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Abstract

Cassava and rice are major food security crops in Nigeria, occupying prominent positions in the diets and farming systems in the Southeast Agro-ecological zone. This study investigated Olokoro Soils status for Cassava/Upland rice intercrops. Profile pits were dug and studied, using the rigid grid survey techniques, soil samples from pedogenetic horizons were collected processed and analyzed, and results showed that the soils colour ranged from dark grayish brown (10 YR 4/2) to dark reddish brown, (5 YR 4/2), the soils were weakly to strongly aggregated, and posses loamy sand to sandy clay loam textures. pH ranged from 4.5 to 4.9 organic carbon ranged from 5 to 36 mg kg-$^{1.}$ The exchangeable bases and CEC were low while the base saturation ranged from 31 to 50 %. Based on the criteria of soil Taxonomy, the soil has been classified as Haplic Nitosol and is moderately suitable for cassava / upland rice intercrops

Keywords: Evaluation, Cassava, Upland Rice, Olokoro Soils, Abia State

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Introduction

Relative scarce commodity of land for agriculture, food security of the world population and suitability assessment of an area for crop production require considerable land use accuracy. Therefore, in order to help developers and agriculturists match the optimum use of land, land suitability evaluation, plays a very important role as a part of rational cropping system (Jafarzadeh *et a*l., 2010) and land use optimization for a specific use (Sys *et al.,* 1991a). Land suitability evaluation has been defined as the fitness of a given tract of Land for a specified kind of use (FAO ,1984). Ibanga (2003) described land evaluation as the process of estimating the potentials of land for alternate kind of use. Based on its attributes and potentials, every land is suitable for a particular use. Thus land suitability is assessed, classified and presented separately for each kind of use. This implies that land suitability evaluation is necessary as a first step to land use planning. This will enhance judicious and maximum utilization of any available piece of land without jeopardizing the prospect of future generation. Again it is essential to the determination of the potentials and constituents of soils to crop yield.

The quest for wise use of soils calls for their characterization as a pre-requisite to proper land suitability evaluation for various competing uses of land, and knowledge of the soil properties is very essential as this can affect crop yield and influence potential management for sustainable productivity. In southeastern Nigeria increasing demographic pressure and ecological problem, particularly soil erosion in addition to oil spillage accelerated rural – urban industrialization, diminish available agricultural land. Thus fallow periods are reduced and the productivity of the available land lowered (Asawalam and Chukwu 2000). The above highlighted problems make crop intensification on the available piece of land imperative. This can result to intercropping cassava and upland rice the two major crops widely cultivated and consumed in Nigeria, which have presidential initiative.

Cassava is an important staple and cash crop. Nigeria is the largest producer in the world. Cassava plays a major role in the economy of Nigeria, as it supplies more than half the calorie intake of Nigerians (Abam *et a*l., 2006). It is also the most widely grown root crop across Nigeria, most especially the Southeast agro ecological zone. Thus increase in the production of cassava is of strategic interest to people of this region to cushion the effects of population pressure, enhance poverty reduction sustainable food and nutrition security and income generation (Nkanleu and Gockowski 2006). Rice is an important staple crop in Nigeria and indeed most countries in the world, though there had been a gradual increase in the production of the commodity over the past years. Its consumption rate is as well on the increase. Oladiran (2010) estimated that Nigeria imported about 22 billon kg of rice in 2010 to meet local requirements. Therefore making sustained research on effort towards increasing local production is very imperative. This can be done through cassava upland rice intercropping system, It should be noted that Nigeria`s leading role in world`s production rate of cassava is not as a result of yield but due to vast area of land being allocated for its production.

Cassava and upland rice are important and commercially produced solely in most parts of Southeastern Nigeria agro ecological zone. Their production depends very much on climate, soil, topography and water availability, that are the most important categories of environmental information required for judging land suitability. Also in different parts of Nigeria, land suitability evaluation has been done for cassava and upland rice production solely, but none has been done on the intercrops. The objective of this study is to characterize, classify, and evaluate the suitability of Olokoro soils for cassava/upland rice intercropping system.

