E-ISSN: 1115 – 831X P-ISSN: 3027-2963
MPRI-JAVS | INTERNATIONAL JOURNAL OF AGRICULTURAL AND VETERINARY SCIENCE
VOL. 03 NO. 1 - JANUARY, 2024

LAND SUITABILITY ASSESSMENT FOR SELECTED CROPS ACROSS A TOPOGRAPHIC LAND SCAPE AT MAISAMARI-MAYO SELBE IN SARDAUNA/GASHAKA LOCAL GOVERNMENT AREAS OF TARABA STATE, NIGERIA.

***JUGULDE, DAUDA ABUBAKAR; &**
****ABDULMUMINI ABDULKADIRI**
*Department of Crop Production, Federal Polytechnic Bali, Taraba State, Nigeria.
**Department of Agric. Tech., Federal Polytechnic Bali, Taraba State, Nigeria

Abstract

To reduce the human influence on natural resources and to identify an appropriate land use, it is essential to carry out scientific land evaluations. Such kind of analysis allows identifying the main limiting factors for the agricultural production and enables decision makers to develop crop managements able to increase the land productivity. Therefore, this study was conducted with the aim of assessing the suitability of soils across a land scape at Maisamari-Mayo Selbe in Sardauna/Gashaka Local Government Areas of Taraba State, for the production of Maize, Rice, Sugarcane and Mango. Three Profile pits each were sunk at the identified physiographic positions (Crest, Upper slope, Lower slope and Foot Mountain). The soils were described for their physico-chemical properties. All soil samples collected were analysed using standard Laboratory procedures. The results revealed that the soil texture predominantly [redacted] varied from Sandy loam (SL) to Loamy sand (LS) and soil pH ranged from 5.37 to 6.42 (slightly acidic in reaction), while soil fertility indicators were generally rated as low. Based on the climatic and soil qualities, the soils of the study areas were classified into various Land Suitability classes. Soil units at the crest and foot mountain were found to be moderately (S2) and marginally (S3) suitable, respectively, for the production of maize, rice and mango, while soil units at the upper and lower

Key word: Land Suitability Assessment, Crops, Topographic Land Scape, Tabara, Nigeria.

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

slope positions were only found to be marginally (S3) and moderately suitable (S2), respectively, for mango production, due to certain non-permanent constraints that can be corrected. Further, all the soil units were generally classified as non-suitable (N) for sugarcane production. Sustainable management of the soil units would require efficient soil management systems through effective drainage, organic matter addition and guided inorganic fertilizer use.

Introduction

Suitability of land is assessed considering rational cropping systems, for optimizing use of a piece of land for a specific use (FAO, 1976; Sys, *et al.,* 1991). The suitability is a function of crop requirements and land characteristics and it is a measure of how well qualities of land unit match the requirements of a particular form of land use (FAO, 1976). A major step towards sufficiency in food production is effective and proper use of land for the purposes for which they are most suitable. Ineffective and unplanned use of agricultural land is a major constraint to agricultural production in developing countries of the world (Fashina *et. al.,* 2005). Therefore, an effective agricultural planning and use of agricultural lands involves soil survey and land evaluation, using methods such as Suitability and Irrigation capability classification (Dent and Young, 1981). Although arable crops grow freely in most part of Nigeria, there is need for land evaluation and soil assessment to ensure productive use and management of scarce land for profitable crop production.

Several research works have been conducted on the suitability of soils in the study area for arable and some tree crops, although majority of this research do not give prime attention to Rice, Maize, Sugarcane and Mango. It is against this backdrop that this research work was initiated to serve as baseline data, hence provide information on soil properties and characteristics of the study areas. Therefore, this paper tends to use obtained data on Land qualities and requirements of the study area to assess the inherent suitability and the extent to which appropriate management recommendations can be made to alleviate the current limitations in the production of the selected crops.

