) in Nigeria deal with the geophysical aspects (Ofomata, 1986 & 1987; Ojanuga, 1978). It could be hypothesised that more than 70% of SE-related losses suffered by Nigerian small farmers is attributable to sheet erosion/soil wash (see Okoye, 1995). The persistent researchers' focus on aggregate 'soil degradation' with less attention to the more specific aspects means that soil wash will remain inadequately analyzed..

2. METHODS

The study area was Enugu North Local Government Area (LGA), Enugu State, South Eastern Nigeria. The LGA covers 134 square kilometres with a population of 332,000 (NEC, 1992). Out of the 20 wards that make up the LGA, we purposively selected four (Mbulujodo West, Mbulujodo East, Ugwogo and Abakpa Nike West) most 'agricultural' leaving out 16 others that were either urban or sub-urban. Subsequently, 6 communities (Amaoji, Ijinike, Ugwogonike, Ugwuomu, Nkwubo and Emene) were randomly selected from the wards followed by a random sample of 12 farmers from each community to make a total of 72 farmers. Structured questionnaires, personal interviews and participant observation were used to collect data.

To obtain losses due to erosion, we estimated:
-labour hours lost (number of hours spent repairing damaged ridges, mounds and other seed beds and replacing destroyed plants);
-cost of establishing conservation measures; and;
-cost of seeds and seedlings for replacing erosion damaged/removed ones.

To arrive at the amount of investment in SEC measures, an attitude scale was constructed to analyze farmers' perceptions about SE. Since verbal expression of an attitude measures disposition toward overt action, the scores of those respondents that were either undecided or disagreed were ignored since their attitudes will be of no consequence in increasing resource commitment to SEC. Total score under the 'agree' category as a percentage of total possible score on all the three categories represent an aggregate subjective propensity of the farmers to add extra soil to a mound/ridge, etc with a specific unrevealed wish to compensate for the effect of SE.

3. FINDINGS AND DISCUSSION

3.1 Context of The Farmers

The farmers ranged between ages 25 and 75 years; median of 60 years; mean of 55 years . Average household size was 9. Size of landholding ranged between 1 and 8 hectares with an average of 3.5ha. Most of the respondents worked on family lands on subsistence basis. Ninety four percent practised shifting cultivation. Average length of fallow was 3 years. Annual cropping mix had yam as the main crop.

3.2 Extent of Soil Erosion and Farmers' Perceptions

Whereas most of the farmers expressed strong awareness of SE as a problem, there was no evidence of a correspondingly equal desire to commit financial and labour resources specifically for SEC. This questions some farm-level SEC policy assumptions. Some of the farmers actually saw sheet and rill erosion as part of normal soil processes and did not see their land as vulnerable.

3.3 SEC Practices

The SEC practices used and the proportions of farmers using each are indicated in table 1. Soak-away pits are constructed outside the farm but are meant to limit runoff into and within the farm. Labour spent desilting these pits is part of the cost of SEC. Non of the farmers used concrete structures. Most of the SEC measures were integral parts of the agronomic (tillage) practices in the area. Only soak-away pits and tree trunk dams were found to be applied not as part, but as independent, of general tillage practices.

What farmers achieve with the measures described above are both SEC and soil erosion prevention(SEP). That is, if we define SEP measures as those that are established more or less before erosion occurs while SEC measures are put in place largely when erosion is already occurring. More often than not, farmers do not institute measures for SEC but for SEP. We did not see any much evidence of post tillage soil amendment meant specifically for SEC. We also found that if at all farmers put SEC measures in place, they were directed at points on the farm where crops were clearly under threat.

Table 1: Some SEC Measures and Proportion of Farmer Users

Conservation Measure	% of Farmers Using
Grassing	36.1
Mulching	31.9
Mounding/Ridging	62.5
Soak-away pits	37.5
Cover crops	38.9
Tree Trunk Dams	13.6
Remoulding mounds and ridges	25.0
Contouring	30.6 .

