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# Effect of Crop Cover on Soil Susceptibility to Erosion in South Eastern Nigeria

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## ABSTRACT

**Effect of crop on soil susceptibility to erosion in south eastern Nigeria was conducted at Cross River State nursery site in May 2014 to evaluate the potentials of some crops in controlling soil loss. Four experimental blocks consisting cassava *(Manihot esculenta)*, maize (zea mays), Cocoyam *(Colocosia sagittifolium)* and melon *(Colocynthis valgaris)*. Complete Randomized Block Design (CRBD) was employed to replicate crops in the various blocks. Soil samples were collected to determine their textual characteristics. Descriptive statistics was used to reveal the crop with the highest soil protection potential. The observed results indicated that, cassava and maize plots generated the highest sediment yield, while melon plots produced the lowest sediment yield followed by the mixed crop plot. Cassava has sediment yield of 2168.3, maize 166.3, melon 113.6 and 124.0 g from mixed crop. For cassava, the yield for cassava was 2805 and melon 1893 g hac$^{-1}$. The result revealed that the volume of soil loss hac$^{-1}$was below the soil tolerance limits. This may be attributable to soil characteristics and farming methods that reduce the vulnerability of soil to the impact of rain. The results show that, the inherent characteristics of the various crops were expressed in their ability to resist erosion perturbation. The study among other things recommends the cultivation of melon crop on slope above 5% as mono crop or intercropped other crops with melon in order to reduce soil susceptibility to erosion and guarantee optimum soil protection. The cultivation of cassava or maize as mono crop on sloppy land terrain will greatly encourage soil erosion process except alternative check mechanisms are considered to ameliorate the impact of water erosion. Crops are generally affordable, available and contain essential nutritive value at the same time guarantee soil protection possibility. The use of appropriate cropping system in an undulating landscape will not only ensure soil stability but will add sufficient value to increased food production.**

**Key word:** Soil susceptibility, Soil erosion, Soil loss, Sediment trap and Tolerance limit.

## INTRODUCTION

Agriculture is essentially the primary occupation of people of the third world countries. Over 80% of the rural workforce that depends on it can no doubt provide economic livelihood at least at subsistent level. Crop cultivation is the dominant agricultural activity in the area offering a wide range of nutrient rich food substances essential for growth and healthy living. This underscores its importance in overall human existence (Opeke, 2006; Anyanwu, 2001). However, the preponderance of soil degradation occasioned by unguided crop production activity on agricultural landscape is having a heavy toll on crop production process. Suleiman and Buucheroithner (2009) enumerated the consequences of mono and continuous cropping to include land degradation and loss of soil and nutrient, respectively. Others include loss of farmland, crop failure, low crop yield and soil pollution occasioned by frequent use of farm input like fertilizer and pesticides to boost food production. Therefore, to ensure sustainable crop production, soil improvement and protection are necessary prerequisites. Assessment of soil susceptibility is the basis for understanding erosion and soil loss study. Soil susceptibility explains the responds of soil to the adverse effects of weather elements particularly rain fall Thus, the ability of the soil to withstand erosion perturbation depicts its stability and sustainability. Such soils no doubt possess important soil properties that permit adequate infiltration and hydrological conductivity. Edem and Okoko (2015) posited that understanding soil hydrological properties is critical for soil erosion study.

It is important to a stress that soil erosion is associated with soil aggregation as well as other properties like infiltration, water retention capacity, tilt, gas exchanges and organic matter decomposition. A good soil is indeed the basis for sustainable crop production activity as it is capable of providing all the necessary nutrient requirements and releasing them systematically to satisfy crops' growth and development. This underscores the significant positive correlation between soil and crops production practice. This correlation suggests attendant mutually beneficial effects they offer. Thus, appropriate crop production activity can facilitate soil enhancement possibility as well as guarantee efficient land use practice. Sustainable agriculture is implied when appropriate soil protection mechanisms are put in place. These mechanisms often include the use of ridges, mould, trees and plant residues to break runoff velocity and to reduce direct rain drop impact. This control method is applicable in controlling splash, rill, and sheet including gully erosion. Erosion is the detachment, transportation and deposition of soil and other materials often at where they are not needed (Egbai et al., 2011). Amongst the materials usually conveyed are loosed soil particles, nutrients, plants and crops residues to mention a few. In Nigeria and South-eastern region in particular, human and natural forces often combined to adversely affect soil integrity.

