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ABSTRACT

The University of Ilorin farmland, situated in the southern Guinea savanna zone of Nigeria, was evaluated for its suitability for the production of cowpea [*Vigna unguiculata* (L.) Walp.]. Potential and actual suitability indices were calculated from raw morphological and chemical data on five pedons. Climate was not a constraint to the production of cowpea in Ilorin and its environ. Available phosphorus was a constraint in two of the five pedons studied. Aggregate potential suitability rating showed that Bolorunduro series was the most suitable for cowpea production, followed by Ilemona, Tanke and Badi series, respectively. Afon series is constrained by both drainage and texture factors.

Key words : Land suitability evaluation, potential and actual suitability indices

INTRODUCTION

Land capability classification systems aim at studying and recording all relevant data which will lead to a decision as to the combination of agricultural use and conservation measures that can allow intensive and appropriate agricultural use of the land without undue dangers of soil degradation. The United States Department of Agriculture system of land capability classification (Klingebiel and Montgomery, 1961) is well known and has been adapted and modified for use in countries like Zimbabwe, the Philippines and Thailand, including countries in which shifting cultivation is widely practised (Moorman, 1973).

Technical and suitability classification system is based, to a large extent, on the purpose which the land is required to serve; it is therefore based on land use types. Land utilization types (LUT) can be defined in broad terms based on differences in agricultural use such as rainfed arable farming, tree crop farming, horticulture and irrigation farming, but also in more narrow refined terms of crop rotations, single crops or even single varieties. This approach implies that the evaluation of land under shifting cultivation for its suitability for intensified agriculture will require the consideration of a number of alternative land utilization types (Moorman, 1973).

The University of Ilorin farmland is located in the southern Guinea savanna ecological zone of Nigeria. In this zone, the practice of shifting cultivation, which aims at the restoration of the production capacity of the land, is usually disrupted by annual bush burning for games. The increase in population in Ilorin and its environ, after the creation of Kwara State in 1967 is taking its toll on agricultural land. The use of marginal land and very short fallow periods of shifting cultivation are the norm, because of intensive land cultivation for arable crops. The grain crops commonly grown in Ilorin and environ include maize, guinea corn, soybeans, groundnut, banbara nut and cowpea.

Land suitability evaluation for oil palm in heavy rainfall areas of Nigeria (Ogunkunle, 1993) and Malaysia (Ng, 1964; Wong, 1970) are well known. Onasanya and Ogunkunle (1996) gave information on the accuracy of land suitability evaluation for maize and soybean intercrop in south-western Nigeria. With increases in the population of Ilorin city, there is a high demand for vegetable protein. This demand can be met by high production of edible vegetable leguminous crops, of which cowpea is popular and commonly consumed. The present study was designed to assess the importance of soil properties for the suitability of land in Ilorin, representing the southern Guinea savanna ecological zone of Nigeria, for

the production of cowpea [*Vigna unguiculata* (L.) Walp.].

MATERIALS AND METHODS

The study was conducted at the University of Ilorin farmland in the southern Guinea savanna ecological zone of Nigeria. Five soil series that were mapped at the University of Ilorin farmland were subjected to morphological, physical and chemical analyses. The total land area of the University farmland is 250 hectares with Bolorunduro series occupying 32.0%, Tanke series 2.0%, Ilemona series 29.0%, Badi series 17.8% and Afon series 18.2%. The remaining 1.0% is rock outcrop. The climatic, topographic and soil analytical data for the soil series are given in Tables 1 and 2. Suitability of the pedons was evaluated by adapting the methods of Ogunkunle (1993) for cowpea and with the use of land qualities given in Table 3.

Evaluating Procedure

The pedons were first placed in suitability classes by matching their characteristics (Tables 1 and 2) with the requirements in Table 3. The suitability class of a pedon is that indicated by its most limiting characteristic. This follows the well known "Law of the Minimum" in agriculture, which states that crop yield will be determined by the plant nutrient in lowest supply (FAO, 1984).

