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EFFECTS OF FLOODING ON SOIL QUALITY IN ABAKALIKI AGRO-ECOLOGICAL ZONE OF SOUTH-EASTERN STATE, NIGERIA

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ABSTRACT: *The study focused on the Effects of Flooding on Soil Quality in Abakaliki Agro-ecological Zone of South-Eastern State, Nigeria, for proper soil and flood management to avert soil degradation. Soil samples were collected from three different floodplains and from arable land at the middle of the stream as control at the depth of 0-30cm, and were used for the determination of the selected soil quality. The treatments were replicated five times and data collected were analyzed using analysis of variance for complete randomized (CRD). All the soil properties assessed were significantly different ($p<0.05$) among the study locations. The results further showed that apart from sand, BD, gravimetric moisture that were higher in control, silt, clay and porosity were recorded highest mean values than control. Mean pH in floodplains recorded mean value of 5.9 being acidic than control with the mean of pH5.38. Also apart from Avail.P(38.50ppm),OC(1.89cmol/kg), Nitrogen (0.15cmol/kg), ECEC(18.16%) and BS(89.65%) being higher in control than floodplains, the mean of OM (2.5cmol/kg), Ca (10.5cmol/kg), Mg(4.7cmol/kg),K(0.14cmol/kg), Na(1.06cmol/kg) and EA(2.07) were higher in floodplains than control, which could support farming during flood cessation for increased food productions. Based on the results, it is recommended that flood best management practice should be encouraged in order to retain soil nutrients, reduce soil and water pollutions for ecosystem sustainability.*

KEYWORDS: Flood, Soil *Quality, Agro, Ecological Zone, Ecosystem sustainability*

INTRODUCTION

Flooding is the most common of all environmental hazards and it regularly claims over 20,000 lives per year and adversely affects around 75 million people world-wide[1] (Smith, 1996). Across the globe, floods have posed tremendous danger to people's lives and properties. Floods cause about one third of all deaths, one third of all injuries and one third of all damage from natural disasters [2] . In Nigeria, the pattern is similar with the rest of world. Flooding in various parts of Nigeria have forced millions of people from their homes, destroyed businesses, polluted water resources and increased the risk of diseases [3,4,5]. Soil nutrient dynamics in seasonal floodplain ecosystems are highly complex [6,] as a result of flood pulses and changing redoximorphic state [6]. Flood pulse refers to the alternating dry and wet conditions in floodplain ecosystems. It facilitates soil nutrient exchange between rivers and their associated seasonal floodplains [7] .During floods, soil nutrients dissolve in floodwaters and are transported from seasonal floodplain surfaces into adjacent rivers, and soil nutrients may also be transported from the river into seasonal floodplains through lateral flow[8].

Flooding can lead to both increases and decreases in soil nutrient content. In tropical regions, floods of high magnitude have resulted in serious consequences caused by heavy rainstorms, hurricanes, snow melt and dam failures [9]. Flooding results in shortage of food crops due to lossof entire harvest and the destruction of soil quality. When a soil is flooded (anaerobic conditions), microorganisms use the available soil O_2 to survive. Free O_2in the soil is usually depleted within a couple of days after flooding. The longer the soil is flooded, the lower the soil O_2 levels become more reduced [10]. Oxygen deficiency is likely the most important environmental factor that triggers growth inhibition and injury in flooded plants[11].Despite the significant consequences of flooding on the environment, flood plays an important role in maintaining key eco-system function and biodiversity in many natural systems. Flood deposits organic materials, minerals, and essential nutrients from rivers and oceans into land which makes the soil richer, fertile and productive. However, these environmental benefits come at a high price when excessive flooding occurs, since natural systems can no longer be resilient to the effects of large and excessive floods [11].

Increasing demand for land as a result of population increase and food scarcity has made farmers to farm in marginal lands such as lands susceptible to erosion and flooding[12,13]. Flood contributes positively to soil properties through the provision of nutrients that maybe lacking in the soil[14,15]. Wetting of the floodplains and meadows by floods releases immediate nutrients that were left over from the last flood and those that result from the rapid decomposition of organic matter that has accumulated during the flood. [16,17] showed that soil properties such as total porosity, moisture content, pH, and organic carbon where higher in a soil after flooding than before flooding.. Therefore, this study focuses on the evaluation of the effect of flooding on soil properties dynamics in tropical agro-eco-zone in Abakaliki based on selected floodplains prone to flooding.

