CASSAVA RESPONSE TO NATURAL AND SIMULATED EROSION ON THE ULTISOLS OF OWERRI, SOUTHEASTERN NIGERIA

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ABSTRACT

The impact of erosion on soil productivity is soil, crop and environment specific. It is therefore important that erosion-soil-productivity relationships be established for each soil type and ecological zone. The results reported here are a part of an elaborate series of studies to quantify the relationship between natural and simulated erosion on the yield of major crops on the ultisols of Owerri, southeastern Nigeria. Two crops of cassava were grown between 1998 – 2000 on non-eroded (NE), slightly (S), moderately (M) and severely (Sv) eroded phases of ultisols within the Otamiri watershed of Owerri. Simultaneously, desurphased experiments with three levels of topsoil depth removals (2.5, 5.0, 7.5, cm) were conducted on the non- eroded reference plateau terrain. Natural erosion had no adverse effect on plant establishment and tuber numbers, but led to significant reductions of total dry matter, stem and storage root yields. For instance, the relative yield performance of fresh tubers in the 1998/1999 planting (40 WAP) was in the order 100:52:59:36 for NE:S:M:Sv and the corresponding yield values were 29.6, 15.4, 17.4 and 10.7 t/ha respectively. Desurphasing led to drastic reductions on all yield parameters and tuber yield declines of 91% were recorded when 7.5 cm of topsoil was removed. Linear functions of storage root yield decline per cm of topsoil eroded naturally was 1.74 t/ha, and 10.34 t/ha for mechanical topsoil removal. The best-fit indicators for predicting tuber yields were soil organic matter (SOM), aluminium saturation, (Ca + Mg)/ (Al + H) ratio, available water capacity (AWC), bulk density (BD) and A-horizon depth, accounting for 68.9 % of the variability in tuber yields. The simulation of erosion through mechanical topsoil removal exaggerated the impact of erosion on cassava yield by factor of 6, therefore the results from such experiments should be used with caution.

Keywords: Erosion, Desurphsed, Cassava, Yield decline and Soil productivity.

INTRODUCTION

Soil erosion is a major soil degradation process of tropical humid regions, where intensive rainfalls of long duration, fragile soils and poor farming systems compound the problem. In areas like Owerri, in southeastern Nigeria, high population pressures have reduced fallow lengths and cropping on steep slopes worsens the problem. Erosion leads to loss of soil productivity by negatively affecting soil chemical properties (Rose, 1981; Yost et al., 1983; Mbagwu, et al., 1984a), soil physical properties (Shaffer et al., 1994; Larney et al., 1995), biological soil function (Lal, 1976a; Turco et al., 1994) and by drastically reducing A horizon depth in severely eroded plots (Al – Kaisi, 2008).It is important to relate loss of soil productivity to actual decline in yields of major crops induced by erosion in different soil types and ecological zones. Zoback and Bilbro (2001) reported 40% lower cotton lint weights, 58% lower grain sorghum yields and 83% lower forage sorghum grain yields caused by erosion in the American Great Plains. In Africa, Eswaram et al., (2001) estimated yield loss attributed to past erosion for major crops to range between 2 – 40% depending on crop and management practices.

In the Altisols and Ultisols of southeastern Nigeria, using desurphased experiments Mbagwu et al. (1984 a, b) reported significant yield decline of maize and cowpea. Lal (1976b) also recorded cassava yield declines in the Altisols of western Nigeria. The results available are limited in the range of crops, geographical spread, soil orders examined and methodology. Over 90% of all reported experiments of erosion-crop-yield relationships were based on the topsoil removal technique to stimulate erosion which is known to give exaggerated results and therefore has only relative value (Olson, et al., 1994; Oti, et al., 1999). Estimates of both the magnitude and impact of erosion on soil properties and crop yields assessed directly from naturally eroded soil phases give superior results to the use of productive models or simulated erosion. Cassava is the second most important staple food in sub-Saharan Africa. It is both a subsistence and food security crop and has become the number one economic crop in Nigeria generating foreign exchange and making significant contribution to national Gross Domestic Product (GDP). It is grown on marginal areas and known to produce reasonable yields on eroded and degraded lands (Howeler, 2002). The results reported in this paper are part of a series of experiments conducted between 1997 – 2000 on the Otamiri watershed of Owerri, to document erosion-induced productivity decline trends of major crops. The specific objectives of this study was to evaluate cassava yield decline associated with different levels of erosion, compare the natural erosion phases method with desurphasing approach and relate cassava yield trends to specific soil properties altered by erosion.

