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Influence of farming systems practices on physicochemical properties of soils in wet and dry season in University of Port Harcourt, Nigeria

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Abstract

We evaluated the impact of cultural practices on arable cropped farmlands of more than 5 years of slash, burn, continuous mixed cropping of crops on physicochemical properties of soils in University of Port Harcourt, Nigeria. 22 cultivated arable farmlands and 3 fallow control sampled in June 2020 as wet and January 2021 as dry season 0-15cm depth from 7 auger borings taken randomly from each of the 22 cultivated and 3 fallows farmlands. Samples air dried in laboratory, prepared for analyses, sent to Fatlab in Ibadan Nigeria. Parameters evaluated for physical properties: sand, clay and silt and for chemical properties; pH, Ca, Mg, K, Na and the trace metals; Mn, Fe, Cu, Zn; available P, OC, ECEC, Acidity and Al. The results revealed sandy loam, differences between the mean values for wet season were slightly higher from the dry season, for example pH, Ca, Mg, K, Na, ECEC, Cu, Silt and Clay. The mean value of P in wet season was 5 times higher than dry season. N in wet and dry season mean value were 0.16% respectively; OC was higher in dry season indicating soil healing process before next season cropping. Slight trace of Al in dry season. However, it was significant ($p<0.05$) between dry and control season, comparison between wet and dry season revealed P, OC, Mg, K, Na, N, Sand and Clay significant ($p<0.05$). It was observed slash, burn, continuous tillage, mixed cropping of crops and times of the year influence soil physicochemical properties in arable farmland in humid high rain forest.

Keywords: Cultural Practices; Mixed cropping; Physicochemical; Seasonal

1. Introduction

Slash and burn is a practice that most farmers in the rural and even urban places have adopted as a means of clearing arable farmland ready for cropping activities in the humid high rain forest unlike what is obtainable in the Savanna regions of Nigeria. The available arable farmlands are continuously cleared every year to plant various crops types for the farmer and family, for sale within and around his homestead, to feed his animals and preserve for the future use. This continuous cropping is as a result of the pressure on the available arable farmland, increasing number in human population and also the need to meet other infrastructural demand that require land.

The soil after the burnt plant parts provide ashes which are incorporated into the soil during tillage and after which seeds of crops are planted in different mixtures based on the farmer's choice.

These methods provide the initial sources of nutrients to the germinating seedlings of crops and weeds which are made available during the wet or "rainy" season. Some of these nutrients provided by the soil through the slash and burn also initiate seeds sprout/ germination according to [1].

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Despite the introduction and experimentation of other mediums of growing crops, which might have looked successful and promising for example hydroponic or soilless practices [2], the soil will continue to play its natural role for the support and the production of crops [3]. In the last 40 years or so, there has been more demand for arable farmlands' for agricultural activities across the globe especially in developing countries [4] and [5].

A "good soil" must have the ability to support the growth and development of crops with the necessary nutrients required. Soil is the reservoir of nutrients, and these nutrients come in various forms and quantities. There are the macro and micro nutrients and the presence of these is a function of the parent soil materials and the plants/organisms that found to live and grow there.

Most of the arable farmlands are continuously used for crop production year in year out because of the increase in demand for arable land. These arable farmlands are over used and depleted of nutrients which lead to poor yield. Continuous use of arable farmland leads to poor yield, soil degradation, soil erosion, leaching of nutrients which influence the physicochemical properties of the soil [6] and [7].

A number of constraints have made this impossible and to mitigate some of these factors that impact on the soil quality and therefore increase food production in developing countries come to terms with food security, for example, high population, increase in demand of arable farmland, poor soils, high rain fall, weather and climate factors like drought, flooding; uncontrolled fire outbreak into arable farmlands, soil pollution, low quality of farm input and inefficient farming systems [8]; [9] and [10].

Soil like any other gift of nature is expendable and could easily lose its quality and quantity of nutrients within a short period of time [11]. And continuous use of soil without any plan to ameliorate it for example use of compost, artificial fertilization, use of cover crops, will deplete the nutrient status of the soil further more [11] and in effect low crop yield.

The soil, apart from supporting the production of crop plays vital roles in agroecosystems for organic matter decomposition, recycling of essential nutrients, and detoxification of organic contaminants, carbon sequestration, regulation of water quality and supply and serve as house for numerous animals and microorganisms, clay, sand, silt and gravels [12].

To sustain the soil for continuous and provide its primary function of supporting crop production, most farmers in developing countries have adopted farming systems practices to ameliorate the expended soil nutrients for example, the practice of mixed farming of keeping animals and planting of crops[13], continuous cropping on the same piece of land [14] slash and burn or shifting cultivation, where arable farmlands are left to rest for a while[15]; mixed cropping of different crops types and crop rotation[16], intercropping of crops with either early and late maturing crops[17]. These measures when carefully planned and carried out with the utmost desire and interest helps to restore the soil and maintain its nutrients building and holding capacity for sustained crop production.