MATERIALS AND METHODS

The study was carried out at the flood meadows along Ebonyi River in Abakaliki South-Eastern Nigeria. These flood meadows are among the major sources of dry season vegetable crops for Ebonyi people especially those residing at Abakaliki urban. Abakaliki lies at latitude 6 ^{o} 15'N and longitude 8^0 5'E in the derived savannah of South-Eastern Nigeria. The two distinct seasons within the zone are rainy season which lasts from April to October and dry season which lasts from November to March. The minimum and maximum temperatures of the area are 270C and 310C, respectively [18]. The relative humidity of the area is between 60 to 80 percent. The annual rainfall of the area ranged between 1500 – 2000mm and the soil of the area belongs to the order ultisol classified as typic Haplustult [19].

Sampling

Soil samples were representatively collected with a soil auger at surface and subsurface depth (0 - 30 cm) from the three flood plains that were randomly selected and from upland 200m away from the flooded farmlands, The flooded plains used for the study include: Iyiudele Floodplain, Iyiokwu Floodplain and Ebonyi River Basin. Collection of the soil samples were carried out after the nationwide flooding that rocked the entire country. Soil samples were representatively collected from three different floodplains at every 100 meters distance apart within the flood affected and control as flood unaffected sampling areas respectively. Soil samples collected from the individual locations were bulked, thoroughly mixed and stored in clean polythene bags prior to laboratory analysis.

Soil Characterization/Physicochemical

Laboratory analysis Bulk density (Bd) and saturated hydraulic conductivity (Ksat) were determined using method according to [20]. The auger soil samples were air-dried in the laboratory ground and passed through a 2 mm sieve. Sieved samples < 2 mm soil fraction was bagged for routine analysis. The fraction of sand, silt and clay was determined using hydrometer method [21] with NaOH as dispersant. Soil pH was determined by [22] method. Total nitrogen was determined using micro- Kjeldahl[23] method. Soil organic carbon was measured by combustion at 840°C (wet-oxidation method) [24]. Exchangeable bases, Ca^{2+} and Mg^{2+} were obtained by ammonium acetate (NH_4 OAC) method, and Na^+ and K^+ by flame photometer. Cation exchange capacity (CEC) was obtained using [25] method. Exchangeable acidity was determined titrimetrically using 0.05 N NaOH. Available phosphorus was obtained using Bray 11 bicarbonate extraction method as described by [26].

Statistical Analysis: Analysis of variance was used to test differences in physical and chemical properties across the three selected floodplains and the inland area as control, significant variations in the means were determined using least significance difference ($LSD_{0.05}$) test [27]. Correlation analysis was carried out to detect functional relationship among key soil variables. All the analyses were done using a statistically software package (SAS Institute Inc, 2001).

RESULTS AND DISCUSSION

Table 1:Mean and F-FSD of the Effect of Flooding on Particle Size distribution of Flooded Soil

Soil Samples	% Sand	% Silt	% Clay	Textural Class
Iyiudele Floodplain	36.40	36.80	26.80	Clay Loam
Iyiokwu Floodplain	42.40	36.80	20.80	Loam
Ebonyi River Basin	32.40	34.80	32.80	Clay Loam
Total	***111.2***	***108.4***	***80.4***	-
Mean	***37.1***	***36.1***	***27***	-
Control /Upland	44.40	34.80	20.80	Loam
F-LSD 0.05	0.45	0.22	0.18	

Particle Size Distribution (PSD): Table 1 shows the distribution of particle size distribution of flooded soils. From the results, sand compositions in the study locations ranged between 32.30 - 44.40% with Ebonyi River Basin having the lowest values and Iyiokwu Floodplain having the highest value with the mean value of 37.1% lower than the control/upland with 44.40 % with F-LSD 0.45.It shows that there is high percolation rates and low capillary action at control. From silt, the result ranged between 34.80 – 36.80% with Ebonyi River Basin having the lowest value and Iyiudele, Iyiokwu Floodplains having the highest values respectively with the mean value of 36.1% above 34.80% of control with F-LSD 0.22The results also indicated that Iyiudele floodplain and Iyiokwu floodplain had the highest values of 36.80% respectively. Clay composition ranged between 20.80-32% with Iyiokwu having the lowest value and Ebonyi Floodplain recording the highest value than all with the mean value of 27% above the control with 20.80% all having F-LSD 0.18. The results show that the study areas are more fertile than control which is good for agricultural. The textural class of Iyiudele floodplain was clay loam and Ebonyi River. The result also showed that the textural class for Iyiokwu floodplain and control was loam**.** It shows that Iyiudele floodplain and Ebonyi River basin is good for cultivating rice, carrot, cucumber, etc., while control and Iyiokwu floodplain is good for cultivating maize, groundnut, yam melon, etc. The result is in line with the observation by [28], who stated that texture was a permanent component of the soil and do not change as much with time.

