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# Influence of ground cover on spillways formation in Ikang, Bakassi Local Government Area of Cross River State, Nigeria

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**ABSTRACT**

**An investigation of various ground covers crops was conducted between January and July 2017 with the aim of identifying the less vulnerable ground cover type to erosion perturbation. Plots dimension of 10m x 80m were delineated at slope range of 2.5 and 3.5 percent. Subplots of 10m x 10m were replicated across the experimental sites. Measurement of erosion features like number of spillways, total length, depth and width of channels were taken across the plots with measuring tape and weighing balance. Descriptive statistics were employed to show the range and other parameters. The result showed a marked difference in the measured parameters. The highest length, width, depth and highest number of spillways were traceable to control plot (near bare land). A total of 21 spillways, depth of 19.1cm, width of 70cm and length of 602cm were recorded in the said plot while the least values were obtained in shrub plot with 4 spillways, 3.3 cm depth, 10.0cm width and a total length of 372cm indicating obvious differences in their ground cover potentials. The study recommends bush fallow (shrubs) and intercropping with melon in the context of sloppy land terrain as effective means of reducing spillways formation.**

**Keywords: Ground cover, spillways, rill, channel, bush fallow, shrubs, erosion features.**

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## INTRODUCTION

Farming systems in the humid tropics are distinct from other region due to its geographical peculiarities. Humid tropics is characterized by an exceptional degree of rainfall, sufficient vegetation cover and an undulating land surface which generally determine the extent of land susceptibility or otherwise to erosion. Spillway refers to the path(s) created by erosion channel arising from land overflow. Spillway development is a common feature of a sloppy or undulating land terrain especially when such landscapes are not sufficiently covered with vegetation. And the type of erosion experienced no doubt influence the type of technology applied in the control. (Chandhury and Jasen, 1999). In agrarian landscape studies have proved that crops can be used to control erosion menace (Egbai, 2011 and Ogogo et al., 2013) Anikwu et al. (2007) used a variety of crops to reduce erosion perturbation at Enugu while Edem and Okoko (2015) have used vitivor grass to check soil loss in Uyo. Ikang is a major crop-based agricultural stronghold of the people of Bakassi Local Government Area in Cross River State, Nigeria. However, the issues of low yield due to soil fertility loss and the preponderance of erosion channels are some of the major challenges confronting large-scale food production in the area. Hypothetically, spillways formation is not entirely dependent on ground cover potentials of crops or vegetation but a combination of other factors example slope, nature of soils, and amount of rainfall. This study attempts to identify the ground cover type that is less vulnerable to erosion perturbation in Ikang.

## MATERIAL AND METHOD

### Study area

The study was carried out at Ikang in Bakassi Local Government Area, Cross River State, Nigeria. The area is located in longitude 080 31' 31E and latitude 040 46' 11N. Rainfall and relative humidity are usually high, ranging between 2000mm to 3500mm per annum (Cross River Agricultural Development Project, 1992). The economic life of the people is strictly dependent on agriculture (crop and fish farming) largely due to available water bodies and the quality of the soils. The soils are deeply weathered. The topography of the place is somehow flat in some areas but mostly undulating or gently sloppy a condition that typifies topography of the humid tropics (Ayaode, 2008). This type of terrain can no doubt support large to moderate scale removal of soil materials in the event of rainfall.

The area falls within the tropical rainforest region (Waugh, 1995). Vegetation is characterized by scanty secondary forest and fallow bushes dominated with shrubs of different plants and grasses example elephant grass suggesting the extent of human activity in the area.

**Land preparation**

Land was acquired in January 2017 and was manually slashed. Although, this area was not allowed to fallow for any reasonable time in view of what the study intends to achieve. Thus, an area previously cultivated and required little or no stumping was used. Effort was made to ensure that no trace of rill erosion path was left resulting from previous activity on the land.

**Site selection**

The selection of the site was based on the slope condition of the area. However, the sites selected have the following slope gradients 3%, 2.5%, 3.5% and 3%. The entire topography typifies that of humid tropics characterized by undulating landscape. In selected site across the study area, a total of 100 X 80m was delineated in each of the selected location. Each of this delineated portion of land consisted of five (5) subplots which measured 10 X 10m. Each subplot carried one crop, thus, the five subplots carried five different crops or vegetation cover types. Each subplot was separated from another by 5m to avoid interference from adjacent plot including the adjoining boundaries at both ends of the experimental plot.

