International Journal of Agriculture, Environment and Bioresearch

Vol. 07, No. 04; 2022

ISSN: 2456-8643

EFFECTS OF SOME TREES ON SOIL MINERALS IN HADEJIA-NGURU WETLAND ZONE IN THE SEMI-ARID REGION OF NIGERIA

Bello, H. B.[1], Usman, D. D.[2] Adeosun, M. O.[3] Coker, A. O.[4] Koko, J. O.[5] and Ajayi, O.A.[6]

[1]Ogun Rural Access and Agricultural Marketing Project (Ogun RAAMP), Ogun State, Nigeria.

[2]Agricultural Mechanization and Sustainable Environment Programme, Centre of Excellence in Agricultural Development and Sustainable Environment (CEADESE), Federal University of Agriculture, Abeokuta.

[3]Ogun Rural Access and Agricultural Marketing Project (Ogun RAAMP), Ogun State, Nigeria.

[4]Ogun State Waste Management Authority (OGWAMA), Abeokuta, Ogun state.

[5]Ogun State Ministry of Agriculture, Okemosan, Abeokuta, Ogun State.

[6]Ogun State Primary Health Care Development Board, Okemosan, Abeokuta, Ogun State.

https://doi.org/10.35410/IJAEB.2022.5752

ABSTRACT

This research work was carried out in Hadejia-Nguru wetland zone (HNWz) in the semi-arid region of the northern part of Nigeria. This region has become a major concern to researchers due to frequently reported soil nutrient decline worsened by climate change and declining environmental quality. This research work investigates the effects of some trees on availability of minerals like potassium (K), nitrogen (N), phosphorous (P) and organic carbon (O.C) on small scale farmlands in the study area. The results obtained from this work, showed that some indigenous savanna trees are deliberately left on farms in a manner that is likened to Agroforestry. Predominant trees found on farms in the study area include; Anogeissus leiocarpus (26%), Faidherbia albida (21%), parkia biglobasa (18%) and Vitellaria paradoxa (9%). Soil analysis carried out on soil samples collected at 4m, 8m, 12m from the trees found on the farms showed statistically significant differences in available soil minerals at $p<0.05$.The nitrogen, potassium, phosphorus and organic carbon availability ranged between 0.16 to 0.26%, 0.1024 to 0.2467 cmol./kg, 58.34 to 65.05 ppm and 1.89 to 2.42 cmol./kg respectively in the study area. Interviews conducted amongst four hundred and fifty (450) small scale farmers agreed that crops that are closer to trees found on the farms yield better than crops that are farther away. This implies that crops closer to tree stands on farms have access to more minerals than those farther apart and this supports better yield for farmers.

Keywords: Wetland, Climate change, Organic carbon, Soil mineral, Potassium.

1. INTRODUCTION

Small scale farming system which is also referred to as smallholder farming system is an old and popular type of farming system in the semi-arid region of the northern part of Nigeria [1]. Hadejia-Nguru Wetland Zone (HNWz) where this study was carried out is not an exception to the practice of small scale farming by large number of farmers. The size of a small scale farm in the northern part of Nigeria is estimated by [2] as a farm with an average size of 0.3ha of land. Soils in the semi-arid region of Nigeria are characterized by low soil fertility and high susceptibility to degradation through erosion and nutrient loss [3]. This issue of decline in soil quality is therefore a major concern to food security issue in the entire region and very important to be worked on. HNWz is a very valuable resource to man and the environment providing avenues for farming, irrigation, fishing, grazing and recreation. The zone supplies agricultural

Vol. 07, No. 04; 2022

ISSN: 2456-8643

produce to other regions in the country and beyond and therefore an important reference in terms of food security. It also performs ecological functions such as flood and storm water control and protects water quality by breaking down and filtering sediments, nutrients and toxins and slowly releasing the water for ground water recharge [4]. In recent times, HNWz have been described to be confronted by multiple natural ecological, social and economic problems [5]. There are concerns about natural changes like impacts of drought, extensive use of fuelwood energy which is reported to have serious impacts for the future of the wetlands and the sustainability of their production system including agriculture [4]. Farmers in the region shares some of the ecological issues associated to the wetland zone. They have the problem of sustaining crop production because they lack the capacity to tackle the issue of low soil fertility having no funds to purchase chemical fertilizers to improve soil quality.