Table 2: Mean and F-LSD of the Effects of Flooding on Soil Physical Properties in the study locations

Soil Samples	**Bulk Density (gcm^{-3})**	**Percentage Moisture content (%)**	**Gravimetric Moisture**	**Porosity**
Iyuidele Floodpain	1.20	22.48	0.29	54.50
Iyiokwo floodplain	1.30	19.34	0.24	51.10
Ebonyi River Basin	1.24	24.78	0.33	53.30
Total	***3.73***	***66.6***	***0.86***	***158.9***
Mean	***1.24***	***22.2***	***0.3***	***53***
Control/Upland	1.61	9.88	0.11	39.20
FLSD (0.05)	**0.13**	**2.98**	**0.01**	**3.92**

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Physical Characteristics of Soil:

Bulk Density (BD): The result of bulk density indicated significant differences among the samples at ($P<0.05$). The result shows that bulk density ranged between 1.20-1.30 **gcm^{-3}**with the mean value of 1.24 **gcm^{-3}** below 1.61 **gcm^{-3}**of the control having LSD O.13The result also showed that control had the highest value of 1.61 gcm^{-3} while Iyiudele floodplain had the lowest value of 1.20gcm^{-3}. Nelson and Terry (1996) observed that soil properties such as bulk density have a large influence on denitrification activities of flooded soils.

Under saturated soil conditions, losses of soil nitrogen can be substantial, nitrate nitrogen can be lost by leaching down and out of the reach of crops. While leaching occurs rapidly on coarse textured sandy soils, it is a slower process on loam and clay soils due to slower water movement. The gaseous loss of nitrogen by denitrification occurs when soil microorganisms reduce nitrate under saturated conditions, leading to loss of nitrogen gas. In addition, soil microorganisms are not very effective at decomposing crop residues and organic matter when the soil is saturated, slowing the release of nitrogen from this source [29]..

Moisture content (MC) : The result of percentages moisture content showed that there were significant differences among the treatment at ($P<0.05$).The result ranged between 19.34-24.78% with the mean value of 22.2% above 9.88% of the control location with LSD being 2.98. The result also showed that Ebonyi River Basin recorded the highest value of 24.78% followed by Iyiudele while control recorded the latest value of 9.88%. This showed that percentage moisture content contributed to the denitrification activities of Iyiudele flooded soil. According to [30], observed that percentage moisture is a contributing factor to denitrification activities of flooded soils.

Gravimetric Moisture Content (GMC): The result indicated that there significant differences among the soil samples at ($P<0.05$) in gravimetric moisture content. The result ranged between 0.24-0.33 with the mean value of 0.3 lower than LSD 0.11. The result further indicated that Ebonyi River Basin had the highest value of 0.33 while control had the lowest value of 0.11. It shows that the rate of denitrification activities are higher at Ebonyi River Basin and Iyiudele but lowest at upland or control.

Porosity: The result of porosity indicates significant difference among the treatment at ($P<0.05$) in porosity. The result then ranged between 51.10-53.30% with the mean value of 53% above 39.20% of the control with LSD being 3.92. The result further states that Iyiudele floodplain had the highest value of 54.50 while the control had the lowest value of 39.2%. It shows that the rate of infiltration and the water-holding capacity is higher at Iyiudele floodplain and lowest at control. [30] observed that soil physical properties such as porosity are poor during flooding and increase denitrification activities of the soil.

Table 3: Mean and F-LSD of the Effect of Flooding on Chemical Properties of the samples.