**Soil samples collection and analysis**

Soil samples were randomly collected from each plot at 5 cm intervals for three depths using Dutch auger into a well-labeled polythene bag for laboratory determination of their particle size distribution in order to ascertain the homogeneity or heterogeneity of the soils. Particle distribution was determined using Day's hydrometer method having been subjected to hydrogen peroxide ($H_2O_2$) for the oxidation of the organic matter contents and sieved through a 2mm mesh followed by particles dispersion with sodium hexametaphosphate solution ($NaPO_3$) (Gee and Or, 2002).

Air dried samples were then measured into a cup and stored continuously for 5 mins with 10 ml of sodium hexapetephosphate and 250 ml of water, the product was then poured into a 1000 ml cylinder through 210 mm serve and water was added up to 1000 ml mark of the cylinder. The residues (sand fraction) were oven dried for percent sand determination. A hydrometer was then used to measure the density of silt and clay respectively.

**Plants material**

Fresh plants of elephant grass were collected and planted in the field in the first week of March 2017. The grasses were planted across the plots at random. The plant adapts and establishes faster than one could imagine. The collection and transplanting from the original site to the experimental site was done three days. Thus different plots took different days since it was difficult to cover all the four sites in three days. Effort was made to ensure that seeds of melon, groundnut were planted the same day the elephant grass was planted. This was based on the assumption that the time taken for the young elephant grass plant to establish will correspond with the time taken for the seeds of melon and groundnut to germinate in order to ensure equal treatment. Recommended planting distances were used (Opeke, 2006). While the shrubs (fallow) and control plots were delineated to reflect areas not covered with specific crop or grass. The control plot represented a bare land situation. In all stations, the various ground covers were duly replicated under different slope gradients in order to subject the various ground covers to the same land condition.

**Monitoring of rill formation**

The adoption of appropriate technology, to tackle erosion perturbation is usually informed by the status and severity of erosion (Udeme and Okoko, 2015 in Chandhury and Jasen, 1999). The authors suggested a walk around the farm to identify where water overflows and where rills formation has taken place. It presumable that ground (crop) cover intensity could influence to a large extent the amount of rill erosion channels.

**Data collection**

Insitu measurement and check of spillways and other parameters were taken at the end of the month. Consequently, at the end of April, May, June and July readings were taken. Measurement of length, depth and width of rill development on monthly basis was accomplished with the aid of a measuring tape which was placed at the beginning (head), middle and end (tail) of erosion path. The average (AV) value was obtained from the summation of the entire values that is the products of the head, middle and tail divided by 3. This was used to calculate the length, width, and depth of erosion in the various plot locations.

**Table 1**. Particle size distribution of soil.

| Plot number | Slope % | Clay | silt | sand |
|---|---|---|---|---|
| Plot 1 | 3 | 4.7 | 7.0 | 88.3 |
| Plot 2 | 2.5 | 11.7 | 7.0 | 81.3 |
| Plot 3 | 3.5 | 6.7 | 6.0 | 87.3 |
| Plot 4 | 3 | 1.7 | 6.0 | 92.3 |

**Table 2.** Average monthly measurement of erosion features from the respective plots.

| Covers | No. of spillways(cm) | | | | Average Depth.(cm) | | | | Average Width (cm) | | | | Average Length (cm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Apr | May | Jun | Jul | Apr | May | June | Jul | Apr | May | Jun | July | Apr | May | June | July |
| Elephant | 3 | 3 | 2 | 2 | 1.0 | 1.2 | 1.5 | 3 | 10 | 11 | 8 | 2 | 150 | 152 | 120 | 50 |
| Melon | 5 | 2 | 1 | 0 | 2.3 | 1.5 | 2.0 | 0 | 11 | 11 | 7 | 0 | 148 | 160 | 110 | 100 |
| Groundnut | 6 | 5 | 3 | 2 | 2.5 | 3.0 | 1.2 | 5 | 15 | 14 | 11 | 7 | 144 | 120 | 150 | 156 |
| Shrubs | 1 | 1 | 2 | 1 | 1.2 | 1.1 | 1.0 | 0 | 5.0 | 5 | 0 | 0 | 144 | 131 | 50 | 50 |
| Control | 5 | 5 | 6 | 5 | 3.0 | 3.1 | 3.0 | 0 | 15 | 13 | 18 | 25 | 146 | 156 | 150 | 150 |

Source: Authors' field work 2017.

