A COMPARATIVE STUDY OF CHANGES IN SOIL FERTILITY UNDER TWO FARMING PRACTICES IN THE KANO CLOSE-SETTLED ZONE

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Abstract

The influence of two farming systems (sole and mixed cropping) on soil properties was investigated in the Wudil area of the Kano Close-Settled Zone. Soil samples collected from plots under the two practices were subjected to physico-chemical analyses. The results indicate that soil under mixed cropping have higher levels of organic carbon, total nitrogen, Cation Exchange Capacity (CEC), exchangeable bases and available phosphorus than sole cropped plots. Mixed cropping is beneficial in enhancing soil fertility through reduction in soil erosion and higher organic matter build-up.

Keywords: Changes, soil properties, management practices, Kano close-settled zone

Introduction

The maintenance of soil fertility includes a range of practices aimed at conserving and improving the soil potentials. The aim of soil management is the control and improvement of soil fertility to give optimal crop production. Soil management has since been a central concern not only to peasant farmers but also to government and other organizations.

There are various methods of improving and maintaining soil fertility and this may include:- the use of animal manures grass burning, bush fallowing, crop rotation, mixed cropping as well as soil erosion control techniques among others.

Fertility of a soil is governed by its physical and chemical properties, either or both of which may limit productivity. However, the study of farming system in any area often makes reference to soil conditions, since the soil is medium on which plants grow. Soil is said to be fertile, when all conditions – physical, chemical, and biological are favorable to crop

development. Absence of any of these, acts as limiting factor and the crop as a whole suffers (Dutta, 1982).

Soil quality is defined as the capacity of a soil to function within the ecosystem boundaries and interact positively with the environment external to that ecosystem (Larson & Pierce, 1991). This however expresses both the inherent properties of a soil and the soil ability to interact with applied input.

Soil management in the agricultural context includes all aspects of soil treatment i.e. subjection, utilization and conservation. This concept can be viewed from two main perspectives, in terms of small holder farmers practice and his ability to use it at sustainable level.

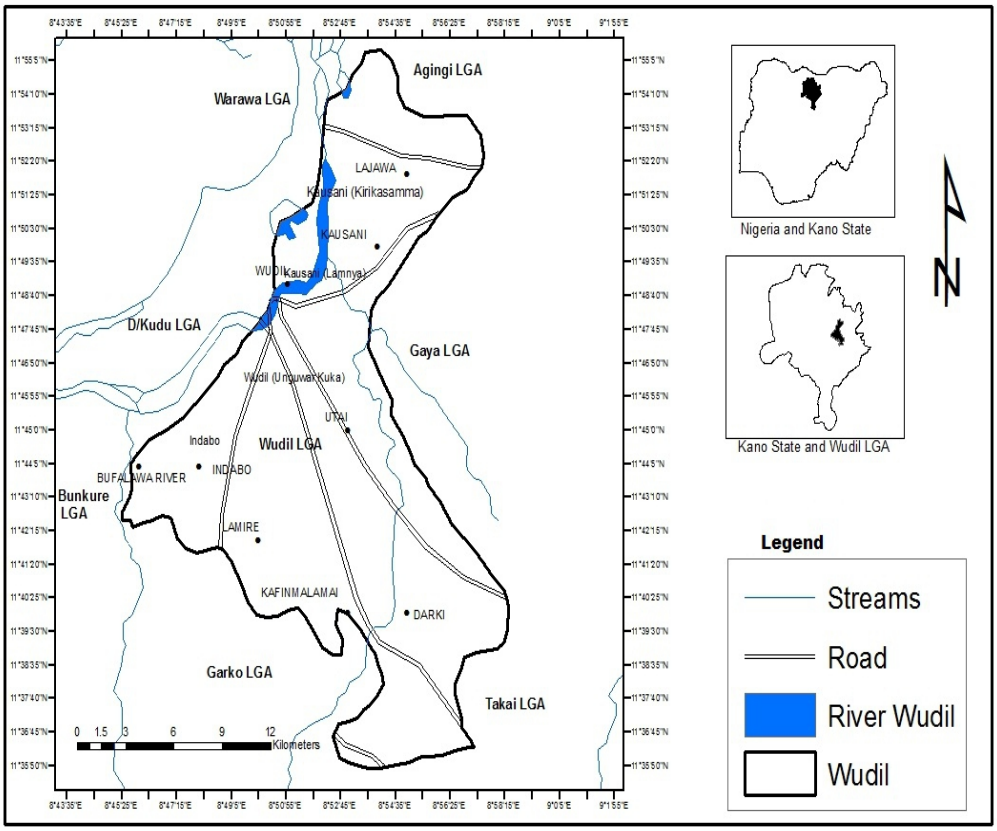
In view of the land use intensification and management systems practiced by the farmers in the Kano Close Settled Zone (KCSZ), this paper is aimed at:

1. Comparing the fertility status of sole and mixed-cropping systems to determine which practice best conserves soil fertility in the study area.