In such scenario, it is necessary to contemplate a more affordable, efficient and cost-effective means of ameliorating these effects on soil. In an agrarian setting where there is a seeming total dependence on crop production for economic livelihood the phenomenon of soil erosion by water may not be inevitable, thus soliciting for effective protection mechanism to safeguard associated ravaging impact may constitute an invaluable option. Soil erosion whether water or wind prevails mostly where there is no interference to reduce its velocity or intensity. Houghton and Chairman (1986) noted that a good soil cover is an essential aspect of soil protection process. The protection of soil against the impact of rain and other weather elements is considered as a function of adequate ground cover (ISSS, 1996; McMaster and Wilhelm, 1999). Plant helps to stabilize soil and protects it against erosion and effectively control runoff. The use of crops to control erosion is critically necessary because of the numerous benefits associated with it. For example, the roots of maize *(Zea mays)* and cassava tuber *(Manihot esculenta)*, can substantially facilitate infiltration of water into the soil, while the leaves of cocoyam *(Colocosia sagittifolium)* help to intercept the impact of rain drop directly on the soil.

The fibrous roots of maize and the creeping stem of melon may help reduce overland flow, slow down flow velocity and increase the amount of water that infiltrates into the soil. Giving the peculiarity of humid tropical soils *vis a vis* the study area where soil degradation is exerting profound pressure; causing inaccessibility to land area, reducing the entire landscape to a state of worthlessness, impeding crop production adversely, aggravating water pollution issue and subjecting the local farmers to resort to unsustainable method of crop production. Amidst this challenging situation it is pertinent to pose the following fundamental questions; (1) can crops provide effective ground cover to the extent of reducing soil loss in the area? (2) Do all crops offer the same degree of soil protection potential? In response to these questions, the study attempts to empirically evaluate the potentials of certain crops in the overall soil protection process in line with Paine et al. (1996) recommendation that, growing certain crops on marginal lands such as highly erodible lands, poorly drained soil amenable to reclamation could be very useful.

## MATERIALS AND METHODS

### Study Area/ Experimental Site

The study was conducted in April 2014 near Cross River State oil Palm nursery site at Ibiea Estate, Nigeria. The area lies between longitude 8º61 East and latitude 5º31$^{1}$ North the annual average rainfall of the area is about 2000 mm (Ayoade, 2004).While temperature rarely falls below 19ºc with an average of 27ºc round the year. The relative humidity is usually between 80 to 100%. The landform consists of undulating topography with varying gradients. The range of the gradient is between 250 to 600 m above sea level. This range of gradient can substantially encourage erosion, reduce the amount of water percolating the soil and invariably decreasing the upper portion of the soil which constitutes the crop growing zone. The vegetation of the area consists of tress of different species typical of the humid tropical rainforest vegetation which have been adversely impacted through human activities resulting in massive extinction and the subsequent replacement of the extinct vegetation with crops. Consequently, various types of crops are cultivated most of which do not provide adequate cover to the soil from the vagaries of weather element (rain). Lack of vegetation cover or scanty vegetation cover in an area that is characterized by high rainfall may inadvertently result in the susceptibility of the said soil to erosion and loss. The relationship between rainfall, soil and vegetation cannot be overemphasized. The removal of the vegetal matter is an indication that the soil surface is exposed to the impact of rainfall.

### Soil Type and Particle Size Distribution

The soil comprises ultisols and ferruginous tropical soils. Ferruginous tropical soils are generally derived from basement complex and old sedimentary rocks formations. Their profiles are distinguished by a marked differentiation of horizons and abundant free iron oxides which are usually deposited as red and yellow concretion. Abawua (2008) remarked that these soils are susceptible to erosion. For the soil particle size distribution, the study of soil erosion and loss is of course incomplete without the assessment of its textural characteristics. The overall texture of the soil connotes the distribution of sand, silt and clay in a given soil system. The knowledge of soil particle distribution is critical in understanding the resistance of soil to erosion and the eventual loss.