Secondly, each limiting characteristic was rated for the parametric method. The index of productivity (IP) for each pedon was calculated using the equation below :

Table 1. Morphological properties and classification of the soils of the University of Ilorin farmland

Pedons	Properties			
	Thickness (cm)	Colour (moist)	Texture+	Structure*
Bolorunduro series				
A horizo	2-10	5YR 3/2	LS	1 mg to 2 mcr
B horizon	>150	5YR 6/6	SCL	2 mc sbk
Tanke series				
A horizon	5-32	10YR 3/4	LS	1 mg to 2 mcr
B horizon	>175	10YR 6/8	CL	2 m sbk
Ilemona series				
A horizon	2-28	7.5YR 3/2	LS	1 m to 2 mcr
B horizon	>140	7.5YR 5/4	SCL	2 c sbk
Badi series				
A horizon	5-17	10YR 4/3	LS	1 m cr
B horizon	>130	2.5Y 5/4	SL	2 m sbk
Afon series				
A horizon	5-18	5YR 3/1	SL	1 m sbk
B horizon	>120	5Y 6/2	SL	2 m sbk

*m=medium, g=granular, cr=crumb, c=coarse, sbk=subangular blocky.
+LS=loamy sand, SL=sandy loam, SCL=sandy clay loam, CL=clay loam.

$$IP = A.\sqrt{\frac{B}{100}.\frac{C}{100}\ldots\frac{F}{100}}$$

Where,A is the overall lowest characteristic rating,
B, C...F are the lowest characteristics rating for each land quality group.

The five land quality groups used in this study were climate (c), topography (t), soil physical properties (s), wetness (w), and chemical fertility (f). Only one member in each group was used because strong correlations exist among members of the same land quality group (e. g. texture and structure in the group of 's') (FAO, 1984). Potential index of productivity (IP_p) and current (actual) index of productivity (IP_C) were calculated without putting the calcium (Ca) mole fraction and available phosphorus (Bray's P_1) into the 'f' group, while the IP_C was calculated with the calcium mole fraction (exchangeable Ca^{2+} as a fraction of cation exchange capacity) and available phosphorus (Bray's P_1) forming part of the 'f' group. Suitability classes S_1, S_2, S_3 and N are equivalent to IP values of 100-75, 74-50, 49-25, and 24-0, respectively.

Table 2. Land qualities/characteristics of soil series in the University of Ilorin farm

Pedons and classification	Annual rainfall (mm)	Length of dry season (days)	Mean atmos. temperature (°C)	Slope (%)	Drainage	Soil depth (cm)	Coarse fragments (plough layer)	Mole fraction of calcium	ECEC (cmol/kg)	Avail. P (mg/kg)	BS (%)	pH (H_2O)
Bolorunduro (Typic Paleustalf)	1200	120	≥29	1-3	Good	≥150	Negligible	0.7-0.9	6-20	8-18	81-97	4.8-6.6
Tanke (Plinthic Paleustalf)	1200	120	≥29	1-3	Good	≥175	Negligible	0.6-0.8	8-20	8-12	95-97	4.9-6.4
Ilemona (Plinthic Paleustalf)	1200	120	≥29	1-3	Moderate	≥140	Negligible	0.5-0.7	7-18	9-13	94-97	5.0-6.3
Badi (Typic Ustropept)	1200	120	≥29	3-4	Imperfect	≥130	Negligible	0.7-0.8	7-14	9-11	96-98	5.0-6.3
Afon (Vertic Ustropept)	1200	120	≥29	4-6	Poor	≥120	Nil	0.6-0.7	8-11	8-10	94-95	5.0-6.5

Table 3. Land requirements for suitability classes for cowpea cultivation (modified from Sys. 1985)

