

*Full Length Research Paper*

# Evaluation of crops' potentials in controlling soil degradation in Betem Watershed, Cross River state, Nigeria

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**Evaluation of Crops' Potentials in the context implies the assessment of the effectiveness of crops with the aim of evolving efficient means of protecting vulnerable or degrading soils from the influence of human (anthropogenic) or weather elements. The potential of four crops and their intercrop to prevent soil loss from a slope farmland was determined. Four blocks were demarcated into five cropping plots each, viz: cassava, cocoyam, maize, melon and an intercrop of all the four in a randomized complete block design. Slope gradients coincided with the blocks while the different crops formed the sub-plots. The potentials of these crops to control soil erosion were measured in terms of their effectiveness to prevent cascade of soil materials down slope range of between 5.4<sup>o</sup> and 6.2<sup>o</sup> (degrees). Measurement of soil loss was carried out with the aid of sediment traps of 50 x 100 centimeters. Results showed that melon plots had the least soil loss potentials of 10.2, 14.2, 16.3 and 25.6 while cassava plots had the highest soil loss potential of 35.2, 37.1, 42.9 and 48.3 grams respectively. It was recommended that melon should be used as a sole crop on slopes below 6.2<sup>o</sup>. Conversely, cassava, cocoyam, maize should not be used as sole crops under these slope conditions but as intercrops. This can help ameliorate undue removal and transportation of soil materials down the slope.**

**Keywords:** Crops' potentials, Soil degradation, Betem Watershed, Nigeria.

## INTRODUCTION

Evaluation of Crops Potentials in the context Implies the assessment of the effectiveness of Crops with the aim of evolving efficient means of protecting vulnerable or degrading soils from the influence of human (anthropogenic) or weather elements. There is hardly any region in the world where human or weather elements have not exerted adverse influence on soil integrity (Megabi, 2008). Soil as a natural resource deserves adequate protection in order to guarantee sustainable human existence on earth. The wanton destruction of environmental variables either by human or natural forces has adversely contributed to the inability of soils to perform their natural functions (Egbai, 2011). The result

of human activities have been known to be detrimental to soil resources (Ovuka, 2000; Ramankutty *et al*, 2002; Lepers *et al*, 2005). A good soil has some important impact on sustainable crop production process. It expresses the dynamics of efficient soil nutrients, their capacity to promote efficient agricultural production and resist soil degradation.

Soil or nutrient loss becomes obvious where there is apparent reduction in the production capacity of soils in terms of their fertility. These type of soils have their natural potentials badly threatened such that protection and rehabilitation become absolutely inevitable (Egbai, 2011). Mayhew and Penny (1988) and Dupriez and De leaner (1988) have identified the inherent potentials of crops to withstand environmental stress and their ability to thrive even in a short fallow period. The potentials of crops in soil restoration process can be holistic (Akorada,

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1994) and USDA (1993) advocated using readily available crops. Betem watershed is very central to the socio-economic life of the people of Cross River State; hence, there is a need to holistically ensure the safety of the adjoining environment so that its various components are not unduly undermined. Recently, human activities (majorly agriculture) in the area have dangerously accentuated huge soil and nutrient loss from adjacent land environment to the extent that there is obvious soil degradation scenario with the attendant impact on water quality status of the adjoining streams. This scenario is detrimental to environmental sustainability issue especially at the watershed scale (Brooks *et al*, 1991; RRDC, 2002; Ononiwu, 2004).

Mbajorgu (2006), identified catchments management as an effective tool for the control of a variety of environmental problem such as the loss of soil and nutrients from upland into the stream system. Various methods have been elucidated for the reduction of soil and nutrient loss (Egbai, 2011). The use of Crops residues was examined by (Andrews, 2006; McMaster and Wilhelm, 1997) Wilson *et al* (2004), used tillage practice that combined tillage residues and fertilizer to combat soil and nutrient loss while Nwadukwe and Udeor (2007), used plant (vertiver grass) in checking the cascade of soil and nutrients by water erosion. The main objective in this study was to assess the potentiality of crops (cassava, cocoyam, maize, melon and an intercrop of all) in the protection of soils in the watershed, Cross River State, Nigeria.

## MATERIALS AND METHODS

### The Study Area

The study area was Betem watershed in Cross River State. This area lies between longitude 8°06' and 8°11'E and within latitudes 5°30' and 5°31' N. The land form consisted of gentle slope with varying gradient range of between 5 and 7 % and an elevation of 600m above sea level. Annual rainfall of between 2000 and 3500mm including a relative humidity of 65% and 95% was recorded in the area (Cross River Agricultural Development Project – CRADP, 1992). The soil is predominantly sandy loam with brownish red or yellow colour. The red or yellow colours which are usually the products of oxidation indicate the level of human activity and the extent to which the soils are exposed to the vagaries of weather elements (Martin, 2006). These soils are naturally susceptible to huge soil particles and nutrient loss, consequently they may need effective means to ensure protection.

### Method of data collection

Four sites were randomly selected in the watershed area and were designated blocks I, II, III and IV having slope gradients of 5.8°, 5.4°, 5.6° and 6.2° respectively. The slope gradient was determined with the Global Positioning System (GPS). The slope was critical in view of its influence on the amount of soil loss at a time. The assumption here was that the greater the quantity of particulate sediment lost at a time the higher the amount of nutrient that will be involved.

