Assessment of Humid Tropic Soils for Freshwater Fish Farming Using Earthen Pond in Beeri, Khana Local Government Area, Rivers State

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ABSTRACT

Understanding soil characteristics is essential for optimizing freshwater fish farming in earth-bottom ponds (earthen pond). A field survey was carried out to assess the suitability of soils of Beeri, Khana Local Government Area of Rivers State for freshwater fish farming which involved soil morphological description and laboratory analysis. Three mapping units or representative pedons (Summit, Middle slope and Valley bottom) were identified and one profile pit each was dug at each identifiable mapping unit and was described appropriately. Results obtained reveal some variations in morphological, physical, and chemical properties of the soils. The soils are sandy to sandy loam in texture with bulk density values ranging from 0.935 to 1.4550 g cm−3. Soil pH values ranged from strongly acidic to slightly acidic (4.89 to 5.47) and had very low to medium organic carbon (OC) (0.21 to 2.14g/kg), available phosphorus (6.31 – 10.52 cmol/kg), exchangeable aluminum (0.2 – 0.5 cmol/kg), exchangeable hydrogen (0.28 – 11.48 cmol/kg), CEC (0.4 – 8.39 cmol/kg) and Base saturation (50 – 90 %). The results showed that land attributes such as soil physical characteristics in terms of water retention capacity (due low clay content), wetness (oxygen availability) and fertility (pH, available phosphorus, exchangeable calcium and CEC) made the land marginally suitable (S3) to not suitable (N) for freshwater fish farming using earthen pond in the three pedons. Therefore, the land is potentially suitable for freshwater fish farming using earthen pond, but currently marginally and not suitable limitations in wetness (drainage) and fertility (low aval. P, Ca and CEC).

Keywords: *Beeri, humid tropic, water retaining properties, seepage and watertight pond bottom*



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INTRODUCTION

Land resources constitute an important agricultural ecology in the world and are major contributors of economic growth of the society for better standard of living (Nsor, and Ubie, 2017 and Peter *et al*, 2022a) Land also constitute an essential part of the earth surface not underwater. Lands are put into different agricultural uses

including fish farming to eradicate food insecurity. Agricultural land can be used for various purposes including crop production, livestock, and fisheries as such, its suitability assessment aimed at estimating the characteristics and economic value based on the condition of the land for optimum use with low degree of degradations (Peter *et al*, 2022). It is also the assessment of land performance when use for specific purposes, FAO, (1984) and Peter and Umweni (2021). Land suitability assessment also aimed at characterizing, classifying and categorizing specific area of land for its capacity and optimum sustainability (Peter *et al,* 2019). Soil suitability assessment involves a scientific procedure, which is essential to assess the potential and constraints of a given land for agricultural purposes (Peter and Umweni, 2021). It also the process of estimating the agricultural land potential for diverse kinds of utilization on a sustainable basis. (Peter and Umweni, 2020a). Fish farming is gaining wide acceptance, and its productions are on the increase in the developing world using improvised materials such as synthetic rubbers that are carcinogenic in nature *(Graff et al 2005).* Therefore, there is need to use land in relation to its capacity for optimum fish production on sustainable bases. Fish farming is a systematic way of producing fish for consumption through subsistence or commercial methods. The utilization and development of land resources in Nigeria, for freshwater fish farming using earthen pond has been constrained by inadequate soil information, poor soil management, limited extension services and poor accessibility ((Nsor, and Ubie, 2017). In setting up an artificial fish farm, using earth pond, there is need to identify and classify such soils in term of it suitability for effective fish farming on such soils as fish is one of the major sources of protein and its production is a profitable aspect of agricultural production to generate income to the farmers at the same time provides employment opportunities were ever it is reared in large quantities. All these benefits cannot be achieved if the suitability assessments of such soils are not determined. Therefore, this study is aimed at the characterization and suitability assessment of the soils for freshwater fish farming in Beeri, a community surrounded by freshwater including the Luubara creek in Khana Local Government Area of Rivers State.