MATERIALS AND METHODS

The Study Area

The study area is at Maisamari-Mayo Selbi in Sardauna/Gashaka local government area of Taraba State. It is located between latitude 5° 30' to 7° 18' N and longitude

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

10° 18' to 11° 37' E within the Savannah ecological zone of the country and forms the southernmost tip of northestern part of Nigeria (Tukur *et al.,* 2005). It lies at an elevation of between 504-1518m. According to Oruonye and Abbass (2011), the geological succession of the study area, is underlain by Basement complex rocks occupying a very distintive part of the study area. They further reported that the basement complex rocks are precambriam in nature. The climate of the area is that of the semi-arid type characterised by wide seasonal and diurnal temperature ranges with two main seasons: rainy season (April-October) and dry season (November to March) (Oruonye and Adebayo, 2013). The average annual rainfall ranges between 1000-2000 mm per annum with the greater part falling between July and October (Oruonye and Adebayo, 2013). The mean temperature varies from according to season. Maximum temperature ranges between 30°C and 39.4°C, while minimum temperatures ranges between 12°C to 23°C (Oruonye and Adebayo, 2013). The harmattan period starts from October/November and continues until about middle of March.

Field Work and Soil Sampling

Four topo-positions were identified and mapped; they are the Crest (CRS), Upper slope (UPE), Lower slope (LOW) and Foot Mountain (FOM)). To achieve the objectives of the study, three soil profile pits were dug on each of the 4 positions identified, and soil samples were then taken from each identified genetic horizons of the dug profile pits. The collected soil samples were then stored in a properly labelled polyethene bags and taken to the laboratory for analysis. In the laboratory each sample was separately air dried, ground using a porcelain pestle and mortar and passed through a 2mm sieve. The sieved samples were then used for all laboratory analysis.

Laboratory Analysis

Particle-size fractions were determined using the Bouyoucos hydrometer method (Gee and Bauder, 1986). Soil pH was determined in 1:2 water ratio using a glass electrode pH metre (Page *et al.,* 1982), while Percentage base saturation was calculated by dividing the total exchangeable bases by the cation exchange capacity multiplied by 100.

Land Suitability Evaluation for Selected Crops

The principle of matching the land use requirements for selected crops (Tables 2 and 3) as described in Tables 2 and 3 (Aruleba and Ayodele, 2015; FAO, 1976; FAO,

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

1983; Sys *et al.*, 1991; Yayock, *et al.*, 1988) with land qualities as described in Table 1, was used to develop suitability classes for the following crops: Maize, Rice, Sugarcane and Mango. The four physiographic positions (Crest, Upper slope, Lower slope and Foot mountain) were treated as unique land (soil) units. Climatic and some soil physical and chemical properties from the four physiographic positions were used in assessing the land characteristics and qualities for the suitability classification for the various crops (Tables 4, and 5). The suitability of the soils for the selected crops was assessed based on the limiting condition principle (the least favorable assessment found limiting was taken as the overall land suitability class). Each factor was assigned a suitability class, which has assigned value ranging from S1, S2, and S3 to N (FAO, 1983). The extent of the combined limitation is used to produce the overall suitability class for each of the crops mentioned above.

Results and Discussion

Suitability ratings for the selected Crops across the different physiographic positions

Crest (CRS)

Soils on the Crest are well drained, moderately acidic, a base saturation of <70%, deep, having a loamy sand to sandy laom texture, a weak soil structure and a slope gradient of 0-2% (Table 1). Based on the above soil qualities, the soil is classified as moderately suitable (S2a,n) in the production of maize, with limitations in nutrient availability (a) and nutrient retention capacity (n), moderately suitable (S2w) for rice production, with limitation in soil workability (w), non-suitable (Nl), for sugarcane production, with limitation in annual rainfall (l) and moderately suitable (S2n) in mango production, with limitations in nutrient retention capacity (n). These limitations will significantly reduce productivity, thus soil unit CRS, is classified into order S, class S2, sub class a, n, g and w as shown in Tables 4 and 5, for the production of maize, rice and mango, while non-suitable (Nl) for sugarcane production.