MATERIALS AND METHODS

Study Area

This study was carried out at the Otamiri watershed basin in Owerri zone, Imo State, southeastern, Nigeria. Through detailed preliminary studies based on the guidelines of Soil Survey Staff Manual (USDA 1975, 1993), A horizon depth was used to identify three levels of erosion as follows: Slightly eroded (S), Moderately eroded (M), Severely eroded (Sv) and Non- eroded reference plateau. All sites were classified as Typic Tropohumult (ultisols).

Land Preparation and Plot Layout:

All sites were under 5 years fallow vegetation. In March 1998, experimental sites were cleared using the traditional slash and burn method. No tillage operation was done. Two experiments were run simultaneously, one based on natural in situ erosion and the other, topsoil removal technique to assess the effect of erosion on cassava yield.

Experiments

Experiment 1: Natural Erosion Phases.

(a) **First planting, 1998/1999:** Four plots each 10 m x 10 m was demarcated by dykes on each eroded phase giving a total of 16 plots. In April 1998, cassava variety, Tropical Manihot Selection 30572 (TMS 30572) was planted, using 10 cm cuttings with 8 nodes from the middle stem portion. Planting distance was 1m x 1 m giving plant population equivalent of 10,000 plants/ha. Weed control was manually done at 3 weekly intervals for the first 3 months, and subsequently at 8 weeks intervals.

Harvest and yield computations: plant establishment was assessed at 12 weeks after planting (WAP). Harvest was done at 20, 30, 40 and 48 WAP. At each harvest 4 whole plants from the middle rows were manually uprooted. Fresh stem and storage roots (SR) weights were measured in the field. Dry matter accumulation was assessed by oven drying samples at 60^0C to consultant weight.

Yield decline rate (YDR): was computed as the difference in yield or yield component between the non-eroded phase (NE) and the next level of erosion (x t/ha) divided by the depth of soil lost (dcm).

(b) **Second Planting 1999/2000:** Plots were allowed to rest for 2 months after final harvest of the first crop. Routine plot demarcation and preparation activities were done. Crops were planted in April 1999. All operations were same as for the first planting.

Experiment 2: Topsoil Removal.

This experiment was conducted on the non-eroded (NE) level landscape within the same contiguous field used for the erosion phase experiment. Plots were arranged in a simple Completely Randomized Design (CDR) format, with depth of topsoil removal (0, 2.5, 5.0, and 7.5 cm) as the only treatment. After marking out plots in sizes of 10 m x 10 m, specified soil depths were removed at random. A total of 16 plots were used (4 replications per treatment).

First and Second Cassava Plantings: Every activity was done the same way and at the same time as for the erosion phase experiment.

Soil Analysis

Soil samples were collected from 2 depths: 0 – 10 and 10 – 20 cm. Composite subsamples were randomly collected from each phase. Bulk density (BD) was measured by the core method using cores 7.5 cm diameter and 7.5 cm depth. Available water capacity (AWC) was computed as the difference between the moisture retained at 0.10 and 15 bars tension. Disturbed soil samples were air dried and sieved through a 2 mm mesh; the less than 2 mm fraction was then used to determine particle size distribution by hydrometer method (Day, 1965). Total aggregation (TA) was determined by the method described by Kemper and Roseneau (1986), and mean weight diameter (MWD) by the method of Youker and MCGuiness (1956). Soil pH was determined in 1:1 soil: water suspension, exchangeable cations (Ca and Mg) displaced in NH_4OAC solution by emission spectroscopy, available P by the Bray – 1 method, CEC by the summation of exchangeable cations, exchangeable acidity by the *N* KCL extraction method (Jackson, 1958), soil organic carbon (SOC) by the method of wet combustion (Walkley-Black, 1934) and total nitrogen (N%) by the micro Kjeldahl method.Statistical analysis included the analysis of variance (ANOVA), and mean separation of significant effects was based on Fishers Least Significant Difference (FLSD) at 5% probability level.

