

Evaluation of the Restorative Effect of three Organic Manures in Rill and Gully Eroded Soil using *Amaranthus hybridus* L. as Test Plant

ABSTRACT

The effect of organic manure in restoration of rill and gully eroded soil using *Amaranthus hybridus* as a test plant was carried out. The aim of this research work was to compare the restorative potentials of [cow dung](#), [goat dung](#), and [poultry manure](#) amendment on rill and gully eroded soil. The experiment was laid out in a randomized block design (RBD) with five treatment replicated thrice. Seeds of *Amaranthus hybridus* were sown directly into the bags and were thinned to two seedlings per bag a week after germination. Soil analysis of the treated samples and control was carried out after six weeks to determine the amount of organic carbon, soil pH, potassium, phosphorus and nitrogen. Also soil particles analysis was carried out to determine the amount of sand, silt, clay and bulk density. Stem height of *A. hybridus*, leaf area, number of leaves per plant and stem girth were the parameters monitored on a weekly basis. The data collected were subjected to analysis of variance (ANOVA) and Fisher's least significant difference (LSD) was used to separate the differences among treatment means. The result showed that [goat dung](#) recorded highest organic carbon content of (1.88 and 1.63), respectively in both rill and gully eroded soil samples. [Poultry manure](#) recorded increase in nitrogen content of (0.92 and 0.84) respectively in both rill and gully eroded soil samples. The combination of [goat dung](#), [poultry manure](#) and [cow dung](#) recorded the highest pH value of (5.90) in rill eroded soil samples while [goat dung](#) recorded the highest pH value of (6.40) in gully eroded soil samples. The least reduction in bulk density in rill soil sample was recorded in [goat dung](#) with value of (1.41) while [poultry manure](#) recorded the least reduction in bulk density of (1.48) in gully eroded soil sample. Percentage clay content recorded highest in control with value of (34.0 and 48.0) respectively in both rill and gully eroded soil samples. The combination of [cow dung](#), [goat dung](#) and poultry manure recorded the highest plant height of (21.02cm and 18.10cm) respectively, stem girth (1.36cm and 2.76cm) respectively, leaf area (10.81cm² and 16.84cm²) respectively in both rill and gully eroded soil sample, in control plant height of (5.64cm and 3.63cm) respectively, in stem girth (0.42cm and 0.32cm) respectively, in number of leaves (7.33cm and 8.33cm) respectively, in leaf area (2.11cm² and 1.55cm²) respectively recorded the least value in both rill and gully eroded soil samples. Analysis of variance showed significant difference among the treatments and within the weeks.

KEYWORDS: [Cow dung](#), [Goat dung](#), Poultry manure, Erosion, Soil, Rill, Gully, *Amaranthus hybridus*.

1. INTRODUCTION

Erosion is one of the surface processes that sculpture the earth's landscape and constitutes one of the global environmental problems. Soil erosion is perhaps the most serious mechanism of land degradation in the tropics [1]. Erosion is a deterioration of soil by the physical movement of soil particles. In agriculture, soil erosion refers to the wearing away of a field's topsoil by the natural physical forces of water and wind or through forces associated with farming activities such as tillage [2].

Soil erosion is the physical removal of topsoil by various agents, including falling rain drops, water flowing over the soil profile and gravitational pull [3]. Erosion, whether it is by water, wind or tillage, involves three distinct actions; soil detachment, movement and deposition [4]. Topsoil, which is high in organic matter, fertility and soil life, is relocated elsewhere "on-site" where it builds up over time or is carried "off-site" where it fills in drainage channels. Soil erosion reduces cropland productivity and contributes to the pollution of adjacent watercourses, wetlands and lakes [5].

The nature of water erosion may involve sheet, rill or gully movement. Irrespective of nature of erosion, the consequences are severe and frequently hazardous to humans and their environment. Gully erosion occurs when water flows in narrow channels during or immediately after heavy rain. This is particularly noticeable in the formation of hollow ways. By 1990, gullies occupy 4% of the land area of Anambra, Imo, Abia and Enugu states. Recently the erosion damage in Imo and Anambra states of Nigeria has been estimated as causing loss of over 20 tons of fertile soil per annum. With gullies extending to the depth of over 120 meters and up to 2km wide in some places [5].