Materials and Methods

The study area is Olokoro Umuahia South Local Government Area (LGA) of Abia State Southeastern Nigeria. The area falls within the tropical rainforest zone and lies between latitude 5^0 27^1 and 5^0 28 N and 7^0 29^1 to 7^0 32^1 E, situated at the elevation of 154.25m. The soils are derived from coastal plain sand. The total annual rainfall of the area is about 2.200mm, the mean annual temperature is about 31^0C and the mean annual relative humidity is about 75%. The soils occupy very complex upper, middle and lower slopes positions but the overall micro-relief consist of slightly undulating to gently sloping terrain of not more than 3% gradient. A detailed soil survey using the rigid grid format was conducted. Transverses were cut along a properly aligned base line at 200m intervals while auger borings were made at 25cm interval to a depth of 100cm. Physical and morphological (colour, texture, structure, consistency and inclusions) soil descriptions were made, Following which three soil units were delineated. Then three profile pits were dug and described according to the guideline for profile pit description (Soil Survey Staff, 2006). Soil samples were collected from identified soil horizons packaged in soil bags, then labeled and transported to the laboratory for analysis.

The soil samples were air dried, gently crushed, sieved through a 0.5mm sieve because of organic carbon and total Nitrogen and analysed in the laboratory using standard routine methods as contained in the method of soil analysis by Udoh *et al.* **(**2010). Soil particle size analysis, was determined using Bouyocos hydrometer method, Soil pH (H_20) was determined in 1:1 soil/water suspensions using a glass electrode, organic carbon by Walkey and black titration method, total nitrogen was by Kyeldahl method; available phosphorus was determined using Bray P -1 of Bray and Kurtz method. Exchangeable bases were extracted using IN NH4OAC at pH 7 and determined by the EDTA titration method and Ca, K and Na by flame photometry method and Mg by EDTA titration, using Molybdenum blue Colorometry Micronutrients (Fe, zn, Cu and Mn) in the soils were extracted with 0. I M HCI solution. And the filtrates determined with Atomic Absorption Spectrometer, at their respective resonance lines using standard calibration method.

Land Suitability evaluation of the soils, were assed using the parametric method of Ande (2011) for cassava. And Fagbemi and Akamigbo (1986) method for upland rice

Results and Discussion

The Meteorological data of the study area are shown in Table 1. The field morphological properties of the pedons studied are presented in table 2. The soils include very deep drained, loamy sand to sandy clay loam dark grayish brown (10 YR 4/2) to dark reddish brown (5 YR 3/2) at the upper horizon, sandy clay loam dark brown (10 YR 4/3) to dark reddish brown (5 YR 3/2) moist at the sub-soils. The rather deep nature of the soils can be attributed to the nature of the parent materials of the soils, which is coastal plain sands Federal Ministry of Agriculture and Natural Resources (1990). The loamy sand to sandy clay texture of the soils confers a weak single grained to moderate medium sub-angular blocky structure.

The sand fraction of the pedons studied ranged from 62.01 to 86.24%, in pedon one it decreased down the depth, whereas there was no definite pattern of distribution in the other pedons. The silt content ranged from 1.40 to 18.60% and did not maintain any particular pattern of distribution. The clay content ranged from 9.20 to 36.00%, and increased with depth in pedon three which is as a result of elluviation-illuviation processes going on in the soils and it fails to maintain any pattern of distribution in other pedons. (Silt + Clay) % values of the soils ranged from 13.76 to 37.40%, which is corroborated by Ezenwa (1987). The values of silt/clay ratio of the soils ranged from 0.04 to 0.50, an indication that apart from soils of AP and Bt3 horizons in pedon 1 and AP horizon in pedon 3 all the soils are old soils derived from old parent materials Asmoa (1983) reported that soils with silt/clay ratio less than 0.25indicateslowdegreeofweathering.

The textual classification of the AP horizons in all the pedons studied ranged from sandy loam to sandy clay loam. Generally the textual classification of these soils agrees with optimum criterion of light medium loams, sandy soils (Onyekwere *et a*l 2009) required for unhindered anchorage and bulking of roots and tubers and for easy harvest. and Adeosun *et al* .(2005) , reported that Sandy loams to heavy clays are better suited for rice production. This gives the indication that these soils are conducive for the production of cassava and rice. N, P and K are primary nutrients most commonly demanded by root and cereal crops most especially cassava and rice as well as other crops in plant nutrition. This explains why most compound fertilizers and fertilizer requirements for this crop are based on N, P and K (Onyekwere *et al* 2009). The results of these nutrients are shown in Table 4