Source: Field Survey.

3.4 Towards Estimates of SEC/Prevention and Damage Costs

SE imposes two types of costs, namely, money spent to institute SEC measures and expenditure of resources to repair erosion damages on existing SEC measures/structures and to replace destroyed farm crops.

3.4.1 *Costs of SEC Measures*

Costs of SEC measures come from spending on materials and labour, broken down into materials for initial construction, materials for maintenance, labour for initial construction, and labour for maintenance.

It is easier to value concrete structures than cultural practices that serve a multiple purpose of SEC and food production. Because all the materials used were of organic origin and untraded they generally do not have market value. Using contingent valuation to obtain these values is ineffective as farmers could not understand the idea of a hypothetical market. Willingness to pay for these materials could hardly be revealed. We therefore ignored the cost of materials other than feeding for labourers.

Except for soak-away channels, all other SEC measures employed by the farmers were integral parts of routine cultural practices. Thus mounds and ridges, for instance, served both as seed bed and as SEC structures. Mulch is applied on yam mounds/ridges and on seed beds for vegetables to reduce soil wash and soil temperature. Melon (citrulus vulgaris) is planted partially to establish rapid ground cover against rain splash impact and runoff. Except figures for soak away pits, the amounts in table 3 represent total spending on general agronomic practices. The difficulties of disaggregating the total expenses in table 3 into those for seed bed preparation and those for SEC measures are enormous. In the next section we attempt doing this using a tentative 'back-of-the-envelop' approach.

3.4.2 Revealed Attitudes and Resource Allocation to SEC

The procedure we have adopted to disaggregate crop production and SEC investments is to calibrate farmers' revealed attitudes to SE in terms of their awareness of its effects and willingness to commit resources (labour and/or money) for SEC and then using the product of the two to multiply total farm spending on tillage practices that have a dual function of crop production and SEC. In effect, the proportion of farmers' total spending on tillage/cultural practices that goes into SEC is a product of (1) a measure of farmers' perception of the SE problem; (2), a measure of farmers' willingness to commit resources specifically to SEC, and; (3) total aggregate expenditure on cultural practices that have joint objectives of SEC and crop production (see Table 3).

The conceptual basis of this method is as follows. Awareness of erosion as a problem generates a desire to control or limit it and this desire culminates in a decision to commit resources for that purpose. A farmer may then add soil here and there while making fresh seed beds or repairing damaged ones to increase their size and/or compactness, etc, depending on how deeply he or she feels the need to reduce the effects of SE. The amount of soil, mulch, other material or energy added or exerted under the above circumstances beyond what is considered adequate for crop production per se in an erosion-free environment, could be a function, among other things, of the farmer's awareness of the adverse effects of SE and of his/her willingness to commit resources to SEC. This assumption has obvious limitations particularly in relation to judgements as to what amount of soil or other input is to be considered adequate for crop production.

Therefore, in translating attitudes into practical effect, there are four possible subjective scenarios within which we may place the overt actions of the farmer. One, a farmer may not perceive SE as a serious problem and would not commit resources for SEC. Examples are those farmers who did not think that erosion was a serious problem, but a normal soil process. Second, a farmer may, in spite of not seeing erosion as a problem, subconsciously allocate resources for SEC. Third, a farmer may perceive SE as a serious problem but is unwilling or unable to commit resources for SEC. Finally, a farmer may perceive the seriousness of erosion and accordingly allocate resources for its control.

Based on the above considerations, we could obtain an estimate of the portion of farm spending directed specifically at tillage/cultural practices for SEC as follows:

$A \times W \times E$ = portion of total farm spending on tillage/cultural practices directed at SEC,

Where; A = measure of awareness of the effects of SE.
W = measure of willingness to commit resources to SEC
E = total farm expenditure on tillage/cultural practices that integrate SEC and crop production objectives.

