Evaluation on the Effects of Organic Amendment on Soil Productivity of Selected Watersheds in Nnamdi Azikiwe University Awka Campus

Notes: The words with red colour words are meaning the words after correction.

FABSTRACT

This study was done to investigate soil physicochemical properties on prevalence of biodiversity at Nnamdi Azikiwe University Awka and Amansea and to compare the performance of the different study areas (abandoned farmland and heavily grazed land) with respect to their productivity using different soil amendments. Soil amendment experiment was carried out using CRBD with four treatment levels of poultry manure for abandoned farmland and heavily grazed land. The study results revealed that soil physicochemical properties vary significantly across the study area. The difference between nitrogen and potassium levels were found to be significant at ($P < 0.05$), indicating favourable conditions for plant growth in specific locations. Conversely, other parameters, such as moisture content, phosphorus, organic matter, and pH, were not significant at ($P > 0.05$), suggesting suboptimal conditions for certain plant species. Roadside ecosystems exhibited the highest soil chemical properties, particularly potassium, making them conducive for plant growth. Perennial watershed ecosystem also offered favourable conditions, fostering a variety of plant species. In contrast, annual watershed areas exhibit the least soil nutrient support due to potential leaching effects. There was a notable positive correlation was observed between soil moisture and soil pH, percentage nitrogen, phosphorus, and potassium content ($p<0.05$). Specifically, significant positive correlations were identified between soil pH and phosphorus, as well as between soil pH and potassium ($p < 0.05$).More so, analysis of variance showed a significant difference between sites in all the physiochemical parameters examined ($p<00.05$).

KEYWORDS: Physicochemical, Soil, Grazed, Farmland, Productivity, Ecosystem, Watershed, Amaranthus

1. INTRODUCTION

The relationship between soil physicochemical properties and biodiversity prevalence has garnered substantial attention in ecological research. Soil serves as a crucial foundation for terrestrial ecosystems, providing essential nutrients and habitat for a myriad of organisms. The physicochemical characteristics of soil play a pivotal role in shaping the composition and abundance of species within an ecosystem.

Soil pH, a fundamental soil property, has been widely recognized for its influence on biodiversity. It acts as a master variable, affecting nutrient availability, microbial activity, and plant growth. Several studies have demonstrated its impact on biodiversity prevalence. For instance, Kai et al. [1] found that higher soil pH levels were associated with increased plant species richness in grassland ecosystems. This relationship is attributed to the availability of essential nutrients like phosphorus and calcium, which are more accessible to plants under optimal pH conditions [2]. Additionally, soil pH influences microbial diversity, which in turn can impact overall ecosystem health. The study by Johnson and Curtis [3]; Rousk *et al.* [4]and Xing et al. [5] highlighted that soil pH was positively correlated with bacterial diversity in forest soils. Microorganisms play a critical role in nutrient cycling and soil organic matter decomposition, further underscoring the cascading effects of soil pH on biodiversity.

Soil texture, determined by the relative proportions of sand, silt, and clay particles, is another key factor shaping biodiversity prevalence. Different soil textures have varying water-holding capacities and drainage characteristics, which can influence plant establishment and microbial communities. Research by Brown *et al.* [6] demonstrated that soil texture influenced the composition of plant communities in grasslands. Sandy soils, with their lower water-holding capacities, tended to support drought-tolerant species, while clay-rich soils hosted a higher diversity of moisture-loving plants. These findings emphasize the role of soil texture in niche partitioning and habitat suitability for various species. Nutrient availability is a critical driver of biodiversity. Nutrients like nitrogen, phosphorus, and potassium are essential for plant growth and development. However, their availability in soil can influence competitive interactions among plants and impact species diversity.

Study by Janssens *et al.* [7]examined the relationship between soil nutrient availability and plant diversity in grasslands. They found that moderate nutrient levels were associated with higher plant diversity, while excessively high nutrient levels led to decreased diversity due to the dominance of a few competitive species. This suggests that an optimal nutrient range is necessary for maintaining a diverse plant community.

Soil organic matter (SOM) is a key determinant of soil fertility and water retention capacity. It is composed of plant and animal residues in various stages of decomposition and significantly influences soil structure and nutrient cycling [8]; [9]. In a study byDelgado-Baquerizo*et al*. [10], it was observed that higher SOM content positively correlated with microbial diversity in agricultural soils. Microorganisms involved in nutrient cycling and organic matter decomposition thrive in soils rich in organic material, leading to increased biodiversity in microbial communities.