The total nitrogen content of the soils studied ranged from 0.01 to 0.21%. apart from soils of Pedon 1 the values of other Pedons decreased down the slope. The surface soils (AP horizons) had total nitrogen content range of 0.08 to 0.21% with a mean value of 0.14%. Apart from that of pedon 2 that had value exceeding the critical level of 0.15% required for sustainable crop production. The remaining pedons studied were deficient in total N. The low content of total N in the soils could be attributed to low organic matter of these soils, since inorganic N is accounting for only a small portion of total N in soils (Almu and Audu 2001). The low amount of total N reflects the amount of organic carbon in the soils. Variable response to applied nitrogen was thus expected in these soils. The available phosphorus values of the pedons ranged from 7.00 to 36.00 mgkg^{-1}. Pedon 1 had no definite pattern of distribution of available P. Pedon 2 values decreased with depth, while those of pedon 3 increased with depth. The upper horizons had values that ranged from 9.00 to 36.00 mgkg-^{1}, with a mean value 26 mgkg-1. The mean value obtained exceeded the critical limit of 8.0mgkg^{-1}. Bray 1-P established for crops in South Eastern Nigeria including cassava and rice (FPDD) 1989) and the critical level of 15 mgkg^{-1} Bray 1 extractable P recommended by Thomas and Peaslee (1973) cited by Onyekwere *et al.* (2009). This result showed that the soils had the available P requirement for the production of the intercrops.

The values of the exchangeable K of the soils studied ranged from 0.01 to 0.07 cmol (+) kg-$^{1.}$ Pedons 1 and 3 did not maintain any definite pattern of distribution of exchangeable K, while values of pedon 2 decreased with depth. The surface soils had values that ranged from 0.02 to 0.07 cmol (+)kg$^{-1,}$ with a mean value of 0.05 cmol (+)kg^{-1}, having values below the critical limit of 0.2 cmol (+)kg^{-1} recommended for soils of South Eastern Nigeria (FPDD) 1989),for the production of the intercrops. These suggest that all the soils will show substantial responses to applied potassium. According to Chukwu (1997), Olokoro farming area is subjected to annual and seasonal bush burning which occur about January to April. Burning deprives the soils of natural organic matter from vegetation and exposes the soils to erosive impact of heavy annual precipitation (about 2000mm) in this area. This aggravates leaching due to the coarse nature of the soils. There is high demographic pressure in the area necessitating unavoidable pressure on the land in quest for food and money with consequential reduction in fallow periods. These factors explain the deficiencies of total N and exchangeable K observed. Selected chemical properties of the pedons studied are presented in Table 5.

The soil reactions expressed as pH (H20) were strongly acidic, with a range of 4.5 to 4.9. There was no definite pattern of changes in pH down the slope in all the pedons studied. The AP horizons had an average value of 4.9. Soil acidity will not pose a problem in the production of the intercrops, as both crops are acid tolerant. The organic carbon content varied from very low to moderate that is from 0.70 to 2.27%. They were distributed irregularly down the slope, apart from pedon 2 where it decreased down the slope. The AP horizons had a value range of 1.75 to 2.27% with a mean value of 2.03%. Maintenance of a satisfactory organic matter status is essential to the production of most of the Nitrogen and half of the Phosphorus taken up by unfertilized crops (Von Uxekull 1986), including cassava and rice. The soils are very low in their content exchangeable Ca, with surface soils value that varied from 0.30 to 0.58 cmol (+)kg^{-1}. Exchangeable Mg in the surface soils were moderate with values that varied from 0.60 to 2.50 cmol (+)kg^{-1}, while exchangeable Na were low ranging from 0.06 to 0.09 cmol (+)kg^{-1}. ECEC values of the soils varied from 1.88 to 8.86 cmol (+) kg^{-1}. This result indicates that the effective Cation Exchange Capacity of the soils is low. The low ECEC and nutrient reserves of the soils have been attributed to the fact that soils of South Eastern Nigeria are strongly weathered have little or no content of weatherable rock in sand And silt fraction and have predominantly kaolinite in their clay fractions (FPDD 1989)

