EVALUATION OF SELECTED FADAMA SOILS IN KATCHA LOCAL GOVERNMENT AREA OF NIGER STATE FOR ARABLE CROPPING

***LAWAL, B.A., A.J. ODOFIN, M.K.A. ADEBOYE AND M.I.S. EZENWA**
Department of Soil Science, School of Agriculture and Agricultural Technology,
Federal University of Technology, P.M.B. 65, Minna, Niger State, Nigeria.

***Corresponding author's e-mail address: lawalba63@yahoo.com**

ABSTRACT

Fadama ecosystems have potential for all season agricultural production thereby enhancing food security for the country. This study was carried out to evaluate the soils of three fadama sites, Katcha, Gbakogi and Kashe in Katcha Local Government Area of Niger State, Nigeria, for arable cropping using the Fertility Capability Classification (FCC) system. Sand was the dominant fraction in all the soils. The silt/clay ratios of all the horizons of the soils were greater than 0.32. All the soils have low organic C and total N with both increasing down the soil depth. The FCC rated all the soils as suitable for arable crop cultivation with Katcha and Kashe fadama soils excellent for flooded rice cultivation. Ploughing, harrowing, ridging and field drainage to conduct water will be required for the successful cultivation of arable crops not tolerant to water-logging due to their clay texture. Gbakogi soil had low K level and will therefore need K fertilization especially for K-sensitive arable crops such as yam. The high P fixation capacity of Katcha and Kashe soils will require heavy application of P fertilizer to satisfy the need of leguminous arable crops that are sensitive to P. Integrated soil fertility management involving combination of inorganic fertilizers and organic manures is recommended for all the soils for their optimum and sustainable productivity.

Keywords: Arable, evaluation, fadama Katcha, Niger State

INTRODUCTION

The oil boom and easy access to external finance undermined agriculture in several developing countries (FAO, 1995). Aside from oil boom, rapid growth in population, the prevalence of traditional farming systems, increasing urban migration was also identified to have caused per capita agricultural production to decrease in some West African countries Nigeria inclusive (ILRI, 1993). One of the measures advocated to increase food production to meet the requirement of rapid growth in population was the opening up of more farmlands which include the floodplains (fadama) (Ojanuga, 2006a). Earlier, a report had estimated Nigeria's floodplain areas to cover 65.785 km^2 translating to 7.2% of the total land area of the country (Ojanuga, 2006b).

Studies have shown that fadama ecosystems have potential for all season agricultural production. Singh (1997) reported that fadama soils of Sokoto State, Nigeria were used intensively for both rain-fed and irrigated farming. Elsewhere, Singh (1999) noted that aside from their nutrients status, fadamas have high level of moisture in terms of ground/residual water even during the dry season as well as under drought conditions. Yet, farmers usually prefer to cultivate the more easily exploitable upland than fadama soils because of water-logging condition, low pH values, low phosphorus values and problem of salinity/sodicity among others (Onyekwere *et al.,* 2001). Despite the challenges farmers do encounter while working on the fadama, Ojanuga (2006a) pointed out that when they are put to use properly, their capacity to contribute to food security can be substantial in the long term.

Land evaluation is a systematic process of identifying and measuring land qualities and assessing them for alternative kinds of use of the land. The broad principles of land evaluation involve comparing the requirements of land use with quality of land thereby assessing the value of each type of land present for each land use considered (Dent and Young, 1980). Land evaluation is necessary; because mapping of natural resources alone does not provide sufficient guidance on how the land can be used and what will be the likely consequences (FAO, 1976). It is important that the land that will be used for agricultural production should be used according to its capacity for optimization and sustainability of soil productivity (Adeboye, 1994). Land evaluation can help bring about this understanding and provide the most productive uses to which the soils can be put into. The Fertility Capability Classification (FCC) developed by Buol (1972) and later modified by Sanchez *et al.,* (1982) is one of several land evaluation systems that are in existence. It is a technical soil classification system that groups soils according to their fertility constraints in a qualitative manner. Soils are assessed in this system by determining whether the characteristics are present or not. The FCC then lists the "type" and "substrata type" (if present) in upper case letters and the modifiers in lower case letters. The absence of modifiers suggests no major fertility limitation other than nitrogen deficiency.