Soil salinity, resulting from elevated levels of soluble salts, can have profound effects on biodiversity prevalence. High salinity levels can limit plant growth and alter soil microbial communities. Research by Pereira *et al*. [11]investigated the impact of soil salinity on plant diversity in coastal ecosystems. They found that areas with lower salinity levels exhibited higher plant diversity, while highly saline soils were dominated by salt-tolerant species. This relationship underscores the importance of soil salinity as a selective force shaping plant communities. The interplay between soil physicochemical properties and biodiversity prevalence is a complex and multifaceted relationship. Soil pH, texture, nutrient availability, organic matter content, and salinity collectively shape the conditions under which organisms thrive. Understanding these connections is vital for informed ecosystem management and conservation efforts. Recognizing the intricate ways in which soil properties influence biodiversity can guide restoration projects, invasive species management, and sustainable land use practices. By preserving optimal soil conditions, we can support diverse plant and microbial communities, fostering healthier and more resilient ecosystems.

This research was aimed at investigating soil physiochemical properties on prevalence of biodiversity at Nnamdi Azikiwe University Awka and Amansea and to compare the performance of the different study areas (abandoned farmland and heavily grazed land) with respect to their productivity.

1. MATERIALS AND METHODS

Description of the Study Areas

This study was carried out in the Nnamdi Azikiwe University Awka campus and Amasea areas of Awka South East Nigeria. Awka is located between the coordinates Latitude 6.24678° or 6° 14' 48" North and Longitude 7.11553° or 7° 6' 56" East (Richards, 2015), elevation 54 metres (177 feet). Total area of 4200m^2 will be mapped out for the study, each of the mapped out area measuring 600m^2 i.e. 30m x 20m^2 each using pegs and ropes for demarcations to identify its borders. Each site's precise location was located using a handheld GPS (Global Positioning System) tool Garmin eTrex (latitude, longitude, and altitude).

Awka is in the tropical rainforest zone of Nigeria and experiences two distinct seasons brought about by the predominant winds that rule the area. The South-western monsoon winds from the Atlantic Ocean and the North-eastern dry wind across the Sahara desert. The monsoon winds from the Atlantic creates seven months of heavy tropical rains which occurs between April and October and followed by five months of dryness November to March (Richards, 2015). The haematin is particularly dry, filled with dusty wind which enters Nigeria in late December or in early part of January and is characterized by grey haze limiting visibility and blocking the sun's rays. The temperature in Awka is generally 32^{0}C to 34^{0}C between January and April, 27^{0}C to 30^{0}C between June and December, with these last few months of dry season marked with intense heat.

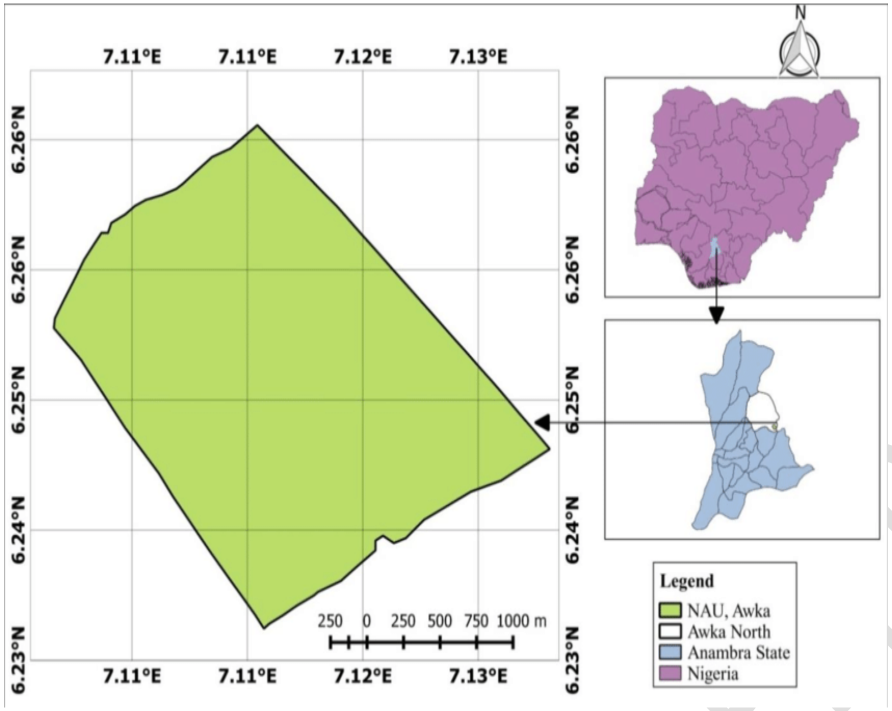

Fig 1. Map showing study location

Site selection

Study sites where selected to represent the four main study areas and where further split to obtain seven study areas to effectively carry out the study objectives. The seven different terrestrial ecosystems, which served as the study areas or experimental sites, include:

1. Abandoned Farmland located opposite Unizik fire station complex (Site 1)
2. Moderate Grazed Land, located at along Unizik Church Complex Gate (Site 2)
3. Heavily Grazed Land, located at Garki Area of Amasea (Site 3)
4. Perennial Watershed, located near Unizik Botany forest (Site 4)
5. Annual Watershed, located near Agric faculty (Site 5)
6. Regularly Used Roadside, located at Science village (Site 6)
7. Footpath located near Botany laboratory (Site 7)

The selection of study sites was systematic to ensure a representative sample of each land use type.

Sampling Techniques

The following sampling techniques where employed in data collection from the various experimental sites in order to test the research objectives and obtain desired results

Analysis of soil physiochemical properties

All the soil chemical properties weredetermined using the method of FAO [12]

Soil Moisture Method of FAO [12]: Five (5) grams of soil was weighed into a crucible. The sample and the crucible was transferred into an oven and oven dried for 1hour. The sample was allowed to cool after oven drying and reweighed. The moisture content of the soil sample was the calculated as follows.

$$\%Moisture = \frac{\text{Final weight after air drying}}{\text{Initial weight before air drying}} \times 100$$

Soil pH, Method of FAO [12]

Twenty (20) grams of soil sample was weighed into 250ml a conical flask. 50ml of distilled water was then added and placed on a magnetic stirrer and shake for 1hour. pH meter was calibrated using calibration solution of pH of 7.0. The calibrate pH meter was then inserted into the solution and allowed to stand for 2 minutes before reading was taken and recorded.

Soil Organic carbon, Method of FAO [12]

Five grams (5g) of soil sample was grounded into fine soil of 0.25mm in size. One gram (1g) was weighed from the prepared samples into a 250ml conical flask. 20ml of sulphuric acid was added and stir then allowed standing for 30mins. 250ml of water and 10ml of phosphoric acid was measured and poured into the sample solution. The solution was filtered and the filtrate titrated against ferrous sulphate solution in the presence of 1ml methyl red indicator and the reading recorded. A control experiment (blank) was also prepared as a control standard. Percentage organic carbon was calculated as follows

$$\%C = \frac{M \times V_1 - V_2}{S} \times 0.39 \times mcf$$

M = molarity of ferrous sulphate solution (from blank titration)

V1 = ml ferrous sulphate solution required for blank

V2= ml ferrous sulphate solution required for sample

S = weight of air dry sample in gram

mcf = Moisture correction factor

Soil Organic matter, Method of FAO [12]

The soil organic matter is calculated as follows:

% Organic matter = 2x % carbon

Soil Nitrogen, Method of FAO [12]

Five (5) gram of the soil samples was weighed into 250ml boiling flask. Selenium, 20ml of copper sulphate and 10ml of sodium sulphate was added then heated on for 50min. 10ml of sodium hydroxide solution was added after heating and transferred into a steam distillation apparatus. Ammonia gas was then trapped under 20ml boric acid and titrated in 0.02N HCL in the presence of 1-2 drops of methyl red and bromocerol indicator. The titrated value was recorded and percentage soil nitrogen calculated using the formula below.

$$\%N = \frac{a - b}{s} \times M\ 14 \times mcf$$

a = ml HCL required for titration sample

b = ml HCL required for titrating blank(control)

M = molarity of HCL(0.02)

mcf = Moisture correction factor

Soil Available Phosphorous, Method ofFAO [12]

This test outlines the procedure for the determination of available phosphorus in soils. Bray No 1 solution is designed to extract absorbed forms of phosphate only and is for use with soils with a ph. Phosphorus is extracted from the soil using Bray No. 1 solution as extracting. The extracted phosphorus is measured calometrically based on the reaction with ammonium molybdate and development of the 'Molybdenum Blue colour'. The absorbance of the compound is measured at 882nm in a spectrophotometer and is directly proportional to the amount of Phosphorus extracted from the soil.

Bray No 1 extracting solution dissolve 2.22g Ammonium Flouride A.R. (NH_4F) in deionised water and transfer to a 2L volumetric flask. Add 5ml concentrated hydrochloric acid and bulk to volume with deionised water. Reagent A dissolve 17.14g ammonium molybdat A.R. [$(NH_4)6Mo7O24.4H_2O$] in 200 ml of warm deionised water. Dissolve 0.392g potassium antimonial tartrate A.R. ($KSBO.C_4H_40_4$) in 150ml deionised water. Place 500ml deionised water in a 2l volumetric flask and slowly add 200ml concentrated sulphuric acid with mixing. When cooled, add the cooled molybdate and tartrate solutions, then mix and bulk to volume with deionised water.