The soils were classified according to the USDA soil Taxonomy (Soil Survey Staff 2006) and correlated with the FAO/UNESCO Soil Legend World Reference Base (WRB) for Soil Resources (FAO 2006) Table 6. The soils are formed under udic moisture regime there is an evidence of argillic, and kandic horizons, presence of old and well developed B horizons so the three pedons were therefore classified as ultisols. The finally met the requirement for classification as Kandic Paleudult under the subgroup level. In the WRB all the soils of the three pedons were classified as Dystric Nitosol. Land suitability classification of the pedons studied is presented in Table 7 to 9. Land Suitability evaluation of the soils, were done using the parametric method of Ande (2011) for cassava. And Fagbemi and Akamigbo (1986) method for upland rice The parameters used for the land quality calculation include rainfall, length of growing season, mean temperature, slope, wetness, drainage and texture Materials are soil depth, fertility, cation exchange capacity, base saturation and organic carbon. The sums of these were divided by the number of the parameters considered to determine their values. The soils suitability classifications consist of assessing and grouping the land types in orders, classes, subclasses and units based on the crop requirements, as sole and as intercrops. The suitability classification was done separately for each pedon identified in the surveyed area

Table7, shows the suitability classification of the pedons for cassava production. All the pedons were moderately suitable (S_{2f}), for cassava production. The suitability subclass shows that fertility was low. However, these soils possess limitations, which were low fertility, especially the primary nutrients (N and K) which are at the critical level . This however, does not preclude its use for sustainable production of cassava, since the soil fertility and nutrient level can be greatly improved with the use of inorganic and organic fertilizers. This result was similar to results of Ande *et al*. (2008) in their research on savanna soils in south western Nigeria. It has also been confirmed that cassava produce maximally on light to medium texture and fertile soil (Howeler, 2002). Sulphate fertilizers should be avoided so as not to raise the level of soil acidity above the present level.

One of the most important requirement of rice crop is the availability of water throughout the period .Water is therefore the most important limiting factor in upland rice production .For this reason soil characteristics that influence infiltration retention and minimal loss of water are considered as limitation in rating for rice production. Soil slope, depth, texture and structure are such characteristics. Table 8, shows the suitability classification of the pedons for upland rice production. Pedons 1 and 2 were marginally suitable (S_3w), for upland rice production. Pedon 3 was moderately Suitable (S_2w). The suitability subclass showed that moisture was the limiting factor All the pedons were light textured soils and were classified as either marginally suitable (pedons 1 and 2) or moderately suitable (pedon 3) due to the availability of water throughout the period .However, these soils possess limitations, which was moisture, as a result of the slope and soil texture which are light. This however, does not preclude its use for sustainable production of upland rice, since the moisture availability can be greatly improved. (Dent and Young 1981). Table9, shows the suitability classification of the pedons for production of the intercrops, All the pedons in both soils, were moderately suitable (S2) for cassava and upland rice production.

This was based on the nutrient requirements of both crops which showed that the limitation, was low fertility, especially the primary nutrients (N and K) which are at the critical level . And based on the fact that cassava was considered as the base crop in the intercropping system and will stay in the soil for up to 12 MAP compared to upland rice that will stay for only 3 to 4 MAP. In terms of wetness, cassava varieties that withstand high moisture level have been developed by the National Root Crops Research Institute Umudike .Therefore, priority need to be placed on cassava in selecting the criteria for land suitability classification for the production of intercropping system involving cassava and some other crops with shorter gestation period.

Conclusion and Recommendations

From the study it was revealed that the soils were deep, well drained, loamy sand to sandy clay loam, dark grayish brown to dark reddish brown, acidic, with low to moderate nitrogen, low exchangeable K and organic carbon content while the available P contents were low to high. The textual classifications of the soils were conducive for the production of the intercrops. The soils were moderately suitable for cassava/upland rice intercropping system

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Tables

Table 1: Ten years meteorological data of the study area

	Temperature (^oC)		Rainfall (mm)		Rel humidity (%)		Sunshine
Year	Minimum	Maximum	Days	Amount	1500	900	Hours
1999	22.67	31.10	159	2701.3	63	79	4.6
2000	23.25	31.92	138	1680.6	66	77	4.2
2001	22.33	31.33	137	2351.4	64	79	4.5
2002	22.67	31.25	137	2351.4	64	79	4.4
2003	22.83	31.75	134	2256.5	66	79	4.1
2004	22.42	31.92	123	1911.4	63	78	4.1
2005	22.50	32.08	147	2064.8	67	80	4.3
2006	22.75	31.50	122	2038.3	66	81	4.9
2007	22.42	31.67	142	2416.7	62	76	4.1
2008	22.58	31.50	141	2395.6	61	76	4.7

Source: National Cereals Research Institute Amakama Olokoro Out-station Meteorological Unit.