It is on this note that this study was carried out to access the current status of arable farmlands in University of Port Harcourt, Nigeria, located in the humid high rain forest, which has been cropped continuously with different crops types for over 5 years and with no fallow break in the nearest future due to human pressure on available arable farmlands. The following soil parameters were evaluated: P, OC, N, Ca, Mg, K, Na, Acidity, Al, ECEC, Mn, Fe, Cu, Zn, Sand, Silt and Clay in soil, during wet and dry season respectively.

2. Material and methodology

The study area is University of Port Harcourt, which lies on Latitude and Longitude coordinates of 4.824167 and 7.033611 and with a GPS readings of 4º 46´38.71" N and 7º.00´48.24" E. The study area experiences rain and dry seasons respectively. The rainy season starts from April to October with one or more intermittent rains during the dry season which begins from November to March. However, the magnitude of rainfall varies within the rainy season, and its distribution is nearly all the year round in high humid rain forest of Nigeria. The monthly mean maximum and minimum temperature ranges from 28ºC to 33ºC and 17ºC to 24ºC [18] respectively.

The most noted and adopted farming systems practices were the "cultural" slash and burn in continuous and mixed cropping systems. Different crops types both annual crops and perennial fruit crops like plantain, pineapple were planted (Table 1).

Most planted crops were corn (*Zea mays* L.), pumpkin (*Telfairia occidentalis* Hook. f.) and other vegetables bitter leaf (*Vernonia amygdalina* Delile), water leaf (*Talinum triangulare* (Jacq.)Willd., cucumber (*Cucumis sativus* L.), cassava

(*Manihot esculenta* Crantz), okra (*Abelmoschus esculentus* (L)Moench etc. The least number of crops planted were 3 and the highest were 12 per arable farmland. At soil samplings for the wet season June 2020, the crops were already well established, dry season January 2021 soils were collected when farming activities have gradually reduced and all crops harvested with the exception of pineapple, plantain (fruit crops), bitter leaf, cassava etc. and from fallow control (Table 1).

Soils were collected randomly within the 22 arable farmlands and 3 fallow controls i.e. 7 auger borings per farm dug to a depth of 0-15cm and mixed properly and composites soil samples taken dried for seven days and passed through 2.0mm for analyses.

The soils for pH were prepared 1:1 soil-water ratio method and were measured with EQUIP-TRONICS digital pH meter model EQ-610. The N was estimated by titration of distillation after Kjeldahl readiness tests and examination [19]. The total P in the soil was measured with the perchloric corrosive albimilation strategy technique [20]. Available P was analyzed by using molybdenum blue colorimetry [21]. Soil organic matter was measured with the potassium dichromate oxidation external heating method. For soil particle size was carried out using hydrometer method as described by [22] and measured with a standard hydrometer, ASTM No.1. 152H-type with Bouyoucos scale in g $^{L-1.}$ The basic procedure were followed to determine sand, silt and clay (dry basis and is generally reproducible to within ± 8% [22]. The exchangeable cations were extracted from the soil using an extracting solution (1 N NH4OAc) at pH 7.0. The extracted solution is then analyzed by AA (atomic absorption) for the soil cations [23]; [24]. The contents in 1/20 dilution (sample/distilled water) soil digests were measured by reading their absorbance on a UNICAM 969 Atomic Absorption Spectrophotometer at 766.5, 422.7 and 285.2 nm respectively. The sodium content in 1/20 diluted sample were determined by reading the absorbance at 248.3 nm [25]. The exchangeable acidity (H^{++} Al^{3+}) in the soil was extracted with 1M KCl [23]. Solution of the extract was titrated with 0.05M NaOH to a permanent pink end point using phenolphthalein as indicator. The amount of base (NaOH) used is equivalent to the total amount of exchangeable acidity (H^{+}+Al^{3+}) in the aliquot taken [26]. The total sum of exchangeable bases (Ca^{2+} + Mg^{2++} K^{+} +Na^{+}) and total exchangeable acidity (H^{+} + Al^{3+}) gave the effective cation exchangeable capacity (ECEC) [27]

Available Cu content was extracted and determined through this method Na-EDTA [28]; extract filtered in a Waltman No.1 filter paper and amount of Cu clear aliquot part analyzed by means of a Perkin Elmer 3100 atomic absorption spectrometer. Metal determinations in filtrate of digested soil samples were performed using Buck Model 205 flame Atomic absorption Spectrophotometer.

The statistical analyses of data obtained for soil samples parameters was two-way analysis of variance(ANOVA) to compare differences between wet and dry , wet, dry and controls using Paleontological statistics Package (Past) Version 3.16[29]; XLSTAT version 2014[30] and Statistical Package for Social Sciences (SPSS) version 22[31]. Means were compared using a threshold of ($p<0.05$) to determine statistical significance.