Soil Physical Analysis

Determination of soil particle size

This was determined by the Bouyoucous hydrometer method Bouyoucous[13] and Beverwijk [14]. 50g soil was weighed and air-dried. 100ml of dispersing agent (sodium hexametaphosphate) was added to the soil. The content of the beaker was weighed into a shaking cap and fitted to a shaking machine and shaken for 5 minutes. The sample was sieved through a 2mm sieve mesh into a 1.0L cylinder. The sand portion was air dried and further separated using graded sieves of varying sizes into coarse, medium and fine sand. These were weighed and their weight taken. The 1.0 L cylinder containing of dispersed soil placed on a vibration-less bench and then filled to the mark. It was covered and allowed to stand over-night. The hydrometer method was used to determine the silt and clay contents. The cylinder with its content was agitated to allow the particles to be in suspension. It was then placed on the bench and hydrometer readings were taken at 40 seconds and 6 hours' interval. At each hydrometer reading temperature was also taken. The percent sand, silt and clay were calculated using this:

% clay = corrected hydrometer reading at 6hours x 100/weight of sample

% silt = corrected hydrometer reading at 40 seconds x 100/weight of sample - % clay

% sand = 100 –(% silt + % clay)

The texture was determined using textural triangle

Determination of soil bulk density

The bulk density was determined using the metal core sampler method [15]. The core sampler was driven into the soil. Soils at both ends of the tube were trimmed and the end flushed with a straight edge knife. The core sampler with its content was oven dried at 105^0c to a constant weight, removed, allowed to cool and its weight taken. The weight of the core cylinder and its volume was determined.

Calculation:

$$\text{Dry bulk density } (gcm^{-3}) = \frac{W_2 - W_1}{V}$$

W_2 = Weight of core cylinder + oven dried soil.
W_1 = Weight of empty core cylinder
V = Volume of core cylinder ($\pi r^2 h$). Where:
π = 3.142
r = radius of the core cylinder
h = Height of the core cylinder.

Determination of Phosphorus, Method of FAO [12]

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Bray No 1 Extracting Solution Dissolve 2.22 g Ammonium Fluoride A.R. (NH_4F) in deionised water and transfer to a 2 L volumetric flask. Add 5 mL concentrated hydrochloric acid and bulk to volume with deionised water. Reagent A Dissolve 17.14 g ammonium molybdate A.R. [$(NH_4)6Mo_7O_{24}.4H_2O$] in 200 mL of warm deionised water. Dissolve 0.392 g potassium antimonial tartrate A.R. ($KSbO.C_4H_4O_6$) separately in 150 mL deionised water. Place 500 mL deionised water in a 2 L volumetric flask and slowly add 200 mL concentrated sulphuric acid with mixing. When cooled, add the cooled molybdate and tartrate solutions, then mix and bulk to volume with deionised water.

Soil Amendment Experiment for Heavily grazed and Abandoned Farmland

Based on the results from sampling of the seven study sites, it was observed that two sites had the least number of Poaceae species when the above ground areas where sampled. Soil sample used for the soil amendment experiment where collected from those sites which includes: Heavily grazed and Abandoned farmland respectively fed with organic manure (poultry droppings) and seedlings of Green amaranth (*Amaranthus hybridus*) planted therein to promote the growth of seedlings and observe the extent of restoration that can thus be adopted to those soils.

Experimental design for soil amendment

The experiment was carried out as a 2 x 5 factorial made up of two different soil samples and four poultry manure rates arranged in a completely randomized block design (CRBD). The total treatment levels wereeight(8) and replicated three(3) times which makes a total of twenty-four(24). The treatment levels are presented on the table below:

Table 1: Randomised Block Design for Soil Amendment Analysis

SOIL SAMPLES	PM rate 0 (0Kg/ha)	PM rate 1 (0.5Kg/ha)	PM rate 2 (1Kg/ha)	PM rate 3 (1.5Kg/ha)	PM rate 4 (2.0Kg/ha)
Heavy Grazed (HG)	PM_0HG	PM_1HG	PM_2HG	PM_3HG	PM_4HG
Abandoned Farmland(AF)	PM_0AF	PM_1AF	PM_2AF	PM_3AF	PM_4AF

PM: Poultry manure levels

HG: Heavily grazed soil

AF: Abandoned farmland

Seed Collection

The seeds of Green amaranths were collected from the farmers market at Nkwo market Nise, Awka South L.G.A of Anambra state and authenticated by Mr Iroka Finian, a taxonomist at the botany department laboratory, Nnamdi Azikiwe University, Awka as *Amaranthus hybridus* (L.) var.

