IMPACT: International Journal of Research in Applied, Natural and Social Sciences (IMPACT: IJRANSS)
ISSN(E): 2321-8851; ISSN(P): 2347-4580
Vol. 2, Issue 12, Dec 2014, 63-68

ASSESSMENT OF AGRICULTURAL POTENTIALS OF TOPSOIL OF DEMSA FLOODPLAINS IN THE BENUE VALLEY AREA OF ADAMAWA STATE, NORTHEASTERN NIGERIA

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ABSTRACT

An assessment of the agricultural potentials of topsoil of Demsa floodplains in the Benue valley area of Adamawa State Nigeria has been carried out. Ten (10) topsoil samples were obtained at 0-15cm and 15-30cm depths respectively from randomly selected farmlands at Linga, Dili, Bbange, Mbomara, Dwam, Zuran, Kwale, Tahou, Kpamnyagi and Kudiri villages of the study area for physicochemical tests. All tests were conducted following standards procedures. Tests results revealed that textural characteristics of the soils ranged from clay-loam to clay. Moisture contents of the soils ranges from moderate to high (42.21% to 63.84%). Chemical analysis indicated that the soils were moderately acidic (pH=5.54) to very slightly aid to neutral (pH=6.72). Organic matter content ranged from low to moderate (0.72% to 1.32%). While total Nitrogen content was very high (0.63% to 0.98%), available phosphorus content was very low (0.07ppm to 0.10ppm). Total Exchangeable Bases (TEB) ranged from 24.62Cmolkg^{-1} to 29.70Cmolkg^{-1} giving rise to high Cat ion Exchange Capacities (CEC) and high percentages of Base Saturations (PBS). The results gave a general indication of high topsoil fertility with Low sodium contents. Therefore, with the availability of water sources (River Benue and its minor streams as well as lakes Fantami and Garambula) in the area, the soils are considered viable for large scale irrigation farming of cereal (Maize, Sorghum, Rice and wheat) and market gardening provided appropriate soil management practices are carried out.

KEYWORDS: Agricultural Potentials, Topsoil Fertility, Demsa Floodplain, Chemical Properties

INTRODUCTION

Amongst all the natural resources, soil assumes an ever increasing importance since the bloom and gloom of most rural dwellers worldwide depend greatly on its potentials for sustainable agricultural production. These potentials are embedded in the term ‘soil fertility’, which is the status of a soil with respect to its ability to supply elements essential for plant growth without a toxic concentration of any element (Foth and Ellis, 1988).

Alluvial Soils are formed from various materials deposited on flat to nearly flat slopes (floodplains) by fluvial and/or colluvial processes, through water flow and gravity force which result to variation in physical chemical, and mineralogical properties, as well as nutrient accumulation (Brubaker, et.al 1993). Thus, the productivity of alluvial soils is often higher than the soils of uplands. The topsoil which is the upper part of the soil profile from 0-30cm depth (Esu, 1999) is the most fertile part of the soil in terms of agricultural productivity due to its high content of both organic matter and plant nutrients. This makes it an important soil portion for studies for fertility potentials.

Demsa Local Government Area of Adamawa state is endowed with a vast floodplain of alluvial soil nesting and supporting a large number of rural dwellers whose mainstay greatly depends on the soils for livelihood. Even though the soils are not very suitable for settlement development due to its poor geotechnical properties (Yonnana, et.al 2011), there is need for temporal assessment of fertility potentials of the soils for agricultural productivity. Hence, the assessment of agricultural potentials of floodplain soils in the Benue valley area of Demsa, Adamawa state.

MATERIALS AND METHODS

The Study Area

The study area lies between latitudes 9° 27'N and 9° 33'N of the equator, and between longitudes12°03'E and 12° 21'E of the prime meridian covering a total land area of about 383.00km^2 (see figure 1). The area is a flat floodable plain characterized by slope angle ranging between 1° and 3° and a mean elevation of 137 meters (450 ft) above sea level. The major channels draining the area include River Benue, Gbalangun and Bwarran streams. The selected villages for the study included Linga, Dili, Bbange, Mbomara, Dwam, Zuran, Kwale, Tahou, Kpamnyagi and Kudiri (see figure 1).

