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Soil Assessment of Selected Floodplain Soil in Nigeria to Support Agriculture Advancement

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Authors' contributions

This work was carried out in collaboration between all authors. Author PKK designed the study and carried out the experiment. Author AIZ wrote the protocol and the first draft of the manuscript. Author HJP managed the literature searches and analyses of the study. Author MEU helped in the experiment. Author TNE wrote the final draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

A series of soils of the Mayo-gwoi flood plain in Jalingo Nigeria were classified and characterized to develop a baseline for soil improvement and increase agricultural productivity. Seven pedons were dug in the area marked Soil units 1, 2 and 3 and were examined with regards to their morphology, physical and chemical properties. The soils were formed over basement complex rocks and alluvial deposits, having shallow to deep pedons, they had high sand fraction and clay content which increased irregularly with depth. The dominant hues were 10YR at the surface and 2.5Y at the subsurface indicating poor drainage. Soil texture varied from sandy clay loam to clay. The pH was slightly acidic to alkaline (6.6 – 7.7), organic carbon was low (mean: 0.2%). The N content was low to moderate with mean value of 0.02%. Available phosphorus content were generally low to moderate in all pedons studied having mean value of 8.8 mg/Kg. Cation exchange capacity (CEC) was generally moderate in all the pedons (mean: 8.31 cmol/kg). This result showed that the soils had low inherent fertility. The soils were classified as *Typic Ustifluvents/Hydragric Fluvisols, Typic*

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Ustifluvents/Hydragric Fluvisols, Plinthic Paleustalfs/Nitic Arenosols, Typic Ustipsamments/Hydragic Arenosols, Typic Ustipsamments/ Hydragic Arenosols, Aquertic Haplustalfs/Haplic Lixisols, Aquic Haplustalfs/Haplic Vertisols according to the USDA Soil Taxonomy and WRB for pedons P1 to P2 respectively. These poorly-drained and low fertility soils require (i) a soil fertilization program and (ii) the development of agronomic guidelines for creating farm profitability.

Keywords: Entisols; alfisols; poorly-drained soils; agriculture advancement.

1. INTRODUCTION

Floodplain soils constitute the back bone of arable crop production in the semi-arid and arid savannah agro-ecological zones where precipitation (rainfall) is limited for agricultural productivity. Flood plains are predominantly flat floored inland valleys bordering or adjacent to the banks of major rivers and streams. They form part of a larger group called the wetland soils [1]. The flood plains also known as "Fadamas" in northern Nigeria have become very prominent because of their use for intensive agricultural production [1]. Fadama soils usually have low gradient and are liable to seasonal flooding at the peak of rainy season [2]. The fadama soils vary widely in morphological and chemical characteristics both within and between valleys owing to differences in morphogenesis, location, hydrological regimes, lithologic origins and climatic condition, therefore they could be rich or very poor in fertility [3]. The terrain features of most West African flood plains comprise levees, back swamps, sandbar, and ox-bow lakes [4].

Fadama is a Hausa word meaning low-lying swamp area consisting of fluvial deposits and containing extensive exploitable aquifers [5]. The word also refers to a seasonally flooded area used for dry season farming. It has been reported by [5] that fadama-like lands are described in Igbo language variously as "ani uro, ude or uda" other language groups have their own words that describe lands under this water-affected area condition. In the discipline of soil science, the word "hydromorphism" describes the situation in which the soil is poorly drained which may be as a result of many factors, for example, the presence of an impermeable underlying layer or shale parent material, valley bottom on the landscape. Hydromorphic soils may be developed in depressions, valley swamps and floodplains. Organic hydromorphic soils are described as "peat" or "muck" depending on the degree of decomposition of the organic deposits. The Mayo-Gwoi floodplain has been on continuous cultivation by peasant farmers because of the importance attached to vegetable and arable crop production. Farmers cultivate the plain on- and off-season due to the residual moisture of the alluvial deposits. The fertility status of the soils of the study area has not been evaluated or classified.