In central Eastern Nigeria, the major causes of soil erosion include high rainfall, deforestation, and fragile nature of soil and farming activities [5]. As a consequence of soil erosion by agent of water, soil nutrient are depleted leading to decline in crops productivity. Increased soil erosion promotes soil compaction [6] and loss of weakened top layer of the soil. Soil chemistry is also altered as a result of soil erosion on the farmland area. It results in net decrease in soil carbon and nitrogen [7] due to loss of soil organic matter. Lack of soil organic matter in the soil result in soil structural instability since soil organic matter is a major binding object [8].

Plants need a well-balanced diet for better growth and yield. Manures are substances which provide nutrients for proper growth of plants. Manure is anything that has been added to the soil to increase its fertility and enhancing for plant growth [9]. Manure is not just the urine and faeces from livestock, but also the bedding, runoff, spilled feed, palorwash, and anything else mixed with it [10]. Manure contributes to soil fertility and tilth. In addition to nutrients, manure provides carbon and other constituents that affect soil humus content, biological activity, and soil physical structure [11]. Manures contribute to the fertility of the soil due to addition of organic matter and nutrients, such as nitrogen that is trapped by bacteria in the soil [12].

The degradation of land by erosion is of great concern to agricultural activities, thus it is pertinent to ascertain how this eroded soil which lack plant nutrient can be restored. The aim of this research work was to compare the restorative potentials of ~~cow dung~~cow-dung, ~~goat dung~~goat-dung and ~~poultry manure~~poultry-manure amendment on rill and gully eroded soil.

2. MATERIALS AND METHOD

2.1 Description of the Study Area

The study was conducted at the Department of Botany Laboratory/Green house located in Nnamdi Azikiwe University, Awka campus, using soil samples collected at different erosion sites (Rill and Gully) in Amawbia. Amawbia lies between latitudes $7^{\circ}00'N$ and $7^{\circ}10'N$ and longitudes $6^{\circ}05'E$ and $6^{\circ}15'E$ in Anambra State of Nigeria. It lies within the humid tropical rainforest belt of Nigeria characterized by trees, evergreen leaves, thick undergrowth, open vegetative lowland, interspersed with tall oil palm trees and deciduous trees. It has an annual rainfall of 1600mm to 2000mm on the average [13]. It has a mean annual temperature which ranges between $27^{\circ}C$ and $30^{\circ}C$ [13].

2.2 Sources of Samples Collections

The ~~cow dung~~cow-dung and ~~poultry manure~~poultry-manure used were collected from Amaenyi slaughter house and Amansea Awka while the ~~goat dung~~goat-dung was obtained from a goat rearing house inside market II, Ifite Awka. The seeds of *Amaranthus hybridus* were collected from Anambra Agricultural Development Program (ADP), Kwata Awka. Rill and Gully eroded soil samples used were collected from an erosion site situated at Amawbia, Akwa in Awka south local government area of Anambra state.

2.3 Experimental Design

The experiment was laid out in a randomized block design (RBD) with five treatments replicated thrice. This design generally assumed that while the general level of the results may be different in the different blocks, the relative effects of the treatment are the same in all blocks apart from the experimental error. In other words, there is no interaction between treatments and blocks.

2.4 Planting

Planting was done on the 22nd of June, 2016. Four seeds were sown per bag with a spacing of 60 x 60cm. The polythene bags used were perforated to avoid water logging.

2.5 Cultural Practices

The cultural practices adopted after planting include the following:

- Weeding: This is done weekly by hand picking.
- Watering: This is done once a week since rainfall at the time of the experiment was heavy and continuous.