Niger State is an agrarian state and is endowed with 110,000 ha of fadama equivalent to about 3.5% of its total land area (Gwarry, 1995). Katcha which is one of the Local Government Areas (LGAs) of Nigerian State is partly inundated by river Niger and many of its tributaries. The fadama ecosystems in Katcha LGA over the years are being used commonly for the growing of paddy rice and sugarcane under rain-fed condition. The available information on soils resources utilization for the study area was on socio-economic survey concerning the adoption of rice cultivars by farmers (Jirgi *et al.*, 2009) and none to assess the agricultural potential of its large fadama ecosystems. Therefore, this study was carried out to evaluate the suitability of three fadama soils in Katcha LGA of Niger State, Nigeria for arable cropping using the FCC system.

MATERIALS AND METHODS

The study site was Katcha LGA occupying an area of 1,681 km^2 in southern part of Niger State lying on latitude 09° 09′ N and longitude 06° 14′ E in the southern Guinea savanna agroecological zone of Nigeria. It was classified under sub-humid Central Niger-Benue Trough agro-ecological zone of Nigeria, characterized by an extensive flat to very gently undulating lowlands with broad interfluves over very deep weathered Nupe sandstones. The soils are broadly described as poorly drained gray soils (*Dystric Fluvisols)* and are predominantly cropped to rice with annual rainfall ranging between 1182 and 1301 mm that usually covers the months of May and October (Ojanuga, 2006b).

Three fadama sites namely Gbakogi, Katcha and Kashe were identified from the baseline survey of hydrogeology and soils of Niger State. Soil samples were collected along diagonal transects from each fadama at 0-15 cm and 15-30 cm depths, bulked together to form a composite sample for each site. The soil samples were analyzed for physical and chemical properties to assess their fertility status and for Fertility Capability Classification.

The soil samples were air-dried and crushed to pass through a 2 mm sieve and some were further passed through 0.5 mm sieve for total N determination. The samples were subjected to analysis using standard methods as outlined in ISRIC/FAO (2002). Briefly, particle size distribution was determined by Bouyocous hydrometer method; pH in H_2O using 1:2.5 soil water ratio; organic carbon content by the Walkley-Black method; total nitrogen (TN) by Kjeldahl method; available phosphorus by Bray P-1 method. The exchangeable cations (Ca, Mg, K and Na) were extracted in ammonium acetate at pH 7. The Ca and Mg were determined by atomic absorption spectrophotometry (AAS) while K and Na were determined by flame photometry. Effective cation exchange capacity (ECEC), exchangeable Na percentage and base saturation were by calculation.

The soils were evaluated for arable cropping using the Fertility Capability Classification (FCC) system of Sanchez *et al.*, (1982).

RESULTS AND DISCUSSION

Soil Physicochemical Properties

The data on physical and chemical properties of the soils are shown in Tables 1 and 2 respectively and the interpretations of chemical properties based on Esu (1991) in Table 3. The textural class of the surface horizons was sandy clay loam for Gbakogi and Katcha and sandy clay for Kashe. However, sand was the dominant fraction, probably because the soils were derived from sedimentary rocks (Nupe sandstones). Sandstone parent material usually gives rise to soils with high sand particle content (Brady and Weil, 2002). In all the sites, there was no evidence of clay migration, suggesting that the soils are young. Silt/clay ratio of > 0.32 in all soils further confirmed the young age of the soils. Asomoa (1973) indicated that young parent material usually have silt/clay ratio greater than 0.25.

The soil reaction for the soils was moderately acidic in Katcha (pH, 5.0) to slightly acidic in Gbakogi (pH, 6.4) and Kashe (pH, 5.8). The low pH may be associated with their silicarich parent material (Ojanuga, 2006a). Relatively, the results imply that some plant nutrients may be more readily available in the soils of Gbakogi and Kashe than those of Katcha. The pH values of Gbakogi and Kashe fell within the normal range of 5.5 – 7.0 reported to be optimum for the release of some plant nutrients (Brady and Weil, 2010). The soils of Katcha may require liming in order to raise the pH level to the normal range. Except in Katcha, the soils of other sites were characterized with decreasing pH down their profile. This trend may be due partly to the aluminosilicate clay minerals releasing $A1^{3+}$ and/H^+ into the soil solution through isomorphous substitution (Tisdale *et al.*, 1985), or may be linked to the effect of nutrient bio-cycling (Ogunwale *et al.*, 2002). The available P and its distribution varied among the sites. The values for the surface horizons were 35, 26 and 12 mg kg^{-1} for Gbakogi, Katcha and Kashe respectively and were rated moderate to high. The moderate to high P status in these soils may be due to the applied phosphorus containing fertilizers by the farmers. Furthermore, a fairly uniform distribution of P observed within the soil profile of Kashe may be as a result of consistent deep tillage practices by the farmers during land preparation which might have resulted in the mixing of the soil and fertilizer P (Andraski *et al.*, 2003).