Study Area

Wudil is located between latitudes 11.59^0 to 11.922^0 North and between longitudes 8.757^0E to 8.973^0 East. Wudil is 35Km from Kano along Kano-Maiduguri road (Fig.1). The town is located in the Kano Close Settled Zone with high population density of 350 persons per Km^2 . By tropical African standard the pressure on agricultural land is high (Mortimore,1967,1987). The soils in the study area are reputed to have developed over an old land surface, and are derived from sandy loam deposits, reddish brown in colour. The soils of the area are described as less leached mature shallow soils on a level to gently undulating land slope (FMANR,1990).

The physical characteristics of soils reflect the presence of sandy loam parent materials and the particle size distribution of the soil of the area range from coarse silt to medium sand fractions. The soils of the area are low in organic matter and plant nutrients and are slightly acidic. Cation exchange capacities, soluble salts and available phosphate are equally low.



Sources: Department of Geography BUK (2012)

FIG. 1: Wudil Local Government: (The Study Area)

Materials and methods

Field methods

Reconnaissance visit to identify plots under the two farming systems from where soil samples were taken was conducted. A number of fragmented plots were found scattered around the study area. Some of the plots were found to be close to one another some belonging to the same family members, while others are sold to other people.

A survey was conducted with the aim of characterizing the plots under different cropping systems, soil types and land use. The soil type over the study area was found to be uniform interns of texture and colour. The predominant texture is sandy loam, while the colour obtained range from light brown colour to slightly reddish in few places.

The land use type over the study area is agricultural with rain fed taking over 90%.Multiple cropping system dominates the study area. Majority of crops grown are the staple types with maize, sorghum, cowpea, millet and groundnuts grown by over 90% of the farmers.

Procedure for Data collection

Series of interviews were conducted with plot owners found on their farmers. A total of 50 farmers were found working on their farms and were interviewed. Issues relating to soil types, soil characteristics, management types, cropping pattern, type of fertilizer applied and why among others. Various reasons for the choice of either mixed or sole cropping were given by the local land users ranging from in adequate land, food supply, nature of soil, soil fertility enhancement etc.

A total of 100 soil samples were purposively collected from the sole cropping plots at the depth of 0-20cm. The 100 samples were then mixed to 10 composite samples which were analysed for the study. Another set of 100 samples were also purposively collected from the mixed cropping plots at the same depth and were equally composited to 10 composite samples, thereby making a total of 20 representative samples: 10 from mixed cropping plots and 10 from sole cropping plots which were treated and analyzed for physical, chemical and fertility related indices.

Procedure for data Analysis

The samples collected were taken to the laboratory air dried and sieved with a 2mm mesh sieve for analysis. The treated soil samples were subjected to analyses using the following methods;

Particle size distribution.This was determined using bouyouscos (1957) method. USDA Textural triangle was also used for determining textural classes.

Organic carbon.This was determined using the Walkley-Black (1934) method.

Phosphorus (P) content determination was done using the colorimeter (CECIL CE 373) method using the sodium hydrogen carbonate extraction. The determination was according to the Bray and Kurtz (1945) method.

The determination of exchangeable bases was done with flame photometer (JENWAY PFP7) after extraction using ammonium acetate extraction technique. The CEC was determined using the ammonium acetate saturation method as outlined by Hesse (1971).

Total nitrogen was determined using the Kjeldal Digestion method. P^H was determined using the 1:2.5 soil water ratios.

Statistical Analysis

The results of soil analysis obtained were subjected to simple descriptive statistic of mean, median and mode. Standard deviations were used to test for significant difference between the 2 cropping systems under study.

Results and discussion

Soil Textural Characteristics

The soil physical characteristics investigated showed that there were variations in the content of sand, silt and clay fraction between the land use types. Textural classification and colour did not significantly differ (Tables1 and 2). The clay content in soils under sole cropping was however lower than in soil under mixed cropping. This may be attributed to soil erosion in sole cropping especially under grain as practiced in the study area.

It is therefore necessary to increase the ground cover to reduce soil loss and to incorporate organic manure to aid aggregation and stability of the soil. Grain mono cropping as widely practiced in the area should be discouraged.

Soil pH and electrical conductivity

The pH and EC values across the two cropping systems do not show very significant variations. The pH values range from 6.3 to 7.1 for sole cropped and 6.1 to 6.5 for multiple cropped land with mean values of 6.8 and 6.3 for sole and multiple cropped lands respectively.