2.6 Methods

Five kilogram of the collected eroded soil samples were measured with the aid of a weighing balance and mixed uniformly with 1.5 ~~kg~~Kg of the different manure treatments and were filled in perforated polythene bags. The mixture of ~~goat dung~~goat-dung, ~~poultry manure~~poultry-manure, ~~cow dung~~cow-dung mixed weighed 0.5 ~~kg~~Kg, respectively to

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make up the 1.5 kg required treatment. Also, another soil sample was weighed and put in a polythene bag without treatment to serve as control. Each of these treatments was replicated thrice making a sum total of 15 perforated polythene bags in each experimental soil sample. Soil samples were collected from rill and gully eroded soil with the aid of auger. The soil samples were air dried and passed through 2mm sieve and store in sample bags for analysis. Organic carbon was determined by dichromate wet oxidation method. Also, total Nitrogen and available phosphorus were analyzed while potassium was measured using flame photometer.

2.7 Data Collection

The following parameters were collected weekly as the plants germinated and grow.

- Stem height of *A. hybridus* in (cm)
- Leaf area of *A. hybridus* in (cm²)
- Number of leaves of *A. hybridus* in (cm)
- Stem girth of *A. hybridus* in (cm)

2.8 Statistical Analysis

The data collected were subjected to analysis of variance (ANOVA) and Fisher's least significant difference (LSD) was used to separate the differences among treatment means.

3. RESULTS

Table 1: Soil Properties of Rill Eroded Soil

TRT	pH(H ₂ O)	Organic C (g/kg)	Total N (g/kg)	K (cmol/mg)	Avail P mg/kg	Clay %	Silt %	F/Sand %	C/Sand %	BD
GD	5.80±0.009	1.88±0.002	0.84±0.003	0.02±0.008	2.82±0.001	26.0±0.002	13.0±0.002	29.0±0.019	32.0±0.006	1.41
PM	5.80±0.002	1.69±0.015	0.92±0.015	0.03±0.019	2.87±0.007	26.0±0.015	14.0±0.005	28.0±0.004	32.0±0.014	1.53
CD	5.10±0.008	1.34±0.005	0.86±0.009	0.06±0.008	4.66±0.010	29.0±0.004	12.0±0.013	31.0±0.015	23.0±0.008	1.56
GD+PM+CD	5.90±0.003	1.22±0.018	0.82±0.001	0.07±0.011	1.87±0.003	26.0±0.011	11.0±0.004	33.0±0.003	30.0±0.019	1.61
CTRL	5.10±0.014	0.90±0.010	0.64±0.016	0.02±0.002	1.80±0.016	34.0±0.018	13.70±0.015	26.30±0.014	36.0±0.010	1.72
F-value	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
p-value	0.015	0.021	0.019	0.020	0.017	0.021	0.017	0.023	0.022	0.019
LSD										

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CD= cow-dung, PM= poultry-manure, GD= goat-dung, GD+PM+CD= goat-dung + poultry-manure + cow-dung, CTRL=Control, F/Sand=, C/Sand=, BD=.

Table 1 showed the nutrients and properties of rill eroded soil sample when treated with goat-dung, cow-dung, poultry-manure and a mixture of goat-dung, cow-dung and poultry manure. The pH (H₂O) value of the sample was highest in the mixture of PM+CD+GD (5.90) and was least in the control (5.10). The amount of organic carbon was the highest value when treated with goat-dung (1.88±0.002) and the least was the control (0.90±0.010). The amount of nitrogen present in the soil sample was highest when treated with poultry-manure (0.92±0.015) and the least was recorded in the control (0.64±0.016). The amount of potassium present in the soil sample was highest the mixture of the three treatments (0.07±0.002) and the least in the control (0.02±0.002). The amount of available phosphorus in the soil sample was highest when treated with cow-dung (4.66±0.010) and the least was in the control (1.80±0.016). The clay percentage of the soil sample was highest in the control (34.0±0.016) and the least was recorded in the goat-dung (26.0±0.002). The percentage silt of the soil sample was highest when treated with poultry-manure (14.0±0.005) and the least was the combination of goat-dung+cow-dung+and-poultry-manure (11.0±0.004). The fine sand percentage of the sample is the highest when treated with the combination of goat-dung+cow-dung+and-poultry-manure (33.0±0.003) and the least was in the control (26.30±0.014). The percentage of coarse sand in the soil sample was the highest in the control (36.0±0.010) and was the least in cow-dung (23.0±0.008). The bulk density of the soil sample was highest in the control (1.72±0.008) and the least was recorded in goat-dung treatment (1.41±0.001).