From the analysis of figures in the attitude scale, 61 percent of the sampled farmers were aware of SE as a problem, while 20 percent expressed willingness to commit resources to fight SE(Table 2).

Table 2: Summary Figures From Attitude Scale (N = 72)

Item	Agree (aware) %	Undecided (not sure) %	Disagree (unaware) %
Awareness of SE as a problem	46	19	10
Desire to commit resources specifically for SEC	20	27	33
Total	61	46	43

Source: Author's calculations.

Awareness of the adverse effects of SE strengthens readiness to commit resources. Therefore, proportion of total spending on cultural practices directed at SEC could be given by; 0.61 x 0.20 x average farm investment on cultural practices.

The resulting estimates of per hectare costs of the farmers' major multiple purpose tillage/cultural practices that integrate SEC are presented in tables 4 and 5. Table 3 contains straight estimates of actual empirically generated costs of tillage/cultural practices while Table 4 is a derivation of the share of SEC investments in those tillage/cultural practices.

Table 3: Per Hectare Costs of Major Multiple Purpose Tillage/cultural Practices (₦).

Cost Element	Cost of Tillage/Cultural Practice(₦/ha)				
	Grassing (cover Cropping)	Mulching	Mounding/Ridging	Soak-away pits*	Total
Materials (feeding only)	-	2400[a]	12250[a]	1440[a]	16090
Labour	1750[e]	7000[b]	12250[c]	4200[d]	25200
Seeds/seedlings	-	-	-	-	
Total Cost(N/ha)	1750	9400	24500	5640	41290

[a] feeding labourers at average of ₦120/manday x 20 mandays.
[b] Mulching yams: 20 mandays/ha x ₦350/manday.
[c] Making yam mounds, average size 2m diameter and 1m height at 35 mandays/ha x ₦350/manday.
[d] Digging average of 2 soak away pits (2m depth x 3m height x 3m breath/ha) at 12 mandays/ha x ₦350/manday.
[e] Sowing melon(*citrulus vulgaris*) cropped field (5 mandays x ₦350/manday)
Exchange Rate: $1 US = ₦150

Sources:1. Field Survey.
2. Labour rates from Philips, T.A. (1977) .

Table 4: Per Hectare Share of SEC Investments in Total Expenses on Major Multiple Purpose Tillage/Cultural Practices (in Naira)*

Cost Element	SEC Measure				
	Grassing (cover-cropping)	Mulching	Mounding/Ridging	Soak-away pits*	Total
Materials	-	293	1495	1440	3228
Labour	214	854	1495	4200	6763
Seeds/seedlings		-	-	-	-
Total Cost(N/ha)	214	1147	2980	5640	9981

*All figures derived as proportions of corresponding ones in Table 3 except for soak-away pits, which are solely for SEC.
Exchange Rate: $1 US = ₦150

Source: Field Survey and Author's calculations.

The contents of Table 4 were obtained by applying our formula (A x W x E = Share of SEC investments in tillage/cultural practices) on the contents of Table 3. For instance, to obtain the figure 214 for labour in column 2 of Table 4 we multiplied 0.61 x 0.20 x 1750. Comparing the grand total figures in Tables 4 (cost of tillage practices) and 5 (cost of the share of investments in SEC), and taking their ratio (41290/9981 =4.1) we find that on the average 24% of the farmers' expenditure on the tillage/cultural practices go for SEC. This means that to maintain the present level of productivity using existing tillage and SEC technologies, farmers should not spend less than 24% of their investments on tillage/cultural practices for SEC. This has to be scaled upwards as the level of SED increases. This knowledge can be used to estimate optimal subsidy levels in programmes of SEC. Any subsidy programme that aims to maintain the present level of SED under current cultural practice (technology) use regimes would have to defray a maximum of 24% of the farmers' total cost of establishment and management of the seed bed, for instance, *ceteris paribus*.