Agricultural development, a subset of economic development, implies a sustained increase in the level of production and productivity over a reasonable length of time and the subsequent improved wellbeing of farmers as reflected in their higher per capita income and standard of living. Rural development relates not only to a sustained increase in the level of production and productivity of all rural dwellers, including farmers, and a sustained improvement in their wellbeing, manifested by increasing per capita income and standard of living, but also leads to a sustained physical, social and economic improvement of rural communities [5].

There is a great increase in human population in Taraba State and this situation calls for more improved scientific food production technique. Increase in food production can be attained by improving the crude and laborious way of land preparation, water management and other scientific methods of soil management and cultivation practices. An inventory of all the soils is required to achieve this. A scientific study of the study area (fadama soils) will create room for classifying the soils, evaluating it for agricultural production and coming up with a suitable management strategy aimed at boosting the productivity of these soils. It is worrisome that in spite of the increasing interest in fadama farming in Taraba State, there has been no studies reported in literature on the fertility assessment of the floodplain nor it classification, and the need for this data cannot be over emphasized especially when viewed against the realization that such information forms the background to an efficient and judicious use of the soil resources. The objectives of this study were to characterize and classify the soils of Mayo-gwoi flood plain.

2. MATERIALS AND METHODS

2.1 Site Description

The Mayo-Gwoi floodplain is located between latitudes 8° 53' and 8° 85' North and longitudes 11° 23' and 11° 75' East. It covers an area of about 120Ha. It is located in Jalingo city, the capital of Taraba State.

2.2 Geology

The geology of the area has been described by [6] as a basement complex and the rocks are mainly pre-cambrian granitic and migmatite gneisses.

2.3 Climate of the Study Area

Jalingo lies within the tropical hinterland climatic region. The natural vegetation of the area is northern guinea savanna; the annual rainfall is between 1000-1500 mm per annum. The region is characterized by double maxima rainfall pattern which has about four months of dry season with relative humidity being generally over 80% in the morning and falling to between 50 and 79% in the afternoon. The dry and wet seasons are controlled by the annual migration of the intertropical zone of convergence (ITZC). The dry season is characterized by the dry dust laden harmattan winds coming across the Sahara desert and occurring between November and February of every year. The wet season sets in by April and lasts till October [7].

2.4 Field Studies

Detailed soil survey was conducted. Rigid method was employed for surveying. Baseline and traverses perpendicular to the baseline were cut and observations were made at 100 m regular intervals. Based on the soil morphological information obtained in the field, three (3) mapping units were identified viz mapping units 1, 2 and 3. In mapping units 1 and 3, two profile pits each were sunk while mapping unit two had three profile pits giving a total of seven profile pits. Profile pits were sampled according to the pedogenetic horizons identified. Soil colour was determined using Munsell soil colour chart. Samples collected were properly labeled in an airtight and clean polythene bags and were immediately taken to the laboratory where they were air-dried. After air-drying, the samples were gently grounded, sieved in a <2 mm sieve ready for laboratory analyses.