3. Results

The results are presented in Tables 1-4. In (Table 1) revealed crops planted; (Tables 2-4) physicochemical properties for wet and dry season, wet and dry and their controls compared. Further in (Table 1), names of crops and varieties: tuberous crops for example cassava and yams; fruits vegetables for example okra, cucumber; grain cereal corn; leafy vegetables are pumpkins and bitter leaf; spicy crops are scent leaf (basil) and pepper, perennial fruits are pineapple and plantain. Tables 2 to 4, also reveals mean values of soils physicochemical parameters analyzed from the study area.

The mean values concentrations of soil physicochemical parameters recorded in the study area for wet season compared with the control across all the parameters indicated only Na (Sodium) (0.23±0.02), (0.26±0.05) been significant at ($p<0.05$). A similar comparison between dry season and control across tested parameters, the following parameters were significant at ($p<0.05$), soil pH (5.85±0.67), (4.98±0.25); N (Nitrogen) (0.16±0.03 %), (0.12±0.01 %); Mg (Magnesium) (0.68±0.20 cmol kg^{-1}), (0.42±0.11 cmol kg^{-1}).

Wet and dry season compared revealed the following parameters were significant at ($p<0.05$); P (Phosphorus) (69.08 ± 40.45 $mgkg^{-1}$),(14.30±5.11 $mgkg^{-1}$); OC(Organic carbon) (0.83±0.25 %),(1.96±0.52 %);Mg(Magnesium)(0.85±0.21 cmol kg^{-1}),(0.68±0.20 cmol kg^{-1});K(Potassium) (0.11±0.04 cmol kg^{-1}),(0.08±0.04 cmol kg^{-1}); Na(Sodium) (0.23±0.02 cmol kg^{-1}),(0.20±0.01 cmol kg^{-1});Mn(Manganese) (54.11 ±20.15 cmol kg^{-1}),(40.79±16.79 cmol kg^{-1}); Sand (73.47±3.04 %),(86.91±3.33 %), Clay (14.13±2.66 %) ,(2.64 ±0. 86 %).

The mean values of pH (1:1) for wet and dry (5.88± 0.59), (5.85±0.67). The exchangeable bases mean values for Ca^{2+}, Mg^{2+}, K^{+} and Na^{+} for wet and dry season respectively are Ca^{2+} (7.94±5.55), (5.96±5.79); Mg^{2+} (0.85±0.21), (0.68±0.20);

K^+ (0.11±0.04), (0.08±0.04); Na^+ (0.23±0.02),(0.20±0.01). The mean values for both wet and dry season for Nitrogen, N(0.16±0.04), 0.16±0.03); Acidity (0.27 ±0.24), (0.62±0.88); Aluminum, Al(0.00±0.01), (0.11±0.35); ECEC (9.39±5.61),(7.55±5.63); mean values for the trace metals Mn, Fe, Cu, Zn are Mn (54.11±20.15),(40.79±16.79); Fe (55.15±42.93), (56.07±40.70); Cu (3.63±3.14), (2.44±3.39); Zn (16.30±31.92),(19.75±26.93) respectively.

Sand, Silt and Clay mean values are sand (73.47±3.04%), (86.91±3.33%); silt (12.13±2.10%), (10.56 ±3.20%); clay (14.13±2.66%), (2.64±0.86%). Both wet and dry season revealed high amount of sand in the soil indicating sandy loam.

Table 1 List of crops planted in sampled arable farmlands and plants species in fallow control

Sample ID	Crops types
Farm-1	okra, cassava, cocoyam, pepper, pepper, yam, corn, cucumber
Farm-2	okra, cocoyam, pepper, pepper, yam, cucumber, yam, water leaf, scent leaf
Farm-3	okra, pepper, corn, pumpkin, water leaf, pumpkin
Farm-4	okra, cassava, cocoyam, cucumber, pumpkin, yam, water leaf, yam, water leaf, sweet potato, plantain, beans
Farm-5	okra, cassava, cocoyam, corn, pumpkin, yam, sweet potato, plantain, groundnut
Fram-6	okra, cassava, cocoyam, pepper, corn, pumpkin, scent leaf, plantain, bitter leaf
Farm-7	okra, cassava, cocoyam, yam, corn, pumpkin, plantain
Farm-8	okra, cassava, cocoyam, yam, pumpkin, yam, scent leaf, bitter leaf
Farm-9	okra, cassava, cocoyam, yam, yam, corn, pumpkin, scent leaf, sweet potato, melon, bitter leaf
Fram-10	okra, cassava, corn, yam, pumpkin, yam, scent leaf
Farm-11	cassava, corn, pumpkin
Farm-12	okra, cassava, cocoyam, corn, yam, cucumber, plantain
Fram-13	cassava, corn, pumpkin, yam, water leaf, plantain
Farm-14	okra, cassava, cocoyam, corn, pumpkin, yam, plantain
Farrm-15	okra, cassava, corn, yam, pumpkin, yam, plantain, beans, melon, pineapple
Farm-16	okra, cassava, cocoyam, pepper, corn, yam, pumpkin, yam, water leaf, pineapple, tomato, soup thickener, garden egg
Farm-17	cassava, cocoyam, corn, yam, cucumber, pumpkin, yam, plantain
Farm-18	okra, cassava, cocoyam, corn, plantain, melon
Fram-19	okra, cassava, cocoyam, pepper, corn, yam, pumpkin, yam, water leaf, plantain, melon, green amaranth
Fram-20	okra, cassava, cocoyam, corn, yam, pumpkin, yam, plantain, bitter leaf
Fram-21	okra, cassava, cocoyam, corn, pumpkin, water leaf, groundnut
Fram-22	okra, cassava, corn, yam, cucumber, pumpkin, yam, pumpkin, soup thickener
Fram-23-25	Bush fallow covered with annual/perennial broad leaves, grasses, sedges and shrubby trees like *Alchornea cordifolia* (Schumach. & Thonn.)Müll.Arg, *Allophylus africanus* P.Beauv. *Millettia* sp