Each block measured 30 x 37meters. The blocks were subdivided into plots. The plots measured 5m by 30m each and were separated by a 2 meter row or furrow. This helped to prevent influence of one crop on the other. The plots were subjected to manual slashing. Slashing was used as the original vegetation was badly disrupted previously through agricultural activities. In each of these sites (blocks) five crop types namely cassava (*Manihot utilisima*), Cocoyam (*Zanthomona sagittifolium*) Maize (*Zea mays*) Melon (*Colocynthis citrillus*) and an intercrop of all five crops were planted, one crop per plot, at recommended spaces (Opeke, 2006) replicated 12 times. Crops were assessed on the basis of their potentials to prevent cascade of soil materials. For this purpose, sediment trap of 50 x 100 centimeters was positioned at the foot of the slope such that the eroded soil from the crop's plot would be emptied into the trap. This allowed for direct measurement of soil particulate sediment with the aid of a calibrated meter rule. The number of spill ways (erosion channels) determined the number of sediment traps each plots or blocks required.

A calibrated pole was made to penetrate right into the deposited soil bed until there was a certain increase in penetration resistance thus indicating the bottom of the sediment (Rausch and Heinnemann, 1984). The volume of soil loss was determined by calculating the difference between the initial or original depth, and the present depth of the meter rule (Ampoflo, 2001).

### Method of data analysis

Data was analysed using Analysis of Variance (ANOVA) method with Statistical Product and Service Solution (SPSS) computer soft ware.(Udofia, 2006,Wikipedia 1996).

## RESULT

Table 1 gives a summary of soil loss data obtained from *in situ* measurement of sediments in the field. Table 1 also shows the quantity of soil loss at each slope gradient and crop type in cubic meters while table 2 shows the

**Table 1.** Quantity of soil lost per gradient per crop type

Slope gradient	Crop type						Mean(LSD=3.614)
	Cassava (12 plots)	Cocoyam (12 plots)	Intercrop (12 plots)	Maize (12 plots)	Melon (12 plots)	Total (60 plots)	
5.8 <sup>0</sup>	515	386	324	473	196	1894	31.6 <sup>a</sup>
5.4 <sup>0</sup>	445	353	162	343	122	1425	23.7 <sup>b</sup>
5.6 <sup>0</sup>	422	299	271	354	170	1516	25.3 <sup>b</sup>
6.2 <sup>0</sup>	580	443	374	394	307	2098	34.9 <sup>a</sup>
Total (48 plots)	1962	1481	1131	1564	795	6933	
Mean (LSD = 4.041)	40.9 <sup>a</sup>	30.8 <sup>b</sup>	23.6 <sup>c</sup>	32.6 <sup>b</sup>	16.6 <sup>d</sup>		

Note: (1) mean values on the same row or column with different superscripts are significantly different ( $p < 0.01$ ).

(2) LSD = Least Significant Difference.

**Table 2.** Analysis of variance of quantity of soil loss within slopes (blocks) and crops.

Source of variation	Degree of freedom	Sum of squares	Mean squares	F.cal	F. tabulated
(Blocks)	11	22234.5	2021.3	20.05	
Slope	3	4851.8	1617.3	16.04	< 0.001
Crops	4	14135.7	3533.9	35.05	< 0.001
Slope/crops	12	1556.6	129.7	1.29	0.228
Residual(Error)	209	21075.0	100.8		
Total	239	63853.6			

analysis of variance of table 1. There was a significant difference ( $p < 0.01$ , table 2) in the mean quantity of soil loss from the different slope gradients (Blocks) with the steepest slope (6.2<sup>0</sup>) having the highest mean value (34.9.0m<sup>3</sup>) followed by slope gradient of 5.8<sup>0</sup> (31.6m<sup>3</sup>) then 5.6<sup>0</sup> (25.3m<sup>3</sup>) while the most gentle slope (5.4<sup>0</sup>) had the least (23.8m<sup>3</sup>). Slopes with gradients of 6.2<sup>0</sup> and 5.8<sup>0</sup> did not differ significantly ( $P > 0.05$ ) in the quantity of soil loss but were significantly different from the other two slope gradients. Slope gradients of 5.6<sup>0</sup> and 5.4<sup>0</sup> were not significantly different ( $P > 0.05$ ) from each other in the quantity of soil loss. Maize and cocoyam with overall mean quantity of soil losses of 32.6m<sup>3</sup> and 30.8m<sup>3</sup> respectively did not differ significantly ( $P > 0.05$ ) from each other, but were higher and significantly different ( $P < 0.01$ ) from those of the other treatments.

Table 3 gives the mean volume of soil loss at each slope gradient and crop type. Melon plots gave the mean volume of soil losses that were significantly ( $P < 0.01$ ) lower than those of all the other crops in all the slope gradients followed by intercrop while cassava plots had

the highest (see table 3).

## DISCUSSION

Slope gradient influenced the quantity of soil lost from the different crop plots. Thus slope range can influence the cascade of soil material, as corroborated by Monkhouse (1971) who stated that above 2 percent slope, considerable volume of soil loss can be possible. Wu and Wang (2001) on the other hand found that the inclination of soil loss with respect to slope steepness decreased as slope fell between steepness of 30 and 45%. Hence the need to ensure adequate protection in order to avert continuous soil loss in the area.

According to Singer and Munns (1999), when soils on hillside are cultivated for crops they become more susceptible to wind and water erosion. When such soil is properly managed with appropriate choice of crops however, soil removal by water or wind can be adequately mitigated. The nature of slope, root system

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