

## *Full Length Research Paper*

# Fertility status of some irrigated soils under constant irrigation (a case study of Mashamari Area of Jere Local Government Borno State Nigeria)

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A study was conducted to assess some parameters on the soil of Mashamari Area of Jere Local Government Borno State Nigeria. These include soil pH, organic matter (OM), Base saturation, total nitrogen, availability of phosphorus, exchangeable cation, cation exchange capacity (CEC), total sodium, magnesium, potassium. The study area is Mashamari Shukari after Mohamet Lawan College of Agriculture Maiduguri, the physical and chemical properties of these soils were evaluated in the University of Maiduguri Laboratory and the result obtained was compared with their respective standard FAO (2004). The textural composition of the soil ranged from loam to sandy loam. The pH ranged from

slightly moderate to slightly acid in some locations. The organic matter was very low in all the study areas. The availability of phosphorus was very low in all the locations. Total nitrogen was predominantly very low. It is recommended that soil conservation practice should be intensified in these areas. The practice should include the use of organic manure, such as cow dung and poultry droppings for the fertilization of the fragile low fertility soil. There should also be a program for monitoring the fertility status of the soil at least five years from the time the soil is first cultivated.

**Keywords:** Fertility, irrigation, soil

## INTRODUCTION

Agronomist receives many questions about agricultural problems that directly or indirectly involve soil fertility problems. Often crop returns have decreased, so farmers want to know how to regain previous harvest levels. Lack of soil fertility causes decreased yields, but many plant diseases are also related to poor soil fertility. Soil fertility guide such as texture, pH, organic matter content, cation exchange capacity, exchangeable sodium percentage, available phosphorus, percentage nitrogen (%N), and percentage base saturation are essential soil chemical properties influencing nutrient availability and retention in soil. Ponnampuruma, (1976) described that organic matter content ranging from low to high could not be used to make yield prediction in an irrigation project because

land development will likely disturb the topsoil organic matter content. On the other hand, Ankerma and Large, (2007) sustained that phosphorus test reading 12 to 15 ppm might be considered adequate for most crops with high yield goals. FAO, (1986) reported that the value of cation exchange capacity (CEC) exceeding 8 Cmol (+) kg<sup>-1</sup> soil reflects soils that are capable of reasonable production under irrigation. Lombin and Knabe, (1981) pointed out that low CEC could be attribute low organic matter content, low clay content and the kaolinitic mineralogy of the soils. Fertility deterioration and general land degradation (Batjes, 2001; UNEP, 2003). The environmental costs of such mismatch are frequently substantial, such as water logging and the build-up of

salinity and sodicity, depletion and pollution of groundwater, and intensification in pests and diseases (Hartemink, 1997; Datta and de Jong, 2002; Bationo *et al.*, 2004). Worldwide, about two-thirds of all agricultural lands have been degraded to some extent within the last half-century (World Resources Institute, 2000). Around 1 to 2% of irrigated land is lost annually as a result of salt-related problems. The objective of the study is to assess the fertility status of the study area through laboratory evaluation compare the results with interpretation guide for evaluating analytical data with a view to making modest recommendations on the rehabilitation and proper management of degraded soil

## METHODOLOGY

### Site description

The study site is located at Mashamari, Jere Local government area of Borno State, situated on Longitude  $14^{\circ} 10^1$  E and Latitude  $12^{\circ} 50^1$  N (Google Earth, 2017). The climate is dry sub-humid in nature as described by (Ojanuga, 2006), characterized by unimodal rainfall pattern. Mean daily temperatures during the cropping season ranges between 23.2 and 34.3°C.