## Site Layout and Design

The land was manually slashed and cleared of vegetation. Experimental blocks measuring 30 x 30 m were demarcated in four separate locations. The experimental design was CRBD. A block consisted of five plots otherwise called sub blocks separated from each other by 1 m. Each plot measures 30 x 5 m contained the following crops viz: cassava *(M. esculenta)*, maize *(Zea mays)*, cocoyam *(C. sagittifolium)*, melon *(C. valgaris)* and mixed crop plot. These crops constitute the major staple crops of the people.

## Soil Samples and Laboratory Analysis

Soil samples were randomly collected from each plot in the experimental block. The auger samples were collected from 0 to 30 cm into polythene bags for the laboratory analysis of particle size distribution. The main reason for the analysis was to ascertain soil status whether the soil is homogeneous or heterogeneous from the point of view of the texture. Day's hydrometer method was used to analyze the soil samples. Here organic matter in the soil samples are first subjected to oxidation with hydrogen peroxide ($H_2 O_2$) after sieving through a 2 mm mesh before introducing hexametaphosphate solution ($NaPo_3$) into it. (Gee and Or, 2002). Soil samples were air dried and stirred mechanically for 5 min after 10 ml of hexametaphosphate and 250 ml of water were added, respectively (Edem and Okoko, 2015).

## Agronomic Practices

Traditional hoes were used in planting crops at proper spacing as indicated below while the lost stands were replaced in all the plots immediately after germination. Weeding was carried out at 21 days and 70 days after planting (DAP). Meanwhile, crops were replicated in all the plots across the blocks at specified planting distances of 75 cm x 1m for maize, 1 x1 m for cocoyam, 2 x 2 m for melon and 1 x 1 m for cassava, respectively. Thinning was carried out in lined with the number of stands required per hole that is, two plants per hole after germination. Planting depth was within 2.5 to 3.5 cm deep in line with Anyanwu (2001) Opeke (2006) specification.

## Installation of Sediment Trap/Measurement Soil Loss

Soil lost was determined using sediment trap positioned at slope bottom of each plot, (Oyegun and Ede, 2005). Effort was made to ensure that the blocks were all located on similar land condition. The slope dimensions range as follows, 5.4, 5.2, 5.5 and 5.7%, respectively. Indicating that all the experimental blocks were situated on similar topographic terrain hence they fell within the same slope range. With this, the volume of soil loss per plot is expected to be the same if the same treatments are administered. But in the case where different crops were used the result is expected to be relative to specific crop potential. The various crops were subjected to all these slope ranges to avoid bias and allow them prove their potential. The installation of sediment trap was ensured after a careful consideration of the direction of flow of water in each plot. The direction of flow was simply indicated by the traces of rill and sheet erosion paths created immediately after planting and subsequent germination of crops. This was achieved by taking a walk round the farm while the rain was still falling in order to detect erosion paths.

The placement of sediment traps was determined by the number of erosion channels /paths observed in each plot. Plots where more than one channel was identified, the collection of sediment yield (soil loss) was achieved by collating the yield from the respective sediment traps in a particular plot and summed up to produce one composite volume which is finally weighed in a balance at the end of each storm event. Measurement of soil loss comes after the installation of sediment traps. Collection of the sediment was conducted per crop unit, that is, at the end of each storm event, sediments or soil loss from the five crop's plots in a block were collected on crop by crop basis. Each of the four experimental blocks consisted of at least five sediment traps/ditches implying that each plot has erosion path(s). Each trap measured 90 x 50 x 30 m which was mounted at the slope bottom of each plot. Collection of soil loss was accomplished with the aid of a metallic blade used in scooping soil out of the sediment trap into a weighing balance at the end of each storm event for recording. 12 storm events were recorded throughout the period of this study. These storm events were presented in phases. Implying that, the 12 storm events were viewed in three phases. Each phase consisted of sediment from four storm events. Thus the $1^{st}$ to the $4^{th}$ storms constituted the first phase, $5^{th}$ to $8^{th}$ form the second phase while the last phase was a product of $9^{th}$ to $12^{th}$ storm events. This was to enhance clarity and avoid clumsiness of data. The purpose was also to ensure adequate measurement of cascaded volume of soil in detail. The progressive account of the storm events gives insight into the response of the land

**Table 1.** Soil particle distribution.

| Treatment blocks | Sand percentage | Silt percentage | Clay percentage |
|---|---|---|---|
| Bock 1 | 68.4 | 18 | 13.6 |
| Bock 2 | 62.8 | 20.2 | 17.0 |
| Bock 3 | 65.6 | 19.0 | 15.0 |
| Bock 4 | 66.4 | 15.0 | 17.2 |
| G/mean | 65.8 | 18.05 | 15.65 |

units cultivated to various crops to erosion. Erosion study can be conducted from a combination of field experiments and observations in long and short time ranges since the phenomenon can be adequately quantified and understood (Bilotta, 2012).