Planting trees with crops and animal rearing at the same time on farmland have been said to help in balancing the ecosystem and improve soil quality termed Agroforestry by [1]. The trees in similar studies have been described to interact with the soil by improving the availability of soil minerals [6]. Tree and soil interactions on farms need to be critically studied within the study area. Change in tree density and composition as a result of fuelwood extraction for energy in the area with the rising issue of climate change are strong reasons why tree planting need to be encouraged on small scale farms. The objectives of this study are: (1) to identify different tree species found on small scale farms within the study area. (2) To evaluate the variations in the quality of soils found on small scale farms with trees planted on them within the study area.

2.MATERIALS AND METHOD

2.1 Study Area

This research work was carried out within the Hadejia-Nguru Wetland Zone (HNWz) located within the geographical coordinates of between longitude $10^0$15'E and $11^0$30'E and latitude $12^0$13'3N and $12^0$55'N. The zone is named after two major towns of Hadejia in the northwestern Nigeria state of Jigawa and Nguru a town in the northeastern state of Yobe [7]. The HNWz is located at a point where the hadejia-jama'are flow through a fossil dune field then converging and draining into Lake Chad [8]. The zone extends approximately 120km from west to east within jigawa state and a further 60-70km downstream in adjacent Yobe state [9]. In width the wetlands range from 10km to more than 50km from north to south, with approximately 8000km^2 of flood plain covering three Nigerian states namely Bauchi, Jigawa and Yobe. Annual rainfall ranges between 200mm and 600mm and is confined to late May to September. The dry Season is normally between Octobers to late May and temperature record in the dry season ranges between 35^0C and 40^0C. Significant quantity of water flows to the wetlands begins in late June or early July with peak discharges in August. The vegetation is a Sahel Sudan type with savanna trees grasses and shrubs. Land use in the area is largely agrarian with numerous sizes of farm cultivation on a small scale sizes. The area is economical important to region and the coastal regions of West Africa as a large supplier of food and other agricultural produce.

2.2 Research Design

Qualitative and quantitative approaches were used in the collection, handling and analysis of data in this research work. Field observation was used to identify the different tree species present on the small scale farms in the area. Soils were randomly sampled at four different points on four farms in each of three statistically selected local government areas in the study area. The Local

Vol. 07, No. 04; 2022

ISSN: 2456-8643

government areas are namely Hadejia, Kirikasama and Nguru. Interviews and Focused Group Discussions (FGD) were carried out with four hundred and fifty statistically selected farmers across the study area to evaluate crop performance around trees planted on their farms.

2.3 Soil Sample Collection

Soil samples were collected at 4m, 8m, and 12m from tree stands on the selected small scale farms. Samples were also collected at distances beyond 12m from the tree stands to serve as the control points for the soil samples. Laboratory analysis was carried out on the soils collected to test for nitrogen (N) using Kjeldal digestion method, available phosphorus (AVP) in the soil was determined using the calorimeter method, potassium (K) content was determined using the flame photometer after extraction with ammonium acetate, organic carbon (OC) content was determined using the walkey and black method [10].

2.4 Determination of Total Nitrogen

The total nitrogen was determined using Micro Kjeldhal method. A digestion mixtures that include K_2SO_4, $Cu_2SO_4.5H_2O$ and Selenium was used in proportions of 10:1:0.5 respectively. Other reagents that were used are H_2SO_4 (Conc.), NaOH solution (40%) H_3BO_3 solution (4%) 0.01N HCl and Tashir's indicator (0.248g methylene blue and 0.375g methyl red dissolved in 300ml ethyl alcohol absolute. The process to be employed took three stages they are:

i. Digestion:

5g soil was weighed into a digestion flask 5g digestion mixture was added to it plus 20m of Conc. H_2SO_4. The flask was put on the digestion board with electric heaters. This was heated gradually low at 10-30mins, then raise heating degree. The sample was transferred to 250mL volumetric flask and volumes completed with distil water.