The area's climate is typically tropical, marked by wet seasons from April to October and dry seasons from while the dry seasons form November to March. The hottest months of the year are mostly March and April with mean temperatures up to about 42.8^{0}C, while the coldest months are November and December, with means of about 18^{0}C. Relative humidity ranges from 20-30% between of January and March to 80% in August and September (Adebayo, 1999)

Cretaceous sedimentary deposits make up the area. The portion of the Benue valley within which lies the study area is characterized by continental conditions of Bima sandstones followed by marine conditions. The sediments which mark the change in these conditions make up a very variable sequence of sandstones and shales with thin limestones referred to as the Yolde formation (Bawden, 1972) Overlying this formation are recent alluvial deposits which make up the soils of the area. The soils fall into 213 soil mapping unit of Adamawa State soils (Ray, 1999; Usman, 2005). They are classified as Typic topaqualf (USDA) or Gleyic cambisol (FAO), with colors ranging from dark brown (10yr 3/2) to very dark grey (10yr 3/1), generally deep, poorly drained and medium textured. They are referred to as embryonic (young) soils which do not show much horizon differentiation in their profiles (Usman, 2005).

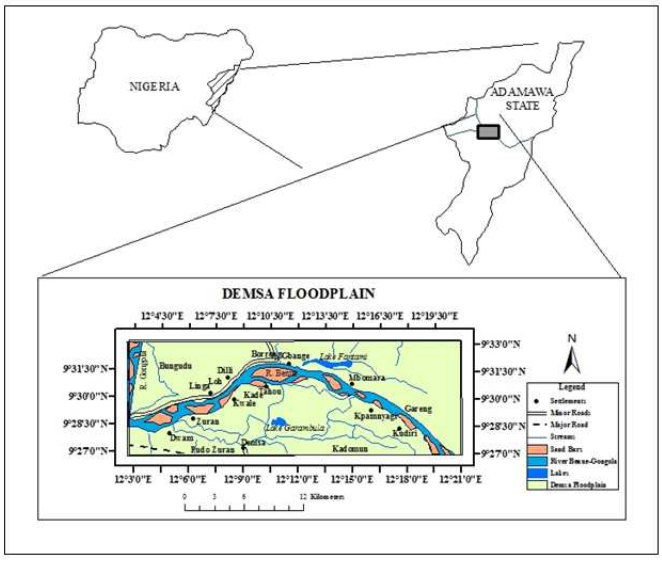

Figure 1: The Study Area

Soil Sampling and Laboratory Analysis

Ten (10) villages were drawn at random for this study. Based on area soil sampling method provided by Udo et.al (2009), two soil samples were then obtained from randomly selected farmlands of each village at 0-15cm and 15-30cm depths respectively for fertility evaluation form which mean values were obtained. The soil samples were air-dried under room condition for 48 hours, crushed and sieved using 2mm sieve then further dried for 24hours before subjecting them to various tests. Textural characteristics of the soil samples were determined by Bouyoucos (hydrometer) method. Moisture contents were obtained in percentages using methods described by Udo et.al (2009). Organic matter content was determined by Walkley-Black Wet Oxidation method. Acidity/Alkalinity reaction (pH) values were obtained by Electrometric method involving the use of pH meter. Regular Macro-Kjeldahl method described by Bremner and Mulvaney (1982) was used to determine Total Nitrogen percentages, while phosphorus contents were obtained by Bray P-1 method as described by Bray and Kurtz (1945). Exchnageable bases (Ca, Mg, K, and Na) and exchangeable Al and H were all determined by Silver Thiourea method (Udo et.al 2009). Total Exchnageable Bases (TEB) and Total exchangeable Acidity (TEA) were then calculted by summation respectively. Cation Exchange Capacity values were computed by summation of corresponding TEB and TEA values. the test results were finally rated by standards adopted from Usman (2005).