Twenty-seven (27) crops types recorded across all the study arable farmlands. See table 1

Legend: Okra: *Abelmoschus esculentus* (L.) Moench; Cassava: *Manihot esculenta* Crantz; Cocoyam: *Colocasia esculenta* (L.)Schott; Pepper: *Capsicum annuum* L.; Corn: *Zea mays* L.; Pumpkin: *Cucurbita moschata* Duchesne; Curry leaf: *Ocimum americanum* L.; Plantain: *Musa paradisiac* L.; Bitter leaf: *Vernonia amygdalina* Del.; Yam: *Dioscorea alata* L.; Yam: *Dioscorea dumetorum* (Kunth).Pax; Yam: *Dioscorea rotundata* Poir; Sweet potato: *Ipomoea batatas* (L.) Lam.; Melon: *Citrullus colocynthis* (L.) Schrad; Cucumber: *Cucumis sativus* L.; Water leaf: *Talinum triangulare (*Jacq.)Willd.; Beans: *Vigna unguiculata* L.; Pineapple: *Ananas comosus* (L.) Merrill; Tomato: *Solanum lycopersicon* L.; Soup thickener: *Mucuna* *sloanii* Rendle & Fawc.; Garden egg: *Solanum sp*.; Green amaranth: *Amaranthus hybridus* L.; Pumpkin: *Telfairia occidentalis* Hook. f.; Groundnut: *Arachis hypogaea* L.; Cocoyam: *Xanthosoma mafaffa* Schott; Scent leaf (basil): *Ocimum gratissimum* L.; Pepper: *Capsicum frutescens*

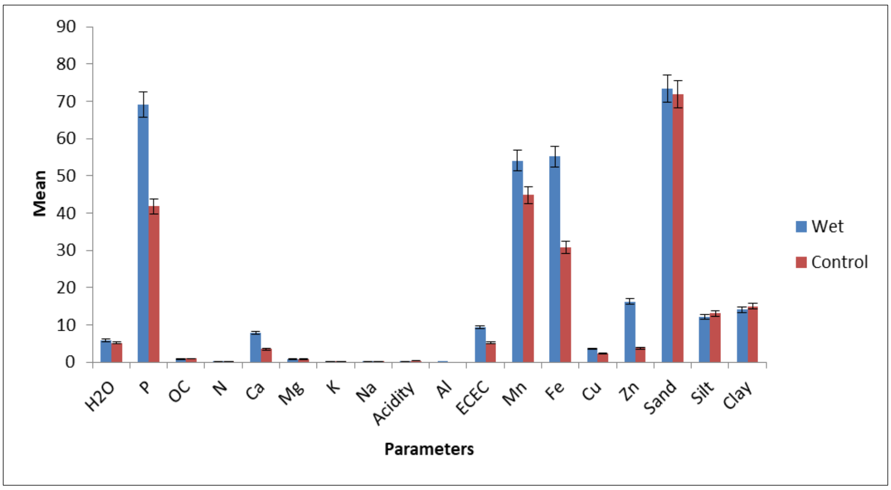

Figure 1 Comparison between wet season and control for various parameters

Table 2 Summary of T-test Statistics for differences between wet period and wet control

Parameters	Means		Standard Deviation		T-Statistics	p-Value	Decision
	Wet	Wet control	Wet	Wet control			
H2O(1:1)	5.88	5.19	0.59	0.12	1.95	0.06	
P	69.08	41.83	40.45	14.35	1.14	0.27	
OC	0.83	1.00	0.25	0.17	1.14	0.27	
N	0.16	0.14	0.04	0.01	0.87	0.39	
Ca	7.94	3.52	5.55	0.77	1.35	0.19	
Mg	0.85	0.84	0.21	0.2	0.05	0.96	
K	0.11	0.10	0.04	0.07	0.4	0.69	
Na	0.23	0.26	0.02	0.05	2.1	0.05	
Acidity	0.27	0.4	0.24	0.08	0.89	0.38	Significant
Al	0.00	0.00	0.01	0.00	0.36	0.72	
ECEC	9.39	5.13	5.61	1.03	1.29	0.21	
Mn	54.11	44.84	20.15	9.22	0.78	0.45	
Fe	55.15	30.82	42.93	13.68	0.96	0.35	
Cu	3.63	2.36	3.14	0.36	0.69	0.5	
Zn	16.3	3.78	31.92	0.59	0.67	0.51	
Sand	73.47	71.87	3.04	2.31	0.87	0.39	
Silt	12.13	13.07	2.1	2.08	0.73	0.47	
Clay	14.13	15.07	2.66	0.58	0.6	0.56	