### The Description of a Sediment Trap

A sediment trap is sometimes called sediment ditch or box. The trap may be constructed with a hard wood or metallic pan with a dimension of 90 x 50 x 30 m depending on the dimension of the spill way of the (mostly sheet or rill) channels where the trap is to be placed. The equipment is usually positioned in such a way that it allows runoff from plot enters into the trap and emptied its cascaded materials. The bottom of the trap is usually prepared with a wire mesh such that only water is allowed to pass through it. To ensure this, the trap was placed on a platform that would allow only water infiltrate leaving the sediment or soil loss inside the trap.

## RESULTS AND DISCUSSION

### Soil Physical Characteristics

Table 1 serves to highlight the particle distribution of soil across the various blocks. To understand the phenomenon of soil erosion, the knowledge of its particle size distribution is of critical essence. Thus, composite soil samples already collected from the four respective blocks were subjected to laboratory analysis to have the amount of sand, silt and clay particles present. The result indicates that sand is the dominant particle distribution with the grand mean value of 65.80% followed by silt particles recording a total of 18.05% while clay particles recorded 15.65%. Result of the analysis is presented in the Table1 as follows.

### Soil Loss From the Respective Crops' Plots Presented in Phases

A total of 12 rain storm events were recorded. For the purposes of simplicity and clarity the storm events were separated and presented in three phases. Phase one comprise the first to the fourth rain storms. This is where the highest sediment yields or soil loss was recorded across the various crop units. Example, a total of 74.3, 73.3, 69.6, 69.0 and 62.0 g were obtained from cassava, maize, melon, cocoyam and mixed crops plots from the various experimental blocks. The phase one produced the highest sediment yield.

### Total Soil Loss and Grand Mean From the Various Plots

This comprises the grand total and grand mean of already weighed soil materials. Amount of soil loss obtained from the various crops' plots presented in three phases gives the grand total (G/t) while the Grand mean (G/t) was obtained by dividing the Grand total (G/t) by the number of phases.

### Volume of Sediment Yield/Soil Loss in Grams Per Hectare

The amount of soil loss/sediment yields collected from plots across the experimental blocks was converted to hectare rather than limit it to the size of the blocks. This was achieved by summing the total area covered by specific crop example cassava on plot by plot basis from the four (4) experimental blocks. In this case, each plot covers 30 x 5m (Chiemeka, 1989). Thus for a specific crop, the areal coverage of four plots by particular crop was computed, that is in each block each plot was earmarked for specific crop. Therefore, to obtain the total amount of sediment in grams per hectare the total sum of sediment obtained from each crop unit example cassava was summed up from the three phases of storm events (168.3 g) divided by 30 x 5 m into 4 (600) Example; 168.3/600 x 10,000 = 2805 g for cassava.

### Soil Physical Properties

Soil particle distribution plays important role the study of soil erosion. Table 1 contains soil textural characteristics. Soil textural characteristic reveals the percentages of the various fractions of sand, silt and the clay components. Understanding the volume or quantity of the various fractions in the soil is critical in determining soil attributes and susceptibility to erosion (Flury et al. 1994). It therefore implies that the ease with which water percolate the soil to a large extent depends on the particle size distribution. Thus, in a situation where the water partially infiltrates into the soil,