Upper Slope (UPE)

Soils at the Upper slope position are well drained, slightly acidic, a base saturation of 85.10%, deep, having a sandy laom to sandy clay loam texture, a weak soil structure and a slope gradient of 25-55% (Table 1). Based on the above soil qualities, the soil is classified as Non suitable (N) in maize, rice and sugarcane production, with high level of erosion due to slope, while high annual rainfall for sugarcane and marginally suitable (S3e) in the production of mango, due to erosion problem. These limitations has restricted production to only mango for the selected crops,

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

thus soil unit UPE, is classified into order S and N, class S3, sub class e and l as shown in Tables 4 and 5, for the selected crops.

Lower Slope (LOW)

Soils of lower slope position is well drained, strongly acidic, a base saturation of 57.10%, deep, having a sandy laom texture, a weak soil structure and a slope gradient of 5-6% (Table 1). Based on the above soil qualities, the soil is classified as Non suitable (N) in maize, rice and sugarcane production, with high level of erosion due to slope, while high annual rainfall for sugarcane and rmoderately suitable (S2n) in the production of mango, due to limitation in nutrient retention capacity. These limitations has restricted production to only mango for the selected crops, thus soil unit LOW, is classified into order S and N, class S2, sub class n and l as shown in Tables 4 and 5, for the selected crops.

Table 1: Climatic/Land units' characteristics and qualities of the study areas

Climatic/Land quality		CRS	UPE	LOW	FOM
Climatic					
Rainfall (l)	Intensity (mm)	1000–2000	1000–2000	1000–2000	1000–2000
Temperature (t)	Hot/cold (^{0}C)	30-32	30-32	30-32	30-32
Land Quality					
Oxygen available (g)	Drainage (Class)	WDR	WDR	WDR	PDR
Nutrient available (a)	Reaction (pH)	5.73	6.42	5.37	6.19
Nutrient retention capacity (n)	Base saturation (%)	60.8	85.1	57.1	78.6
Rooting condition (r)	Depth (Cm)	150	120-150	120-130	62-88
Soil workability (w)	Texture (Class)	SL, LS	LS,SL,SCL	SL	SL, LS,SCL
Erosion hazard (e)	Slope (%)	0-2	25-55	6-13	0-2

Key: SL: Sandy Loam, LS: Loamy Sand, SCL: Sandy Clay loam, WDR: well drained, PDR: Poorly drained, CRS: crest, UPE: upper slope, LOW: lower slope, FOM: foot mountain

Table 2: Climatic and soil requirements for Maize and Rice production

Suitability Ratings									
			Maize			Rice			
Requirements	Diagnostic Factor	S1	S2	S3	N	S1	S2	S3	N
Climatic									
Rainfall (l)	Intensity (mm)	>800	700-800	600-700	<600	>900	800-900	600-800	<600
Temperature (t)	Hot/cold (^{0}C)	24-30	20-24	15-20	<15	24-30	30-32	32-35	<24, >35

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

Land Quality									
Oxygen available (g)	Drainage (Class)	WDR	MWDR	PDR	VPDR	WDR	MWDR	PDR	VPDR
Nutrient available (a)	Reaction (pH)	6-7	5.5-6	5-5.5	<5,>7	5.5 – 7.9	4.4 – 5.5, 7.8 – 8.0	4 – 4.5 >8	< 5
Nutrient retention capacity (n)	Base saturation (%)	>70	50-70	30-50	<30	>50	35-50	20-35	<20
Rooting condition (r)	Depth (cm)	>120	50-120	30-50	<30	>100	70-100	40-70	<40
Soil workability (w)	Texture (Class)	SL, L	SCL, SiL	LS,CL, SiCL	SC, SiL, C	C,SC, SiC	L,SCL, CL,SL	C	S,LS
Erosion hazard (e)	Slope (%)	0-2	2-4	4-6	>6	0-2	2-4	4-6	>6

Modified from: FAO, (1983); Yayock, *et al.*, (1988); Sys *et al.*, (1991)

Key: SL: Sandy Loam, LS: Loamy Sand, SCL: Sandy Clay Loam, S: Sand, C: Clay, CL: Clay Loam, WDR:well drained, MWDR:moderately well drained, PDR:poorly drained, VPDR:very poorly drained,