Table 3 Summary of T-test Statistics for differences between dry season and dry control

Parameters	Means		Standard Deviation		T-Statistics	p-value	Decision
	Dry	Dry control	Dry	Dry control			
H2O(1:1)	5.85	4.98	0.67	0.25	2.20	0.04	Significant
P	14.3	9.22	5.11	1.96	1.68	0.11	
OC	1.96	1.70	0.52	0.17	0.85	0.40	
N	0.16	0.12	0.03	0.01	2.08	0.05	Significant
Ca	5.96	2.76	5.79	2.78	0.93	0.36	
Mg	0.68	0.42	0.20	0.11	2.18	0.04	Significant
K	0.08	0.05	0.04	0.00	1.60	0.12	
Na	0.20	0.19	0.01	0.03	1.68	0.11	
Acidity	0.62	1.41	0.88	0.92	1.46	0.16	
Al	0.11	0.45	0.35	0.79	1.40	0.18	
ECEC	7.55	4.83	5.63	3.62	0.80	0.43	
Mn	40.79	38.39	16.79	15.34	0.23	0.82	
Fe	56.07	41.70	40.70	20.41	0.60	0.56	
Cu	2.44	1.23	3.39	0.50	0.61	0.55	
Zn	19.75	2.75	26.93	1.69	1.07	0.29	
Sand	86.91	87.93	3.33	1.15	0.52	0.61	
Silt	10.56	10.07	3.20	1.15	0.26	0.80	
Clay	2.64	2.00	0.86	0.00	1.26	0.22	

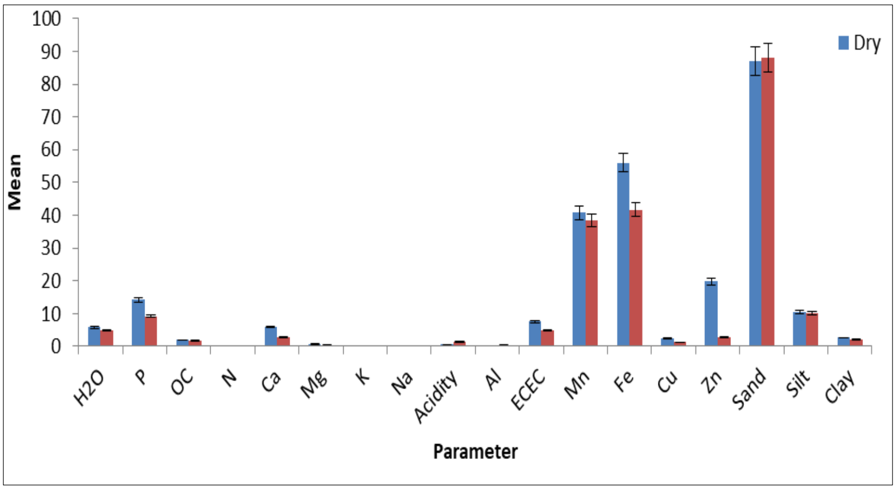

Figure 2 Comparison between dry season and control for various parameters

Table 4 Summary of T-test Statistics for differences between wet and dry season

Parameters	Means		Standard Deviation		T-Statistics	p-value	Decision
	Wet	Dry	Wet	Dry			
H2O(1:1)	5.88	5.85	0.59	0.67	0.16	0.88	
P	69.08	14.30	40.45	5.11	6.3	0.00	Significant
OC	0.83	1.96	0.25	0.52	9.15	0.00	Significant
N	0.16	0.16	0.04	0.03	0.12	0.90	
Ca	7.94	5.96	5.55	5.79	1.16	0.26	
Mg	0.85	0.68	0.21	0.20	2.69	0.01	Significant
K	0.11	0.08	0.04	0.04	2.4	0.02	Significant
Na	0.23	0.20	0.02	0.01	6.53	0.00	Significant
Acidity	0.27	0.62	0.24	0.88	1.77	0.08	
Al	0.00	0.11	0.01	0.35	1.4	0.17	
ECEC	9.39	7.55	5.61	5.63	1.09	0.28	
Mn	54.11	40.79	20.15	16.79	2.38	0.02	Significant
Fe	55.15	56.07	42.93	40.70	0.07	0.94	
Cu	3.63	2.44	3.14	3.39	1.21	0.23	
Zn	16.3	19.75	31.92	26.93	0.39	0.70	
Sand	73.47	86.91	3.04	3.33	13.97	0.00	Significant
Silt	12.13	10.56	2.10	3.20	1.92	0.06	
Clay	14.13	2.64	2.66	0.86	19.3	0.00	Significant