3.4.3 *Proximate SEDCs*

Whether farmers institute SEC measures or not, they are more or less likely to suffer varying levels of SED. In the absence of SEC measures, however, damages are bound to be higher. If farmers had adequate information about SEDC trends in their locality, are rational, and wish to maximize returns to total farm resources, or to minimize total farm expenses, they would choose between erosion control/limitation and tolerance of SEDCs. Based on direct observation, farmer recalls and evidence from farm budget records, we arrived at the SEDCs summarised in Table 6.

Table 4 Per Hectare Estimates of Average SEDCs for One Cropping Season.

Damage Type/Losses	Adopted Remedy	Required Labour in Mandays/ha	Cost(₦)			Grand Total Cost (₦)
			Labour	Materials	Feeding	
Seed bed washed	remoulding[a]	7.0	840	-	245	
.Loss of seeds[b]	supplying	2.8	336	98[f]	98	
Loss of seedlings[b]	supplying	1.9	228	53[f]	67	
Unearthing of roots[c]	reburial	2.7	324	-	97	
Silting of saokaway pits	desilting[d]	2.0	240	-	70	
Total		164.0	1968	151	577	2686

[a] reference to yam.
[b] reference to maize as typical of grains, beans and vegetables.
[c] reference to cassava. Required labour hours could be much higher because some reburial of roots is done while remoulding seed beds.
[d] Two soak-away pits/ha, desilted three times a year.
[e] Including feeding at ₦120/manday.
[f] Average of reported spending on seeds and seedlings.

We note that recorded SEDCs occur in spite of incurring of so much soil erosion control costs (SECCs). From tables 5 and 4, the ratio of the total costs of SEC measures to EDCs is 1:3.7 and conveys an important message: that the average farmer in Enugu State spends four times more per Naira of SEDCs to institute SEC measures, in this case, in the form outlined in table 1. In other words, per hectare SEC-related defensive expenditures by the farmers is 3.7 times more than the per hectare SEDCs.

4. CONCLUSIONS AND RECOMMENDATIONS

We have shown that investing specifically in SEC is not an important small-farmer consideration. Given the level of SE being experienced in the study area, are the cultural tillage and other practices that integrate SEC functions adequate? Should we encourage farmers to start using measures specifically for SEC? If we do, then we ought to think of ways (eg., subsidies and credit) to induce the farmers to adopt such conservation measures as mechanical structures, soak away pits and terraces where necessary and this will hopefully reduce their recurrent farm costs that go into the minimum (24%) provision in the tillage investments for SEC.

Because the costs of SEC and the benefits of controlling it can vary considerably even within narrowly defined agro-ecological boundaries, these are empirical and site-specific matters depending on both biophysical and economic conditions faced by farmers. We need many micro studies which should give rise to a coalescence of policy-relevant findings.

There is need for more systematic research on the valuation of SED and the inputs that go into controlling SE and approaches for disentangling investments for SEC from investments on tillage cultural practices for food production per se. The Federal government of Nigeria has established the National Environmental Standards and Regulations Enforcement Agency (NESREA), the National Resources Conservation Council (NRCC), and The Federal Ministry of Environment (FME) to tackle environmental problems. But we are yet to see any initiative in the empirical analysis of environmental degradation at the farm level.

Designated monitoring stations should collect information regularly on average ECCs and EDCs as the basis of advise on level of targeted assistance required by farmers in specific locations. Using machinery created at the state, local government and community levels by NESREA, and FME and exercising their powers Land Use Act, state governments could use micro farm survey data for planning, monitoring and influencing local farm/environmental conditions because the ratio of ECC/EDC is a good indicator of sustainability. A focus on costs alone is sufficient because small farmers appear bother about the benefits of SEC measures but by costs given that financing a critical problem to them. There is need for public education programmes on SEC issues, particularly relating to farmers' perceptions of the magnitude and inter-temporal implications of erosion impacts and adoption of more efficient SEC technologies and less erosive farming practices.

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