Table 3: Climatic and soil requirements for Sugarcane

Suitability Ratings									
		Sugarcane				**Mango**			
Requirements	Diagnostic Factor	S1	S2	S3	N	S1	S2	S3	N
Climatic									
Rainfall (l)	Intensity (mm)	<900	800-900	600-800	<600	1700-2000	1450-1700	1000-1450	<700
Temperature (t)	Hot/cold (^{0}C)	24-30	30-32	32-35	<15, >35	25-32	20-25	18-22	<18
Land Quality									
Oxygen available (g)	Drainage (Class)	PDR, VPDR	MWDR	WDR	EWDR	WDR	MDR	PDR	VPDR
Nutrient available (a)	Reaction (pH)	5.5 – 7.9	4.4 -5.5, 8 – 8.0	4 – 4.5 >8	<5	6.0-7.0	5-6	4-5	<4/>7
Nutrient retention capacity (n)	Base saturation (%)	>50	35-50	20-35	<20	>70	50-70	30-50	<30
Rooting condition (r)	Depth (Cm)	>100	70-100	40-70	<40	>100	70-100	50-70	<50
Soil workability (w)	Texture (Class)	C,SC,SiC	L,SCL,CL,SL	C	S,LS	LS,SL,SC,L,CL	SC	S,LC	C
Erosion hazard (e)	Slope (%)	0-2	2-4	4-6	>6	0-8	8-16	16-30	>30

Modified from: Aruleba and Ayodele (2015); FAO (1976); FAO (1983); Sys *et al.* (1991); Yayock, *et al.* (1988)

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

Key: SL: Sandy Loam, LS: Loamy Sand, SCL: Sandy Clay Loam, S: Sand, C: Clay, CL: Clay Loam, WDR: well drained, MWDR: moderately well drained, PDR: poorly drained, VPDR: very poorly drained

Table 4: Matching land unit's requirement with land qualities for Maize and Rice

	Maize					Rice			
	Suitability ratings of Land Unit					Suitability ratings of Land Unit			
	CRS	UPE	LOW	FOM		CRS	UPE	LOW	FOM
Climatic									
Rainfall (l)	S1	S1	S1	S1		S1	S1	S1	S1
Temperature (t)	S1	S1	S1	S1		S1	S1	S1	S1
Land Quality									
Oxygen available (g)	S1	S1	S1	S3		S1	S1	S1	S3
Nutrient available (a)	S2	S1	S2	S1		S1	S1	S2	S1
Nutrient retention capacity (n)	S2	S1	S2	S1		S1	S1	S1	S1
Rooting condition (r)	S1	S1	S1	S2		S1	S1	S1	S2
Soil workability (w)	S1	S1	S1	S2		S2	S2	S2	S2
Erosion hazard (e)	S1	N	N	S1		S1	N	N	S1
Overall Suitability	**S2 a, n**	**Ne**	**Ne**	**S3g,r,w**		**S2w**	**Ne**	**Ne**	**S3g,r,w**

Table 5: Matching land unit's requirement with land qualities for Sugarcane and Mango

	Sugarcane					Mango			
	Suitability ratings of Land Unit					Suitability ratings of Land Unit			
	CRS	UPE	LOW	FOM		CRS	UPE	LOW	FOM
Climatic									
Rainfall (l)	N	N	N	N		S1	S1	S1	S1
Temperature (t)	S1	S1	S1	S1		S1	S1	S1	S1
Land Quality									
Oxygen available (g)	S3	S3	S3	S1		S1	S1	S1	S3
Nutrient available (a)	S1	S1	S1	S1		S1	S1	S1	S1
Nutrient retention capacity (n)	S1	S1	S1	S1		S2	S1	S2	S1
Rooting condition (r)	S1	S1	S1	S2		S1	S1	S1	S2
Soil workability (w)	S2	S2	S2	S2		S1	S1	S1	S1
Erosion hazard (e)	S1	N	N	S1		S1	S3	S2	S1
Overall Suitability	**Nl**	**Nl,e**	**Nl,e**	**Nl**		**S2n**	**S3e**	**S2en**	**S3g,r**