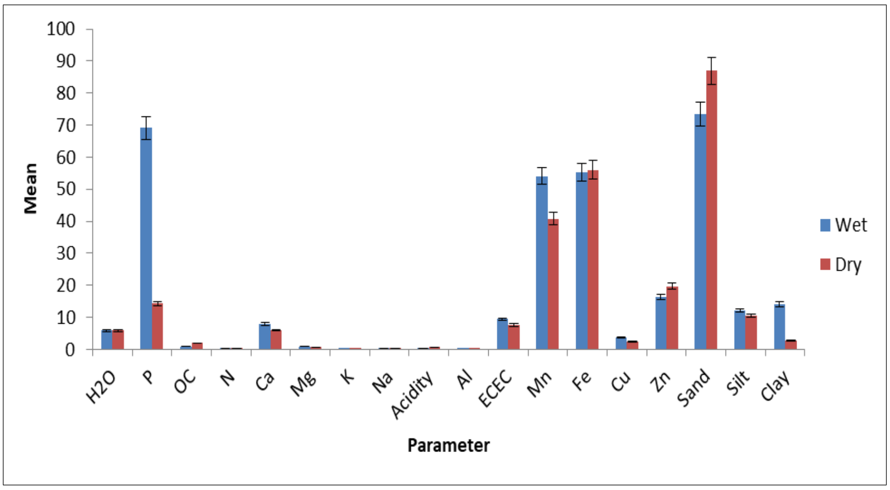

Figure 3 Comparison between wet and dry season for various parameters

4. Discussion

Undoubtedly, soil is the only medium that can accommodate farming systems practices in crop production for example slash and burn or shifting cultivation, crop rotation, mixed cropping, continuous cropping, no-tillage etc., and in the quest to produce more food for the teaming population, these practices has in most cases impacted on the soil either directly or indirectly on the soil parameters [32]; [33]. Soil is a combination of many materials which includes microorganisms, dead plants and animals, organic matters, clay, sand, silt, macro and micro elements which constitute the soil. It is meant to anchor and supply all the necessary nutrients mostly needed for plant growth and development.

Anthropogenic activities have always put pressure on the ability of the soil to carry out some of its functions which nature has placed on it. Many authors have reported the influence of slash and burn, continuous cropping, mixed cropping and many others practices on the soil physicochemical properties either adding or removing from the soil through some of these practices which affects the soils microorganisms, vaporization of some nutrients, burn off the accumulated delicate debris/plant materials that cover the top soil which helps in the formation of humus and which microorganisms feed on and cause decomposition , soil erosion, leaching of minerals, soil degradation[34];[35].

Continuous use of an arable farmland exposes the soil to degradation, soil erosion, soil compaction, while mixed cropping of various crops types is in line with the view to maximize the soil for its continuous use and at the same time harvest varieties of crops produced with its challenges both on the soil, crop and equally on the farmer. In mixed cropping, combination of cover crops, will improves the physical, biological and chemical properties of the soil, control soil erosion, degradation and suppression of weed competing with crops[36];[37].

The crops types listed in Table 1 complement one another in terms of nutrients demand and use up of space. Deep rooted crop can go right deep to satisfy its nutrients requirement, while the shallow rooted crops obtain theirs close to the soil surface and therefore create a balance in the nutrient distribution of the soil.

There is also the root binding effect which helps to hold the soil together and prevent soil erosion, fine soil particles wash-off for example silt and clay are prevented. The effect of all these crops sourcing for nutrients to grow and develop could influence the variations on the soil parameters tested.

[38] observed that variation exits in soil properties due to differences in crop soil requirement type. Our observation is in line with [38] because due to so many crop species planted with the least been 3 and the highest 12 on the same piece of arable farmland; such could cause variation on the soil parameters. Some of the cropping management systems employed on these arable farmlands in the course of the growing season could have had a great deal on the physicochemical properties shown in Tables 2-4, which fluctuates between the wet and dry season. This corroborate the finding of[39] , observed that for example, external factors like land use, soil and crop management practices interaction with the environment could influence the soil quality and cause variations.

The dead leaves which drops to the ground add up to the leaf litter, which break down to form organic matter, and are released back to the soil as nutrients. The diverse crops stands are expected to improve resilience and increase overall yield compared to the corresponding monoculture [40]; [41].

The physical properties of the soil reveal that the soil composed of high percentage of sand in wet and dry season and therefore sandy loam. Wet season has a lower percentage of sand than the dry season as presented in the Tables 2-4; the reverse is the case with silt and clay, dropped in mean value (12.13±2.10) to (10.56±3.20), clay mean value dropped (14.13±2.66) to (2.64±0.86).