Comment [m2]: The author did not mentioned that these values was significantly different with the control treatment or not. Please revise this part for all tables.

Table 2: Soil Properties of Gully Eroded Soil

TRT	pH(H ₂ O)	Organic C (g/kg)	Total N (g/kg)	K (cmol/mg)	Avail P mg/kg	Clay %	Silt %	F/Sand %	C/Sand %	BD
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Comment [m3]: All comments in table (1) must be applied here

GD	6.40±0.006	1.63±0.013	0.65±0.004	0.13±0.019	4.66±0.011	28.0±0.003	7.0±0.017	27.67±0.018	37.33±0.017	1.52±0.006
PM	5.80±0.010	0.98±0.018	0.84±0.013	0.05±0.016	1.87±0.014	37.0±0.001	11.0±0.010	21.0±0.011	35.0±0.006	1.48±0.018
CD	5.10±0.017	0.72±0.007	0.56±0.001	0.04±0.013	2.80±0.002	34.0±0.014	8.0±0.006	23.0±0.016	35.0±0.018	1.57±0.011
GD+PM +CD	5.10±0.008	0.89±0.015	0.58±0.006	0.02±0.008	2.80±0.005	44.0±0.008	12.0±0.018	21.0±0.003	23.0±0.003	1.58±0.005
CTRL	4.16±0.002	0.53±0.019	0.42±0.011	0.02±0.006	1.87±0.009	48.0±0.019	7.0±0.005	18.0±0.014	25.0±0.002	1.78±0.019
F-value										
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LSD	0.018	0.027	0.015	0.024	0.016	0.020	0.023	0.024	0.021	0.024

CD= ~~cow dungcow-dung~~, PM= poultry manure, GD= ~~goat dunggoat-dung~~, GD+PM+CD= ~~goat dunggoat-dung + poultry manure-poultry-manure + cow dungcow-dung~~, CTRL=Control.

Table 2 showed the nutrients and properties of gully eroded soil sample when treated with ~~goat dunggoat-dung~~, ~~cow dungcow-dung~~, ~~poultry manure-poultry-manure~~ and a mixture of ~~goat dunggoat-dung, cow dung and poultry manure~~. The pH (H₂O) value of the sample was ~~the~~ highest in the sample treated with ~~goat dunggoat-dung~~ (6.40±0.006) and the least is ~~recorded in the~~ control ~~treatment~~ (4.16±0.002). The amount of organic carbon was ~~the~~ highest value when treated with ~~goat dunggoat-dung~~ (1.63±0.013) and the least was ~~recorded in the~~ control (0.53±0.019). The amount of nitrogen present in the soil sample was ~~the~~ highest when treated with ~~poultry manure-poultry-manure~~ (0.84±0.013) and ~~was~~ the least ~~was in the~~ control ~~treatment~~ (0.42±0.011). The amount of potassium present in the soil sample was ~~the~~ highest when treated with ~~goat dunggoat-dung~~ (0.13±0.019) and ~~was~~ the least ~~in the was~~-control (0.02±0.006). The amount of available phosphorus in the soil sample was ~~the~~ highest when treated with ~~goat dunggoat-dung~~ (4.66±0.011) and ~~was~~ the least ~~is in both~~ ~~poultry manure-poultry-manure~~ and control ~~treatments, respectively~~ (1.87±0.014 and 1.87±0.009). The clay percentage of the soil sample was ~~the~~ highest in control (48.0±0.019) and the least was ~~recorded in~~ ~~goat dunggoat-dung~~ (28.0±0.003). The percentage silt of the soil sample is ~~the~~ highest when treated with combination of ~~goat dunggoat-dung+, cow dungcow-dung+ and poultry manure poultry-manure treatment~~ (12.0±0.018) and the least was ~~in the~~ control (7.0±0.005). The fine sand percentage of the sample was ~~recorded the highest value~~ when treated with ~~goat dunggoat-dung~~ (27.67±0.017) and the least ~~is was in the~~ control ~~treatment~~ (18.0±0.014). The percentage of coarse sand in the soil sample is ~~the~~ highest when treated compost manure (37.33±0.017) and the least is ~~recorded in the~~ combination of ~~goat dunggoat-dung+, cow dungcow-dung+ and poultry manure-poultry-manure~~ (23.0±0.003). The bulk density of the soil sample was ~~the~~ highest in ~~the~~ control (1.78±0.019) and the least is ~~recorded in~~ ~~poultry manure-poultry-manure treatment~~ (1.48±0.018).