RESULTS AND DISCUSSION

Initial Soil Characteristics

Table 1 shows selected chemical and physical properties of the study sites at the beginning of the experiment in 1998.

Table 1: Some physical and chemical properties of the experimental sites at the beginning of the experiment in 1998

Erosion Phase		**TN**	**BS**	**SOC**	**CEC**	**Sum BC**	**P**	**AWC**	**TA**	**MWD**	**TP**	**Bulk**
A. 0 – 10 cm												
Non-eroded	4.8	0.09	56	1.01	6.3	3.81	8.25	14.65	88.09	0.91	45	1.39
Slight	4.9	0.07	50	0.75	4.5	2.26	6.43	18.66	86.36	0.91	52	1.50
Moderate	4.9	0.06	52	0.64	4.3	2.31	6.95	13.90	87.92	0.86	67	1,48
Severe	4.7	0.06	43	0.60	3.6	1.55	10.25	18.77	87.07	0.78	53	1.47
LSD (0.05)	NS	0.01	06	0.02	0.6	0.13	0.20	1.40	0.31	0.05	NS	0.04
B. 10 – 20 cm												
Non-eroded	4.9	0.11	52	1.22	4.6	2.44	5.30	17.49	88.26	0.77	51	1.51
Slight	4.9	0.05	51	0.51	4.0	2.15	3.95	20.46	84.01	0.72	57	1.59
Moderate	4.9	0.04	46	0.39	3.3	1.61	6.60	17.20	84.87	0.70	59	1.51
Severe	4.6	0.02	44	0.20	4.3	1.94	9.25	15.75	87.04	0.66	46	1.53
LSD (0.05)	NS	0.02	NS	0.08	0.2	0.11	0.28	0.41	0.20	0.04	NS	0.03

NS = not significant at p = 0.05, TN = total nitrogen; BS = base saturation; SOC = soil organic matter; CEC = cation exchange capacity; BC = Basic cations;
P = available phosphorus; AWC = available water capacity.

Chemical Properties

Natural erosion had significant impact on total soil nitrogen (TN%), base saturation (BS%), cation exchange capacity (CEC), sum of basic cations and available phosphorus at the 0 – 10 cm soil layers. The general trend was NE > S > M ≥ Sv. It had no impact on pH. Similar patterns were observed for the 10 – 20 cm, except that in addition to pH, base saturation percentage was also not significantly different for the different erosion phases. By way of fertility ratings pH was very strongly acid, soil organic matter low - moderate, sum of basic cations low – moderate, CEC very low, BS moderate, TN low, and available P low – moderate. Chemical fertility indicators decreased as severity of erosion increased, deteriorating from moderate in the NE plots to low-very low in the severely eroded phase. Erosion, therefore, significantly reduced the chemical fertility status of the eroded sites. Onweremadu et al. (2007), had also reported changes in some soil chemical properties like SOC and TN associated with erosion of southeastern Nigerian soils. Declining soil chemical fertility associated with increasing levels natural erosion has been reported by several researchers in temperate soils (Fry et al., 1982; Verity and Anderson, 1990; Krenzor et al., 1992) and tropical soils (Tegene, 1992; Nill, 1993, Styczen, 1992).

Physical Properties

The impact of increasing levels of natural erosion on soil physical properties was inconsistent depending on the physical property in question. For instance while bulk density (BD) increased with increasing severity of erosion, silt/clay ratio decreased, and the effect on total porosity was non-significant. Effect on total aggregation (TA) was marginal and available water capacity (AWC) had no clearly defined trend. Textural class was not affected. Styczen (1992) reported similar results for two Altisols and an Ultisol in Samaru Nigeria. Even though reports of consistent decreases in AWC induced by erosion for temperate soils abound (Fahnestock et al., 1995; Mokma and Sietz, 1992; Al-Kaisi, 2008), results of this study are inconclusive on the impact of erosion on the AWC of ultisols. In most studies relating AWC of soils to soil factors, only about 40% of the variability of AWC is explainable (Ebeid et al., 1995). Several workers have also reported that bulk density always increased with increasing severity of erosion (Nill, 1993; Igwe et al., 1995). Erosion had no effect on soil texture.