RESULTS AND DICUSSIONS

Textural and moisture content characteristics of studied soil samples are presented on table 1. The results revealed that the soils were clayey with textural classes ranging from clay loam in Dilli, Bange and Mbomara to clay in Dwam, Zuran, Kwale, Tahou, Kpamyagi and Kudiri. This result clearly showed that the floodplain soils north of the Benue channel possessed higher percentages of sand than the soils on ths southern floodplain. This could possibly be attributed to some topographical variations the two sides which reflect on water and sediment accumulation during flood events. The results also showed that soils of the southern floodplain were characterised by higer moiture contents (56.19% - 63.84%) than soils of the northern side (42.21% - 51.98%) owing to the textural differences aforementioned.

Table 1: Physical Properties of Demsa Vertisols

Sample Sites	Depth (Cm)	Particle Size Distribution (%)			Textural Class	Moisture Content (%)
		Sand	Silt	Clay		
Linga	0-15	17.42	23.86	58.72	Clay	46.24
	15-30	16.23	23.95	59.82	Clay	47.35
Dilli	0-15	22.10	32.60	45.30	Clay loam	42.78
	15-30	19.34	32.83	47.83	Clay loam	43.16
Bange	0-15	21.63	36.05	42.32	Clay loam	42.21
	15-30	19.74	36.11	44.15	Clay loam	42.77
Mbomara	0-15	23.16	35.66	44.18	Clay loam	51.76
	15-30	21.77	34.72	43.51	Clay loam	51.98
Dwam	0-15	16.68	15.11	68.21	Clay	60.11
	15-30	16.02	15.74	68.24	Clay	62.04
Zuran	0-15	13.59	15.67	70.84	Clay	63.21
	15-30	11.88	15.32	72.80	Clay	63.84
Kwale	0-15	16.86	24.17	58.97	Clay	57.17
	15-30	14.25	23.94	61.81	Clay	58.95
Tahou	0-15	15.86	23.33	60.81	Clay	59.08
	15-30	15.13	24.04	60.83	Clay	59.55

Table 1: Contd.,						
Kpamnyagi	0-15	19.18	22.31	58.51	Clay	56.19
	15-30	18.78	21.96	59.26	Clay	56.82
Kudiri	0-15	16.88	24.31	58.81	Clay	56.57
	15-30	16.02	24.30	59.68	Clay	57.34