Table 3: Effect of organic manure amendment of rill eroded soil on the plant height of *Amaranthus hybridus*

Week	Control	CD	GD	PM	CD+GD+PM	F-value	p-value	LSD	Comment [m4]: P-value
1	2.127±1.363	3.133± ± 0.28 9	3.167± ± 0.28 9	2.167± ± 0.11 6	3.667± ± 0.2 89		0.060	1.11	Formatted Table
2	3.633± ± 7.9 43	4.667± ± 0.28 9	5.833± ± 0.28 9	3.800± ± 0.10 0	6.533± ± 0.5 77		0.820	6.488	
3	4.333± ± 0.2 89	6.167± ± 0.76 4	7.667± ± 3.05 5	4.671± ± 0.28 9	9.667± ± 1.1 55		0.008	2.749	
4	4.637± ± 1.0 41	8.637± ± 2.25 5	10.833± ± 2.5 66	6.833± ± 1.04 1	13.50± ± 2.2 84		0.002	3.551	
5	5.167± ± 1.0 41	9.833± ± 1.52 8	14.50± ± 2.18 0	8.667± ± 1.75 6	17.50± ± 8.2 21		0.002	7.224	
6	5.64± ± 0.52 4	11.047± ± 0.5 78	17.033± ± 1.2 58	9.033± ± 1.04 1	21.02± ± 6.7 64		0.024	5.696	
F-value									Formatted: Highlight
P-value									Formatted: Font: Italic, Highlight
LSD									Formatted: Highlight

The table 3 showed the effect of ~~cow dungcow-dung~~, ~~goat dunggoat-dung~~, ~~poultry manure-poultry-manure~~, ~~separately~~, and ~~cow dungcow-dung~~ mixed with ~~goat dunggoat-dung~~ and ~~poultry manure-poultry-manure~~ on the amendment of rill eroded soil sample on the plant height of *Amaranthus-A. hybridus* after six weeks. The table indicates that ~~cow dungcow-dung~~ mixed with ~~goat dunggoat-dung~~ and ~~poultry manure-poultry-manure~~ gave the ~~highest maximum~~ plant height (21.02±6.764cm) followed by ~~goat dunggoat-dung~~ (17.033±1.258cm) ~~followed then~~

by cow dungcow-dung (11.047±0.578cm) and followed by poultry manure-poultry-manure (9.033±1.041cm) and the least was recorded in the control (5.64±0.524cm). Analysis of variance showed significant difference among treatment means and within the weeks.

Table 4: Effect of organic manure amendment of rill eroded soil on stem girth of *Amaranthus hybridus*

Week	Control	CD	GD	PM	CD+GD+PM	F-value	pP-value	LSD
1	0.167±0.00	0.183±0.004	0.186±0.002	0.168±0.000	0.168±0.002	0.000	0.000	0.000
2	0.186±0.008	0.261±0.100	0.288±0.003	0.188±0.052	0.363±0.008	0.027	0.111	0.111
3	0.200±0.000	0.300±0.100	0.360±0.000	0.210±0.000	0.520±0.100	0.016	0.182	0.182
4	0.310±0.000	0.566±0.567	0.707±0.008	0.340±0.000	1.033±0.008	0.174	0.664	0.664
5	0.360±0.000	0.803±0.000	1.110±0.000	0.573±0.073	1.167±0.009	0.000	0.212	0.212
6	0.420±0.000	1.120±0.100	1.22±0.106	0.713±0.053	1.364±0.110	0.000	0.155	0.155

F-value

P-value

LSD

The table 4 showed the effect of cow dungcow-dung, goat dunggoat-dung, poultry manure-poultry-manure and cow dungcow-dung mixed with goat dunggoat-dung and poultry manure-poultry-manure on the amendment of rill eroded soil sample on the stem girth of *Amaranthus-A. hybridus* after six weeks. The table indicates that cow dungcow-dung mixed with goat dunggoat-dung and poultry manure-poultry-manure gave the highest stem girth (1.364±0.110cm) followed by goat dunggoat-dung (1.22±0.106cm), followed by cow dungcow-dung (1.120±0.100), then followed by poultry manure-poultry-manure (0.713±0.053cm) and the least is recorded in the control (0.420±0.00cm). Analysis of variance showed that there was a significant difference in the stem girth of *Amaranthus-A. hybridus*.