Natural Erosion's Effect on Cassava Yield

There were significant effects of natural erosion on fresh tuber (FTY), fresh stem (FSY) and total dry matter yield (TDMY) of cassava as shown in Table 2. The trend in decreasing order was consistently NE > S > M > Sv. The relative yield performance for storage root and TDMY were 100:53:49:30 and 100:59:50:29, respectively. Erosion had no effect on plant establishment and tuber numbers. The partitioning of dry matter was evaluated using the model developed by Boerboom (1978). In this model a plot of total dry weight (TDW) against storage root dry weight (SRDW) yields a straight line, the slope of which gives the level of efficiency with which storage roots are produced. Figure 1 shows the linear relationship, but with different slopes. Severe erosion affected storage root efficiency of cassava. As erosion progressed beyond the moderate level (where over 50% of horizon had been lost, reducing effective rooting depth to 12 cm) cassava adapted to the restrictive environment by allocating more of the TDM, to storage roots. The severely eroded phase therefore had the highest storage root accumulation efficiency. Cassava is a very tolerant crop, with capacity to produce tubers even under harsh environments.Howeler, (1986) also reported substantially lower cassava yields on eroded soils than on non-eroded soils. The fresh tuber yields of 29.6 t/ha recorded in the non-eroded plots of these studies are similar to cassava yields reported by Asian countries (26 – 30 t/ha) without the use of fertilizers and soil amendments (Sittibusaya, et al,. 1995). The yields from the degraded plots which ranged from 10.7 to 17.4 t/ha, were 50% or less of the Asian figures suggesting that the differences in cassava yields commonly reported between Nigeria and Asian countries could be attributed to erosion and other forms of land degradation. Erosion had no adverse effect on plant population (94 – 95%) at all sites. Although not statistically significant tuber numbers were highest in the non-eroded sites. Tuber yield differences among the different erosion phases were due more to superior individual tuber weights than tuber numbers. In the second year cropping, erosion impact trends were similar to the first planting, but the magnitudes of yield performance were lower. For example, fresh tuber yields in the non-eroded plots were 29.6 t/ha in the 1998/1999 season, and only 16.9 t/ha in 1999/2000 planting, a reduction of 43%, and plant establishment was 94% in the first planting and only 75% in the second a different attributed to reduced soil fertility status and possibly surface crusting at the later season.

Table 2: Natural erosion effect on yield and yield attributes of cassava at 40 WAP

A. Actual values (1998/1999)	PE (%)	Tuber No	FTY	FSY	TDMY
NE	94	8	29.6	16.5	11.9
S	95	6	15.4	9.8	7.0
M	95	5	17.4	9.1	5.9
Sv	94	5	10.7	3.3	3.5
LSD (0.05)	-	NS	8.7	6.6	2.9
B. % Reduction in yields					
NE	0	100	100	100	100
S	0	25	48	41	41
M	0	38	41	45	50
Sv	0	38	64	80	71
A. Actual values (999/2000)					
NE	75	7	16.9	9.9	-
S	74	6	14.5	7.6	-
M	75	6	9.2	5.6	-
Sv	75	4	7.9	6.1	-
LSD (0.05)	-	NS	5.2	2.9	-
B. % Reduction in yields					
NE	0	100	100	100	-
S	0	14	14	23	-
M	0	14	46	43	-
Sv	0	43	53	38	-

PE = plant establishment; FTY = fresh tuber yield; FSY = fresh stem yield; TDMY = Total dry matter yield; WAP = weeks after planting; NS = not significant.