**Table 3**. Summary of total number of spillways, total depth, width and total length obtained from the various ground cover types.

| Crops | Total spills | Total depth (cm) | Total width (cm) | Total length (cm) |
|---|---|---|---|---|
| Elephant | 10 | 6.7 | 31 | 472 |
| Melon | 8 | 4.8 | 28 | 518 |
| Groundnut | 16 | 11.7 | 47 | 570 |
| Shrubs | 4 | 3.3 | 10 | 370 |
| Control | 21 | 19.1 | 70 | 602 |

Authors' field work (2017).

## RESULT AND DISCUSSION

Table 1 shows particle size distribution of soils across the various experimental sites revealed that sand, silt and clay particles showed ranges of 81.3-92.3, 6-7 and 1.7-11.7 cm respectively. It thus follows that the soils are homogenous hence posses identical textural characteristic in this regard. The dominant particle size is sand and sand lack cohesion implying that a minimal amount of rainfall can cause substantial loss of soil materials especially with the small of amount rain (Esu, 1999). The situation is worsened under a sloppy land condition (Singer and Munns 1999).

The result of this investigation has shown that, number of spillways and other parameters produced in various plots are directly related to their ground cover intensity. The quality of plant leaves by plants is expressed by the quality of soil (Egbai, 2011). It thus follows that the leaves of crop/plant do not only cover the soil thereby protecting it from the impact of raindrop but can as well enrich the soil by adding some important elements that enhance its exchange capacity. Singer and Munns (1999) emphasized the effect of nutrient and organic matter removal. The leaf falls of the plant can effectively enhance soil coherence and the more coherence the soil is, the more invulnerable the soil is to erosion perturbation. Etukudo (2000) stated that the type of crop cover involved in soil management process is a critical aspect of soil protection strategy. This implies that the depth, width, and length of rill formation are associated with the type of cover involved in the process. From the study, it shows that worst-case scenario was witnessed in control plot (near bare land.) The total length of erosion channel was highest with the control seconded by groundnut and melon plots. The lowest length covered was associated with undisturbed fallow vegetation (shrubs) seconded by elephant grass and melon plots. The number of spillways was lowest with undisturbed vegetation and seconded with the melon plot. In table 2 the result of average monthly measurement of erosion features, shows general reduction of the number of spillways in all the plots that have ground covers. Elephant grass plot progressively decrease from 3 in the month of April to 2 spillways in the month of July. While melon and groundnut plots showed drastic reduction in the number of spillways from 5 to 0 and 6 to 2 spillways respectively. The shrubs cover type proved to be more effective as there was no pronounced effect of soil erosion in view of sufficient ground cover throughout the period of the study. Similar result was obtained in relation to the depth, width and length of erosion channels. The number of spillways as indicated in table 3 showed that the total depth of 33cm was obtained while 10cm and 370cm were

**Table 4**. Range, Mean (M), Standard Deviation (Sd), Standard Error (Se) And Coefficient Of Variation (Cv) of cover types.

| Ground cover | Number of spillways | Depth (cm) | Width (cm) | Length(cm) |
|---|---|---|---|---|
| Elephant grass | | | | |
| Range | 2-3 | 1-3 | 2-11 | 50-152 |
| Mean | 2.5 | 1.68 | 7.75 | 118 |
| SD | 0.58 | 0.91 | 4.03 | 47.64 |
| SE | 0.26 | 0.41 | 1.80 | 21.30 |
| CV(%) | 23.09 | 54.14 | 52.01 | 40.37 |
| MELON | | | | |
| Range | 0-5 | 0-23 | 0-11 | 100-169 |
| Mean | 2 | 1.45 | 7.25 | 129.5 |
| SD | 2.16 | 1.02 | 5.19 | 29.00 |
| SE | 0.97 | 0.46 | 2.32 | 12.97 |
| CV(%) | 108.01 | 70.44 | 71.56 | 22.37 |
| GROUNDNUT | | | | |
| Range | 2-6 | 1.2-5 | 7-15 | 120-156 |
| Mean | 4 | 2.93 | 11.75 | 142.5 |
| SD | 1.83 | 1.58 | 3.59 | 15.78 |
| SE | 0.82 | 0.71 | 1.61 | 7.06 |
| CV(%) | 45.46 | 53.94 | 30.59 | 11.07 |
| SHRUBS | | | | |
| Range | 1-2 | 0-1.2 | 0-5 | 50-144 |
| Mean | 1.25 | 0.83 | 2.5 | 93.75 |
| SD | 0.50 | 0.56 | 2.89 | 50.80 |
| SE | 0.22 | 0.25 | 1.29 | 22.72 |
| CV(%) | 40.00 | 67.40 | 115.47 | 54.18 |
| CONTROL | | | | |
| Range | 5-0 | 0-31 | 13-25 | 146-156 |
| Mean | 5.25 | 2.28 | 17.75 | 150.5 |
| SD | 0.50 | 1.52 | 5.25 | 4.12 |
| SE | 0.22 | 0.68 | 2.35 | 1.84 |
| CV(%) | 9.52 | 66.70 | 29.59 | 2.74 |