**Table 2**. Presentation of soil loss in phases.

| Crops | 1st – 4th storms | 1st phase | 5th – 8th | 2nd phase | 9th – 12th storms | 3rd phase |
|---|---|---|---|---|---|---|
| | $P_1$ $P_2$ $P_3$ $P_4$ | total | $P_1$ $P_2$ $P_3$ $P_4$ | Total | $P_1$ $P_2$ $P_3$ $P_4$ | total |
| Cassava | 20 18 20 16.3 | 74.3 | 15 13 15 13 | 56 | 10 10 8 10 | 38 |
| Maize | 19 21.8 19 17.1 | 73.3 | 13 12 15 10 | 50 | 12 10 11 20 | 43 |
| Melon | 19.6 17 17 16 | 69.6 | 9 7 7 5 | 28 | 3 6 5 2 | 16 |
| Cocoyam | 20 18 16 15 | 69.0 | 12 15 16 13 | 56 | 9 10 10 7 | 36 |
| Intercrop | 19 16 17 10 | 62.0 | 9 6 8 8 | 31 | 8 5 10 8 | 31 |

$P_1$, $P_2$, $P_3$, $P_4$ represent the various rain storm events that results in soil loss or sediment yield.

**Table 3.** Grand total and mean of Soil loss from the three phases of storm events.

| Crop type | Phase 1 | Phase II | Phase III | G/total (g) | G/mean (g) |
|---|---|---|---|---|---|
| Cassava | 74.3 | 56 | 38 | 168.3 | 56.1 |
| Maize | 73.3 | 50 | 43 | 166.3 | 55.4 |
| Melon | 69.6 | 28 | 16 | 113.6 | 37.8 |
| Cocoyam | 69.0 | 56 | 36 | 161.0 | 53.6 |
| Intercrop | 62.0 | 31 | 31 | 124.0 | 41.3 |

**Table 4,** Volume of sediment yield in grams per hectare.

| Crop type | Phase I | Phase II | Phase III | G/total (g) | (Kg) | (g) |
|---|---|---|---|---|---|---|
| Cassava | 74.3 | 56 | 38 | 168.3 | 2.81 | 2805 |
| Maize | 73.3 | 50 | 43 | 166.3 | 2.77 | 2771 |
| Melon | 69.6 | 28 | 16 | 113.6 | 1.88 | 1893 |
| Cocoyam | 69.0 | 56 | 36 | 161.0 | 2.68 | 2683 |
| Intercrop | 62.0 | 31 | 31 | 124.0 | 2.07 | 2066 |

two conditions are possible, first, flooding of the land in the case of a flat land and second, is excessive runoff in a situation where the land is undulating or sloppy. Soil susceptibility or vulnerability is critical to the study of erosion. This means that the ability of soil to withstand erosion perturbation must be assessed essentially to reveal its status and the inherent properties before venturing into project. Implicitly, such soil must possess some important textural characteristics that permit adequate infiltration and conductivity of water in the soil. Edem and Okoko (2015) posited that understanding soil hydrological properties is critical for erosion studies, they also noted that soil erosion is associated with soil aggregation as well as other properties like infiltration, water retention capacity, tilt, gas exchanges and organic matter decomposition. Edem and Okoko (2014) posited that water erosion is affected by natural condition such as, runoff, infiltration and human activities. Soils loss during erosion is largely associated with rainfall intensity and the rate of water percolation into the soil (Bobalola, 2000). From Table 1, it is obvious that the soil has homogenous textural characteristics meaning that the percentage of sand, silt and clay fractions in the various blocks are not different from one another and from the general mean.

It is clear from the results that the soil textural properties are typical of a tropical rain forest soil which has not been unfavorably exposed to the negative effects of weather elements hence may retain the important soil organic and inorganic properties that are necessary in soil stabilization. Tables 2, 3 and 4 indicate that cassava and maize plots generated the highest sediment yield. While melon plots produced the lowest sediment yield followed by mixed crop. In Table 4 the total sediment yield obtained from cassava plots was 168.3 g, maize 166.3 g while, melon plots generated a total of 113.6 g and 124.0 g from intercrop or mixed crop plots, respectively. The grand mean of sediment from each plot as represented in Table 3 indicates that cassava has grand mean of 56.1 g, maize, 55.4 g while, melon has 37.8 g and intercrop has 41.3 g representing average sediment yield from crops plots. Attempt to quantify the total sediment yield base on hectare revealed that under the same land condition cassava plot is capable of generating 2805 g of sediment yield $hac^{-1}$.The least sediment yield by melon 1893g seconded by intercrop with the total value of 2066 g. Meanwhile Soil Tolerant Limit (STL) is 11 tons $hac^{-1}$ (Cunningham and Saigo, 2003), implying that even the worst eroded plot still falls within the threshold of the Tolerant Limit. However, it is important to emphasize that continuous cultivation of crops be it sole (mono) or mixed crops without adequate attention to the degree of soil loss in the area will certainly get to a point where astounding amount in excess of STL will be experienced, thus resulting in diminishing marginal return. From the above result, it is possible to attribute the low amount of sediment recorded in virtually all the plots in comparison to the STL to the agronomic practice, soil type, and traditional farming system (weeding in particular) and crop type. Bulg and Puigdefabregas (2005) remarked that the potential for soil erosion and runoff are highly dependent on rainfall intensity and method of conservation measures. Considering the time it takes to form 1mm volume of soil, it means that conscious effort is needed to prevent soil loss through cover crop otherwise soil components will be dangerously affected.