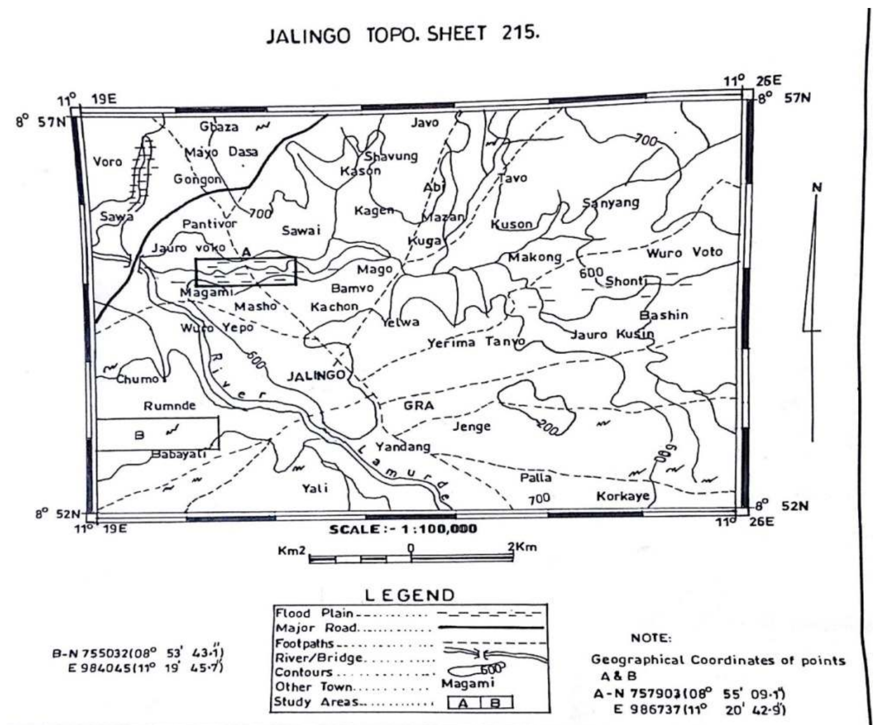

Fig. 1. Map of the study area

2.5 Soil Physical and Chemical Analyses

The Particle size distribution was determined by Bouycous hydrometer method using sodium hexametaphosphate (calgon) as a dispersant and the textural class determination adopted was the USDA textural triangle method. The Soil pH was measured in a 1:1 soil water suspension ratio using a glass electrode. Electrical conductivity of the soil was measured. Organic carbon was determined via dichromate wet oxidation method, the organic carbon content was multiplied by a factor (1.724) to get the percentage organic matter. Total nitrogen was determined by the regular micro Kjeldahl digestion, distillation and titration procedure. The available phosphorus was determined using Bray I method (Black 1965). Exchangeable bases was extracted with 1 normal (1N) ammonium acetate. In the extract, the exchangeable Potassium and sodium were determined using flame photometer while calcium and magnesium were determined by titration with 0.01N EDTA (ethylene di-amine tetra-acetic acid). Cation exchange capacity (CEC) was determined by neutral ammonium acetate displacement method. The soils were classified using the USDA Soil Taxonomy [8] and soil map of the World legend [8].

3. RESULTS AND DISCUSSION

The morphological properties of Mayo-Gwoi floodplain are presented in Table 1. The surface and subsurface soil colours slightly differed with a general yellowish red colour at the surface and yellow to grayish brown at the subsurface. The dominant hues are 10 YR at the surface and 2.5 Y at the subsurface respectively. All the pedons were generally poorly drained to very poorly drained. This finding agrees with the report of [9] who reported that the striking feature of fadama soils is the poor drainage as manifested by their colours. [10] equally reported that fadama soils are generally poorly drained apparently due to the flat and low-lying topography in which these soils are found making them liable to flooding.

The structure of these soils varied from fine subangular blocky in the surface horizons to medium subangular blocky in the subsurface horizons. The consistency of the soils studied ranged from friable, very friable to very firm when dry. Fadama soils have varied structures and consistencies attributably to parent materials. These values are considered safe for root penetration because penetration might be hindered in soil having bulk density above 1.75 mg/m^3 [11].

The surface soils had different textures from the subsurface horizons (Table 2). This result is in agreement with those reported by [9] and [10] that the textures of fadama soils are variable and that these variations may be due to differences in parent materials and topography. However, the clay increase seems to be very irregular in all the pedons studied. The higher clay content observed in the subsurface horizons could be as a result of illuviation.

The results of the soil reaction are given in Table 3 which showed that the pH status of these soils ranged between 6.6 and 7.6 signifying that the soils were slightly acidic to slightly alkaline. This result agrees with reports of [9] who reported that fadama soils are slightly to moderately acidic in reaction with a general trend of decreasing pH values with depth. The electrical conductivity increases with increasing soil depth, which could be attributed to the percolating soluble salts with infiltrating water down the profile as reported by [12].