ii. Distillation:

20ml of H_3BO_3 was put in Erlenmeyer flask, 4drops of indicator was added and the flask was put so that the lower lip of the glass receiver tube was below the boric acid surface. Cooling water was run into the condenser. Waters in the boilers was boiled, 25ml of the sample was put in the funnel with distil water.

iii. Titration

Ammonia was titrated with HCl or H_2SO_4

$$\text{N \% in soil} = \frac{(Sample\ titration - Blank)\ x\ normality\ x\ 14x\ dilution}{Sample\ Weight}$$

2.5 Determination of Available Phosphorous

Available phosphorous was determined using the Bray I method or Ammonium Molybdate blue method and reagents A, B and P Extract was used. A is composed of dissolved 17.14g Ammonium Molybdate [$(NH_4)_6\ MO_7\ 24.4H_2O$] in 200ml of warm de-ionized water and 0.392g Potassium Antimonyl Tartrate ($K_5BO.\ C_4H_4O_6$) dissolved separately in 150ml de-ionized water.

Vol. 07, No. 04; 2022

ISSN: 2456-8643

500ml de-ionized water was placed in 2L volumetric flask and Sulphuric acid was slowly be added to the composition. Reagent B is a combination of reagent A and 0.529g of Ascorbic acid and has to be freshly prepared when needed. P extracts is a combination of, 2.22g Ammonium Floride (NH_4F) in de-ionized water and Conc. HCl. The procedures of carrying out the test involves weighing 2g of air dried soil sample pour into a plastic bottle add 14ml of P. Extract and shake in a centrifuge for 15mins. The sample was thus filtered and 4mls of the filtrate (Aliquot) was transferred to 50mls volumetric flask where 20mls of distilled water was added. 8mls of B was added to the sample with distill water to make up to the mark of 50mls and allowed to stand for 30mins. The sample was then moved to the colorimeter and the wavelength adjusted to the required point, like for phosphorus it was 400nm and absorbance is recorded on the samples.

2.6 Determination of Organic Carbon

The organic carbon content of soils was determined using the walkey-Black method [10]. Approximately 1 of 2mm sieved soil was weighed into a conical flask and 10ml of a 1N $K_2Cr_2O_7$ solution was added. 5.0ml H_2SO_4 was added and the mixture gently mixed and allowed to stand for 30mins .absorbance of the calibration standards and samples are read in the spectrophotometer set at 600nm wavelength. Organic carbon was calculated using Equation below

$$\% \text{ O. C} = \frac{\text{mgCsample} - \text{mgCblank x F x mcf x 100}}{\text{Wmg}}$$

% O.C = percentage of organic carbon content of soil,

Mg C_{sample}= Analyte/Conc. of C in sample

Mg C_{blank} = Analyte/ Conc. in blanks

Where, W= mass of air dry sample, mg. F=correction factor 1.3 and Mcf = moisture correction factor

2.7 Determination of Potassium

Potassium concentration was determined by using flame photometer and the appropriate calibration curve. Standard solution was prepared from potassium chloride 1000ppm and sodium 1000ppm by preparing series of dilutions in solution of 1N ammonium acetate (pH7) concentration of K or Na was calculated by slope calculation.

2.8 Data Analysis

Mean values for the results obtained from soil analysis was estimated and Analysis of Variance (ANOVA) was carried out on the mean values obtained at the different distance points of sample collections from the tree. The statistical analysis was done using the Statistical Package for Social Science (SPSS) software 25 version. The trees on the landscape of the small scale farms

Vol. 07, No. 04; 2022

ISSN: 2456-8643

were identified from interviews and FGD conducted and presented in frequencies and percentages.

3. RESULTS AND DISCUSSION

Results obtained from field survey showed that *Faidherbia albida* (28%) is the most common tree seen on small scale farms in the study area. this was followed by *Anogeissus leiocarpus* (24%), *Parkia biglobosa* (18%), *Vitellaria Paradoxa* (11%) and other savanna trees that are scattered on farms with less frequencies (table 1).