### Environmental characteristics of the study site

The geologic formation initiated in the upper Cretaceous. The Mashamari sandstone overlies the basement rocks unconformable. There is an intense folding of the Cretaceous formations at the end of the Cretaceous, leading to the formation of several anticlinal features and erosional activities partly wearing away the upper Cretaceous strata thereby creating an unconformity surface (Okpikoro and Olorunniwo, 2010). The sedimentation commenced with the deposition of continental, poorly sorted, sparsely fossiliferous, medium to coarse-grained sandstone (Bima Formation) lying directly in the basement (Boboye and Abimbola, 2009).

Farming and animal rearing are the two main economic activities in the area. It is one of the largest centers in West Africa producing major agricultural products like sorghum, millet, maize groundnut, cotton, fruit, vegetables, fish, hide and skin, as well as gum Arabic, Borno State dairy (2004). Arable farming and live-stock grazing along with the high and increasing demand for fuel wood have significantly contributed to environmental degradation. The land-use practices that affect the environment are cultivation, bush burning, grazing, deforestation, and irrigation. The changes caused by these land-use practices, especially cultivation, are often positive because of careful adaptation by the inhabitants who have a vested interest in preserving their homesteads

(Udo, 1993).

### Sampling techniques

Soil samples were collected from Five (5) Farms across the Mashamari ward of Jere Local Government using soil auger. Samples were collected at the zig-zag pattern to form a composite sample across each farm at levels of 0-15, 15-30 and 30-45 cm. Samples were packaged inside a sterilized polythene bags and transported to the laboratory for subsequent analyses.

### Laboratory analysis

The organic carbon contents of the soils were determined according to the method given by Walkley and Black, (1934), as modified by Nelson and Sommers, (1996). The soil was oxidized with standard potassium dichromate solution and sulphuric acid which generated the heat of reaction, followed by titration of the excess dichromate with 0.5 N ferrous sulfates, using ortho-phenanthroline as an indicator. Total nitrogen was determined through the macro-Kjeldahl method as reviewed by Bramner, (1965) after digesting the soil sample with sulphuric acid. Available P was determined by the Bray No.1 extraction method Bray and Kurtz, (1945). Na and K were determined using the flame photometer. The Cation Exchange Capacity (CEC) of the soils was determined through saturating the soil with standard neutral ammonium acetate solution, washing excess with alcohol. The exchangeable bases were determined using the ammonium acetate extract from CEC determination. The samples were later distilled and titrated against standard hydrochloric acid.

## RESULTS AND DISCUSSION

### Physical properties of the study area

The physical properties of the soils in the five study areas show in (Table1). The textural composition of the study area Mashamari farm indicated A and E are loam while B, C, and D are sandy loam in nature from the surface area, subsurface, and beneath, respectively.

### Soil pH

The result in (Table 2) compared with the standard of the pH ranged from 6.59 in topsoil at Shukari to 6.68 in subsurface layer at Mashamari farm. The soil in Shukari farm was slightly acid at both the cultivated and uncultivated areas. The pH range indicates slightly acid to moderately acid for the soils of the cultivated (A) and fallow site (B), respectively. At Shukari, the soil was

**Table 1.** Physical property of the study area.

	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Textural class
A	0-15	44.60	41.60	15.80	Loam
	15-30	64.60	21.560	13.80	SL
	30-45	49.60	31.60	18.80	Loam
B	0-15	44.60	39.10	16.30	Loam
	15-30	54.60	29.10	16.30	SL
	30-45	62.10	24.10	13.80	SL
C	0-15	69.60	16.60	13.80	SL
	15-30	57.10	29.10	13.80	SL
	30-45	52.10	29.10	18.80	SL
D	0-15	57.10	24.10	18.80	SL
	15-30	69.60	11.60	18.80	SL
	30-45	72.10	16.60	11.30	SL
E	0-15	42.10	31.60	26.30	Loam
	15-30	57.10	24.10	18.80	SL
	30-45	47.10	34.10	18.80	Loam