The organic carbon content of the soil was low to moderate, having mean value of 0.2% (Table 3). Total nitrogen content changed irregularly with depths, the low values observed could be attributed to the continuous cultivation aggravated by the unwelcomed habit of complete removal of crop residues after harvest by farmers and thus depriving the soils of its organic matter turnover. [13] gave a similar report on the low N values of some fadama soils.

Available phosphorus content was generally within the range of low to moderate in all pedons studied with a mean value of 8.8 mg/kg (Table 3). This result showed that the soils under study have low values in the surface horizons than the subsurface horizons. The values tend to follow the same trend with that of the total nitrogen as they increase with increasing depths. This could be partly attributed to the low organic matter content as a result of constant bush burning.

Table 1. Morphological characteristics of pedons of flood plain soils of Mayo-Gwoi

Soil unit	Horizon designation	Profile depth (cm)	Soil Colour (moist)	Mottles	T.C	Structure	Consistency	Boundary	Inclusions or miscellaneous observ.
SU1	AP	0-18	10 YR 6/4	fn, light gray 2.5Y7/2	Sl	2fsbk	Friable	Gs	Fine and medium roots
	AC1	18-61	10YR5/4		Sl	2msbk	Friable	D	Many fine and medium roots.
	AC2	61-82	7.5YR6/2		Sl	3msbk	v.friable	Ds	Few medium roots
	AC3	82-99	7.5YR6/3		S	2msbk	v.firm	Ds	Fine and medium roots with nodules
	C1	99-144	7.5YR4/2	f.fn light gray2.5Y7/2	Sl	2fsbk	v.friable	Gs	
	C2	144-158	10YR6/4		Sc	2fsbk	v.friable	Ds	Few fine roots
	Bt1	158-178	10YR4/2		Sc	3msbk	v.firm	Gs	Few fine roots
	AB	178-200	10YR4/4		Sc	2msbk	v.firm	Gs	Few roots
	Ap	0-14	10YR5/2		Cl	3fsbk	v.friable	Gs	v.few medium fine roots
	A2	14-41	2.5YR4/2	Fn lightgray5Y3/3	Sl	2fsbk	Friable	Gs	v.few roots
	AC1	41-78	5YR4/6		Sl	2fsbk	Friable	Ds	Few roots
	AC2	78-122	10YR4/4		Sl	2fsbk	v.friable	Ds	None
	Ag1	122-141	10YR4/3		Sl	2msbk	Friable	Gs	None
	Ag2	141-180	7.5YR2.5/1		Sl	1msbk	Friable	Ds	Few fine roots
	Ck	180-200	10YR5/6	-	S	1msbk	Friable	Ds	Few medium roots
SU2	Ap	0-30	10YR5/2		Sl	2fsbk	Firm	Gs	Few fine and medium roots
	BA	30-50	7.5YR5/2		Sl	1fsbk	Friable	Ds	Few fine roots
	Bt1	50-85	10YR3/3		Sc	2fsbk	v.friable	Gs	Few fine roots
	Bt2	85-140	10YR3/6		Sl	2msbk	v.firm	Gs	Few Fine roots
	Crtg	140-175	10YR3/6	-	Sl	2msbk	v.friable	Gs	Few fine nodules
	Ap	0-38	2.5YR4/2		Sl	2msbk	Friable	Ds	Few fine roots
	A1	38-62	10YR3/3		Sc	3msbk	v. friable	Gs	Very fine and medium roots
	A2	62-120	10YR3/4		Sc	3msbk	v. friable	Gs	Few fine roots