Land qualities	Suitability classes					
	$S1_1$ (85-95%)	$S1_2$ (60-85%)	S_2 (40-60%)	S_3 (25-40%)	N_1 (25-40%)	N_2 (0-25%)
Climate (c)						
Annual rainfall (mm)	>1200	1000-1200	800-1000	600-800	-	>600
Length of rainy season (months)	>5	4-5	3-4	2-3	-	>2
Mean annual maximum temp. (°C)	>29	27-29	24-27	22-24	-	>22
Average daily minimum temp. (°C)	>20	18-20	16-18	14-16	-	>14
Mean annual temp. (°C)	>25	22-25	20-22	18-20	-	>18
Relative humidity (%)	>75	70-75	65-70	60-65	-	>60
Topography (t)						
Slope (%)	0-4	4-8	8-12	12-16	>16	-
Wetness (w)						
Flooding	F_0	F_0	F_1	F_2	-	F_3
Drainage	Well drained	Well drained	Well drained	Imperfect	Poor	V. Poor
Soil physical properties (s)						
Texture	LS	SL	SC	SCL	Any	C, CL
Structure	Crumb	Crumb	S.a blocky	S.a blocky	Columnar	Columnar
Coarse fragments (vol. %) 0-30 cm	3-10	10-15	15-35	35-55	-	>55
Depth (cm)	>100	90-100	50-90	25-50	-	>25
Fertility (f)						
Cation exchange capacity (cmol/kg)	>10	8-10	6-8	4-6	2-4	<2.0
Base saturation	>70	60-70	40-60	20-40	-	0
pH	>6.0-6.5	6.0-7.0	5.5-6.0	5.0-5.5	4.5-5.0	<4.5,-7.5
Organic carbon (%) 0-30 cm	>1.5-2.0	1.5-2.0	1.25-1.5	1.0-1.25	< 1.0	<1.0
Ca (mole fraction)	0.8-0.9	0.7-0.8	0.6-0.7	0.4-0.6	0.2-0.4	<0.2
Avail. P (mg/kg) 0-30 cm	>20	16-20	12-16	8-12	4.8	<4.0
Salinity and alkalinity (dS/m) (n)	<1	1-2	2-3	3-4	4-8	>8

RESULTS AND DISCUSSION

Land Requirements for Cowpea [*Vigna unguiculata* (L.) Walp.]

Climate : Climate is not a constraint to the production of cowpea in Ilorin and environ. There are more than five months of steady rainfall and about five months during which there are no rains. Cowpea, as a matter of fact, does best when the planting and developmental stages are programmed to fall within the months of July to October in the year (Tables 2 and 3; Olofintoye, 1986, 1995).

Topography : The topography of the University of Ilorin farmland is suitable for cowpea. The areas with slopes greater than 4% cover about 17.8% of the farm (Table 2).

Soil physical characteristics and moisture : The soil depth in the study area ranges between 120 to 175 cm (Table 2). Soil depth of 100 cm is considered adequate for a good crop of cowpea (Purseglove, 1979). Three pedons (Bolorunduro, Tanke and Ilemona) have moderate to good drainage, while Badi and Afon have imperfect and poor drainages, respectively. Afon is the only pedon that has the tendency to be flooded during the months of July and/or September, the two months that constitute the two rainfall peaks in the year.

Potential soil fertility : The chemical properties that are not easily altered are considered as constituting potential soil fertility. These include cation exchange capacity, base saturation, pH and organic matter content (Ogunkunle, 1993). Most of the soils do not have limitations in these properties (Tables 2 and 3).

Current soil fertility : This refers to chemical fertility that puts into consideration the properties that are easily altered (exchangeable calcium, available phosphorus and calcium mole fraction) as well as the requirements for potential fertility as it affects the production of cowpea. The Ca mole fraction is adequate in all the pedons studied, but the available phosphorus is a constraint in two of the five pedons (compare Table 2 with Table 3).

Major Limitations to Suitability of Cowpea

In the University of Ilorin farmland, climate and topography are optimum or nearly so for cowpea production. Potential soil fertility is also optimal. Soil depth, volume of coarse fragments and texture are optimal except for Afon pedon where texture is sub-optimal because it influences the poor drainage recorded for the pedon. Good drainage is conducive to optimum growth and yield of cowpea (Purseglove, 1979). The sandy loam to loamy sand texture of the plough layers of the other four pedons, apart from Afon, allow for good drainage in the rooting zone of cowpea.

The rainfall in Ilorin area is moderate when compared with those of Benin in Edo State (>2000 mm per annum in the average. However, the calcium and magnesium contents of these soils are greater than those reported for pedons in Benin (Omoti and Ataga, 1982) and Ibadan (Greenland, 1981), respectively.

Suitability Classes

The individual ratings of the land characteristics and the aggregate rating for the five soil series encountered at the University of Ilorin farmland. The aggregate rating is for both the potential (excluding available phosphorus and calcium mole fraction) and the current suitability (considering all characteristics) using the law of the minimum (FAO, 1984).