Experimental Layout

The soil samples collected from the heavily grazed and abandoned farmland where put in poly bags, weighing 30kg of soil and treated with different levels of poultry manure to observe the growth attributes of the intended plants cultivated in each soil sample. *Amaranthus hybridus* also popularly known as green amaranth or green vegetable is not a deep rooted plant and grows well within the soil depth of 0-5cm. The soils where bagged, perforated to drain excess water and carefully labelled for easy identification, after which they were placed in the Botany department green house near the department laboratory at Nnamdi Azikiwe University. Amaranthus seedlings where transplanted three seedlings per bag and treated with four poultry manure measurements; the treatments where 0.5Kg/ha, 1Kg/ha, 1.5Kg/ha, 2Kg/ha respectively.

Data Collection for Soil Amendment

Measurements of plant height, plant girth, number of leaves and leaf area where recorded weekly from the day of transplanting over a period of six(6) weeks. This early seedling growth of *Amaranthus hybridus* was used to monitor the effects of the amendment.

3. RESULTS

Soil Physiochemical Properties of the Experimental Sites

Result of the soil physiochemical properties of the experimental site revealed that percentage soil moisture was highest in the perennial watershed site (15.03±0.289%) and lowest in the roadside experimental plot (6.83±0.144%). The soil PH was highest perennial watershed site (7.55±0.214) and lowest in the heavily grazed experimental plot (4.29±0.012.). The percentage soil nitrogen was highest in the perennial watershed site (0.46±0.040 %) and lowest in the roadside experimental plot (0.29±0.005 %). The percentage soil phosphorus was highest in the perennial watershed site (14.80±0.693 %) and lowest in the roadside experimental plot (7.65±0.566 %). The potassium soil content was highest in the perennial watershed site (183.33±1.155 kg/ha) and lowest in the roadside experimental plot (120.71±0.612 kg/ha) while percentage soil carbon was highest in the annual watershed site (4.07±0.017 %) and lowest in the heavily grazed experimental plot (2.78±0.012%). Analysis of variance showed a significant difference between sites in all the physiochemical parameters examined ($p<00.05$).

Test of correlation between soil physiochemical properties, above ground diversity and seedbank diversity

The results of the Pearson momentum correlation analysis conducted between the soil physiochemical properties of the experimental sites, above-ground diversity, and seed bank diversity revealed several significant findings. Firstly, a notable positive correlation was observed between soil moisture and soil pH, percentage nitrogen, phosphorus, and potassium content ($p<0.05$). Specifically, significant positive correlations were identified between soil pH and phosphorus, as well as between soil pH and potassium ($p < 0.05$). Additionally, a significant positive correlation was found between soil phosphorus and potassium ($p < 0.05$).

However, no significant correlation was detected between the soil physiochemical parameters and above-ground diversity or seed bank diversity ($r < 0.5$, $p > 0.05$). Despite this, a weak positive correlation ($r = 0.410$) was noted between seed bank diversity and soil carbon. Furthermore, above-ground diversity exhibited a positive correlation with seed bank diversity ($r = 0.514$), albeit this, the relationship did not reach statistical significance ($p < 0.05$).

Table 2: Soil Physiochemical Properties of the experimental sites

Sites	Moisture Content (%)	PH	Nitrogen (%)	Phosphorus (%)	Potassium kg/ha	Organic Carbon (%)
Heavily Grazed (HG)	9.34±0.196c	4.29±0.012a	0.35±0.006c	8.15±0.127a	136.67±0.577c	2.78±0.012a
Moderately Grazed (MG)	9.95±0.127d	5.29±0.254b	0.32±0.012b	8.03±0.029a	149.32±0.589e	4.20±0.173d
Roadside (RS)	6.83±0.144a	4.51±0.081a	0.29±0.005a	7.65±0.566a	120.71±0.612b	3.18±0.069b
Abandoned Farmland (AF)	10.71±0.248e	5.57±0.029c	0.40±0.006d	10.70±0.606b	145.39±0.531d	4.09±0.012d
Footpath (FP)	7.34±0.035b	5.14±0.052b	0.29±0.005a	7.67±0.577a	115.63±0.318a	3.65±0.566c
Annual Watershed (AW)	13.87±0.231f	7.07±0.023d	0.40±0.006d	13.73±0.635c	157.87±0.115f	4.07±0.017d
Perennial Watershed (PW)	15.03±0.289g	7.55±0.214e	0.46±0.040e	14.80±0.693d	183.33±1.155g	3.56±0.035c
p-value	0.001	0.001	0.001	0.001	0.001	0.001

