TARABA JOURNAL OF AGRICULTURAL RESEARCH
ISSN: 978-978-923-450-9
Email: tajar2011@yahoo.com, tajar2011@gmail.com
©tajar publication 2021

LAND SUITABILITY EVALUATION FOR SOME ARABLE AND TREE CROPS IN THE TEACHING AND RESEARCH FARM, AMBROSE ALLI UNIVERSITY, EKPOMA.

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Received 13th February, 2021 Accepted 28th December, 2021

ABSTRACT

This experiment was carried out in the Teaching and Research Farm of Ambrose Alli University, Ekpoma. The aim of this research was to: determine the suitability of the three existing mapping units for arable (cassava and maize) and tree crops (Rubber and oil palm) cultivation. Three pedons were sampled and analyzed for the physical and chemical characteristics. The crop requirements for cassava, maize, rubber and oil palm were matched with soil characteristics and the climatic data. Results showed that the three pedons were highly suitable for cassava cultivation, moderately suitable for maize cultivation due to some climatic defects and marginally suitable for both rubber and oil palm with base saturation, texture and rainfall being the limiting factors.

Keywords: Suitability, evaluation, mapping units, pedons, arable crops.

INTRODUCTION

Land suitability evaluation is the process of assessing the land for specified kind of use. Land suitability is the fitness of a given type of land for a defined use. The process of land suitability classification is the appraisal and group of specific area of land in terms of their suitability for defined uses. (FAO 1998).

Land suitability evaluation can be used for rain fed Agriculture, build –up, forestry etc or land utilization types which described in more detail according to the intensity and purpose of the survey. There is nothing new about the principle of sustainable evaluation from the earliest time, farmers have been deciding which crop are best for land they possess or as settlers where there is to be found land suited for the crop they wish to grow. This must often have been a process of trial and error. One may suppose that the well-defined zone in which oil palm plantation occurs was not found without failure in area which proved to lay out- side the climate limit of the crops. Land sustainability assessment for agriculture means to evaluate the ability of a piece of land to provide the optimal ecological requirement of a certain crop variety. In other words, assessing the capability of land in enabling optimum crop development and maximum productivity. This evaluation needs a specification of the respective crop requirement and calibration with the terrain and soil parameter.

The identified limiting factors could be managed to suit the various crop requirement and the improved crop productivity maximization in the agricultural sector.

In this case, the land suitability assessment for this study has the following objective:

to determine the suitability of the land for arable (cassava and maize) and tree crops (Rubber and oil palm) cultivation in Ambrose Alli University Teaching and Research Farm.

MATERIALS AND METHODS

The study was conducted on a 30-hectare parcel of land at the University Teaching and Research Farm of Ambrose Alli University, Ekpoma in Esan West L.G.A of Edo state. The study site is located between latitudes 6.18ºE and 6.46ºE and longitude 6.00ºN and 6.180ºN. It has a mean annual rainfall of about 1,500mm and rainy days of about 250. The mean annual temperature is about 31ºC and there are two distinct seasons, the dry season (November-

March) and rainy season April- October, (Remison,2005). The soils of the area are of sedimentary parent material origin, highly weathered and susceptible to erosion. The soils of the area have earlier been classified as Rhodic Kandiudult (Obazuaye, 2009).

Three mapping units were identified from an existing soil map and eventually suitability evaluation was carried out on each mapping unit.

Soil Sample Collection

Four samples were collected from each of the three profile pits making a total of 12 samples. The soil samples were collected from each profile from the lower horizon upward to avoid contamination of the horizons. Measuring tape, polythene bag, maker was used for demarcating the horizon depths and for labeling samples. The horizons were differentiated on the basis of colour, texture, boundaries and depths. In profile 1 samples were collected at a depth of 0-25cm, Ho, 25-45cm, H_A 45-70cm $H_{B,}$ 70-160cm H_c . In profile II samples were collected at a depth of 0-15cm $H_{o,}$15-40cm, H_A 40-65cm $H_{B,}$ 65-170cm H_c . In profile III samples were collected at a depth of 0-30cm $H_{o,\,30\text{-}}$55cm, H_A 55-82cm $H_{B,}$ 82-160cm H_c . The soil samples were air dried, crushed with a mortar and pestle and sieved with 2 mm sieve, bagged and labeled for laboratory analysis.