The organic C was 0.47, 1.25 and 1.32 g kg^{-1} for Gbakogi, Katcha and Kashe respectively and was slightly more in the subsurface. It was rated low for all the sites irrespective of soil depth. The low organic C content of the soils is characteristics of the savanna due partly to rapid decomposition and mineralization of organic matter and to poor management sometimes by burning of crop residues by farmers. Greenland *et al.*, (1992) attributed decline in soil organic matter content to intensification of agricultural activities through clearning and clean cultivation of soils for annual cropping. Thus, the farmers within the study area need to adopt cultural practices that will encourage the return and incorporation of plant/crop residues into these soils in order to beef up the soil organic C level. The total nitrogen (TN) values were 0.07-0.39, 0.28-0.42 and 0.14-0.21 g kg^{-1} for Gbakogi, Katcha and kashe respectively and were all rated low at the surface and high in the subsurface. Similar to organic C, the TN increases with depth in all the soils. Soil organic matter is the main source of N in the soil. The increase in soil organic C and TN down the soil profile depth is an indication of the young or immature nature of the profile due to seasonal deposition of materials. Generally, the C/N ratio was less than 20 for all the sites and this ratio may favour nitrogen mineralization in these soils (Brady and Weil, 2010).

The Ca values were 2.96 – 9.72, 4.00 – 5.28 and 4.00 – 6.00 cmol kg^{-1} for Gbakogi, Katcha and Kashe respectively and were rated high except for the surface horizon of Gbakogi which was rated as medium. Ca was the dominant cation in all the sites, probably because the alluvial materials from which these soils were formed from were derived from sedimentary rocks (Nupe sandstones) rich in minerals such as calcite/dolomite. The dominance of Ca on the exchange sites may also be attributed to Ca being the least easily lost from the soil exchange complex. It has been said to be the most abundant cation in exchange complex of nearly all soils that are not so acidic as to have a high aluminium saturation (Brady and Weil, 2010). In all the sites, Mg was high irrespective of soil depth and was more in the surface than subsurface except in Gbakogi. Mg had values of 2.00 – 2.94, 4.00 – 4.64 and 3.52 – 4.08 cmol kg^{-1} for Gbakogi, Katcha and Kashe respectively. K was low in Gbakogi (0.05-0.10 cmol kg^{-1}) and high in Katcha (1.07-0.78 cmol kg^{-1}) and Kashe (1.80-0.51 cmol kg^{-1}). Similarly, Na was high in all the sites except the surface horizon of Gbakogi where it was rated as medium. Furthermore, Na increased with increasing soil depth and had values of 0.28-0.63, 0.61-0.65 and 1.00-1.37 cmol kg^{-1} for Gbakogi, Katcha and kashe respectively. Currently, the highest exchangeable sodium percentage (ESP) recorded for these soils was 10.89% which is below the critical limit of 15%, thus, removing the possibility of soil dispersion, poor tilth, surface crusting and impermeable to water (George, 1983). However, there is a need for proper management of these soils by farmers in order not to raise the Na to a level that may destroy the soil structure. Omar (2011) suggested incorporation of organic materials, crop residues and or farmyard manure into the soil to reduce Na ion concentration in the soil. The effective cation exchange capacity (ECEC) values were 12.60-20.99, 12.72-14.31 and 12.60-16-88 cmol kg^{-1} respectively for Gbakogi, Katcha and Kashe. The ECEC in all the soils was rated high except in the surface horizon of soils of Gbakogi where it was rated as medium. The medium to high ECEC values was probably as a result of fairly high clay content in the soils (Table 1).

Fertility Capability Classification

The summary of the FCC is shown in Appendix 1, while the Fertility Capability Units (FCU) and interpretation for each soil is given below.