Soil unit	Horizon designation	Profile depth (cm)	Soil Colour (moist)	Mottles	T.C	Structure	Consistency	Boundary	Inclusions or miscellaneous observ.
SU3	AP	0-18	7.5YR5/3	-	Sc	2msbk	v. friable	Gw	Few fine roots
	AC1	18-54	7.5YR3/4		Cl	3msbk	v. friable	Gs	Few fine roots
	AC2	54-105	10YR2.5/1		Cl	2msbk	v.firm	Ds	Few roots
	C1	105-134	10YR6/4		Sc	2msbk	v. friable	Gs	Few fine roots
	C2	134-184	10YR4/2		Sc	2msbk	v. friable	Gs	Few roots
	Ap	0-38	10YR3/6	Fn,liht gray5Y3/3	Sc	1msbk	Friable	Ds	Few roots
	A2	38-52	10YR6/4		Sl	2msbk	Friable	Gs	Few roots
	Bt1	52-93	10YR5/2		Sl	1msbk	Friable	Gs	Few fine roots
	Bt2	93-130	2.5YR6/8		Sl	2msbk	v. friable	Ds	Few roots
	Ap	0-38	7.5YR3/2	Fn,light gray 2.5Y7/2	Sc	2msbk	v. friable	Gs	Few fine roots
	A2	38-60	10YR4/6		Sc	2msbk	v. friable	Gs	Few roots
	Bt1	60-90	2.5YR4/2		Sl	2msbk	v. firm	Gw	Few roots
	Bt2	90-120	2.2YR3/3		Sc	2msbk	v. firm	Gs	Few fine roots
	C2	120-150	2.5Y4/2		Sc	2msbk	v. firm	Gs	Few fine roots

Footnote: V=Very; Gs =gradually and smooth; Gw =gradual and wavy; Ds =diffuse and smooth

Table 2. Particle size distribution of Mayo Gwoi flood plain soils

Soil unit	Pedon	Horizon designation	Profile depth (cm)	Sand (%)	Silt (%)	Clay (%)	Textural class
SU1	P1	AP	0-18	56	21	23	Scl
		AC1	18-61	66	11	23	Scl
		AC2	61-82	62	13	27	Scl
		AC3	82-99	52	38	23	S
		C1	99-144	54	5	41	Scl
		C2	144-158	28	43	29	Cl
		Bt1	158-178	47	40	53	Sl
		AB	178-200	52	43	47	Sl
	P2	Ap	0-14	10	61	29	Scl
		A2	14-41	58	3	39	Sc
		AC1	41-78	58	19	23	Scl
		AC2	78-122	78	3	19	Sl
		Ag1	122-141	74	3	23	Scl
		Ag2	141-180	58	3	39	SC
		Ck	180-200	52	5	43	Scl
SU2	P3	Ap	0-30	42	31	27	L
		BA	30-50	8.0	29	63	C
		Bt1	50-85	58	19	23	Scl
		Bt2	85-140	35	58	27	L
		Crtg	140-175	10	45	45	SL
	P4	Ap	0-38	32	35	33	Cl
		A1	38-62	10	47	43	Sc
		A2	62-120	42	23	35	Cl
SU3	P5	AP	0-18	32	35	33	Cl
		AC1	18-54	58	21	21	Scl
		AC2	54-105	2.0	53	45	Sl
		C1	105-134	8.0	51	41	Sc
		C2	134-184	4.0	19	23	Sc
	P6	Ap	0-34	36	21	43	C
		A2	34-52	22	5	73	C
		Bt1	52-93	18	9	73	C
		Bt2	93-130	40	3	57	C
	P7	Ap	0-38	32	17	51	C
		A2	38-60	34	9	57	C

Soil unit	Pedon	Horizon designation	Profile depth (cm)	Sand (%)	Silt (%)	Clay (%)	Textural class
		Bt1	60-90	32	45	23	L
		Bt2	90-120	32	16	53	C
		C2	120-150	32	45	23	L
	Mean			38	26	36	L