Results are in Mean ± Standard Deviation

Mean Values with the same letter in each column are not significantly different from each other by DNMRT (P > 0.05)

Table 3: Test of correlation between soil physiochemical properties, above ground diversity and seedbank diversity

	Moisture Content	PH	Nitrogen	Phosphorus	Potassium	Organic Carbon	Above Ground Diversity	Seedbank Diversity
Moisture Content	1							
PH	**0.921**	1						
Nitrogen	**0.842**	0.691	1					
Phosphorus	**0.952**	**0.954**	**0.842**	1				
Potassium	**0.953**	**0.843**	**0.824**	**0.867**	1			
Organic Carbon	0.372	0.515	-0.066	0.332	0.321	1		
Above Ground Diversity	-0.215	-0.254	0.034	-0.229	0.049	-0.158	1	
Seedbank Diversity	0.206	0.371	0.066	0.311	0.333	0.410	0.514	1

Values in bold are significant (p<0.05)

Response of *Amaranthus hybridus* to different rates of poultry manure using soil samples from abandoned farmland and heavily grazed plots.

The effect of different rates of poultry manure on stem height of *Amaranthus hybridus* is shown in Table 4. The table revealed that based on soil samples from abandoned farmland the poultry manure rate of 1.5kg/ha gave the highest increase in stem height from 14.30±0.000 cm in week 1 to 55.37±0.058 cm in week 4 while the control gave the least increase in stem height from 9.97±0.058 cm to 17.07±0.115 cm. Similarly, based on soil samples from heavily grazed site, the poultry manure rate of 1.5 kg/ha gave highest increase in stem height from 17.25±0.092 cm in week 1 to 78.97±0.058 cm in week 4 while the control gave the least increase in stem height from 15.00±0.006 cm to 20.16±0.098 cm. Analysis of variance showed a significantdifference in the height of *Amaranthus hybridus* between the rates of poultry manure for both abandoned farmland andheavily grazed ($p<0.05$). Overall, the stem height of *Amaranthus hybridus* was higher in heavily grazed soils than in abandoned farmland. Analysis of variance also showed a significant difference in height of *Amaranthus hybridus* between soil types.

Table 4: Mean weekly stem height of *Amaranthushybridus* in different rates of poultry manures and soil samples (Abandoned Farmland and Heavily Grazed).

		Mean Weekly Stem Height (cm)			
Soil Type	**Treatment**	**Wk1**	**Wk2**	**Wk3**	**Wk4**
	P0	9.97±0.058a	13.03±0.056a	14.97±0.058a	17.07±0.115a
	P1	12.07±0.115b	15.03±0.062b	16.00±0.000b	20.03±0.058b
Abandoned farmland	P2	14.07±0.115c	29.33±0.058e	41.07±0.058e	51.23±0.058c
	P3	14.30±0.000d	21.97±0.058d	40.07±0.115d	55.37±0.058e
	P4	14.20±0.000d	21.02±0.029c	38.20±0.000c	55.10±0.000d
	p-value	0.000	0.000	0.000	0.000
	P0	15.00±0.006b	15.73±0.058a	17.47±0.046a	20.16±0.098a
	P1	17.02±0.029c	17.21±0.010b	21.02±0.029b	24.03±0.058b
Heavily Grazed	P2	18.51±0.011e	26.53±0.058d	34.47±0.058c	58.53±0.058c
	P3	17.25±0.092d	35.96±0.075e	61.03±0.052e	78.97±0.058e
	P4	8.11±0.017a	22.02±0.029c	41.01±0.013d	63.06±0.096d
	p-value	0.000	0.000	0.000	0.000

The effect of different rates of poultry manure on stem girth of *Amaranthus hybridus* is shown in Table 4. The table revealed that based on soil samples from abandoned farmland the poultry manure rate of 2kg/ha gave the highest increase in stem girth from 1.00±0.006 cm in week 1 to 3.86±0.098 cm in week 4 while the control gave the least increase in stem girth from 0.50±0.000a cm to 0.90±0.000a cm. In contrast, based on soil samples from heavily grazed site, the poultry manure rate of 1.5 kg/ha gave highest increase in stem girth from 2.15±0.092 cm in week 1 to 4.47±0.058 cm in week 4 while the control gave the least increase in stem girth from 0.83±0.058b cm to 2.06±0.098a cm. Analysis of variance showed a significant difference in the girth of *Amaranthus hybridus* between the rates of poultry manure for both abandoned farmland and heavily grazed ($p<0.05$). Overall, the stem girth of *Amaranthus hybridus* was higher in heavily grazed soils than in abandoned farmland. Analysis of variance also showed a significant difference in girth of *Amaranthus hybridus* between soil types.