Soil	Unit	Interpretation
Gbakogi	Lgk	Good water holding capacity; medium infiltration capacity; limitation in drainage, hence tillage operations and some crops may be adversely affected unless drainage is improved; low ability to supply K, availability of K should be monitored, K fertilizer may be required for plants requiring high levels of K.
Katcha and kashe	Cghi	Undesirable clay-textured surface soils; drainage limited, hence tillage operations and some crops may be adversely affected unless drainage is improved; moderately acid soils, so liming may be required for some crops; excellent soils for flooded rice, as acidity will be eliminated by flooding; high P fixation, heavy application of P fertilizer may be required by plants sensitive to P.

CONCLUSION

The soils are rated suitable for arable crops cultivation but they will all require different management practices for optimum and sustainable productivity. In their present form, Katcha and Kashe are excellent soils for flooded rice cultivation with both of them requiring heavy P fertilization especially for leguminous crops that are sensitive to P. Gbakogi soil will require K fertilization especially for root, tuber and vegetable crops that need high amount of K. All the soils will require land preparation involving ploughing, harrowing and ridging in addition to field drainages to conduct excess water away from the fields when arable crops not tolerant to water-logging are cultivated. In all the soils, there is the need to increase the organic matter content by incorporation of crop residues and organic manure

Table 1: Physical properties of the selected Fadama soils of Katcha LGA, Niger State, Nigeria

Site	Soil Depth (cm)	Texture (g kg^{-1}) Sand	Silt	Clay	Textural class*	Silt/clay ratio
Gbakogi	0-15	578	180	242	Scl	0.74
	15-30	658	90	249	Scl	0.36
Katcha	0-15	473	173	354	Scl	0.49
	15-30	413	353	334	Cl	1.07
Kashe	0-15	453	133	414	Sc	0.32
	15-30	432	273	294	Cl	0.93

*Scl = sandy clay loam; cl = clay loam; sc = sandy clay.

Table 2: Chemical properties of Fadama soils of Katcha LGA, Niger State, Nigeria.

Location	Soil Depth (cm)	pH (H_2O)	Av. P (mg kg^{-1})	TN	O.C	C/N	Exch. Bases (cmol kg^{-1})				Ex. Ac.	ECEC	ESP* (%)
					(g kg^{-1})		Ca	Mg	K	Na	(cmol kg^{-1})		
Gbakogi	0-15	6.4	35	0.07	0.47	6.71	2.96	2.00	0.05	0.28	3.20	8.49	3.30
	15-30	6.0	5	0.39	0.54	1.38	9.72	4.94	0.10	0.63	5.60	20.99	3.00
Katcha	0-15	5.0	26	0.28	1.25	4.46	4.00	4.64	1.07	0.61	2.46	12.72	4.80
	15-30	5.4	7	0.42	1.50	3.57	5.28	4.00	0.78	0.65	3.60	14.31	4.54
Kasha	0-15	5.8	12	0.14	1.32	9.43	6.00	4.08	1.80	1.00	4.00	16.88	5.92
	15-30	4.8	14	0.21	1.53	7.29	4.00	3.52	0.51	1.37	3.20	12.60	10.89

*Av. P = available phosphorus; TN = total nitrogen; O.C. = organic carbon; Ex. Ac. = exchangeable acidity; ECEC = effective cation exchange capacity; ESP = exchangeable sodium percentage.

Table 3: Critical limits for interpreting levels of analytical parameters

Parameter	Low	Medium	High
Ca^{2+} ($cmol_{(+)}\ kg^{-1}$)	< 2	2 – 5	> 5
Mg^{2+} ($cmol_{(+)}\ kg^{-1}$)	< 0.3	0.3 – 1	> 1
K^{+} ($cmol_{(+)}\ kg^{-1}$)	< 0.15	0.15 – 0.3	> 0.3
Na^{2+} ($cmol_{(+)}\ kg^{-1}$)	< 0.1	0.1 – 0.3	> 0.3
CEC ($cmol_{(+)}\ kg^{-1}$)	< 6	6 – 12	> 12
Org. C ($g\ kg^{-1}$)	< 10	10 – 15	> 15
Total N ($g\ kg^{-1}$)	< 0.1	0.1 – 0.2	> 0.2
Avail. P. ($mg\ kg^{-1}$)	< 10	10 – 20	> 20
B.S (%)	< 50	50 – 80	> 80

Source: Esu (1991)

REFERENCES

Adeboye, M.K.A. (1994). The physicochemical properties and evaluation of Kaduna Polytechnic Farm soils for arable cropping *Spectrum,* 1:36-42.