**Table 2.** pH rating of the soils of the study site.

S/N Location	pH Value (H <sub>2</sub> O)	pH Range	Rating
A	6.59-6.68	6.1-6.5	Slightly acid
B	6.13-6.46	6.1-6.50	Slightly acid
C	6.06-6.11	6.1-6.5	Slightly acid
D	6.10-6.14	6.1-6.5	Slightly acid
E	5.67-6.97	5.60-6.0	Moderately acid

**Table 3.** Organic matters rating, total nitrogen rating of the soils of the study sites.

Location	Range	Rating	N value (%)	Rating	Classes	Value
A	1.55	<2	Very low	0.22	0.1-0.2	Low
	1.10	<2	Very low	0.17	0.1-0.2	Low
	1.74	<2	Very low	0.25	0.1-0.2	Low
B	1.52	<2	Very low	0.21	0.1-0.2	Low
	1.14	<2	Very low	0.17	0.1-0.2	Low
	1.10	<2	Very low	0.18	0.1-0.2	Low
C	1.28	<2	Very low	0.21	0.1-0.2	Low
	1.52	<2	Very low	0.22	0.1-0.2	Low
	1.14	<2	Very low	0.18	0.1-0.2	Low
D	0.84	<2	Very low	0.13	0.1-0.2	Low
	0.64	<2	Very low	0.10	0.1-0.2	Low
	2.29	>2	Low	0.32	0.1-0.2	Low
E	2.09	>2	Low	0.31	0.1-0.2	Low
	0.74	<2	Very low	0.11	0.1-0.2	Low
	0.88	<2	Very low	0.14	0.1-0.2	Low

slightly acid to moderately acid in the cultivated and the fallow soil.

### Soil organic matter (OM) content

The result of organic matter content in (Table 3) in all locations was very low. The very low organic matter content indicates of very high biological degradation of all the soil of the study areas, that is, both the cultivated and fallow soils. Also, the low OM content is a phenomenon

associated with the savanna soils, which could be due to high temperatures that rapidly breakdown OM and inhibit nitrogen fixation by rhizobacteria, (Harpstead that incorporated crop residue must be of high quality, that must have C/N ratio of below 20/1. Legume plant provides such high-quality residue (Table 4).

### Cation exchange capacity (CEC) of the soils

The rating for the Cation exchange capacity (CEC) in all

**Table 4.** Base saturation rating of the soils of the study sites.

Location	Bs value (%)	Range	Class
A	64(89-92)	>80	Very high
B	91-94	>80	Very high
C	81-97	>80	Very high
D	93-95	>80	Very high
E	91-93	>80	Very high

**Table 5.** Cation exchange capacity, available phosphorus rating phosphorus (CEC) rating of the soils.

Location	CEC Value	Rating	Class	Value (ppm)	Range (ppm)	Class
A	5.92-7.35	6-12	Low	4.4-4.8	<8	Low
B	6.37-10.42	6-12	Low	4.46-5.5	<8	Low
C	8.06-9.80	6-12	Low	4.52-4.56	<8	Low
D	8.34-9.29	6-12	Low	4.00-4.48	<8	Low
E	7.08-10.77	6-12	Low	4.50-4.52	<8	Low

**Table 6.** Exchangeable cation rating for the soils of the study sites.

Loc/Range	Ca	Mg	K	Na
1* Range A	2-5	0.3-1.32	<0.2	0.1-0.4
Class A low	1.40-1.80	3.40-4.60	0.59-1.14	0.13-0.34
	Low mod.	Low	Low mod.	
2* Range B	2-5	0.3-1.04	0.2-0.3	0.7-0.84
Class A low	1.00-1.80	3.40-4.60	0.59-1.14	0.13-0.34
	Low-mod	Low mod.	Mod. -High	
3* Range C	2-5	0.3-1.44	0.2-0.3	0.3-0.7
Class A	0.80-2.40	4.80-8.00	0.40-0.68	0.14-0.37
	Low mod	Low mod	Mod	
4*Range D	2-5	1-3	0.1-0.22	0.1-0.22
Class	0.80-2.00	4.60-6.80	0.45-0.82	0.09-0.12
	low	Mod.	low-low	Low mod.
5* Range E	2-5	0.3-3	0.06-2.0	0.23-0.42
Class	1.00-2.80	4.80-6.40	1.02-1.41	0.16-0.26
	v.low-low	Low-mod	Low mod	Low mod