Laboratory Analysis

Particle size determination was carried out by hydrometer method (Okalebo *et al* 2002). pH of the soil was measure in 1:1 soil water by glass electrode pH meter method (IITA 1979). Organic carbon was determined by the microkjeldahi method Bremmer and muluanoy (1999). Available phosphorus was extracted with Bray I solution measured by the molybdenum blue method on the technical auto analyzer as modified by Olsen and Sommer (2002).Exchangeable base (Ca, Mg, Na, K) were extracted with ammonium acetate (NH_4 OAC) at pH 7.0 according to Anderson and ingram (1993) and then read with an absorption spectrometer. Effective cation exchange capacity (ECEC) was by the summation of exchangeable base and exchangeable acidity Anderson and Ingram (1993). Base saturation was obtained by dividing the sum of the exchange base by ECEC and multiplies by 100.

Land Evaluation

The suitability of the soil for some arable and permanent crops production was carried out using the method adapted by Sys (1985).

RESULTS AND DISCUSSION

Ambrose Alli Univerity Teaching and research farm was evaluated for the suitability of some arable (cassava and maize) and permanent crops (Rubber and Oil Palm) cultivation. The results are discussed below pedon by pedon.

Table 1: Physiochemical Properties for Mapping Units 1 To 3

DESCRIPTION	pH	EC	N	C	O.M	P	Ca	Mg	Na	K	H^+	Al^{3+}	ECEC	Clay	silt	san	
Sample			Hos/	%	%	%	ppm	Cmol	Cmol	Cmol/k	Cmol/k	Cmol/k	Cmol	%	%	%	TC
				Cm /kg	/kg	g	g						Soils				
P1 0-10CM	4.9	77.6	0.102	1.344	2.324	2.766	5.20	0.80	0.343	0.053	1.70	0.50	8.596	3.3	8.0	88.7	LS
P1 10-25CM	6.6	29.6	00.69	0.800	1.383	3.247	2.40	0.48	0.319	0.037	0.4	0.0	6.636	5.8	7.5	86.9	LS
P1 45-70CM	6.6	24.6	0.025	0.480	0.830	3.488	4.72	0.96	0.383	0.048	0.4	0.0	6.431	15.3	7.0	77.7	LS
P1 70-160CM	6.6	24.1	0.017	0.288	0.498	3.776	5.28	0.48	0.343	0.032	0.4	0.0	6.535	20.3	6.0	73.7	LS
P2 HO 0-15CM	6.6	53.3	0.090	1.088	1.881	6.278	6.00	0.16	0.360	0.64	0.4	0.0	6.984	5.3	8.0	86.7	LS
P2 HA 15-40CM	5.4	101.5	0.038	0.544	0.941	13.470	3.94	0.08	0.352	0.080	0.5	0.1	5.752	8.8	77.5	83.7	LS
P2 HB 40-65CM	6.4	34.7	0.038	0.544	0.941	4.402	4.08	0.88	0.384	0.058	0.4	0.0	5.802	16.3	6.3	77.4	LS
P2 HC 65-170CM	6.1	47.2	0.018	0.384	0.664	2.718	3.92	1.28	0.368	0.069	0.5	0.0	6.137	18.6	5.5	75.9	LS
P3 HO 0-30CM	6.1	46.3	0.142	1.344	3.324	5.099	4.96	1.76	0.360	0.058	0.40	0.0	7.538	4.3	8.5	87.2	LS
P3 HA 30-55CM	6.4	42.7	0.055	0.736	1.273	7.336	5.36	1.68	0.384	0.085	0.30	0.0	7.809	13.8	6.5	79.7	LS
P3 HB 55-82CM	5.7	60.1	0.038	0.544	0.941	8.779	4.61	0.16	0.417	0.106	0.6	0.2	6.123	16.3	6.0	77.7	LS
P3 HC 82-160CM	5.0	142.8	0.015	0.256	0.443	3.560	3.60	0.32	0.540	0.213	0.90	0.0	5.872	20.8	7.0	72.2	b L

Suitability Assessment for Mapping Unit 1.