Andraski, T.W., L.G. Bundy and K.C. Kilian (2003). Manure history and long-term tillage effects on soil properties and phosphorus losses in runoff. *J. Environ. Qual.,* 32: 1782-1789.

Asomoa, G.K. (1973) Particle-size from iron oxide distribution in some latosols and groundwater laterites of Ghana. *Georderma.* 10:285-297.

Brady, N.C. and R. Weil (2010). *Elements of the Nature and Properties of soils.* 3rd edition, Pearson Education, Inc., Upper Saddle River, New Jersey 07458, 163 pp.

Brady, N.C. and R. Weil (2002). *The Nature and Properties of Soils.* 13th edition. Singapore, Pearson Education. 976 pp.

Buol, S.W. (1972). Fertility Capability Classification System. In: Agronomic-Economics Research on Tropical Soils. Annual Report, 1971. Soil Science Department, North Carolina State University, Raleigh, N.C. pp 45-50.

Dent, D. And A. Young (1980). Soil Survey and Land Evaluation. George Allen & Unwin, London. 278 pp.

Esu, I.E. (1991). Detailed Soil survey of NIHORT Farm at Bunkure, Kano State, Nigeria. Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. 72 pp.

FAO (1976). A Framework for Land Evaluation. Soils Bulletin 32, Food Agricultural Organization, Rome.

FAO (1995). *World Agriculture: Towards 2010. An FAO Study.* Alexandratos, N. (ed.). Published by the Food and Agriculture Organization of the United Nations and John Wiley & Sons Ltd. England. 383 pp.

George, P.R. (1983). Agricultural Water Quality Criteria Irrigation Aspects. Resource Management Technical Report No. 30. Department of Agriculture Western Australia. 12 pp.

Greenland D.J., A. Wild, and D. Adams (1992). Organic matter dynamics in soils of the tropics – from myth to reality. In: Lal R. And Sanchez P.A. (eds.), *Myths and Science of Soils in the Tropics.* Soil Science Society of America, Madison, pp. 17-39.

Gwarry, D.M. (1995). *Sustainable food production through fadama farming in the Semi-Arid zone of North-Eastern Nigeria.* A paper presented at 11th Annual Conference of Farm Management Association of Nigeria, Uyo.

ILRI (1993). *Inland Valleys in West Africa: An Agro-Ecological Characterization of Rice-Growing Environments.* P.N. Windmeijer and W. Andriesse (eds.), Publication 52, International Institute for Land Reclamation and Improvement. 160 pp.

ISRIC/FAO (2002). Procedures for Soil Analysis. Sixth edition L.P. van Reeuwijk. International Soil Reference and Information Centre/Food and Agricultural Organisation, 119 pp.

Jirgi, A.J.M. Abdulrahman and F.D. Ibrahim (2009). Adoption of Improved Rice Varieties among Small-Scale Farmers in Katcha Local Government Area of Niger State, Nigeria. *Journal of Agricultural Extension,* 13 (1): 95-101.

Ogunwale, J.A., J.O. Olaniyan and M.O. Aduloju (2002). Morphological, Physico-Chemical and Clay Mineralogical Properties of Soils Overlaying Basement Complex Rocks in Ilorin East, Nigeria. *Moor Journal of Agricultural Research,* 3(2): 147-154.

Ojanuga, A.G. (2006a). Management of Fadama Soils for Food Security and Poverty Alleviation. In: S. Idoga, S.A. Ayuba, A. Ali, O.O. Agbede and S.O. Ojeniyi (eds). Management of Fadama Soils for Environmental Quality. Food Security and Poverty Alleviation in Nigeria. *Proceedings of the 30th Annual Conference of Soils Science Society of Nigeria.* University of Agriculture, Makurdi, Nigeria, pp 10-15.

Ojanuga, A.G. (2006b). Agroecological Zones of Nigeria Manual. FAO/NSPFS, Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria, 124 pp.

Omar, G. (2011). Assessment of the Fertility Status of some Irrigated Fluvisols in Northern Guinea Savannah of Nigeria. *Savannah Journal of Agriculture.* 6(1): 19-31.