Table 1: Percentage of Trees found on the Farms

Names of Tree	*Number of Trees*	*% of Trees*
Faidherbia	124	28
Anogeissus	108	24
Parkia	80	18
Vitellaria	50	11
Ficus	24	5
Tamarindus	18	4
Acacia	18	4
Balanites	18	4
Diospyros	5	1
Others	5	1
Total	450	100

Results from laboratory analysis of sampled soil showed that total nitrogen in the soil have the highest mean value across the LGAs around 4m from the tree (0.26%) and the lowest value was found around 12m from the tree at 0.16% (figure1). The value obtained in the control point (0.17%) is higher than that obtained in 12m point and this may be due to leaf droppings from other trees nearby. ANOVA result showed that there is statistically significant difference in the mean values obtained at the distance of 4m from tree stands across each LGA when compared to mean values obtained at other distances from tree stands in each of LGAs selected. ANOVA results obtained in the control points in each of the selected LGAs showed no significant difference to mean values of samples obtained at 12m from tree stands (p=0.347) in each of the LGAs. The results obtained for nitrogen was similar to the work of [1].

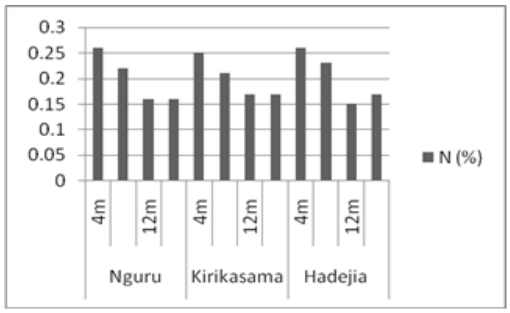


Figure 1: Mean percentage of nitrogen (N) across the study area.

Vol. 07, No. 04; 2022

ISSN: 2456-8643

Potassium content in the soil has the highest mean value at 4m point from the tree (0.2467cmol/kg) (figure2), this mean value from ANOVA test showed statistically significant difference to the values obtained at 8m (0.2034cmol/kg), 12m (0.1984cmol/kg) and the control point (0.1024cmol/kg) with $p<0.05$. This finding was similar to the findings of [6].

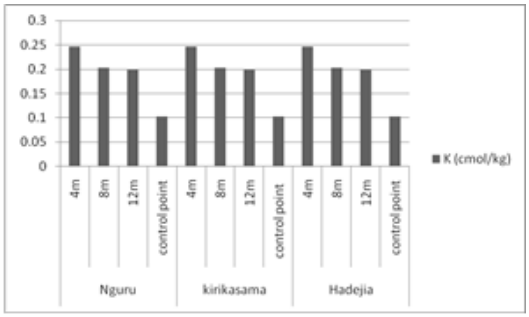


Figure 2: Mean value of available potassium (K) across the study area

Available phosphorous content in the sampled soil showed the highest mean value to be obtained at 4m points (65.05ppm) to the tree on the farms (figure3). The lowest value was obtained at the control point with mean value of 58.34ppm. The mean values obtained showed from ANOVA test result, statistical significant differences when each of the values obtained at different distances were compared between one another with $p<0.05$.

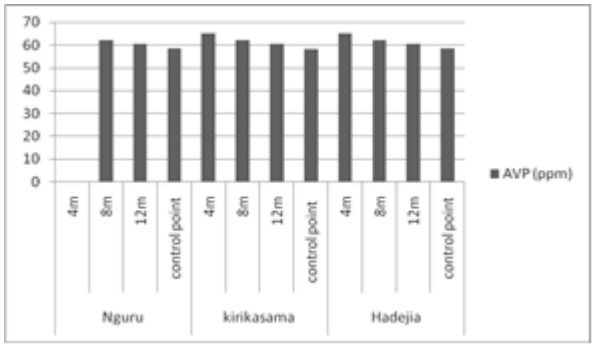
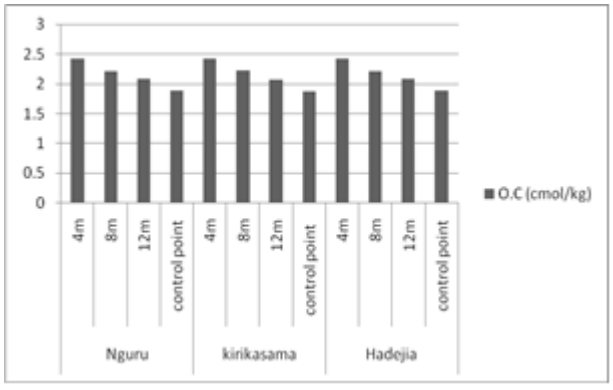