Soil Samples	Avail .Phosphorous	pH (H_20)	% Organic Carbon	% Organic Matter	% Nitrogen
Iyiudele Floodplain	34.80	6.15	1.12	1.63	0.13
Iyiokwu Floodplain	29.20	5.89	1.80	3.11	0.15
Ebonyi River Basin	28.20	5.95	1.53	2.65	0.14
Total	**92.2**	**18**	**4.45**	**7.39**	**0.42**
Mean	**30.7**	**5.9**	**1.5**	**2.5**	**0.14**
Control /Upland	38.50	5.38	1.89	0.13	0.15
F-LSD 0.05	0.44	0.001	0.04	0.01	0.007

Available Phosphorus (AP): The result of available phosphorus showed that were significant differences among treatments in available phosphorous at ($P<0.05$). The result of available phosphorus ranged between 28.20-34.80 with the mean value of 30.7 below the control with 30.50 having F-LSD 0.05 -0.44. The result further indicates that control had the highest value of 38.50ppm, while Ebonyi River Basin had the lowest value of 28.20ppm (Table3). The result showed that there is large amount of phosphorus in Ebonyi River Basin and Iyiudele Floodplain had 34.80ppm. [31] observed that flooding generally increases the availability of phosphorous to crops especially rice which is at variance with the present study. Possible leaching of available phosphorusas phosphate in the soil by the flood could account for this observation, since in water columns, anaerobic conditions renders it soluble. Phosphorus reduction in the flood affected farmlands is in strong contrast with the findings of [32] where increased phosphorus levels were seen in flood affected cultivated soils in India

pH: The result of the soil pH (H_2O) indicated significant differences among treatment in pH at ($P<0.05$). The soil pH ranged between 5.15-615, with the mean value of 5.9 greater than 5.38 as control with F.LSD being 0.001.These values are in the same range with the values reported by [33,34,35] but lower than the values reported by [36,37,38] . The result also showed that Iyiudele floodplain had the highest value of 6.15 and the control treatment had the lowest value of 5.38. It shows that the Iyiudele floodplain and Ebonyi River Basin are good for agriculture with pH range of 6.15, 5.85 and 5.95 respectively. [39] observed that after a soil is flooded regardless of its original pH before flooding, the pH would approach neutrality (6.5 to 7.5).Micronutrients may also be influenced by soil wetness. Soluble manganese (Mn) concentrations may "explode" in flooded soils, interfering with iron (Fe) nutrition and causing iron chlorosis, especially in flax. Flooding of alkaline (high pH or high lime) soils causes a buildup of bicarbonate, which interferes with iron uptake and causes iron deficiency and chlorosis [40].

Organic carbon (OC): There were significant differences between the treatment at ($P<0.05$) in percent organic carbon. The results of OC ranged between 1.12-1.80%, with the mean value of 1.5% less than 1.98% of control having LSD of 0.04 The result further showed that control treatment had the highest value of 1.89 % while Iyiudele floodplain had the lowest value of 1.12%. The above shows that there is a bacterial decomposition or ration that has taken place in the Iyiudele floodplain., thereby reducing the content to 1.12 % that is the organic carbon is low. A slight reduction in total organic carbon was observed in the flood affected farmlands, which could bead due to the effect of flooding; as most soil organic content such as organic acids and humus which are the sole source of organic carbon could have been leached out by the impact of the flood. Decreased organic carbon content of soil adversely affects soil quality and fertility since organic carbon is required to stimulate microbial respiration and activities. The reduced organic carbon content in the flood affected farmlands is at variance with the findings of [32] where increased organic carbon content was observed in flood affected cultivated areas in India

Organic Matter (OM): There were significant differences among treatments at ($p<0.05$) in percent organic matter. The result ranged between 1.63-3.11% with the mean value of 2.5% greater than 0.13 as control wit LSD being 0.13%. It also showed that control or upland treatment had the highest value of 3.26 % while Iyiudele floodplain had the lowest value of 1.93 %. It shows that the control has large amount of organic matter decomposed into humus. The results conformed with the finding of [41] , who observed that, soil flooding can cause hypoxia leading to a reduction in the soil nutrient content available to plants .As a result of hypoxia, the organic matter decomposition rate is reduced [42] leading to low soil nutrient content release [43].Another factor that could lead to reduced soil nutrients during high flood is the rate of decomposition of organic matter. Organic matter is a reservoir of nutrients which are released when it decomposes [44].During flooding, water displaces oxygen from the soil [45,46] ,leading to anaerobic conditions [47,48] .Under anaerobic conditions, the rate of decomposition of organic matter declines, resulting in low soil nutrient content.