Table 5: Effect of organic manure amendment of rill eroded soil on number of leaves of *Amaranthus hybridus*

Week	Control	CD	GD	PM	CD+GD+PM	F-value	pP-value
1	2.000±0.00	2.333±0.578	2.667±0.578	2.333±0.578	2.667±0.058	0.384	0.384
2	3.00±0.00	4.00±0.00	5.00±1.00	4.00±0.00	5.00±1.00	0.015	0.015
3	3.667±0.577	7.33±0.577	8.333±1.155	4.00±0.00	6.00±0.00	0.000	1.150
4	7.00±1.00	8.333±1.528	9.667±0.577	8.333±0.577	9.667±1.528	0.075	2.048
5	7.333±1.155	8.667±2.082	9.667±0.577	9.333±1.15	10.667±1.155	0.096	2.394
6	7.333±0.578	11.00±0.00	12.333±0.577	10.333±2.082	12.333±0.577	0.001	1.879

F-value

P-value

LSD

The table 5 showed the effect of cow dungcow-dung, goat dunggoat-dung and poultry manure-poultry-manure, separately and cow dungcow-dung mixed with goat dunggoat-dung and poultry manure-poultry-manure on the amendment of rill eroded soil sample on the number of leaves of *Amaranthus-A. hybridus* after six weeks. The table indicates that cow dungcow-dung mixed with goat dunggoat-dung and poultry manure-poultry-manure and goat dunggoat-dung alone gave the highest number of leaves (12.333±0.577 leaves) followed by cow dungcow-dung (11.00±0.0 leaves) then followed by poultry manure-poultry-manure (10.333±2.082 leaves) and the least is recorded in the control (7.333±0.578 leaves). There was significant difference between the numbers of leaves.

Table 6: Effect of organic manure amendment of rill eroded soil sample on leaf area of *Amaranthus hybridus*

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5	0.300±0.000	1.133±0.058	1.520±0.100	0.633±0.473	1.867±0.289	0.000
6	0.320±0.000	1.715±0.100	2.267±0.116	1.033±0.153	2.767±0.153	0.000

F-value
P-value
LSD

The table 8 showed the effect of cow dung, goat dung, poultry manure and cow dung mixed with goat dung and poultry manure on the amendment of gully eroded soil sample on the stem girth of Amaranthus A. hybridus after six weeks. The table indicates that cow dung mixed with goat dung and poultry manure gave the highest stem girth (2.767±0.153cm), goat dung (2.267±0.116cm), cow dung (1.715±0.100cm), poultry manure (1.033±0.153cm) and the least was the control (0.320±0.000cm). -There was significant difference in the stem girth.

Table 9: Effect of organic manure amendment of gully eroded soil on number of leaves of A. hybridus

Week	Control	CD	GD	PM	CD+GD+PM	F-value	pP-value	L
1	2.333±0.578	2.333±0.578	2.667±0.578	2.333±0.578	2.667±0.578	0.871	1.	
2	4.00±0.00	4.00±0.00	5.00±1.00	4.00±0.00	6.00±0.00	0.001	0.	
3	4.00±0.00	7.33±0.577	8.333±1.155	4.667±0.577	8.333±1.528	0.000	1.	
4	5.00±1.00	9.667±0.577	10.333±1.15	7.333±0.577	11.00±0.00	0.000	1.	
5	7.333±1.15	11.667±2.08	12.333±0.57	9.333±1.15	12.667±1.15	0.002	2.	
6	8.333±0.57	12.00±0.00	15.333±0.57	10.333±2.08	15.667±4.50	0.010	1.	