Onyekwere, I.N., A.U. Akpan-Idiom, U.C. Aminu, D.O. Asawalam and P.C. Eze (2001). Conditions and opportunities in Agriculture utilization of some wetland soils of Akwa-Ibom State. In: S.O. Ojeniyi, I.E. Esu, U.C. Amalu, F.O.R. Akamigbo, I.J. Ibagan and B.A. Raji (eds.). Management of wetland soils for sustainable agriculture and the environment. Proceedings of the 27th Annual Conference of Soil Science Society of Nigeria, pp 139-149.

Sanchez, P.A., W. Croto and S.W. Buol (1982). The Fertility Capability Classification System: Interpretation, applicability and modification. *Geoderma,* 27: 283-309.

Singh, B.R. (1999). Fertility and salinity/sodicity status of fadama soils in north-western Nigeria I. Kebbi State. *Nigerian Journal of Basic and Applied Sciences,* 8:1-14.

Singh, B.R. (1997). Potentials and challenges of fadama farming in the semi-arid erstwhile Sokoto State, Nigeria. In: Proceedings of the 23rd Annual Conference of Soil Science of Nigeria, held at the Congregation Hall, City Campus, Usman Danfodiyo University, Sokoto, Nigeria.

Tisdale, S.L., W. Nelson and J.D. Beaton (1985). Soil Fertility and Fertilizer. 4th Edn. MacMillan Publishers, New York, pp 382-391

APPENDIX 1

Summary of fertility capability classification system (Sanchez et al., 1982)

There are three categorical levels: Type, Subsrata type and modifiers (15). Class designation from the three levels are combined to form an FCC unit.

Type: Texture of plow layer or surface 20 cm whichever is shallower.

S = sandy topsoil: loamy sands and sands;

L = loamy topsoil: < 35% clay but not loamy sand or sand;

C = Clayey topsoil: > 35% clay;

O = Organic soil: > 30% O.M. to a depth of 50 cm or more.

Substrata Type: Texture of subsoil, Used only if there is marked change from the surface, or if a hard root restricting layer is encountered within 50 cm:

S = Sandy subsoil: texture as in type;

L = Loamy subsoil: texture as in type;

C = Clayey subsoil: texture as in type;

R = Rock or other hard root restricting.

Modifiers:

g = (gley): soil or mottles 2 chroma within 60 cm of the surface and below all A horizons, or soil saturated with water for > 60 days in most years;

d = (dry): ustic, aridic or xeric moisture regimes;

e = (low CEC): applies to plow layer or surface 20 cm whichever is shallower. ECEC a me/100 g soil or CEC (NH_4Oac), 7 me/100g soil or 10 me/100 g soil (by $BaCl_2$ at pH 8.2).

a = (aluminium toxicity): > 60% Al saturation of ECEC or 67% acidity saturation of CEC by NH_4Oac.

h = (acid): pH 1:1 H_2O between 5.0 and 6.0;

i = (high P-fixation) by iron): % free Fe_2O_3/ % clay > 0.15 and > than 35% clay or hues of 7.5 YR or redder and granular structure. Applicable only to $^{(C)}$ types and for the plow layer or 0-20 cm whichever is shallower.

x = (x-ray amorphous): pH K 10 in 1N NaF;

v = (vertisol): > 35% clay and > 50% 2:1 expanding clays or severe topsoil shrinking and swelling

k = (low K reserves): Exchangeable K < 0.2 me/100g;

b = (basic reaction): Free $CaCO_3$ within 50 cm of soil surface (effervescence with HCl), or pH > 7.3

s = (salinity): > 4 mhos/cm EC_{25} within 1 m of the surface;

n = (nitric): > 15% Na-saturation of CEC within 50cm of surface;

c = (cat clay): pH in 1:1 H_2O is < 3/5 after drying and jarosite mottles with hues of 2.5 Y or yellower and chromas of 6 or more are present within 60cm of the soil surface;

1 = (gravel): a prime (′) denotes 15-35% gravel or coarser (> 2 mm) particles by volume to any type substrata type texture; two prime marks (″) denote > 35% gravel or coarser (> 2 mm) particles by volume;

% = (slope): where it is desirable to show slope, with the FCC, the slpe range percentage can be placed in parenthesis after the last condition modifier (e.g. Sb (1-6 %).

The FCC unit list the type and substrata type (if present) in capital letters. The absence of modifiers suggests no major fertility limitations other than nitrogen deficiency