The suitability for each parameter for both arable crops (cassava and maize) and permanent crops (rubber and oil palm) were evaluated using the guidelines provided by sys (1985). The land was evaluated using land and climatic characteristics which are climate, topography, wetness, physical soil characteristics, soil depth and fertility limitation. In climate, we have a total rainfall of 1200-1500 and according to the guidelines, this amount of rainfall put the mapping unit in suitability class 1 (S_1) and 2 (S_2) for Cassava cultivation. That means the amount of rainfall in mapping unit 1 is highly suitable for cassava cultivation but moderately suitable for maize, oil palm and rubber cultivation. In terms of temperature, we have the mean to be 28-31^{0}c, which is highly suitable for cassava cultivation but moderately suitable for maize, rubber and oil palm cultivation. For topography, we have a slope of <5% and this according the guidelines puts the mapping unit in suitability class 1 (S_1), highly suitable for cassava, maize, rubber and oil palm cultivation. Under wetness we have flooding and drainage there was no flooding and the drainage was good for all the crops.

In considering the physical soil characteristics, the textural class for mapping unit 1 was loamy sand which was S_1 (highly suitable for the two arable crops) and S_2 (moderately suitable for the two tree crop cultivation). The depth of this mapping unit 1 was 160cm (S_1) for both arable and tree crops cultivation. The fertility characteristics as expressed in ECEC/CEC was 6.6-8.6 cmol/kg was S_1 (highly suitable for both arable and tree crops cultivation). While the base saturation range for pedon 1 is 74.4-93.9% which according to the guidelines puts the mapping unit in suitability class (S_3) i.e marginally suitable for rubber cultivation, but for oil palm, cassava and maize which also according to the guidelines fit into suitability class (S_1) i.e. highly suitable for oil palm, cassava and maize cultivation while the organic matter is 2.324 which falls in S_1 i.e. highly suitable for cassava, maize, rubber and oil palm cultivation. The EC (Exchangeable cation) was 0.77 which was highly suitable for the two tree crops.

Suitability Assessment for Mapping Unit 2

The suitability classes are in bracket for each parameter using the guidelines provided by sys (1985). The land was evaluated using land and climate, topography, wetness, physical soil characteristics, soil depth and fertility limitation.

In climate, we have a total rainfall of 1200-1500 and according to the guidelines; this amount of rainfall put the mapping unit in suitability class 1 (S_1), the rainfall in mapping unit 2 is highly suitable for cassava cultivation and suitability class 2 (S_2), the rainfall in mapping unit 2 is moderately suitable for maize, oil palm and rubber cultivation. For temperature, we have a mean range of 28-31^{0}c, which is highly suitable (S_1) for cassava, rubber and oil palm cultivation but moderately suitable for maize cultivation. For topography, we have a slope of <5% and this puts the pedon in suitability class 1 (S_1), highly suitable for both crops. Under wetness we have flooding and drainage, there was no flooding and the drainage was good in this pedon for cassava, maize, rubber and oil palm cultivation,

The suitability therefore is S_2, moderately suitable. Then for the physical soil characteristics the textural class for both crops was loamy sand which was highly suitable (S_1) for the arable crops and moderately suitable (S_2) for the tree crops. The depth of pedon 2 was 170cm which is a good depth for both arable and tree crops cultivation. The fertility characteristics as expressed in ECEC/CEC was 5.7-6.9 which was highly suitable (S_1) for cassava, rubber and oil palm cultivation but moderately suitable (S_2) for maize cultivation, While the base saturation range for pedon 2 is 89.6-94.3% which according to the guidelines puts pedon 2 in (S_1) which is highly suitable for cassava, maize and oil palm cultivation and (S_3) which is marginally suitable for rubber cultivation. While the organic matter is 1.881 is highly suitable for cassava, maize, rubber and oil palm cultivation. The EC (Exchangeable cation) was 0.53 which was highly suitable for the tree crops.

Suitability Evaluation for Pedon 3

The suitability classes for each parameter for cassava, maize, rubber and oil palm using the guidelines provided by sys (1985). The land was evaluated using land and climatic characteristics which comprises of rainfall and temperature, then

topography, wetness, physical soil characteristics, soil depth and fertility limitation.