Table 2: Field morphological description of pedons studied

Horizon	**Depth**	**Matrix Colour**	**Texture**	**Structure**	**Consistency (Moist)**	**Boundary**	**Other Feature**
Pedon	**1**						
AP	0-15	5YR 3/2	LS	1fsg	vfr	Cs	m2rts
AB	15-35	5YR 4/3	SL	1fsbk	fr	Gs	m2rts
Bt1	35-70	5YR 4/6	SCL	2msbk	fr	Cs	f2rts
Bt2	70-110	5YR 4/4	SCL	2msbk	fr	Gs	m2rts, 3chcl
Bt3	110-150	5YR 3/2	SL	2msbk	fr	-	f2rts, 3chcl
Pedon	**2**						
AP	0-27	5YR ¾	SL	2msbk	sfm	Cw	m1rts,m3rts
AB	27-56	5YR 5/6	SCL	2msbk	fm	Gw	m1rts
Bt1	56-98	5YR 5/6	SCL	2msbk	fm	Cw	f2rts
Bt2	98-150	5YR 4/6	SCL	2msbk	vfm	-	f2rts
Pedon	**3**						
AP	0-15	10 YR 4/2	SL	1msg	fr	Gw	m1rts
AB	15-40	10 YR 4/3	SL	1msbk	fr	Gw	m1rts
Bt1	40-85	10 YR 4/4	SCL	2msbk	fr	Gw	f1rts
Bt2	85-120	7.5 YR 5/4	SCL	2msbk	fm	Gw	f2rts
Bt3	120-150	7.5 YR 5/6	SCL	2msbk	fm	-	f2rts

Boundary: a = abrupt, b = broken, c = clear, d = diffuses, s = smooth, w = wavy, I = irregular. When a dash (-) is present the property is not recorded. Structure: sbk = sub angular blockly, sg = single grained, c = coarse, cr = crumb, f = fine, m = medium, l = weak, 2 = moderate, 3 = strong. Consistency: Sfm = slightly firm, frm = firm, vfm = very friable, fr = friable. Texture: s = sand, SCL = sandy clay loam, Sl = sandy loam, LS = loamy sandy. Remarks: rts = roots, m = many, c = common, f = few, q = fine, 2 = medium, 3 = coarse, Fe-mm = manganiferrous concretionQtz = quartz fragments, Fe = iron nodules, chcl = Charcoal

Table 3: Physical properties of the pedons studied

Horizon	Depth	Particle	Size clay (%)Silt	(%) Silt	Clay + Silt (%)	Silt/Clay Ratio	Texture Class
Pedon	**1**						
Ap	0-15	81.40	14.80	18.6	18.60	0.22	LS
AB	15-35	80.80	16.80	2.40	19.20	0.14	SL
Bt1	35-70	71.81	16.79	3.40	28.20	0.14	SCL
Bt2	70-110	73.81	24.80	3.39	26.20	0.15	SCL
Bt3	110-150	75.80	18.80	5.40	24.20	0.29	SL
Pedon	**2**						
Ap	0-27	76.60	21.60	1.80	23.40	0.08	SL
AB	27-56	77.52	19.78	2.70	22.50	0.14	SCL
Bt1	56-98	68.01	29.59	2.40	32.00	0.08	SCL
Bt2	98-150	62.01	36.00	1.40	37.40	0.04	SC
Pedon	**3**						
Ap	0-15	86.24	9.20	4.56	13.76	0.50	SL
AB	15-40	78.24	19.20	2.56	21.76	0.13	SL
Bt1	40-85	72.24	24.20	3.56	27.76	0.15	SCL
Bt2	85-120	72.24	25.20	2.56	27.76	0.15	SCL
Bt3	120-150	73.24	25.20	1.56	26.76	0.06	SCL