Table 5: Mean weekly stem girth of *Amaranthushybridus* in different rates of poultry manures and soil samples (Abandoned Farmland and Heavily Grazed).

Mean Weekly Stem Girth (cm)

Soil Type	Treatment	Wk1	Wk2	Wk3	Wk4
Abandoned farmland	P0	0.50±0.000a	0.72±0.029a	0.80±0.000a	0.90±0.000a
	P1	0.90±0.000b	0.97±0.058b	1.07±0.058b	1.17±0.115a
	P2	1.37±0.115c	2.43±0.058d	2.67±0.058c	2.93±0.058b
	P3	1.17±0.289c	1.77±0.635c	2.87±0.231d	3.33±0.289c
	P4	1.00±0.006b	1.63±0.058c	2.97±0.046d	3.86±0.098d
	p-value	0.000	0.000	0.000	0.000
Heavily Grazed	P0	0.83±0.058b	0.90±0.006a	0.97±0.046a	2.06±0.098a
	P1	1.02±0.029c	1.11±0.010b	1.22±0.029b	4.43±0.058d
	P2	1.51±0.011d	2.03±0.058d	2.67±0.058c	3.23±0.058b
	P3	2.15±0.092e	2.56±0.075e	4.13±0.052d	4.47±0.058d
	P4	0.61±0.017a	1.52±0.029c	2.61±0.013c	3.56±0.096c
	p-value	0.000	0.000	0.000	0.000

The effect of different rates of poultry manure on leaf area of *Amaranthus hybridus* is shown in Table 5. The table revealed that based on soil samples from abandoned farmland the poultry manure rate of 1.5kg/ha gave the highest increase in leaf area from 15.85±1.305 cm^2 in week 1 to 66.37±2.540d cm^2 in week 4 while the control gave the least increase in leaf area from 3.60±0.525 cm^2 to 7.12±1.253 cm^2. Similarly, based on soil samples from heavily grazed site, the poultry manure rate of 1.5 kg/ha gave highest increase in leaf area from 32.55±0.092 cm^2 in week 1 to 79.53±0.052 cm^2 in week 4 while the control gave the least increase in leaf area from 0.40±0.006 cm^2 to 7.56±0.098 cm^2. Analysis of variance showed a significant difference in the leaf area of *Amaranthus hybridus* between the rates of poultry manure for both abandoned farmland and heavily grazed ($p<0.05$). Overall, the leaf area of *Amaranthus hybridus* was higher in heavily grazed soils than in abandoned farmland. Analysis of variance also showed a significant difference in girth of *Amaranthus hybridus* between soil types.

Table 6: Mean weekly leaf area of *Amaranthushybridus* in different rates of poultry manures and soil samples (Abandoned Farmland and Heavily Grazed)

Soil Type	Treatment	Wk1	Wk2	Wk3	Wk4
Abandoned farmland	P0	3.60±0.525a	4.40±0.520a	6.61±0.531a	7.12±1.253a
	P1	4.65±0.606a	6.47±0.645b	16.52±0.722b	18.30±2.598b
	P2	23.91±0.877d	49.87±1.501d	55.00±1.905d	57.80±1.212c
	P3	15.85±1.305c	48.62±1.426d	61.70±2.419e	66.37±2.540d
	P4	6.71±0.364b	35.32±0.895c	47.62±2.117c	65.97±1.514d
	p-value	0.000	0.000	0.000	0.000
Heavily Grazed	P0	0.40±0.006a	5.23±0.058a	7.17±0.046a	7.56±0.098a
	P1	0.72±0.029b	7.71±0.010b	12.12±0.029b	19.83±0.058b
	P2	17.31±0.011d	50.23±0.058c	63.87±0.058d	64.23±0.058c
	P3	32.55±0.092e	61.96±0.075e	77.17±0.058e	79.53±0.052e
	P4	4.51±0.017c	54.52±0.029d	62.21±0.013c	69.66±0.096d

	p-value	0.000	0.000	0.000	0.000

The effect of different rates of poultry manure on number of leaves of *Amaranthus hybridus* is shown in Table 7. The table revealed that based on soil samples from abandoned farmland the poultry manure rate of 1.5kg/ha gave the highest increase in number of leaves from 7.33±0.577 in week 1 to 49.33±0.577 in week 4 while the control gave the least increase in number of leaves from 5.33±0.577 to 11.30±0.520. Similarly, based on soil samples from heavily grazed, the poultry manure rate of 1.5 kg/ha gave highest increase in number of leaves from 7.33±0.577 in week 1 to 49.00±0.000 in week 4 while the control gave the least increase in number of leaves from 3.33±0.577 to 9.33±0.577. Analysis of variance showed a significant difference in the number of leaves of *Amaranthus hybridus* between the rates of poultry manure for both abandoned farmland and heavily grazed ($p<0.05$). Overall, the number of leaves of *Amaranthus hybridus* was slightly higher in abandoned farmland than in heavily grazed soils. Analysis of variance also showed a significant difference in number of leaves of *Amaranthus hybridus* between soil types.