In the humid region soils have low organic matter content and are fragile hence the need to adapt a more efficient soil protection mechanism. Park (1992) averred that susceptibility of soils to degradation is relatively high in the humid tropics especially when vegetal cover is removed indiscriminately. Anikwe et al. (2007) posited that soil protection is a function of crops cover potential. The ability of crops to sheath soil surfaces from the negative effect of rainfall is an indication that such crops can significantly guarantee soil protection. Plant cover includes both the aerial and basal plants covering a given area against the impact of rain and other environmental hazards (ISSS, 1996). Wiersum (1985) noted that vegetation protects the soil against surface erosion and decreases the volume and the amount of rainfall reaching the ground. The different crops here have different potentials in soil protection. While it is obvious that melon plot generated the least sediment yield it is however worth mentioning that given the low scale agricultural practice in the south eastern Nigeria there is no doubt that farmers prefer sole cropping instead of mixed cropping system probably because of cost implication and land availability. Suffice it to say that mixed or intercropping system has not only proved to be an effective soil protection mechanism but has the capacity to offer a wide range of crops on the same piece of land at the same time. Notwithstanding the low scale of sediment yield in the area, the preference of certain types of crops as sole crops is unequivocal in view of their soil protection potentials. Example, melon and mixed crop provided sufficient soil protection capacity by not leaving any reasonable space empty for the impact of rain fall. Undoubtedly, the mixed crop plots also featured prominently because of the combined effect of other crops on the same plot each with its unique soil protection potentials. From the results it is clear that top soil loss progressively reduce in all the plots across the blocks as the crops progressively stabilized and mature.

It takes melon plant a short time to establish and spread over the land surface thereby preventing direct impact of rain drop on the soil surface while other crops such as cassava, maize and cocoyam took time to gain this fit, implying that, a lot of time is required for these crops to establish its root system and the leave to enable them offer adequate protection. There is no doubt that these crops tend to gather more ground cover advantage as they progressively mature. Table 2 proves that as cassava cocoyam and maize crops were advancing they tend to protect the soil considerably well far better than at the beginning where their leaves and root systems were not fully developed like in the case of maize indicating that the duration and time within which a particular crop stabilize in the field have direct bearing on the protection of soil. From the results, three things are implicit in tackling soil wash with crops they include root system, the morphological characteristics of the crop (nature of leaf) and the nature of the slope. While the fibrous root system of maize trapped soil particles the broad leaves of cocoyam intercepted rain drop. The same applied to cassava leaves. The trailing stem and leaves of melon plant enabled it to effectively cover a reasonable ground space. Obviously, the possession of these features underscores the capacity of these crops to contend with erosion perturbation and enhance soil stability. The specific potential of the various crops in erosion control process is relative to the morphology of the crops. This explains why some crops are comparably better in soil protection than others. The basic physical characteristics like leaves structure, roots, tubers and combs are paramount in ensuring soil protection. Tables 2 and 3; show the relationship between soil loss and the crops.

### *Cassava*

Daily recording of soil loss from cassava plots shows that cassava has the highest amount of soil loss in the first few storm events which produced 20, 18, 20, and 16.3 g of soil loss. In Table 3 we can see a total of 168.3 g and grand mean of 56.1 g. These figures indicate the highest amount of soil loss produced from all the crops. The reason may be attributed to the nature of the leaves and the fact that as at when the crop was tender it lacks certain features like more number of leaves, longevity and production rate (CATIE, 1981). From the foregoing, it could be said with certainty that some cassava varieties can facilitate erosion than others in view of absence of some of features. Cultivation of cassava involves opening the ground to bury the stem a situation that can facilitate infiltration and prevent overland flow.