Sand increase in dry season could be attributed to some natural courses like soil erosion in wet season which could have carried so much sand from slopes top to the bottom of the slopes, tillage activities could have also increased the move of soil from one place to the other when weeding off weeds in the cropping season, and the wash away of some organic matter from soil therefore reducing the amount of silt and organic matter as indicated from the result (Tables 2-4).

The pH mean values between wet and dry season, wet, dry and controls are presented in Tables 2-4. Result revealed a slight reduction in the pH of wet compared with dry season. Soil pH however has a great relationship between the nutrients uptake by crops. The decrease in mean value of the soil pH could be attributed to the crops use up of the nutrients through break down of organic matter, soil leaching, water erosion and nutrient demand varies from one crop types to another and temperature of the time. This observation corroborate the findings of [42] reported relationship between climate and topography influenced soil pH; and also temperature and precipitation [43]; [44]. Some anthropogenic activities during the cropping season impact on the nutrient recycling ability and overall well-being of the soil for example, weeds during weeding are not returned back to the soil, rather heaped on the boundary or edges of the arable farmlands and which decays there.

Crop residues after harvests are hardly returned back to the soil and left with no leafy materials for soil fauna to act and break down to ameliorate the soil pH. Soil pH values for the two season of wet and dry and their control also reveal reduction in the percentages mean value for wet (5.88±0.59), control (5.19±0.12); dry season and control (5.85±0.67), (4.98±0.25) which is in agreement with earlier works by [45] and [46] reported a pH of (5.94 and 4.58 ± 0.10) from the same area of study.

Available phosphorus (P) mean value compared wet season (69.08±40.45) and dry season (14.30±5.11) was significant. The result revealed high amount of phosphorus in the soil during wet season and declined in dry season. It is attributed to the initial ash from the yearly slash and burn at the beginning of the cropping season with rapid supply of phosphorus which stimulates seed germination, growth and demand for phosphorus by plant species. The mean value for P when compared with earlier works from the same area by [45] and [46] contradict each other as result of the higher values due to length of time and from slash and burn.

Other authors confirmed contribution of slash and burn to influence increment on available P compared with the unburned soil [47].The importance of phosphorus in the soil and among the three most important nutrients required by crops would have necessitated the reduction of the available phosphorus in wet (69.08±40.45) to (14.3±5.11) in the dry season.

The decline could also be attributed to anthropogenic activities for example weeding further exposes the soil to rainfall, leaching of nutrients which alter and cause a decline in soil pH. This finding corroborate the finding of [48] ; [49], which revealed that available phosphorus decreased sharply during the peak of rains and further stated it could be attributed to growing plant competing for nutrients accumulation of biomass during growing season.

The organic carbon content of the soil (0.83±0.25) and (1.96±0.52) when compared with wet and dry season was significant at ($p<0.05$) and not significant when wet and dry season were compared with their control respectively.

The amount of organic carbon in the soil during the dry season increased twice from what it was in the wet season. This increase is attributed to majority of the farmers weed their farms as one of the last farm operations when the rainy frequency and duration begin to decline signifying end of rains leading into dry season. This last weeding operation carried out to keep the arable farmland clean and free from weeds, in which case the weeds are scattered well over the soil surfaces to decay with less rain, to conserve moisture as well and further keep away weed seeds from germinating and compete for the available moisture in the soil.

The decay which begins before dry season set in, could have increased organic carbon value as noted by [48] and same observation was also noted by [50] practices which promote accumulation and supply of organic matters for example cover crops and refraining from burning and those activities that reduces decomposition processes.

Aluminum revealed in wet and its control (0.00±0.01), (0.00±0.00); dry and its control (0.11±0.35), 0.45±0.79); wet and dry compared (0.00±0.01), (0.11±0.35). Wet and dry season and controls, wet and dry compared were not significant at ($p<0.05$). This slight trace of aluminum in the soil should be cautiously interpreted. In wet season, the trace of aluminum was noted in one farm and the same farm also revealed its presence in dry season and in addition to two other farms indicated such. This could be attributed to parent soil material, concentration of Al in the soil and chemical environment of the solution with pH value beyond 5.5 and above pH 8.5 will encourage the solubility and availability of Al in the soil [51].

The mean value of Nitrogen in wet and control (0.16±0.04%), (0.14±0.01%); (0.16±0.04%) (0.14±0.01%) season, was not significant while for dry season and control (0.16±0.03%), (0.12±0.01%) was significant ($p<0.05$). The mean of wet and dry season compared did not show any significance (0.16±0.04%), (0.16±0.03%), (see Tables 2-4).