Figure 3: Mean value of available phosphorous (AVP) across the study area

Organic Carbon results showed significant difference between mean values obtained from the different points and the control points on the farms. The highest and the lowest mean values were obtained at 4m point (2.42cmol/kg) and the control point (1.89cmol/kg) respectively (figure 4).



Vol. 07, No. 04; 2022

ISSN: 2456-8643

Figure 4: Mean values of Organic carbon across the study area.

The results showed that soils collected at 4m from the trees have the highest mean values for the mineral contents investigated in this study which will be beneficial to crops cultivated at those points. Trees common on the farms were mostly leguminous trees with the ability to carry out nitrogen fixation and bring mineral element deep in the soil to layers that can be easily accessible to the crops [1]; [11];[12]. The social survey conducted among 450 small scale farmers confirmed that crops planted close to the trees do very well in terms of yield compared to crops planted faraway from trees on the farm. Responses from the farmers as regards the yield of crops were similar to the findings of [13].

4. CONCLUSION

The results obtained from laboratory analysis of the soils collected showed that soils closer to trees have more mineral elements than those farther in distances to trees. Farmers interacted with affirmed that crops closer to trees yield more than crops farther from trees which may be due to availability of higher mineral elements at those points. This implies that farms with enough trees will improve farmers yield and income, improving the socio-economy of the area. Leguminous trees like *Faidherbia albida* and *Parkia biglobosa* are nitrogen fixing plants with the ability to bring soil mineral nutrients from huge depth in the soil to levels that crops can easily take them up for usage. From the findings of this work it is recommended that tree planting should be promoted on small scale farms with more emphasis on leguminous trees. The use of trees for energy generation should be seriously discouraged with the provision of alternative and cheap source of energy. More studies should be carried out on tree distance interaction with soil mineral contents and individual tree species effects on soil mineral content.

REFERENCES

[1] I. Yakubu, and B.H. Babatunde, "Impacts of Some Savanna Trees on Soil Quality on Smallholder Farms in a Part of Kano, Nigeria". Bayero Journal of Pure and Applied Sciences, Vol9, No1, 2016, pp.166-169.

[2] E.U. Essiet, "A Comparison of Soil Degradation under Smallholder farming and Large Scale irrigation Landuse in Kano State, Northern Nigeria". Land Degradation and Rehabilitation, Vol2, 2012, pp.209-214.

[3] Audu, E.B. "Fuelwood Consumption and Desertification in Nigeria". International Journal of Science and Technology Vol, 3. No 1, 2013.

[4] M. Babagana, M. Maria, A. Adamu, A.Y. Magama, and A.G. Suleiman, "Typha Grass (Typha domingensis) and its Control Strategies along Nguru Wetlands,Yobe State, Nigeria". International Journal of Agriculture, Environment
Bioresearch Vol 3, No 2, 2018, pp. 1-15

[5] H.K. Haladu, and A.A. Bello, "Prospects and Challenges of Farming along the Hadejia-Nguru Wetlands in Jigawa state, Nigeria", Inter. Jour of Aca. Res.Ineco.andman.scie. Vol. 3, No. 6, 2014.

[6] A.R. Sanda, and M. Atiku, "Effects of Faidherbia albida on Soil Nutrients Management in the Semi-Arid region of
Kano State, Nigeria". International Journal of Science and Technology, Vol2, No 7, 2012, pp. 201-203

Vol. 07, No. 04; 2022

ISSN: 2456-8643

[7] A.O. Ayeni, A.A. Ogunsesan, and O.A. Adekola, "Provisioning Ecosystem Services Provided by the Hadejia Nguru Wetlands, Nigeria –Current Status and Future Priorities". Published by Elsevier B.V. on behalf of African Institute of Mathematical Sciences / Next Einstein Initiative. 2468-2276© 2019.