Table 7: Mean weekly number of leaves of *Amaranthushybridus* in different rates of poultry manures and soil samples (Abandoned Farmland and Heavily Grazed).

		Mean Weekly Number of Leaf			
Soil Type	**Treatment**	**Wk1**	**Wk2**	**Wk3**	**Wk4**
Abandoned farmland	P0	5.33±0.577a	7.33±0.577a	10.00±0.000a	11.30±0.520a
	P1	7.33±0.577b	9.33±0.577b	13.33±0.577b	17.00±0.000b
	P2	8.33±0.577b	17.67±1.155e	30.33±0.577c	34.33±0.577c
	P3	7.33±0.577b	12.33±0.577d	35.33±0.577d	49.33±0.577e
	P4	7.33±0.577b	11.00±0.000c	30.67±1.155c	42.33±0.577d
	p-value	0.001	0.000	0.000	0.000
Heavily Grazed	P0	3.33±0.577a	7.00±0.000a	9.33±0.577a	9.33±0.577a
	P1	4.33±0.577a	10.33±0.577b	11.33±0.577b	12.33±0.577b
	P2	9.33±0.577c	14.67±1.155d	29.33±0.577c	40.33±0.577c
	P3	7.33±0.577b	12.33±0.577c	35.33±0.577d	49.00±0.000e
	P4	7.33±0.577b	11.33±0.577c	30.00±0.000c	42.30±0.520d
	p-value	0.000	0.000	0.000	0.000

4. DISCUSSION

The study further revealed that apart from soil carbon, the perennial watershed ecosystem gave the highest percentage soil moisture, nitrogen, phosphorus, potassium, and pH. The heavy grazed location recorded the lowest pH, and carbon while roadside location recorded the least soil moisture, nitrogen, phosphorus, nitrogen, and potassium. The superiority of the perennial watershed ecosystem with regards to having higher composition of most of the soil physiochemical properties examined could explain the reasons for its high *Poaceae* species diversity associated soil moisture to increased species richness and diversity of watersheds.

Conversely, the study did not find significant correlation between soil properties, above ground diversity and seedbank diversities. This finding disagree with the study of Guo *et al.*[16] who found that the species composition and plant life forms of three typical vegetation types were significantly influenced by soil properties. Also, the finding of this study disagrees with the study of Catalán *et al*. [17] who found a relationship between *Poaceae* diversity and soil seed banks in natural grasslands. The lack of significant correlation between soil properties, above ground diversity and seedbank diversities could imply existence of confounding factors. For instance, Buisson*et al.* [18] study revealed that at short term severity of disturbance contributes more to changes in species diversity than edaphic factors.

Meanwhile, the study indicated that using the soil samples from abandoned farms and heavy grazed location, the test plant (*Amaranthus hybridus*) produced better response in the poultry manure treated soils than in the untreated soils (control). This finding suggests the potential of organic manure in restoring poor vegetative unproductive sites. Further results indicated 1.5kg/ha of poultry manure to be optimum rate for ensuring optimum performance of *Amaranthus hybridus* in both soil types. In addition, the performance of *Amaranthus hybridus* was higher in heavy grazed treated soils than abandoned farms treated soils. Therefore, conservation initiatives aimed at restoring abandoned farmland to natural grasslands may need to consider using the rate of 1.5kg/ha of poultry manure.

Regarding soil management, poultry manure rate of 1.5 kg/ha was found to optimize the performance of *Amaranthus hybridus* in both abandoned farms and heavily grazed locations. Therefore, this rate could be recommended to farmers seeking to improve soil and nutrient conditions in abandoned farm areas. By assessing soil properties across study locations, the study sheds light on the relationship between soil conditions and plant diversity. The findings suggest that certain soil characteristics, such as moisture content and nutrient levels, may influence the abundance and diversity of Poaceae species. The study also suggests practical implications for land management and conservation strategies. For example, the recommendation of using poultry manure to improve soil quality in abandoned farms highlights a potential method for restoring degraded landscapes and enhancing agricultural productivity.

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