Topsoil Removal Effect on Cassava Yield

The effect of desurphasing on cassava yield and yield components is shown on Table 3. The highest fresh tuber yield of 29.6 t/ha was obtained in undisturbed plots, and the least (2.5 t/ha) in plots from which 7.5 cm of topsoil had been removed. The relative impact of topsoil removal on all plant components were the same. The general order was 0 > 2.5 > 5.0 > 7.5 cm depth of soil removed. The percentage reductions for fresh stem yields were 100:36:78:80 for 0:2.5:5.0:7.5 cm depth of soil removal. Similar reductions were obtained for other plant components. The removal of the first 2.5 cm of topsoil had the greatest impact leading to sharp yield declines of 64%; even though it represented only 5.5% of A horizon - depth. Cassava establishment was generally poorer for plots from which incremental depths had been removed then on the undisturbed non-eroded plots. Plants population was about 25% less in the plots from which 7.5 cm of topsoil had been mechanically removed than in other treatments. There is very scanty literature, on the impact of topsoil removal on cassava yield. Lal

(1978a) also reported drastic cassava tuber yield declines with increasing depths of topsoil removal. Boerboom's 1978 model was used to produce figure 2. Storage root efficiency increased with increased level of simulated erosion. Cassava is known to adjust to adverse environments by conserving energy in the tubers. This attributes makes it a crop of choice in degraded environments.

Table 3: Simulated erosion effect on yield and yield attributes of cassava at 40 WAP

Depth of Topsoil Removed (cm)	PE (%)	Tuber No	FTY	FSY	TDMY
A. Actual values (1998/1999)					
0	94	8	29.6	16.5	11.9
2.5	64	7	3.8	2.2	3.1
5.0	59	8	2.8	1.4	1.9
7.5	51	5	2.5	0.7	1.2
LSD (0.05)	-	NS	5.9	3.9	1.9
B. % Reduction in yields					
0	100	100	100	100	100
2.5	32	13	87	87	74
5.0	37	0	91	92	84
7.5	46	38	92	96	90
A. Actual values (1999/2000)					
0	75	7	16.9	9.9	-
2.5	60	4	10.8	6.1	-
5.0	45	5	3.8	2.9	-
7.5	43	6	3.4	2.5	-
LSD (0.05)	-	NS	4.4	1.9	-
B. % Reduction in yields					
0	100	100	100	100	-
2.5	20	43	36	38	-
5.0	40	29	78	71	-
7.5	43	14	80	75	-

PE = plant establishment; FTY = fresh tuber yield; FSY = fresh stem yield; TDMY = Total dry matter yield; WAP = weeks after planting; NS = not significant.

Linear Function of Cassava Yield Declines

Natural Erosion

The response of cassava fresh tuber and stem yields at the first cropping in 1998/1999 to a unit loss of A horizon caused by natural erosion is shown in Table 4. The average rate of yield decline was 1.74t, 0.86t and 0.79t/ha for slight, moderate and severely eroded plots respectively for each centimeter of soil lost to natural erosion. The slightly eroded phase was the most sensitive to productive decline, with yield reductions of twice the value for the moderate and severe erosion sites. The impact was similar for stems. The first level of erosion had the greatest impact on the yield of crops. The shift of land from non-eroded to slightly eroded (caused by the loss of 10 cm of topsoil) caused a quantum reduction of the soils productive capacity. Increasing severity of erosion that is the shift from slight to moderate or moderate to severe led to only marginal additional reductions on productivity.

Top Soil Removal

Data on the rate of cassava storage root and stem (planting material) yield decline rates per unit centimeter of soil surface mechanically removed is shown in Table. The highest rate of yield decline

10.34 t/ha/cm of topsoil removed was recorded for the first 2.5 cm of soil lost. It was followed by 5.62 t/ha/cm for 5.0 cm soil depth removal and 4.19 t/ha/cm for 7.5 cm soil depth lost. The first 2.5 cm of the surface soil of the ultisols of eastern Nigeria are critical for good cassava/tuber yields and should be protected from loss, as earlier reported by (Oti et al., 1999).