Nitrogen is easily lost during the peak of rains and also used up during critical time when crops need nitrogen for growth and proper development afterward not needed for maturity and at crop harvest. The demand for nitrogen reduces, frequency of weeding also influence its redistribution across soil surface, with reduction of rain and eventually the stop of rain would further helped to conserve nitrogen in the soil and reduction of some of the farming activities that encourages loss of nitrogen in rainy season [52] and [53]. This explains why the means values of wet and dry season were the same as a result of reduction in soil moisture level, microbial activities reduction and plant growth demanding much nutrients also reduced while weeds and some plant debris could have also contributed to the nitrogen stock piling, an indication of healing processes before the next cropping season for the yearly cropped farmlands. This is in line with the assertion of [54] that climate, vegetation and the topography of the burnt area control the resilience of the soil system and also if plants succeed from the shock of burn and recolonized can equally recover all the affected properties and even enhanced it further.

The mean values distribution of exchangeable bases for wet and dry seasons and its controls (Tables 2-4) reveals Ca, Mg and K, were higher than control in wet season; Ca, Mg, K and Na were also higher than control in dry season. Only Na was significant at ($p<0.05$) for wet season and control, while Mg was significant at ($p<0.05$) for dry season and control. The mean values from the comparison between wet and dry season shows that Ca, Mg, K, and Na at wet were higher than those of dry season. Mg, K and Na were significant at ($p<0.05$). The mean values reduction in the wet and dry season could be attributed to rain, leaching of minerals by moving water when the soil becomes saturated and cannot retain it or used up by crops, some of the these nutrients are highly needed by fruit or tuber formation for example yam, cassava, leaf production in the vegetable. These findings are slightly lower compared with the work of [45]. These minerals are not needed during the dry season as they would be immobile and less active due to reduced soil moisture to effect it's unlocking and made available in the mobile form for crops.

The trace extractable ions in the study are presented Tables 2-4. Mn, Fe, Cu, and Zn for wet season and control are higher and the same trend was observed for dry season and control. Wet and dry season compared, Mn and Cu are higher than dry season, while the reverse was the case with dry season mean values higher in Fe and Zn.

Many authors have reported increase of micronutrients after burn [47]; [55] and [56]. The differences are probably due to variations in precipitation regime, vegetation type and soil type. The increase of extractable Fe might be associated with Fe losses from the eroding sediments. Extractable Fe and Zn have the overall tendency to decrease with time. Extractable Cu has a higher level of variability; this variation may be possibly influenced by the soil pH [57]. Trace elements are micro-nutrients needed in micro quantity, very essential for the proper growth and development of crop. The sources of trace metals are through nature or naturally occurring, and anthropogenic activities which includes agricultural, industrial, domestic and atmospheric [58] and geological bedrock and rock substration [59].

The effective cation exchange capacity (ECEC) is defined as the total amount of exchangeable cations, which are mostly sodium, potassium, calcium and magnesium (hereafter collectively termed as bases) in non-acidic soils. ECEC has relationship with soil pH, clay and soil organic matter content. The mean values of ECEC for the season of wet, dry and controls, and also compared with wet and dry season in Tables 2-4. In wet season mean values (9.39 ± 5.61), (5.13 ± 1.03), dry (7.55 ± 5.63), (4.83 ± 3.62); wet and dry season (9.39 ± 5.61), (7.55 ± 5.63). There was reduction in the control mean value to that of wet season and same applied to control mean value to that of dry season. However, comparing the mean values between wet and dry season shows a reduction in dry season and when evaluated with the rating of [60], the mean values are considered low.

The reduction in values of ECEC might be attributed to the degree of weathering, leaching processes, low fertility status and low resistant to changes in soil chemistry which are also caused by land management practices [61]. In another study by [62] asserted that low values could be attributed to the nature of most of the soil. This was in line with the mean values of sand which was eight times higher than silt and clay. A closer observation on the values of these parameters of pH, OC, N, silt, clay also influenced the low values of ECEC due to some of the anthropogenic activities of tillage, continuous use of the arable farmlands and other natural act like soil erosion, parent rock. This observation corroborate the assertion, by [63] stated that "generally" tropical soils have low CEC, especially for high sandy and low pH soils.

5. Conclusion

The soil is the reservoir of many minerals, provided by nature in different proportions and state in the soil. These nutrients are made available to crops in different forms suitable for crop use. In effort to maximize these different minerals for crop production, different farming systems practices are applied for example slash and burn, continuous cropping, tillage, mixed cropping etc. which have influenced the avai1abi1ity of these macro and micro nutrients to crops as at when needed most1y during the rainy season. Some soi1 parameters like pH, organic matter, N, percentage of sand, c1ay and silt p1ay some important ro1es in the avai1bi1ity of these macro and micro e1ements in soi1. The avai1bi1ity of nutrients are more in rainy and 1ess in dry season. Therefore, more can still be done to explore ways of tapping into the resources of the dry season by the introduction of irrigation faci1ities during dry season for more crop production in areas where such facilities does not exist for improved crop production all the year round.

Compliance with ethical standards

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Disclosure of conflict of interest

No potential conflict of interest by the authors.

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