Scl = Sandy Clay Loam, Sc = Sandy Clay, C = Clay, Sl = Sandy Loam, L = Loam

Table 3. Chemical properties of Mayo-Gwoi floodplain soils

Soil unit	Pedon	Horizon designation	Pedon depth (cm)	pH (H_20)	EC (dSm^{-1})	Org. C (%)	Org. M. (%)	T.N (%)	Avail. P ($mgkg^{-1}$)
SU1	P1	AP	0-18	7.4	0.08	0.2	0.34	0.01	0.3
		AC1	18-61	7.3	0.01	0.3.	0.52	0.02	0.2
		AC2	61-82	7.5	0.04	0.2	0.34	0.02	6.5
		AC3	82-99	7.5	0.06	0.1	0.17	0.02	9.5
		C1	99-144	6.8	0.14	0.2	0.34	0.01	11.2
		C2	144-158	7.1	0.12	0.4	0.68	0.02	8.1
		Bt1	158-178	6.8	0.18	0.5	1.86	0.01	11.2
		AB	178-200	7.1	0.01	0.1	0.17	0.01	8.8
	P2	Ap	0-14	7.3	0.08	0.2	0.34	0.02	11.6
		A2	14-41	7.2	0.08	0.4	0.68	0.02	10.5
		AC1	41-78	7.7	0.06	0.3	0.52	0.01	8. 7
		AC2	78-127	7.6	0.08	0.2	0.34	0.02	9.1
		Ag1	127-141	6.8	0.04	0.2	0.34	0.01	1.1
		Ag2	141-180	7.2	0.06	0.1	0.17	0.02	8.8
		Ck	180-200	7.2	0.08	0.1	0.52	0.01	11.6
SU2	P3	Ap	0-30	6.9	0.01	0.3	0.34	0.02	9.5
		BA	30-50	7.0	0.06	0.2	0.17	0.02	9.5
		Bt1	50-85	7.0	0.06	0.1	0.34	0.01	12.3
		Bt2	85-140	7.2	0.06	0.2	0.35	0.01	8.4
		Crtg	140-175	6.6	0.08	0.1	0.68	0.01	12.6
	P4	Ap	0-32	7.8	0.12	0.2	0.52	0.02	9.1
		A1	32-62	7.9	0.01	0.1	0.52	0.02	10.2
		A2	62-120	2.9	2.01	0.1	0.34	0.02	10.2
SU3	P5	AP	0-18	7.1	0.01	0.2	0.52	0.02	11.2
		AC1	18-54	7.2	0.05	0.4	0.68	0.02	7.2
		AC2	54-105	7.5	0.06	0.3	0.34	0.01	8.1

Soil unit	Pedon	Horizon designation	Pedon depth (cm)	pH (H_20)	EC (dSm^{-1})	Org. C (%)	Org. M. (%)	T.N (%)	Avail. P ($mgkg^{-1}$)
		C1	105-134	7.5	0.07	0.3	0.34	0.01	11.6
		C2	134-184	7.5	0.08	0.2	0.17	0.02	6.5
	P6	Ap	0-38	7.5	0.16	0.3	0.34	0.02	9.1
		A2	38-52	7.5	0.08	0.4	0.34	0.03	9.1
		Bt1	52-93	7.8	0.08	0.2	0.52	0.03	10.5
		Bt2	93-130	7.3	0.01	0.3	0.68	0.01	9.5
	P7	Ap	0-38	7.4	0.01	0.3	0.33	0.02	8.1
		A2	38-60	7.1	0.14	0.1	0.34	0.04	9.1
		Bt1	60-90	7.5	0.06	0.2	0.52	0.02	8.1
		Bt2	90-120	7.7	0.08	0.1	0.33	0.01	8.6
		C2	120-150	7.7	0.08	0.2	0.52	0.01	10.9
Mean				7.2	0.12	0.2	0.45	0.02	8.8

OC=organic carbon; OM=Organic Matter; AVP=available phosphorus; CEC=cation exchange capacity; TN=total nitrogen; ECEC= Effective Cation Exchange Capacity, SU= Soil unit, P1-P7 = Soil Profile numbers

Table 3. Chemical properties of Mayo-Gwoi floodplain soils (Contd.)