Table 2: Chemical Properties of the Soils

Sample Sites	Depth (Cm)	Ph	O.M (%)	Tn (%)	Av.P (Ppm)	Exchangeable Bases (Cmolkg^{-1})				Exchangeable Acidity (Cmolkg^{-1})		Teb (Cmolkg^{-1})	Tea (Cmolkg^{-1})	Cec (Cmolkg^{-1})	Pbs (%)
						Ca	Mg	K	Na	Al^{+}	H^{+}				
Linga	0-15	5.82	1.21	0.82	0.09	18.91	7.93	0.49	0.13	0.31	0.43	27.46	0.74	28.20	97.38
	15-30	5.79	0.95	0.75	0.09	19.01	7.97	0.46	0.15	0.30	0.41	27.59	0.71	28.30	97.49
Dilli	0-15	6.34	1.09	0.91	0.08	18.32	7.11	0.39	0.15	0.43	0.42	25.97	0.85	26.82	96.83
	15-30	6.11	0.92	0.82	0.08	18.35	7.17	0.38	0.15	0.41	0.43	26.05	0.84	26.89	96.88
Bange	0-15	5.67	1.23	0.85	0.07	20.20	6.35	0.37	0.11	0.50	0.39	27.03	0.89	27.92	96.81
	15-30	5.53	0.98	0.81	0.07	20.32	6.41	0.37	0.13	0.52	0.38	27.23	0.90	28.13	96.80
Mbomara	0-15	5.83	1.32	0.83	0.08	19.45	7.72	0.53	0.11	0.44	0.35	27.81	0.79	28.60	97.24
	15-30	5.83	1.01	0.77	0.07	19.52	7.71	0.54	0.10	0.41	0.32	27.87	0.73	28.60	97.45
Dwam	0-15	5.79	1.31	0.72	0.09	19.73	8.30	0.66	0.17	0.42	0.63	28.86	1.05	29.91	96.49
	15-30	5.75	0.98	0.68	0.08	19.18	8.35	0.61	0.18	0.42	0.65	28.32	1.07	29.39	96.36
Zuran	0-15	6.01	1.11	0.63	0.08	19.89	8.87	0.76	0.17	0.56	0.41	29.69	0.97	30.66	96.84
	15-30	5.95	0.87	0.6	0.08	19.91	8.89	0.73	0.17	0.53	0.32	29.70	0.85	30.55	97.22
Kwale	0-15	6.72	1.07	0.98	0.07	19.80	6.96	0.89	0.11	0.35	0.32	27.76	0.67	28.43	97.64
	15-30	6.71	0.84	0.94	0.07	19.84	6.70	0.85	0.11	0.33	0.32	27.50	0.65	28.15	97.69
Tahou	0-15	6.10	0.79	0.90	0.10	18.23	6.24	0.93	0.09	0.40	0.34	25.49	0.74	26.23	97.18
	15-30	6.11	0.72	0.83	0.09	18.28	6.26	0.90	0.11	0.40	0.33	25.55	0.73	26.28	97.22
Kpamnyagi	0-15	5.56	1.01	0.92	0.10	18.58	5.02	0.91	0.11	0.46	0.46	24.62	0.92	25.54	96.40
	15-30	5.54	0.88	0.86	0.09	18.60	5.11	0.91	0.13	0.45	0.44	24.75	0.89	25.64	96.53
Kudiri	0-15	5.54	1.13	0.89	0.09	19.42	5.13	0.89	0.11	0.44	0.44	25.55	0.88	26.43	96.67
	15-30	5.55	0.92	0.82	0.09	19.48	5.17	0.87	0.11	0.44	0.45	25.63	0.89	26.52	96.64
Mean		**5.91**	**1.02**	**0.82**	**0.08**	**19.25**	**6.97**	**0.67**	**0.13**	**0.43**	**0.41**	**27.02**	**0.84**	**27.86**	**96.99**

Chemical properties of the soils are presented on table 2. The results showed that soil reaction (pH) values of the soils ranged from 0.53 (moderately acidic) to 6.72 (very slightly aid to neutral). Even though the results showed that soil acidity tend to increase with depth, variations at 0-15cm and 15-30cm of the topsoil were insignificant. Organic matter content ranged from low (0.72%) to moderate (1.32%) possibly due to continual wash of the floodplain surface by annual floods. The results also revealed very high Total Nitrogen (TN) contents (0.72% - 0.98%) which could be attributed to the combined processes of atmospheric nitrogen fixation and nitrification of amonium conpounds generated from the little organic materials present. On the other hand, available Phosphorus contents were very low with a mean content of 0.08ppm. A general assessment of exchangeable bases showed very high Total Exchangeable Bases (TEB) values with a mean of 27.02Cmolkg^{-1}, high Cation Exchange Capacities (CEC) and very high Percentage Base Saturation (PBS) values, which reulted from high Calcium, Magnesium and Potassium contents with low Sodium. The high exchangeable bases and TN contents of the soils indicated high fertility status.

CONCLUSIONS

Studied floodplain which covers an area of about 383.00km^2 is large expanse of land, large enough for intensive irrigation crop cultivation in commercial quantity. This research has unveiled the fertility potentials of the soils for cultivation of such corps as rice, sorghum, cowpea, sugar cane and market gardening among others under appropriate soil management practices.

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