### *Maize*

The crop showed obvious inability to protect the soil from being eroded. The result in Table 2 shows that the first few weeks after germination experienced remarkable amount of soil loss. By this time the crop has not developed sufficient features that help protect soil besides, maize leaves encourages concentrated flow path through the leaves to the ground thereby increasing erosion (Abdin et al., 2000). However, the amount of soil loss started decreasing from the 5th to 12th storm events. This is probably because by this time the cobs and other features like the inflorescence and the fibrous root system have started developing thus contributing sufficiently in reducing the volume of soil that is carried away by runoff.

### *Cocoyam*

The result in Table 2 shows that 1st to 8th rain storms, yielded considerable amount of soil loss in cocoyam plots. This may no doubt be attributed to the undeveloped leaves which cannot intercept rain drop. From the 9th to 12th rain storms the crop showed reasonable degree of resistance because by this time much of it leaves have developed and have extended and become broad enough as to intercept rain drop and must have started producing cobs that can facilitate infiltration of water into the soil. Cocoyam cultivation may no doubt play significant role in conservation through erosion control and soil fertility maintenance including food value.

### *Melon*

At the first few rains after germination, precisely the 1st to 4th rain storms the amount of soil loss increased almost the same amount with what was obtained from other crops. But decreased considerably from the 5th to 12th rain storm events making it the highest soil protection crop hence it produced the least soil loss amount. This is probably because melon has spreading characteristic such that the more space it covers the more it exerts its effect by preventing the protected area from having direct impact of rain drop and intercepting the cascaded soil materials from being eroded. Increased density of melon crop has proved significant effect in preventing soil loss (Wahua, 1985).

### *Intercrop*

Sometimes refers to mixed crop provides opportunity for crops combination in a plot of land. The effect is not only in ensuring crop varieties in that same piece of land but plays some important ecological function by providing efficient and effective soil protection mechanism. In Table 2 from the beginning of the rain to the 12th storm events the intercrop plot demonstrated sufficient ability in combating soil loss by producing the least quantity of soil loss after melon plot. This may be due to the combined effects of various crops in the same piece of plot. Wahua (1985) noticed significant improvement in yield and weed control coupled with soil protection in a field intercropped with legumes. This is an effective way of enhancing proper soil conservation practice (Houghton and Charman, 1986). Brooks et al. (1991) stressed that the most effective way of ensuring normal erosion is by allowing vegetation cover on land surface. Opeke (2006) emphasized the need for mixed cropping as it could foster adequate utilization of soil nutrients. Cheema et al. (2006) reported similar finding. Without equivocation a good ground cover is an efficient means of reducing flooding scenarios thus necessitating protection of adjoining streams in the context of watershed setting. With appropriate soil protection practice, sustainable food production would be achieved (El-Ashry et al., 1987) according to Oyegun and Ede (2005) if the degree of sediment loss is in equilibrium with the climatogenic and natural vegetation characteristics of any area of man's environment, what will be experienced is the normal type of erosion thus, erosion can be normal when it is within the tolerable limit where no significant harm is caused to man's environment.

## CONCLUSION

The quest for increased food production and the problems associated with soil degradation have necessitated the desire and need to evolve a variety of agronomic practices that are compatible with specific agricultural land. In the context of agrarian community where there is no possibility of separating the people from crop production activity it is necessary to adopt crop varieties that have important attributes essential for the prevention of soil loss and have the ability to adapt to the environment at the same time have the potential to produce reasonable yield within the period. The use of crops with these qualities is beneficial provided they are compatible to the agricultural environment. Crops are generally affordable, available and contain essential nutritive value at the same time guarantee soil protection possibility. Growing melon as a mono crop or using intercropping on slopes above 5% proved compatible, efficient and effective means of combating soil erosion. The cultivation of cassava or maize as mono crop on similar land terrain will worsen or greatly encourage soil erosion process except alternative check mechanisms are considered to ameliorate the impact of erosion by water. The issue of soil loss with its attendant negative effect can only be controlled by employing those crop production methods that are capable of discouraging accelerated soil loss scenario.

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