Total Nitrogen (TN): There were significant differences among treatment at (P<0.05) in percent nitrogen. Results ranged between 0.13-0.15% with the mean value of 0.14% less than control being 0.15%, with 0.007 LSD. It also showed that the control treatment and Iyiokwu floodplain had the highest values of values of 0.15 % while Iyiudele floodplain had the lowest value of 0.13 %. It indicates that there will be rapid fruiting and ripening of fruiting and there will be increased resistance in grains in Iyiudele floodplain.

Table 4: Mean and F-LSD of the Effects of Flooding on soil Exchangeable basis

Soil Sample	Ca (Cmol/kg)	Mg (Cmol/Kg)	K(Cmol/kg)	Na (Cmol/kg)
Iyiudele Floodplain	11.20	5.20	0.154	0.096
Iyiokwu Floodplain	8.40	3.60	0.133	0.087
Ebonyi Basin	12.00	5.20	0.133	0.135
Total	**31.6**	**14**	**0.42**	**0.318**
Mean	**10.5**	**4.7**	**0.14**	**0.106**
Control/Upland	12.40	3.60	0.133	0.087
$FLS_{(0.05)}$	0.17	0.11	0.007	0.002

Calcium (Ca): Table 4 showed that there were significant differences among treatments at (P<0.05) in Calcium. The also indicated that control treatment had the highest value of 12.40 Cmol/kg followed by Iyiudele with 11.20Cmolkg^{-1} while Iyiokwu floodplain had the lowest value of 8.40Cmol/kg. [49] observed that flooding affected soil properties including exchangeable cations like calcium. These results are consistent with findings from previous studies. [50,51,52] , who observed that Ca content decreased with an increase in moisture content during flooding .
Magnesium (Mn): Table 4 showed that there were significant differences among treatments at (P<0.05)In magnesium. It also showed that Iyiudele floodplain and Ebonyi River basin had the highest values of 5.20Cmol/kg while Iyiokwo floodplain and control or upland had the highest values of 3.60Cmol/kg. But a reduction in Mn concentration in the affected soils on account of the flooding effect is not a healthy development because these are essential micronutrients required in the soil for improved soil productivity .Reduced levels of manganese and potassium in theflood affected farmlands are in strong contrast with the findings of [32] where increased levelswere seen in flood affected cultivated soils in India.
Potassium (k): The result showed that there were significant differences among treatments at (P<0.05) in potassium. The results also showed that control has the highest value of 0.174Cmol/kg, followed by Iyiudele floodplain with 0.154cmol/kg^{-1} while Iyiokwu floodplain and Ebonyi River basin had the lowest value of 0.133Cmol/kg (Table 4).. The result was further explained that, It was found that P binding to clay decreased with an increase in pH from 7 to 9, which was attributed to formation of hydroxyl species of the lanthanum ions decreasing the number of P binding sites on the clay sites [53]. A high flood is expected to lead to anoxic conditions because of increased water depth and prolonged waterlogging, which leads to mobilisation of P and results in its increase.[2,3] Under aerobic conditions, P binds to iron oxides. Because of prolonged anaerobic conditions imposed by flooding, Fe bound to P is reduced from

Fe (III) to Fe (II), releasing P from iron-phosphate complexes [6,8], [54].It is expected that during low flooding conditions, P reacts with Ca, Al and Fe oxy-hydroxides as a result of aerobic conditions, consequently reducing its available content in the soil. Potassium is a macronutrient that is not only required for healthy plant growth in the soil, but also for proper microbial functioning; thereforea reduction in potassium levels in the flood affected soils is a negative impact on soil quality.

Sodium (Na): Table 4 showed that there were significant differences among treatments at (P<0.05) in sodium. It also indicated that Ebonyi River Basin had the highest value of 0.139Cmol/kg and control had 0.104Cmolkg^{-1} and Iyiudele recorded 0.096Cmolkg^{-1} while Iyiokwu floodplain had the lowest value of 0.087Cmol/kg. All these showed that there is loss in exchangeable cations during flooding. Low Ca, Mg, K and Na during high flood in the study locations could be a result of leaching and dilution [55], because flooding increases the solubility of mineral nutrients [56].It could be expected that during a high flood more soil nutrients dissolve in water and are lost through leaching as water infiltrates the soil. It could also be expected that because clay is negatively charged [57], cations would bond to the soil particles, thus reducing leaching. However, leaching of cations has been found to be accelerated by dissociation of NO_{3-} from HNO_3 (from nitrification) [57], and study locations experienced high flooding depth and long flooding duration, which would suggest that more of their soil nutrients dissolved in the water and were lost through leaching.