On the other hand the EC values range from 0.02ms/cm to 0.04ms/cm for both plots with 0.03ms/cm value obtained as mean in the two systems. This uniformity may not be un connected with the similarities in soil type, geology and the agricultural management found in the study area. This low EC values indicate that the area is not prone to salinity threats and the soils will support many crops.

The slightly acid nature of the soil will enhance the availability of nutrients and as shown above may further facilitate the solubilisation of sodium ions which are the primary agents of salinization and alkalinisation especially in irrigated soils(Alhasan,1996).

Organic Carbon

The results revealed that the organic carbon content in the multiple cropping plots is higher than those in sole cropping plot. Generally values <1% are regarded as low and 1 – 1.5% are regarded as medium (Adamu, 1997).

The direct implication of this low organic carbon content in the sole cropping soils is that organic matter is also low. This is not unexpected in tropical environments because generally addition of organic residues which determines the organic matter content in the soil is low and their lost through mineralization is high (Binns et al, 2003).

Total Nitrogen

Total nitrogen analysis showed very significant difference between the plots (Table3). The results show a general low nitrogen content in the two soils of the study area.This may be due to the nature and the origin of the soils and the inadequate application of nitrogen based chemical fertilizers (Jones & Weld, 1978). Nonetheless, the N contents of multiple cropped plots are a bit higher Most of the N is however in the ammonium form as can be observed in Tables 1 and 2.

Available Phosphorus

The available phosphate values are within the same range,. Even at that, the values of the multiple cropped plot is higher than the sole cropped plot. The P content in the soil is also another factor that agrees with the organic matter content of the soil (Adamu and Dawaki 2008).

That is with low organic matter in the soil, the N and P may likely be low because mineralization of organic matter is known to significantly contribute to the concentrations of both. The application of good organic manure is important for the maintenance of available phosphate to the crops.

Cation Exchange Capacity(CEC)

The CEC results obtained showed significant difference between the plots (Table3). The mean values of CEC are higher in multiple cropping than sole cropping even though, still within low range. The CEC values in all the plots could be regarded as low or medium despite the apparent variability between plots which is not unexpected giving the types of treatments given to the soils that led to difference in terms of clay and organic matter content which are the principal determinants of CEC. The soil CEC may have been significantly contributed by the clay content, because of the poor state of the soil in terms of organic matter (Alhasan, 1996).

Exchangeable Cation

The analysis carried out showed no difference in sodium values between the two plots. There was however a significant difference in mean values of potassium and magnesium in multiple cropped plots (Table3). The Mg values are however within the medium range across all the plots, while the K values are however fairly high in the mixed cropped plots.

The high amount of K in the mixed cropped soils may have also contributed to the low Ca and Mg values because of its better competitive ability for exchange sites, although their values are not however extremely bad (Foloronsho,1998).

Base Saturation

The results of base saturation percentage obtained from the two plots are all within the acceptable ranges and fall within BSP soil classification of FAO-UNESSCO,(1974).

Conclusion and recomendations

From the results the following generalizations could be made:

i. The soil pH is suitable for most chemical reactions with soil nutrients and salinity not posing problem.
ii. The levels of exchangeable bases are low and the total nitrogen and cations exchange capacity values are very low?

However, leaching of bases may pose a problem especially in plots under sole cropping

To check this problem and also increase the efficiency of fertilizer added. It is recommended that organic residue be added to the soil.

Sustainability of the management systems should be enhanced through multiple cropping. This has the advantage of ensuring better efficiency of the added fertilizer.

Multiple cropping improves the physical attributes of the soil such as moisture holding capacity and resistant to erosion.

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Table 1: soil characteristics under sole cropping in kano close settled zone