The table 9 showed the effect of cow dung, goat dung, poultry manure and cow dung mixed with goat dung and poultry manure on the amendment of gully eroded soil sample on the number of leaves of Amaranthus A. hybridus after six weeks. The table indicates that cow dung mixed with goat dung and poultry manure gave the highest number of leaves (15.667±4.509), goat dung (15.333±0.577), cow dung (12.00±0.00), poultry manure (10.333±2.082) and the least is the control (8.333±0.578). There was significant difference in the number of leaves.

Table 10: Effect of Organic manure amendment of gully eroded soil sample on leaf area of A. hybridus

Week	Control	CD	GD	PM	CD+GD+PM	F-value	pP-value	L
1	0.040±0.010	0.046±0.00	0.190±0.37	0.040±0.00	0.197±0.133	0.628	0	
2	0.130±0.715	1.733±0.029	2.56±0.100	0.171±0.02	3.333±1.531	0.001	1	
3	0.600±0.805	3.400±1.473	4.967±3.086	0.810±0.28	5.833±1.350	0.010	3	
4	0.757±0.422	6.890±2.072	7.250±0.00	1.253±0.15	9.627±7.528	0.040	6	
5	1.407±0.636	8.877±1.811	13.00±1.090	1.947±2.06	13.58±2.773	0.000	3	
6	1.553±0.663	12.733±1.13	16.717±2.66	2.230±0.00	16.847±3.640	0.000	3.820	

F-value
P-value
LSD

The table 10 showed the effect of cow dung, goat dung, poultry manure, separately, and cow dung mixed with goat dung and poultry manure on the amendment of gully eroded soil sample on the leaf area of Amaranthus A. hybridus after six weeks. The table indicates that cow dung mixed with goat dung and poultry manure gave the

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highest leaf area ($16.847 \pm 3.640 \text{ cm}^2$), [goat dunggoat-dung](#) ($16.717 \pm 2.66 \text{ cm}^2$), [eow dungcow-dung](#) ($12.733 \pm 1.13 \text{ cm}^2$), [poultry manure-poultry-manure](#) ($2.330 \pm 0.00 \text{ cm}^2$) and the least was the control ($1.553 \pm 0.663 \text{ cm}^2$). Analysis of variance showed that there was significant difference in the leaf area.

4. —DISCUSSION AND CONCLUSION

Analysis of rill and gully eroded soil as shown in table 1 showed that [goat dunggoat-dung](#) increased the pH content of the soil by 5.80, [poultry manure-poultry-manure](#) by 5.80, [eow dungcow-dung](#) by 5.10, mixture of the three by 5.90 and finally control without amendment by 5.10. [Goat dungGoat-dung](#) added the highest amount of organic carbon (1.88), [poultry manure-poultry-manure](#) (0.92), [eow dungcow-dung](#) (0.86), followed closely by the mixture of [goat dunggoat-dung](#), [eow dungcow-dung](#) and [poultry manure-poultry-manure](#) (0.82), control being the least with (0.64). This confirmed the report of Wagner and George [11] which indicated that in addition to nutrients, cow manure provides carbon and other constituents that affect soil humus content, biological activity, and soil physical structure.

From the nitrogen content in the rill and gully eroded soil, it was observed that [poultry manure-poultry-manure](#) increased the nitrogen content by 0.92, [eow dungcow-dung](#) 0.86, [goat dunggoat-dung](#) 0.84, followed by the mixture of [goat dunggoat-dung](#), [poultry manure-poultry-manure](#) and [eow dungcow-dung](#) with 0.82 and control with 0.64 as the least. Examining the potassium and the phosphorus content from table 2, [goat dunggoat-dung](#) has the highest value (0.13 for potassium, 4.66 for phosphorus). [Cow dungCow-dung](#) was (0.04 for potassium and 2.80 for phosphorus). This was in agreement with the report of Merka and Segars [14] which stated that chicken manure fertilizer is very high in nitrogen and also contains a good amount of potassium and phosphorus.