Soil unit	Pedon	Horizon designation	Pedon depth (cm)	Exchangeable bases ($cmolkg^{-1}$)						CEC ($cmolkg^{-1}$)	ECEC ($cmolkg^{-1}$)	BS (%)
				Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}	Al^{3+}	H^{+}			
SU1	P1	AP	0-18	5.20	2.60	0.28	1.57	1.30	0.40	9.65	11.35	85.0
		AC1	18-61	4.90	2.73	0.02	1.94	1.20	0.50	9.59	11.29	85.0
		AC2	61-82	4.60	2.40	0.03	1.95	1.80	0.60	8.98	11.38	79.0
		AC3	82-99	4.50	2.21	0.03	1.94	1.50	0.80	8.19	10.49	78.0
		C1	99-144	3.70	1.80	0.84	1.85	1.60	0.89	8.14	10.63	77.0
		C2	144-158	3.65	1.81	0.02	2.01	1.40	0.90	7.14	9.44	76.0
		Bt1	158-178	3.40	1.87	0.02	2.02	1.30	0.99	6.94	9.23	75.0
		AB	178-200	2.90	2.10	0.03	1.91	1.40	0.29	8.66	9.23	94.0
	P2	Ap	0-14	4.00	2.30	0.02	2.30	1.20	0.36	8.85	10.41	85.0
		A2	14-41	4.16	2.40	0.03	2.24	1.19	0.42	9.87	11.48	86.0
		AC1	41-78	4.10	2.70	0.03	2.04	1.08	0.55	9.14	10.77	85.0
		AC2	78-127	4.70	2.50	0.02	1.92	1.60	0.66	8.73	10.99	79.0
		Ag1	127-141	4.50	2.07	0.02	2.10	1.70	0.22	7.18	9.10	79.0
		Ag2	141-180	3.20	1.99	0.04	1.85	1.40	0.88	6.45	8.73	74.0
		Ck	180-200	3.27	1.29	0.03	1.86	1.30	0.99	7.14	9.43	76.0

Soil unit	**Pedon**	**Horizon designation**	**Pedon depth (cm)**	**Exchangeable bases (cmolkg^{-1})**						**CEC (cmolkg^{-1})**	**ECEC (cmolkg^{-1})**	**BS (%)**
				Ca^{2+}	**Mg^{2+}**	**K^{+}**	**Na^{+}**	**Al^{3+}**	**H^{+}**			
SU2	P3	Ap	0-30	3.07	1.98	0.02	2.05	1.40	0.17	7.58	9.15	83.0
		BA	30-50	3.11	2.00	0.02	2.45	1.60	0.88	7.31	9.79	75.0
		Bt1	50-85	2.90	2.21	0.02	1.94	1.70	0.77	7.40	9.51	78.0
		Bt2	85-140	2.29	2.88	0.03	1.84	1.29	0.66	7.38	9.13	81.0
		Crtg	140-175	2.51	2.99	0.03	1.85	1.29	0.33	7.72	8.07	96.0
	P4	Ap	0-32	3.10	2.89	0.02	1.71	1.66	0.22	8.81	9.05	96.0
		A1	32-62	4.20	2.66	0.03	1.92	1.68	0.21	8.80	9.47	96.0
		A2	62-120	4.20	2.66	0.04	1.92	1.69	0.22	9.65	9.22	100
SU3	P5	AP	0-18	4.60	2.99	0.02	2.04	1.69	0.16	8.86	8.89	99.0
		AC1	18-54	4.15	2.67	0.02	2.0 2	1.39	0.51	8.73	9.28	94.0
		AC2	54-105	4.19	2.59	0.03	1.92	1.32	0.22	8.49	9.26	92.0
		C1	105-134	3.70	2.88	0.03	1.88	1.79	0.33	8.20	10.93	75.0
		C2	134-184	3.60	2.91	0.03	1.89	1.22	0.22	8.22	10.24	80.0
	P6	Ap	0-38	3.65	2.66	0.03	1.68	1.33	0.31	8.37	11.29	74.0
		A2	38-52	3.50	2.65	0.02	2.05	1.22	0.80	8.18	10.88	75.0
		Bt1	52-93	3.80	2.60	0.03	1.94	1.33	0.82	8.18	10.85	75.0
		Bt2	93-130	3.50	2.65	0.02	2.01	1.29	0.83	8.10	10.35	78.0
	P7	Ap	0-38	3.60	2.65	0.03	1.87	1.66	0.20	7.55	10.30	73.0
		A2	38-60	3.65	2.80	0.02	1.71	1.80	0.21	8.10	10.26	79.0
		Bt1	60-90	3.20	2.99	0.02	1.89	1.81	0.23	10.3	9.94	100
		Bt2	90-120	3.25	2.44	0.02	1.84	1.29	0.28	8.70	8.48	100
		C2	120-150	3.28	2.69	0.03	2.01	1.01	0.29	8.10	9.60	84.0
Mean				3.7	2.47	0.05	1.94	1.44	0.49	8.31	9.94	83.7