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]

Foot Mountain (FOM)

Soils at the Foot mountain is poorly drained especially during the raining season, slightly acidic, a base saturation of >70%, moderately shallow, having a sandy laom to sandy clay loam texture, a weak soil structure and a slope gradient of 0-2% (Table 1). Based on the above soil qualities, the soil is classified as marginally suitable (S3g,r,w) for the production of maize, rice and mango, with limitations in drainage (g), rooting conditions (r) and soil workability (w) and non-suitable (Nl) in sugarcane production, with limitation in annual rainfall (l). These limitations will significantly reduce productivity, thus soil mapping unit FOM, is classified into order S, class S2 and S3, sub class g, r and w as shown in Tables 4 and 5, for the production of maize, rice and mango.

Conclusion and Recommendations

Based on the above findings, it is very clear that, soil units at the crest and foot mountain were found to be moderately (S2) and marginally (S3) suitable, respectively, for the production of maize, rice and mango, due to limitations, such as nutrient retention and availability, soil workability, drainage and rooting conditions. However, soil units at the upper and lower slope positions were only found to be marginally (S3) and moderately suitable (S2), respectively, for mango production due to limitations in nutrient retention capacity and soil erosion. Further, all the soil units were generally classified as non-suitable (N) for sugarcane production. The study also revealed that the general agronomic constraints of the studied soils which varied as one move from the crest to the foot mountain, include low nutrient reserve, soil workability and highly prone to soil erosion. Management practices such as periodic monitoring of soil quality, addition of organic manure, guided inorganic fertilizer use and provision of adequate drainage is recommended for sustainable agricultural productivity.

References

Aruleba, J. O. and Ayodele, O. J. (2015). Land Evaluation and Management of an Utilisol for Fruit Crops Production in South Southern Nigeria. Journal of Global Biosciences 4 (4): 1982-1989.

Dent, D. and Young, A. (1981). Soil Survey and Land Evaluation. George Allen and Unwin publishers, UK. Pp. 172174.

FAO, (1976). A Frame work for land Evaluation. Soil Bulletin, 3.

FAO, (1983). Guidelines: Land Evaluation for Rain fed Agriculture, FAO Soils Bulletin, 52. Rome pp.237.

Fashina, A. S., Aruleba, J. O., Omotoso, S. O., Omotayo, F. O. and Shitu, O. S. (2005). Evaluation of Potentials of some soils for crop production in Ado Ekiti, South Western Nigeria. Nigerian Journal of Soil Science. pp 16-20

Gee, G. W. and Bauder, J. W. (1986). Particle size analysis In: A Klute (Ed). Method of soil analysis 2nd No. ASA Inc. SSSA. Inc. Madison, Washington DC Pp 383-409.

Oruonye, E. D. and Abbass, B. (2011). The Geography of Taraba State, Nigeria. LAP Publishing Company, Germany.

Oruonye, E. D. and Adebayo, A. A. (2013). An Assessment of the effects of the 2012 Floods in Taraba State. Proceedings of the 5th annual conference of the Nigerian Association of Hydrological Sciences (NAHS), held at University of Nigeria Nsukka, October 21-24, 2013. Pp. 13 – 20.

Page, A. L., Miller, R.H. and Keeney, D.R. (1982). Methods of soil analysis (Eds) agron 9, part 2, ASA, Madison Wisconsin.

Sys, I., Van Ranst, E., Debaveye, J., (1991). Land evaluation, Part I. Principles in land evaluation and crop production calculations, General administration for development cooperation, Brussels, p.40.

Tukur, A. L., Adebayo, A. A. and Galtima, A. (2005). The land and people of the Mambilla Plateau, Nigeria. Heinemann educational books.

Yayock, J. Y., Lombin, G. and Onazi, O. C. (1988). Crop science and production in warm climates. Macmillan publishers. pp 307.

EDITOR-IN-CHIEF
Prof. H. U. Nwanjo [Nigeria]