Analysis on gully eroded soil treated with different organic manure showed that the mixture of [goat dunggoat-dung](#), [poultry manure-poultry-manure](#) and [eow dungcow-dung](#) has value (5.10) for the pH content added to the soil while control has the least (4.16). [Goat dungGoat-dung](#) has the highest value (6.40) and [poultry manure-poultry-manure](#) added pH to the soil by (5.80). The analysis on the amount of organic carbon shows that the highest input was given by [goat dunggoat-dung](#) (1.63) while the least was control (0.53).

[Poultry manure-Poultry-manure](#) added the highest amount of nitrogen nutrient by (0.84), closely followed by [goat dunggoat-dung](#) (0.65). Analysis on rill eroded soil the combination of [goat dunggoat-dung](#), [poultry manure-poultry-manure](#) and [eow dungcow-dung](#) had potassium content of (0.07) than any of the organic manures used as treatment for the rill eroded soil where [goat dunggoat-dung](#) and control recorded the least content of (0.02). [Cow dungCow-dung](#) increased the phosphorus content by 4.66 and the least was control having the value 1.80. Analysis of gully eroded soil showed that [goat dunggoat-dung](#) increased the organic carbon of the soil by 1.63, [poultry manure-poultry-manure](#) by 0.98, [goat dunggoat-dung + eow dungcow-dung + poultry manure-poultry-manure](#) by 0.89, [eow dungcow-dung](#) by 0.72 and finally control without amendment by 0.53-. According to table 2 Control has the least value of 0.53 for carbon analysis in gully eroded soil while [goat dunggoat-dung](#) showed the highest value of 1.63.

Nitrogen analysis in gully eroded soil showed that [poultry manure-poultry-manure](#) had the highest value of 0.84 while control had the least value, 0.84 which is significantly different from their control value 0.42. Soil nutrient like organic matter, total nitrogen and phosphorus are lost mostly in gully erosion system than in sheet and rill erosion [3] therefore, results from table 2 showed that these lost nutrient can be restored by amendment of gully eroded soil with organic manure such as [goat dunggoat-dung](#) which had the highest of 1.63 increase for carbon and [poultry manure-poultry-manure](#) which had the highest of 0.84 for nitrogen content as observed from the soil treated with [goat dunggoat-dung](#) and [poultry manure-poultry-manure](#) respectively to show higher plant height, leaf area, stem girth and number of leaves compare to [Amaranthus-A](#) growing on gully eroded soil amended with other treatments. ~~But~~ Nevertheless, [Amaranthus](#) grown on gully eroded soil treated with [poultry manure-poultry-manure](#) showed the least development in the growth parameter mentioned above.

[Amaranthus](#) that grew on gully eroded soil with no amendment that is control treatment, showed no growth in the first week, and slow progressive growth as the plant progresses with age. It also had small leaves, thin and weak stem due to inadequate essential soil nutrients. Soil mineral deficiency often limits the growth of crops and may even cause soil failure [15].

Potassium analysis from table 2 shows that [goat dunggoat-dung](#) increased the presence of potassium and phosphorus in the gully eroded soil by 0.13 compared to others. It was observed that control and the mixture of [goat dunggoat-dung](#) mixed with [poultry manure-poultry-manure](#) and [eow dungcow-dung](#) had the same amount of potassium to the

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soil by 0.02, which is the least of all. [Cow dung](#) and the mixture of [goat dung](#), [poultry manure](#) and [cow dung](#) added the same amount of phosphorus to the soil (2.80) while the control (1.87) which was also the least.

The early seedling growth of [Amaranthus A. hybridus](#) in the two eroded soil samples showed that [goat dung](#) recorded the highest amendment option in the four growth parameters studied (plant height, stem girth, leaf area and number of leaves). There was significant difference in the effect of the different treatments on plant height and leaf area as seen in the tables while growth parameters such as stem girth and number of leaves of [Amaranthus A. hybridus](#) showed no significant difference, the findings of this is in agreement with the study by Ekwealor *et al.* [16] where gully eroded soil was restored and *Abelmoschus esculentus* thrived very well on it.

5. CONCLUSION

The ability of the organic manure used as treatment to effect significant amendments in the two eroded soil samples especially in the gully eroded soil sample was an indication that organic manure has great potentials in restoration of organic carbon content, available nitrogen, reduction of soil bulk density and increased productivity in plants.

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