SOIL CHEMICAL CHARACTERISTICS												SOIL PHYSICAL CHARACTERISTICS				
							cmol/kg									
Sample	pH H_2O	pH Kcl	Ecms/cm	OC %	T N%	Av. P ppm	CEC	Na	K	mg	Ca	BSP %	Clay %	Silt %	Sand %	Tex. class
1	6.5	5	0.03	0.23	0.01	22	3	0.02	0.1	0.3	1.5	65	10	18	72	SL
2	6.3	4.6	0.02	0.4	0.03	19	5.2	0.04	0.2	0.4	1.7	45	9	17	74	SL
3	6.5	5	0.04	0.22	0.02	20	3	0.04	0.2	0.4	2.2	96	12	18	70	SL
4	6.7	5.2	0.02	0.2	0.02	25	4.1	0.03	0.1	0.3	1.7	53	8	14	78	SL
5	7.1	5.7	0.02	0.17	0.01	18	2.3	0.02	0.2	0.4	1.6	94	6	20	74	SL
6	6.4	5	0.03	0.3	0.03	20	2.8	0.03	0.2	0.4	2.1	98	10	22	68	SL
7	7	5	0.03	0.25	0.02	23	3.5	0.04	0.1	0.3	2	71	10	16	74	SL
8	6.8	5.2	0.02	0.33	0.02	15	4	0.03	0.2	0.4	1.7	57	8	18	74	SL
9	6.9	5.3	0.03	0.25	0.02	25	2.8	0.05	0.1	0.4	1.9	88	10	12	78	SL
10	6.8	5	0.04	0.21	0.01	20	3.3	0.03	0.1	0.4	1.5	62	9	19	72	SL
MEAN	6.7	5.1	0.03	0.26	0.02	21	3.4	0.03	0.2	0.4	1.8	73	9.2	17.4	73.4	

SL= Sandy Loam

Table 2: soil characteristics under mixed cropping in kano close settled zone

SOIL CHEMICAL CHARACTERISTICS												SOIL PHYSICAL CHARACTERISTICS			
							cmol/kg								
Sample	pH H_2O	pH Kcl	Ecms/cm	OC %	T N %	AV .Pppm	CEC	Na	K	mg	Ca	BSP %	Clay %	Silt %	Sand %	Tex class
1	6.3	5.7	0.02	0.35	0.03	18	5.7	0.03	0.2	0.55	2.15	51	14	18	68	SL
2	6.1	5	0.02	0.25	0.03	25	3.5	0.03	0.2	0.43	2.17	81	12	20	66	SL
3	6.5	5.1	0.03	0.33	0.04	18	4	0.04	0.2	0.52	1.53	56	12	18	70	SL
4	6.3	5.3	0.02	0.24	0.03	20	5.1	0.02	0.2	0.34	2	51	14	19	67	SL
5	6.2	5.3	0.04	0.3	0.05	23	3.3	0.03	0.2	0.42	1.7	71	10	20	70	SL
6	6.1	5	0.03	0.38	0.03	25	7.1	0.04	0.4	0.5	3.5	62	16	20	64	SL
7	6.2	5.3	0.02	0.25	0.02	18	3.9	0.02	0.2	0.3	2.1	68	12	18	70	SL
8	6.3	5.1	0.04	0.37	0.05	35	4.5	0.02	0.3	0.5	2.5	74	18	16	66	
9	6.3	5.3	0.02	0.3	0.04	27	5.3	0.03	0.2	0.47	2.9	68	14	20	66	SL
10	6.5	5.1	0.02	0.22	0.02	20	3.5	0.03	0.2	0.51	2	78	16	14	70	SL
MEAN	6.3	5.2	0.03	0.3	0.04	23	4.6	0.03	0.2	0.43	2.26	66	14	18	67.7	

SL= Sandy Loam

Table 3: mean, standard deviation and t-values of soil properties Under the two management systems

SOIL PROPERTIES	SOLE CROPPING			MULTIPLE CROPPING			
	X	SD	t value	X	SD	t value	
pH in H_2O	6.7	0.27	4.71*	6.28	0.14	4.71*	
pH in KCl	5.1	0.28	1.28^{ns}	5.2	0.21	1.28^{ns}	
EC ms/cm	0.03	0.008	0.48^{ns}	0.03	0.01	0.48^{ns}	
Organic carbon %	0.26	0.069	1.67^{ns}	0.3	0.06	1.67^{ns}	
Total Nitrogen %	0.02	0.007	3.5*	0.04	0.01	3.5*	
Available P ppm	20.7	3.13	0.92^{ns}	22.9	5.38	0.92^{ns}	
CEC me/1000g	3.39	0.85	2.31*	4.59	1.21	2.31*	
Na me/1000g	0.03	0.009	1.08^{ns}	0.03	0.01	1.08^{ns}	
K me/1000g	0.15	0.05	4.65*	0.23	0.06	4.65*	
mg me/1000g	0.37	0.04	3.73*	0.45	0.08	3.73*	
Ca me/1000g	1.79	0.25	2.59*	2.26	0.28	2.59*	
Base saturation %	72.9	19.58	0.89^{ns}	66	10.7	0.89^{ns}	
Clay %	9.2	1.62	5.2*	13.8	2.39	5.2*	
Silt %	17.4	2.88	0.76^{ns}	18.3	2	0.76^{ns}	
Sand %	73.4	3.14	4.64*	67.7	2.21	4.64*	

KEY
X- Mean