Table 4: Linear functions of cassava fresh tuber and planting material yield reductions per unit of soil lost under natural and simulated erosion 1998/1999 growing season

Dept of Topsoil lost (cm)	Average rate of yield decline per cm soil lost (t/ha)	Rate of yield decline 10 cm of topsoil lost (t/ha)
A. Natural Erosion		
(a) Fresh tuber		
10	1.74	17.42
20	0.86	0.29
30	0.79	6.60
(a) Fresh tuber (Planting Material)		
10	0.61	6.10
20	0.38	1.51
30	0.42	5.05
B. Simulated Erosion		**Yield decline per 2.5 cm removed**
(b) Fresh tuber		**(t/ha)**
2.5	10.34	25.85
5.0	5.62	2.25
7.5	4.19	3.33
(c) Fresh stem (Planting Material)		
2.5	5.37	13.42
5.0	2.81	0.61
7.5	2.02	1.13

Relationship between Cassava Yields and Soil Properties

Table 5 shows the simple covariate correlation coefficient between fresh tuber yield and total dry matter yield of cassava and selected soil chemical and physical properties. Significant correlations were observed between fresh tuber yields and soil organic carbon, total nitrogen, CEC, base saturation, aluminium saturation, sum of basic cations and (Ca + Mg)/(Al + H) ratio for chemical properties and bulk density, A horizon depth and mid weight diameter (MWD) for physical properties. The same trend was observed with TDMY at 30 WAP. Multiple correlations and stepwise regression analysis with accompanying best – fit equations between cassava yield parameters and soil properties are shown in Table 6. The analysis identified (Ca + Mg)/(Al + H) ratio (an indicator of nutrient imbalance) ($R = 0.99$) as the singular most influential factor determining cassava storage root yield. The other indicator variables were soil organic carbon, aluminium saturation, available water capacity, bulk density and A horizon depth ($R = 0.99$). These six predictors explained 68.9% of the variability of storage root yields. For total dry matter yield of cassava, soil organic carbon was the most important factor ($R = 0.97$); and the best fit model identified the same 6 factors responsible for storage root performance.

Table 5: Correlation coefficients of cassava yield (kg/ha) with soil properties of 0 to 10cm of eroded sites

Soil Properties	Fresh tuber yield		Total dry matter yield (30 WAP)		
	R	**R^2**	**R**	**R^2**	**n**
Soil organic matter (%)	.96**	.93	.97**	.95	8
Total nitrogen (%)	.72*	.52	.67	.45	8
CEC (mequiv.100^{-1})	.91**	.82	.90**	.80	8
Base saturation (%)	.86**	.73	.75*	.57	8
Aluminum saturation (%)	-.97**	.94	-.86**	.74	8
Sum of all basic cations (mequi.$100g^{-1}$)	.99**	.99	-.89**	.80	8
Ex acidity(mequiv.$100g^{-1}$)	-.63	.39	-.77*	.60	8
(Ca + Mg) (Al + H) ratio	.99**	.99	.90**	.81	8
PH	.37	.14	.64	.41	8
Ex. H^+ (mequiv.$100g^{-1}$)	-.49	.24	-.80*	.63	8
Ex. Al (mequiv.$100g^{-1}$).	-.53	.28	-.81*	.65	8
Available water capacity (volumetric %)	.55	.30	.23	.01	8
Bulk density (g/cm^3)	-.84**	.70	-.60	.36	8
Clay (%)	.26	.07	.40	.16	8
Clay + silt (%)	.07	.01	.22	.05	8
Ap depth (cm)	.90**	.81	.97**	.94	8
MWD (mm)	.79*	.63	.88**	.78	8

*. ** denote Significant at 0.05 and 0.01 level of p, respectively.

Table 6. Multiple Correlations and regression equations relating cassava with soil properties of eroded sites. 0 to 10cm layer.