Authors' field work 2017.

recorded for width and length respectively. From the result it is clear that there was general reduction in the impact of erosion in shrubs and melon plots with 8 spillways, 4.8cm of total depth and a total of 28cm width. While elephant grass produced 10 spillways, 6.7cm depth, 31cm width and total length of 472cm next to shrub cover type. The control plot showed inability to protect the soil as it recorded 21 spillways, 19.1cm depth, 70cm width and 602cm length which is apparently the highest.

The role of ground cover in erosion control cannot be overestimated giving its nutrient recycling and soil stability benefits (Anikwe and Atumia 2003) different vegetation covers have different degrees of soil protection potentials (Egbai et al., 2011 and Egbai, 2016). According to the authors the thicker the vegetation the thicker the leaves fall and the humus content, implying that thickness of humus content of soil is directly proportional to the thickness of the vegetation. Conversely, the thicker the vegetation cover the lesser the rain drop interface with the soil. This is what applies in a natural system and it is applicable in an agro-ecosystem where impact of human activities is noticeable. This condition however calls for a mechanism that can effectively prevent continuous exposure of the land surface to the impact of weather elements. Table 4 shows result of range, mean, standard deviation (SD), standard error (SE) and coefficient of variation (CV) of the number of spillways, depth, width and length of erosion channel across the various ground cover types. The numbers of spillways were highest in control and groundnut plots with ranges of 5-6 and 2-6 but lowest in shrubs, elephant grass and melon plots with ranges of 1-2, 2-3 and 0-5 respectively. Similar values were obtained in depth, width and length of channel produced by erosion. The SD, SE and CV show that different ground covers demonstrated differences in their soil protection potentials. The result shows that some ground covers can offer considerable reparation of land that is gradually affected by rill development. Example, melon crop reduced the number of spillways from 5-0, depth from 2.3-0, width from 11-0 and length from160-100.

Different crops have different morphological arrangement and different root systems. These features play important role in preventing raindrop impact on the soil surface and enhancing infiltration capacity of soil (Egbai, 2011). Spillways connote erosion channels which are determined by exposure of land surface or soil type, slope condition and nature of vegetation cover. This implies that how much of erosion path that is produced is dependent on the influence of the aforementioned variables (Ogogo et al 2013). Landscapes with more than 2% slope can greatly facilitate soil wash (Monkhouse 1971)

At the beginning of the rains in April where rains are generally known to begin in the tropics, the various plots witnessed a general increase in the number of spillways formation. This may not be unconnected with fact that various ground cover types have not sufficiently established in terms of the providing sufficient roots, and leaves which are critical plant parts that enable them to protect the soil from being eroded. As the leaves protect the soil from the vertical impact of raindrop the roots protect the soil from horizontal movement of water or runoff.

## CONCLUSION

Agricultural production is often bedeviled by a number of factors ranging from man-made to natural factors. Removal of vegetation cover irrespective of the scale is usually attributed to human activity and has continued to account for a huge loss of soil materials at every major rainfall events. Coping with the menace of soil loss with an affordable and cost-effective means is very desirable giving the enormity of devastating impact associated with the phenomenon.

This study has succinctly revealed that the use of certain crop/vegetation covers can guarantee the protection of soil and offer effective soil stability and recovery potentials. Certain features of erosion, example rill paths (spills ways), if not checked immediately may result in profound gully situation. In this study, fallow vegetation cover proved very effective in the control of erosion by producing the least number of rill channels (spillways), negligible depth and width coupled with an unreasonable length of the channel. This was seconded by melon and elephant grass plots respectively. The control plot offers the least protection potential in all plots considering the preponderance of spillways, increasing length, depth and width of channels seconded by the groundnut plot. It, therefore, implies that in the tropics were the study area belongs, every attempt must be made not to expose the soil surface have is sufficient rainfall and characteristics undulating surfaces.

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