Under the climatic characteristics which comprises of rainfall and temperature, we have a total rainfall of 1200-1500 which according to the guidelines put pedon3 in suitability class (S_1) which is highly suitable for cassava cultivation and (S_2) which is moderately suitable for maize, oil palm and rubber cultivation. For temperature, it ranges from 28-31^{0}c, which is highly suitable for cassava, rubber and oil palm but moderately suitable for maize cultivation. For topography, we have a slope of <5% and this according to the guidelines in pedon3 is highly suitable for all the crops under consideration. For wetness, we have under it flooding and drainage, for pedon3, the suitability class was highly suitable (S_1) there was no flood and the drainage was good for cultivation while considering the physical soil characteristics the textural class for pedon 3 was loamy- sand which was (S_1) highly suitable for cassava and maize cultivation but (S_2) moderately suitable for rubber and oil palm cultivation the depth of this pedon 3 was 160cm which was highly suitable (S_1) for cassava, maize, rubber and oil palm cultivation. The fertility characteristics as expressed in ECEC/CEC was 5.9-7.8 cmol/kg was highly suitable(S_1) for cassava, oil palm and rubber cultivation and moderately suitable (S_2) for rubber cultivation then the organic matter was 2.324 which is highly suitable for the cultivation of all the crops under study. The EC (Exchangeable cation) was 0.46 and it was highly suitable for cassava, rubber and oil palm cultivation.

Table 2: Summary of Cassava Suitability Evaluation for Mapping Units 1, 2 And 3

Land and climate characteristic	Pedon 1	pedon2	pedon3
Climate (c)			
Rainfall (mm/yrs)	1200-1500 (S_1)	1200-1500 (S_1)	1200-1500 (S_1)
Temperature (^{0}c)	28 -31 (S_1)	28 -31 (S_1)	28 -31 (S_1)
Topography (t)			
Slope (%)	<5 (S_1)	<5 (S_1)	<5 (S_1)
Wetness (w)			
Flooding	F_0 (S_1)	F_0 (S_1)	F_0 (S_1)
Drainage	good (S_1)	good (S_1)	good (S_1)
Physical soil characteristics			
Texture / structure	LS (S_1)	LS (S_1)	LS (S_2)
Soil depth	160cm (S_1)	170cm (S_1)	160cm (S_1)
Fertility characteristics (F)			
CEC/ECEC	6.6-8.6 (S_1)	5.9-6.9 (S_1)	5.9-7.8 (S_1)
Base saturation %	74.4-93.9 (S_1)	89.6-94.3 (S_1)	79.6-96.1 (S_1)
Organic matter (0-15cm)	2.324 (S_1)	1.0881 (S_1)	2.324 (S_1)
EC (salinity)	0.77(S_1)	0.53 (S_1)	0.46 (S_1)
Suitability class	S_1	S_1	S_1

Summary of Maize Suitability Evaluation for All Mapping Units

Land and climate characteristics	Pedon 1	pedon2	pedon3
Climate (c)			
Rainfall (mm/yrs)	1200-1500 (S_2)	1200-1500 (S_2) 1200-1500 (S_2)	
Temperature (^{0}c)	28 -31 (S_2)	28 -31 (S_2)	28 -31 (S_2)
Topography (t)			
Slope (%)	<5 (S_1)	<5 (S_1)	<5 (S_1)
Wetness (w)			
Flooding	F_0 (S_1)	F_0 (S_1)	F_0 (S_1)
Drainage	good (S_1)	good (S_1)	good (S_1)
Physical soil characteristics			
Texture / structure	LS (S_2)	LS (S_2)	LS (S_2)
Soil depth	160cm (S_1)	170cm (S_1)	160cm (S_1)
Fertility characteristics (F)			
CEC/ECEC	6.6-8.6 (S_1)	5.9-6.9 (S_2)	5.9-7.8 (S_2)
Base saturation %	74.4-93.9 (S_1)	89.6-94.3 (S_1)	79.6-96.1 (S_1)
Organic matter (0-15cm)	2.324 (S_1)	1.0881 (S_1)	2.324 (S_1)
Suitability Class	S_2	S_2	S_2

Summary of Rubber Suitability Evaluation for All Mapping Units.