Predictors Variables	**Regression Equation**	**R**	**R^2**	**n**
a) Dependent Variable Y_3: Storage root yield (kg/ha)				
(Ca + Mg)/(Al + H) ratio	Y_3 =--1450 + 17045 Ratio	.99**	.98	8
(Ca + Mg)/(Al + H) ratio, and BS	Y_3 = 6443 + 20640 Ratio – 214 BS	.99**	.99	
SOC. TN, CEC. BS. Al Sat and. Sum B	Y_3 = 22801 + 4391 SOC + 52503 TN - 529 CEC - 224 BS - 273 Al Sat + 3408 Sum B	.99**	.99	8
SOC, Al Sat (Ca + Mg)/(Al + H) ratio, AWD, BD and Ap Depth	Y_3 = 34732 + 3488 SOC – 158 Al Sat - 8010 Ratio – 603AWC – 16557 BD - 53 Ap Depth	.99**	.99	8
b) Dependent Variable Y_4: Total dry matter yield at 30 WAP				
SOC	Y_4 = -7030 + 17075 SOC	.97**	.95	8
SOC, TN, CEC, BS, Al Sat and Sum B	Y_4= -37394 + 23676 SOC – 114609 TN +1687 CEC +298 BS + 265 Al Sat - 558 Sum B	.99**	.99	8
SOC, Al Sat (Ca + Mg) (Al + H), AWC, BD and Ap Depth	Y_4= 24734 + 14718 SOC + 74 Al Sat +17369 Ratio + 811 AWC + 5504 BD + 132 Ap Depth	.99**	.99	8

** Significant at P = 0.01

TN = Total Nitrogen (%): BS = Base Saturation (%): Al Sat = Aluminum Saturation (%): Ap Depth = Depth of Ap horizon (cm), CEC = Cation Exchange Capacity (mequiv. $100g^{-1}$), AWC = Available Water Capacity (volumetric %), and Sum B = Sum of all Basic Cations (mequiv. $100g^{-1}$)

Natural versus Simulated Erosion Techniques

Linear functions of cassava yield decline rates per centimeter of soil lost or removed showed that mechanical topsoil removal approach in the study of erosion-induced yield decline of cassava exaggerated the impact of erosion by a factor of 6. The sudden loss of topsoil by desurphasing would appear to disrupt not only the soils physical and chemical functions but also nutrient recycling and biological functions by the loss of organic matter and soil microorganisms (Mbagwu 1984a, b; Oti et al., 2007), unlike natural erosion which is a gradual process, and makes up for traumatic forces through soil resilience, Gollany et al. (1992), and therefore, advised that results from desurphased experiments should be used with caution as they tend to overestimate the effects of soil erosion on crop yields.

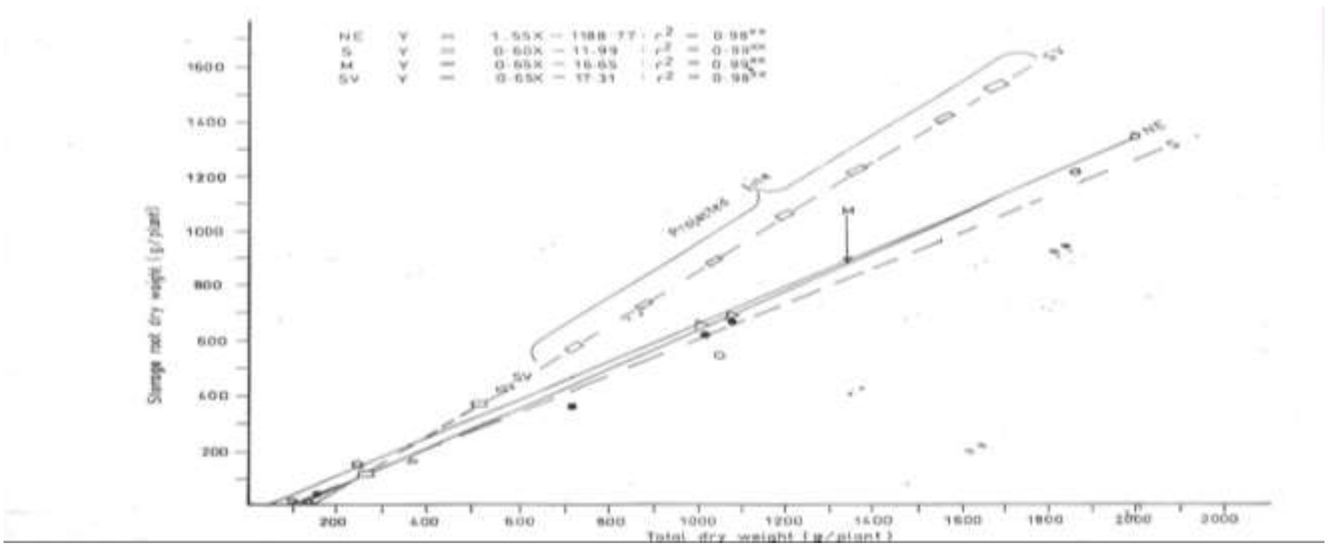

Fig 1: Effect of erosion on cassava storage root accumulation efficiency
(NE –non eroded, S – slightly eroded, M – moderately eroded, Sv – severely eroded)