Table 5: Mean and F-LSD of the Effect of Flooding on Exchangeable Acidity, Effective Cation Exchange Capacity and % Base saturation.

Treatment	**Exchangeable Acidity (Cmol/kg^{-1})**	**ECEC (Cmol/kg^{-1})**	**% Base Saturation**
Iyiudele Floodplain	2.08	18.73	88.89
Iyiokwu Floodplain	1.96	14.18	86.18
Ebonyi River Basin	2.16	19.63	88.99
Total	6.2	52.54	264.1
Mean	2.07	17.5	88.02
Control/Upland	1.88	18.16	89.65
FLS (0.05)	0.03	0.53	1.40

Exchangeable Acidity (EA): There were significant differences among the treatments at (P<0.05) in exchangeable acidity. The result also showed that Ebonyi River Basin had the highest value of 2.16 Cmol/kg^{-1} while the control or upland had the lowest value of 1.88Cmol/kg (Table 5). The showed that there is high rate of acidity in Iyiudele floodplain compared to that in the control meaning that there is high rate of negative changes on soil clays and organic matter in Iyiudele floodplain.[58] observed that flooding affects the exchangeable acidity of soil due to its intensity.

Effective Cation Exchange Capacity (ECEC): The result indicated that there were significant differences among the treatments at (P<0.05) in effective cation exchange capacity. It also showed that Ebonyi River Basin had the highest value of 19.63 Cmol/kg^{-1} while Iyiokwu floodplain had the lowest value of 14.18Cmol/kg^{-1} and Iyiudele recorded 18.73cmolkg^{-1}. It indicates that there is high presence of negative charges on soil clays and organic matter in

Iyiudele, Ebonyi River Basin compared to control. Reduced organic matter in the flood affected soils could have also accounted for the reduction in cation exchange capacity, since organic matter contributes to the cation exchange capacity of the soil by increasing adsorption sites fo rcations [58] .Reduced cation exchange capacity is not favorable for agricultural soil because it limits the availability of essential positively charged macro and micro nutrients to be adsorbed on soil particles, since few negatively charged sites will be available to attract them. The reduction in cation exchange capacity levels on the flood affected farmlands is similar to the findings of [32] where reduced levels were also observed on flooding of cultivated areas from river Krishna in Southern India..

Percentage Base Saturation: There were significant differences among the treatment at ($P<0.05$) in percentage base saturation. The result also showed that the control treatment had the highest value of 89.65% while Iyiokwu floodplain had the lowest value of 86.18%. Ebonyi River Basin recorded 88.99 % and Iyiudele floodplain had 88.99 % according to [59] who observed that there is a loss in percentage base saturation during flooding.

CONCLUSION AND RECOMMENDATION

Conclusion: The results obtained from the study showed that most of the available nutrients added to the soil during the flooding are washed down slope to the lower course of the river. For instance, flooding increases the availability of phosphorus to soils, [31], but in the result obtained upland (control) had the highest value of phosphorus while the other three soil samples collected from flooded land had low values of available phosphorus. This could be attributed to the washing of nutrients along the river channel where the samples were collected down to the lower course of the river.

Environmental Effects: Since floodwater that flows downslope is from urban environment that composed of sewage will pollute rivers and land when it drains back into the river. Similarly, the river that floods onto farmland composed of pesticides and other chemicals sprayed onto the farmland that, when drained back into the river, can pollute it and kill off aquatic organisms such as fishes that inhabits the river.

Recommendations.

- These results have direct implications for flood recession farming. We recommend that farmers operation on the floodplains should plough immediately after the onset of flood recession when the soil is still moist and rich in nutrients availability. Those crops that could be planted and harvested before the rain set in should be cultivated.
- The finding of this study suggests that measures should be put in place by government and concerned agencies like NEMA and NESTRA to help reduce the probability of such heavy floods in the future to avoid future flooding of farmlands, so as not to further expose the natural quality of these farmlands to the degradative and devastating effect of flooding to avoid the pollution and siltation of the rivers serve as habitat for fishes and other reptiles, hence extinction.

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