Land and climate characteristics	Pedon 1	pedon2	pedon3
Climate (c)			
Rainfall (mm/yrs)	1200-1500 (S_2)	1200-1500 (S_2)	1200-1500 (S_2)
Temperature (^{0}c)	28 -31 (S_2)	28 -31 (S_1)	28 -31 (S_1)
Topography (t)			
Slope (%)	<5 (S_1)	<5 (S_1)	<5 (S_1)
Wetness (w)			
Flooding	F_0 (S_1)	F_0 (S_1)	F_0 (S_1)
Drainage	good (S_1)	good (S_1)	good (S_1)
Physical soil characteristics			
Texture / structure	LS (S_2)	LS (S_2)	LS (S_2)
Soil depth	160cm (S_1)	170cm (S_1)	160cm (S_1)
Fertility characteristics (F)			
CEC/ECEC	6.6-8.6 (S_1)	5.9-6.9 (S_1)	5.9-7.8 (S_1)
Base saturation %	74.4-93.9 (S_3)	89.6-94.3 (S_3)	79.6-96.1 (S_3)
Organic matter (0-15cm)	2.324 (S_1)	1.0881 (S_1)	2.324 (S_1)
EC (salinity)	0.77(S_1)	0.53 (S_1)	0.46 (S_1)
Suitability Class	S_3	S_3	S_3

Table 3: Summary Oil Palm Suitability Evaluation For All The Mapping Units

Land and climate characteristics	Pedon 1	pedon2	pedon3
Climate (c)			
Rainfall (mm/yrs)	1200-1500 (S_2)	1200-1500 (S_2)	1200-1500 (S_2)
Temperature (^{0}c)	28 -31 (S_1)	28 -31 (S_1)	28 -31 (S_1)
Topography (t)			
Slope (%)	<5 (S_1)	<5 (S_1)	<5 (S_1)
Wetness (w)			
Flooding	F_0 (S_1)	F_0 (S_1)	F_0 (S_1)
Drainage	good (S_1)	good (S_1)	good (S_1)
Physical soil characteristics			
Texture / structure	LS (S_2)	LS (S_2)	LS (S_2)
Soil depth	160cm (S_1)	170cm (S_1)	160cm (S_1)
Fertility characteristics (F)			
CEC/ECEC	6.6-8.6 (S_1)	5.9-6.9 (S_1)	5.9-7.8 (S_1)
Base saturation %	74.4-93.9 (S_3)	89.6-94.3 (S_3)	79.6-96.1 (S_3)
Organic matter (0-15cm)	2.324 (S_1)	1.0881 (S_1)	2.324 (S_1)
EC (salinity)	0.77(S_1)	0.53 (S_1)	0.46 (S_1)
Suitability Class	S_3	S_3	S_3

Table 4: Summary of Suitabilities for All Mapping Units.

S/N	Mapping Unit	Cassava	Maize	Rubber	Oil palm
1	One	S_1	S_2	S_3	S_3
2	Two	S_1	S_2	S_3	S_3
3	Three	S_1	S_2	S_3	S_3

The summary of the table above for both arable crops (cassava and maize) shows that cassava is highly suitable while maize is moderately suitable for cultivation. The tree crops (rubber and oil palm) are marginally suitable for cultivation in the three mapping units. For cassava, the three mapping units (1, 2, 3) falls in the suitability class 1 (S_1) which means the soils in the area are highly suitable for cassava cultivation. Maize on the other hand falls in the suitability class 2(S_2) meaning the soils in the area are moderately suitable for maize cultivation due to defects in both climatic factor (rainfall and temperature) and fertility characteristics (CEC). For rubber and oil palm, the three mapping units (1,2,3) fall in suitability class 3 (S_3) which means marginal suitability, due to defects in both climatic factor (rainfall), texture and fertility characteristics (f).

As shown in table 4 above, it was discovered that mapping unit 1, 2 and 3 were the best soils for the cultivation of cassava and favours the local farmers that practice intercropping because of its high suitability evaluation results. The three mapping units can also be cultivated to maize at moderate suitability level. Technically, mapping units 1, 2, and 3 can also be cultivated to rubber and oil palm at marginal suitability level since the limiting factor (f) can be ameliorated with fertilizer that is high in acidity such as urea when cultivating rubber and oil palm to reduce the base saturation from the present state.

CONCLUSION AND RECOMMENDATIONS

The evaluation of three mapping units at the Teaching and Research Farm revealed that the mapping units assessed were highly suitable for cassava, moderately suitable for maize cultivation and marginally suitable for rubber and oil palm cultivation. The incorporation of organic materials into the soil will go a long way to improve the soil texture deficiency. Fertilizers high in acidity such as urea should be added to the soil when cultivating rubber and oil palm to reduce the base saturation from the present state.

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