OC=organic carbon; OM=Organic Matter; AVP=available phosphorus; CEC=cation exchange capacity; TN=total nitrogen; ECEC= Effective Cation Exchange Capacity, SU= Soil unit, P1-P7 = Soil Profile numbers

Table 4. Classification of Mayo-Gwoi floodplain soils

Pedon	USDA				FAO/WRB
	Order	Suborder	Greatgroup	Subgroup	
P1	Entisols	Fluvents	Ustifluvents	Typic Ustifluvents	Hydragric Fluvisols
P2	Entisols	Fluvents	Ustifluvents	Typic Ustifluvents	Hydragric Fluvisols
P3	Alfisols	Ustalfs	Paleustalfs	Plinthic Paleustalfs	Nitic Arenosols
P4	Entisols	Psamments	Ustipsamments	Typic Ustipsamments	Hydragic Arenosols
P5	Entisols	Psamments	Ustipsamments	Typic Ustipsamments	Hydragic Arenosols
P6	Alfisols	Ustalfs	Haplustalfs	Aquertic Haplustalfs	Haplic Lixisols
P7	Alfisols	Ustalfs	Haplustalfs	Aquic Haplustalfs	Haplic Vertisols

The surface and the subsurface horizons had low content of exchangeable acidity in all the pedons (Table 3). The values ranged from 0.1-2.9 cmol(+)kg^{-1} with a mean of 1.5 cmol(+)kg^{-1} . The low values recorded appear to be attributable to the action of exchangeable hydrogen alone since no pH value was less than 5.5. This report agrees with the earlier report of [14] who stated that an induced acidity is unlikely to be experienced in soils having pH values above 5.5**.** The cation exchange capacity of these soils (Table 3) were generally low in almost all the pedons studied except those in pedon P7 which is moderate and may be attributed to six year fallow period it underwent. The low CEC values in these soils could be attributed to the low organic matter content as reported by Allison (1973) that the organic matter content in soils accounts for about 30-60% of the CEC values.

The effective cation exchange capacity was generally moderate across all the pedons (mean: 9.94 cmol/kg) (Table 3) and the exchange sites of the soils were dominated by exchangeable calcium and magnesium Table 3). Exchangeable potassium was low; the exchangeable sodium content of the soils was very low generally as evidenced in Table 3. The sodium content varied irregularly with depths. The soils studied have little or no horizon development in the profiles other than the ochric and a man-made anthropic or agric epipedons with albic subsurface horizons, mostly derived from alluvial materials. The studies also revealed that the moisture regime of the soils is udic. The soils therefore qualified at the order level of generalization as Entisols and Alfisols. The summary of the classification of the soils are presented in Table 4 above.

4. CONCLUSION

The results of the study conducted on the soils of Mayo-Gwoi flood plain showed that the soils have low inherent fertility. Total nitrogen content in the soils was low, and the available phosphorus, potassium, exchangeable bases, cation exchange capacity, organic matter content were all low in the soils. The soils were classified as *Typic Ustifluvents/Hydragric Fluvisols, Typic Ustifluvents/Hydragric Fluvisols, Plinthic Paleustalfs/Nitic Arenosols, Typic Ustipsamments/Hydragic Arenosols, Typic Ustipsamments/ Hydragic Arenosols, Aquertic Haplustalfs/Haplic Lixisols, Aquic Haplustalfs/Haplic Vertisols* according to the USDA Soil Taxonomy and FAO/WRB for pedons P1 to P2 respectively.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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