Aggregate potential suitability rating indicated that Bolorunduro was the most suitable soil series for cowpea production, while the suitability decreased with increase in slope except for Tanke series. Drainage (w) and texture (s) both account for the low rating of Afon series. The same Afon series that rated least under potential suitability consideration was rated non-suitable (N) under actual (current) suitability consideration.

Cowpea yields have been known to increase with increase in the number of spraying regimes against insect-pests (IADP, 1982). Olofintoye (1995) used four spraying regimes starting from two weeks after planting (WAP) and at two weekly intervals until eight WAP to control insect pests. Other works in Ilorin environ used three spraying regimes with Cymbush (an insecticide) at the outset of flowering (7 WAP) and at two weeks intervals until 11 WAP (IADP, 1982). Phosphorus application at 60 kg P_2O_5/ha was found to give improved grain yields of cowpea, especially with pre-planting broadcast application at the University of Ilorin (Olofintoye, 1986, 1995). Grain yields of cowpea ranged between 0.74 and 0.94 t/ha with pre-planting application of 60 kg P_2O_5/ha on Bolorunduro series (Olofintoye, 1995). Phosphorus applications to leguminous crops are known to enhance their growth and grain yield (Purseglove, 1979). The aggregate suitability ratings given above for the five soil series were done with the assumption that extraneous factors of pest management shall be adequately addressed.

CONCLUSION

Bolorunduro series, which covers about 32%, is the most suitable in the University of Ilorin farmland, followed by Ilemona (29%), Tanke (2%), Badi (17.8%), and Afon (18.2%) soil series, respectively. Afon series is constrained by both drainage (w) and texture (s) factors.

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REFERENCES

Food and Agricultural Organization (1984). Guidelines : Land Evaluation for Rainfed Agriculture. *FAO Soils Bull.* **52** : 237.

Greenland D. J. (ed.) (1981). *Characterization of Soils*. Clarendon Press, Oxford. 284 p.

Ilorin Agricultural Development Project (1982). Annual Report of IADP. 42 p.

Klingebiel, A. A. and Montgomery, P. H. (1961). Land capability classification. *Agric Handbook No. 210*. USDA Conserv. Service, Washington, DC. 21 p.

Moorman, F. R. (1973). Classification of land for its use, capability and conservation requirements. FAO/SIDA Regional Seminar on Shifting Cultivation and Soil Conservation in Africa. 12 p.

Ng, S. K. (1964). Soil suitability for oil palm in West Malaysia. Kuala Lumpur.

Ogunkunle, A. O. (1993). Soil in land suitability evaluation : An example with oil palm in Nigeria. *Soil Use and Management* **9** : 35-40.

Olofintoye, J. A. (1986). Cowpea [*Vigna unguiculata* (L.) Walp.] response to different levels of phosphorus and nitrogen in the Guinea Savanna of Nigeria. *Philippine Agric.* **69** : 411-18.

Olofintoye, J. A. (1995). Response of cowpea to time and methods of phosphorus application on soils derived from parent rock of granite-gneiss/banded-Gneiss Complex in the Guinea Savanna, Nigeria. *Int. J. Environ. Educ. and Inform.* **14** : 75-84.

Omoti, U. and Ataga, D. O. (1982). Root activity pattern of the oil palm (*Elaeis guineensis* Jacq.) determined with radioactive phosphorus. 1. Dry season study. *J. Nigerian Inst. for Oil Palm Res.* **6** : 37-47.

Onasanya O. S. and Ogunkunle, A. O. (1996). Accuracy of land suitability evaluation for maize and soybean intercrop along some toposequences in south-western Nigeria. Proc. 3rd African Soil Sci. Soc. Conference, University of Ibadan, Nigeria. 19-22 August, 1995. pp. 535-43.

Purseglove, J. W. (1979). *Tropical Crops : Dicotyledons* [*Vigna unguiculata* (L.) Walp.]. Longman Group Limited, London. pp. 321-28.

Wong, I. F. T. (1970). *Soil Suitability Classification for Malaysia*. Kuala Lumpur : Drainage and Irrigation Department, Ministry of Agriculture and Cooperative. pp. 13-20.