Table 4: Primary nutrients of the pedons studied

Horizon	Depth (cm)	Total N (%)	Available P (mgkg-1)	Exchangeable K Cmol (+) kg-1
Pedon	**1**			
Ap	0-05	0.14	36.00	0.07
AB	15-35	0.11	36.00	0.03
Bt1	35-70	0.06	18.00	0.04
Bt2	70-100	0.08	30.00	0.04
Bt3	100-150	0.10	31.00	0.03
Pedon	**2**			
Ap	0-27	0.21	33.00	0.07
AB	27-56	0.16	8.00	0.04
Bt1	56-98	0.15	7.00	0.40
Bt2	98-150	0.14	5.00	0.03
Pedon	**3**			
Ap	0-15	0.08	9.00	0.02
AB	15-40	0.06	11.50	0.03
Bt1	40-85	0.04	15.50	0.03
Bt2	85-120	0.01	15.60	0.01
Bt3	120-150	0.01	20.00	0.05

Table 5: Selected chemical properties of the pedon studied

Horizon	Depth (cm)	pH (H20)	0C %	Exchangeable Bases Ca	Mg	Na	Exch. Acidity	CEC NH4OAC	ECEC	Base Salt (%)
				(← cmol(+)Kg^{-1}				→		
Pedon 1										
Ap	0-15	4.9	2.06	0.58	1.65	0.09	1.40	6.29	3.80	38.00
AB	15-35	4.9	1.50	0.39	1.15	0.04	1.60	6.42	3.20	50.00
Bt1	35-70	4.8	0.70	0.39	0.96	0.09	1.40	3.10	2.90	48.00
Bt2	70-100	4.8	0.90	0.39	0.96	0.10	1.20	2.98	2.80	50.00
Bt3	100-150	4.9	1.75	0.80	1.60	0.08	5.2	7.90	7.72	32.6
Pedon 2										
Ap	0-27	4.9	2.27	0.30	2.50	0.09	6.10	11.19	8.86	31.00
AB	27-56	4.7	1.27	0.80	1.60	0.08	5.20	7.88	7.72	32.60
Bt1	56-98	4.8	0.99	1.00	1.40	0.09	5.20	8.25	8.09	35.70
Bt2	98-150	4.7	0.69	0.60	1.60	0.08	5.30	10.00	7.81	32.00
Pedon 3										
Ap	0-15	4.9	1.75	0.40	0.60	0.06	0.80	2.70	1.88	40.00
AB	15-40	4.7	0.99	1.46	0.70	0.02	2.00	4.42	4.21	50.00
Bt1	40-85	4.8	0.66	1.16	0.77	0.04	4.00	6.06	4.00	33.30
Bt2	85-120	4.5	0.67	1.65	0.15	0.01	2.10	3.96	2.35	46.00
Bt3	120-150	4.9	0.16	1.16	0.38	0.08	1.00	3.90	3.10	41.00

Table 6: Taxonomic classification of soils studied

Pedon	USDA	WRB
Pedon 1	Kandic Paleudult	Haplic Nitosol
Pedon 2	kandic Paleudult	Haplic Nitosol
Pedon 3	Kandic Paleudult	Haplic Nitosol

Table 7: Suitability classification of the soils studied for cassava production using ande (2011) system

PEDON	ORDER	CLASS	SUBCLASS	UNIT
Pedon 1	S	Suitable	S2 (Moderately Suitable)	S_2fe
Pedon 2	S	Suitable	S2 (Moderately Suitable)	S_2fe
Pedon 3	S	Suitable	S2 (Moderately Suitable)	S_2f e

f = Nutrient deficiencies e = erosion

Table 8: Suitability classification of the soils studied for upland rice production using fagbemi and akamigbo (1986) system

PEDON	ORDER	CLASS	SUBCLASS	UNIT
Pedon 1	S	Suitable	S3 (Marginally Suitable)	S_3fwe
Pedon 2	S	Suitable	S3 (Marginally Suitable)	S_3fwe
Pedon 3	S	Suitable	S2 Moderately Suitable)	S_2f we

f = Nutrient deficiencies, w = wetness e = erosion

Table 9: Suitability Classification of the Soils studied for the production of the intercrops

PEDON	ORDER	CLASS	SUBCLASS	UNIT
Pedon 1	S	Suitable	S2 (Moderately Suitable)	S_2fe
Pedon 2	S	Suitable	S2 (Moderately Suitable)	S_2fe
Pedon 3	S	Suitable	S2 (Moderately Suitable)	S_2fe

f = Nutrient deficiencies, e = erosion