[8] E.B. Barbier, and J.R Thompson, "The value of water: floodplain versus large-scale irrigation benefits in northern Nigeria", Ambio 27, 1998, 434–440.

[9] J.R. Thompson, and G.E. Polet, "Hydrology and land use of a sahelian floodplain Wetland", Wetlands 20, 2000, pp. 639– 659.

[10] A. Walkey, and A. Black,"Wet Oxidation Method for Measuring Active and Decomposable Organic Matter in Soil Sample." Journal of soil science, 37, 1934, pp. 2-9.

[11] I. Yakubu, "Climate change Impact on the Density of Faidherbia albida on Smallholder Farms in the Degraded Lands of Kano, Northern Nigeria". Environmentalist, 30, 2010, pp.330-332.

[12] G.K. Adamu, "Use of Faidherbia albida for Soil Improvement in Smallholder farming system of Gezawa L.G. Kano State, Nigeria". Res.J. Environ. Earth Sci. Vol4, No 10, 2012, pp.895-899.

[13] H.B. Bello, Fuel Extraction and its Effect on the Environment in Hadejia L.G.A, PGD Essay, Department of Geography Bayero University Kano, Nigeria, 2012.

Vol. 07, No. 04; 2022

ISSN: 2456-8643

Author Profile

Bello, Hafiz Babatunde (correspondent Author) received His B.sc in Microbiology from Olabisi Onabanjo University, Ago-Iwoye, Ogun state in the year 2009 and his M.sc. in 2017 in Land resources development from the department of geography Bayero University kano. He also obtained a Post Graduate Diploma in Environmental Management from the geography department of Bayero University Kano in the year 2012. Between the years of 2017 and 2021 he worked as an Agricultural Research Officer at the Planning Research and Statistics Department, Ogun ministry of Agriculture Currently his with the World Bank and Agence Francaise development sponsored project named Ogun rural access and agricultural marketing project (Ogun RAAMP) as an Assistant Environmental Safeguard officer and also a PhD scholar at the World Bank Center of Excellence in Agricultural Development and Sustainable Environment(CEADESE), Federal University of Agriculture, Abeokuta (FUNAAB) with area of specialization in Environmental System and Climate Change.

Usman, Danladi Drambi received the B.Engr. and M.Engr. degrees in Agricultural Engineering from University of Maiduguri, Borno State in 1998 and Federal University of Technology, Yola, Adamawa State in 2012, respectively. During 2010-2019, he works with Abubakar Tafawa Balewa University, Bauchi, as a Lecturer with the department of Agricultural and Bioresource Engineering. He is now with Agricultural Mechanization and Sustainable Environment Programme, Centre of Excellence in Agricultural Development and Sustainable Environment (CEADESE), Federal University of Agriculture, Abeokuta, as a PhD Scholar.

Adeosun, Mary Olusubomi studied Biochemistry from Ogun State University, Ago-Iwoye, Ogun State in the year 2002 and proceeded to study a Postgraduate Diploma in Environmental Management in the same University. She worked with the Ogun State ministry of Environment as a Chief Scientific Officer in the capacity of a Director. She is currently the Environmental

Vol. 07, No. 04; 2022

ISSN: 2456-8643

Safeguard specialist of the Ogun Rural Access and Agricultural Marketing Project (Ogun RAAMP)

Koko, John Olusegun, studied Micobiology (Bsc) at the Lagos State University, Ojo Lagos and proceeded to obtain his M.sc in Food and Industrial Microbiology. He currently works with the Planning Research and Statistics department, Ogun state ministry of Agriculture.

Coker, Adediran Oluwarotimi studied Biochemistry from Lagos State University, Ojo, Lagos State in the year 2008. He currently works as a Scientific Officer at the Ogun State Waste Management Authority (OGWAMA).

Ajayi, Olumayowa Ayotunde studied Microbiology in 2013 at the Redemers University, Ogun state. He currently works as a sxientific Officer in the Ogun State Primary Health Care Development Board.