the locations as shown in (Tables 5 and 6).CEC was low at the Shukari farm site. The cultivated site was very low while the uncultivated area was considered low. CEC in the cultivated/eroded as well as the fallow soil. The low CEC may be highly related to the low organic matter (OM) content.

### Available phosphorus

Table 5 shows the rating of available phosphorus in all the study areas as compared with the standard (Table 5). The soils were all low. The values obtained were below 8 ppm.

### Soil pH

The mean pH values of soil samples of the study area ranging from 6.59-6.68 pH, meaning slightly acid to

neutral. Such pH values are perfect range from normal crop response. It changes to slightly alkaline, 7.67, and 7.86, respectively.

### Organic carbon (C)

The organic carbon content of the soil was low as per the rating scale of Esu, (1991). The mean organic carbon contents ranged from 0.39 to 0.49gkg<sup>-1</sup>. All who fall within the low rating as per the rating scale in (Table2).

### Total nitrogen (N)

Nitrogen levels of the soil samples were found to be high. Total nitrogen values ranged from 0.1 to 0.3 gkg<sup>-1</sup> in the study site. Esu, (1991) rated similar nitrogen values as high.

### Available phosphorus (P)

Available phosphorus ranged from 13.0mg kg<sup>-1</sup> and 16.3 mg/kg<sup>-1</sup> in the study site. The soil could be rated as medium in available phosphorus as per the rating scale. According to Esu, (1991) rating scale, the soils have low phosphorus.

### Calcium (Ca)

Calcium in the study site varied from 5.25 – 10.50 Cmolkg<sup>-1</sup> for the soils in all the locations. Esu, (1991) gave the critical levels of calcium in soils as values greater than 5 Cmolkg<sup>-1</sup> as high.

### Magnesium (Mg)

Exchangeable magnesium values obtained were also high as per the rating scale, the values ranged from 1.65 – 3.00 Cmolkg<sup>-1</sup> in soil samples According to Esu, (1991) scale of rating, the magnesium contents were rated as medium to high.

### Potassium (K)

Potassium content ranged from 0.13 to 0.18 for the soil sample. By the rating scale of Esu, (1991) the soils are generally medium.

### Sodium (Na)

Sodium concentrations ranged from 0.18 Cmolkg<sup>-1</sup> to 0.34 Cmolkg<sup>-1</sup> for the soils Esu, (1991) rated such values as a medium to high.

### Conclusion

An investigation conducted in 2017 to assess the fertility status of some irrigated soils of Mashamari under continues irrigation for crop production. The parameters assess soil pH, Organic matter; total Nitrogen, CEC, exchangeable cations, available phosphorus, Base saturation, total sodium, magnesium, potassium. The main objective was to assess the status of these soil quality indicators through laboratory evaluation and to compare the result with an interpretation guide for evaluating analytical data. Most of these indicators were found to range from low to low, while others ranged from low to moderate. In the cultivated part of study areas, most of the indicators were below the thresh hold limit for crop production. This is an indication that the soils in such areas have been overused.

### Recommendation

Base on the finding of this study the following recommendation is made; (i) The applications of organic manure such as cow dung and poultry droppings, is recommended to improve the productivity of these degraded soils. Also, farmers are encouraged to leave crop residue on their farm and incorporate the same during tillage rather than burning them. (ii) The portions of the Mashamari farm that had been used continuously for cultivation for quite some time should be allowed for fallow, as the higher degree of degradation observed may be due to their prolonged use.

### Authors' declaration

We declared that this study is an original research by our research team and we agree to publish it in the journal.

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