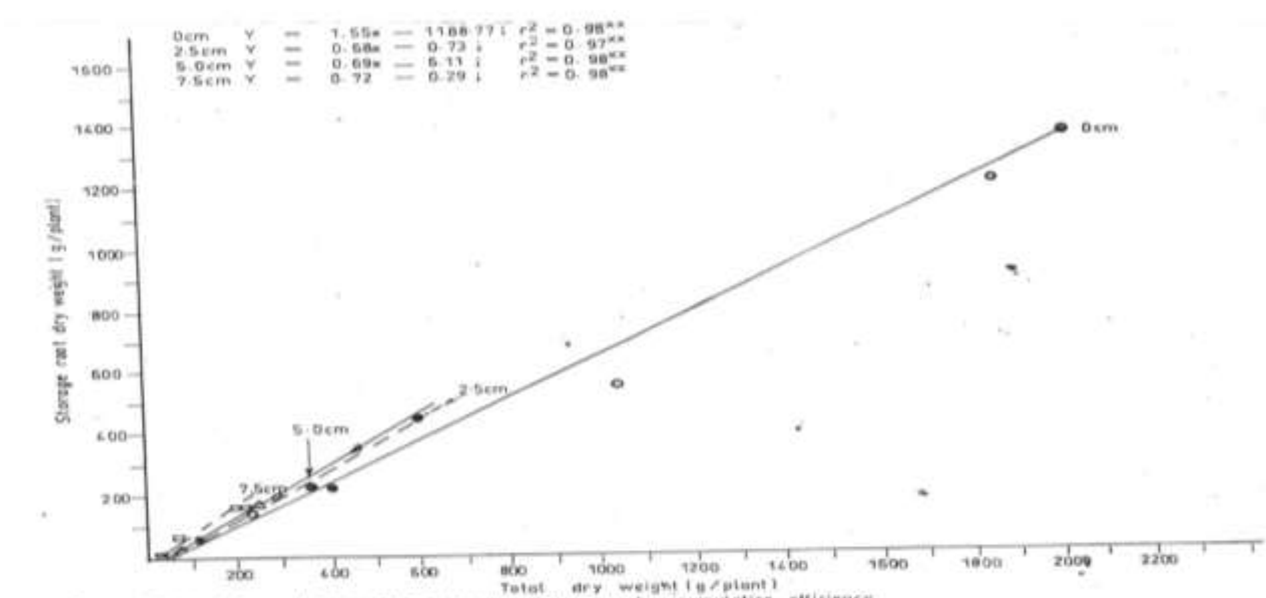

Fig 2 Effect of top soil removed on cassava storage root accumulation efficiency

CONCLUSION

This research was conducted to quantify the effects of natural erosion on the yield of cassava. Topsoil removal technique was also used to simulate erosion to enable comparison of both. Erosion led to drastic reductions of cassava yield, which ranged from 14 to 64% depending on erosion severity and method of assessment. Results lead to the following conclusions:

(a) Erosion has negative impact on the ultisols of Owerri Nigeria, leading to reduced soil fertility and crop yields.
(b) The removal of the first few centimeters of the topsoil led to the most drastic declines in soil productivity.
(c) Topsoil removal technique did not accurately simulate the natural erosion process and its use exaggerated the impact of erosion on crop yields.
(d) Loss of organic matter, total nitrogen, aluminium toxicity, nutrient imbalance, available water capacity and increased bulk density were responsible for cassava yield decline in eroded plots.
(e) Erosion by whatever means leads to significant reductions in cassava yields, soils should therefore be protected through appropriate conservation measures.

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