MATERIALS AND METHODS

This study was carried out in Beeri community in Khana Local Government Area of Rivers state (Figure 1). It occupied approximately 300.5 hectares of land and located within latitude 04.68838 and 04.66826 and longitude 007.42315 and 007.42362 with an elevation of 11meters above sea level. The study area has an average annual rainfall between 2000 – 2500mm (Peter and Ayolagha, 2012 and Peter and Umweni, 2021). The rainfall distribution is in a bimodal form with a peaks in July – September and a period of low precipitation in August normally called August break (Peter and Ayolagha 2012).

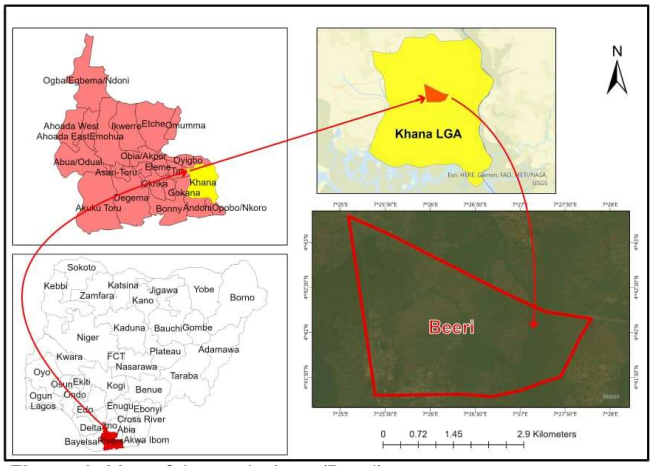


Figure 1: Map of the study Area (Beeri)

The monthly temperature ranges from 27 – 35oC with relatively humidity of 83%. Soils in the study area are well drained and derived from coastal plain sand of Marine deltaic deposits commonly called Ogoni sands (Peter and Oweremadu, 2015, Peter et al 2021, and Peter and Umweni 2021). The vegetation of the study area is the multistoried high tropical rainforest characterized by a multiplicity of tree species and the climax of the vegetation has been tremendously altered by the impact of land degradation, uncontrolled forest exploitation and continuous land Cultivation (Peter and Oweremadu, 2015). We also have some tropical tree species that are predominant in the study area are Delinoxregia, Mahogany, Iroko, Crotariaexelsa etc. Some lands in the study area are grown with secondary vegetation and fallow with grasses such as Panicum maximum, Penesetum purpureum etc. The vegetation of the study area to some extent has been seriously affected due to anthropogenic activities especially continuous cropping and deforestation, resulting to deplete vegetation due to population pressure (Peter and Oweremadu, 2016, 2017, Peter et al 2019, and Peter *et al* 2022a and Peter *et al* 2022b).

Field Studies

A reconnaissance visit was made to the study area to identify the different mapping units based on vegetation, drainage pattern, topography or physiography and soil texture. Based on toposequence/topography, vegetation and slope aspects, three mapping units were identified (Summit, Middle slope and Valley bottom). The geographic coordinates of the Area and profile points were taken using a handheld Global Position System (GPS). One profile pit each was dug at each identifiable mapping unit and was described respectively; while soil morphological properties such as colour, texture, structure, drainage, consistence, boundaries and root outcrop were identified in situ. Typically, samples are collected down – top from each

identifiable profile horizons to avoid contamination and were taken to the Soil Science Laboratory, Rivers State University, Port Harcourt where they were air dried, crushed with mortar and pestle to pass through a 2mm mesh size sieve and labelled appropriately for laboratory analysis Core samples were also collected using core cylindrical samplers and soil colours were determined in situ using Munsell colour chart.

Land Suitability Evaluation (LSE)

The potential of the soils for freshwater fish farming using earthen pond was assessed using the land suitability evaluation (LSE) methods of Balarin (1998); Cole and Rogers (1985); Andriesse and Fresco (1991) as modified by Peter and Umweni (2022). In this process, the non-parametric productivity index was be used or adopted. The land suitability will be estimated using the equation below:

P1= H x P x T x Sr x Om x Ce x Mr x Ap

Where P1 = productivity index, H = soil moisture, D = drainage, P = effective soil depth, T = texture, Sr = soil reaction, Om = organic matter, Ce = cation exchange capacity, Mr = mineral reserved and Ap = available phosphorus. The following rating will be used for three degrees of limitations and based on the resulting productivity index (PI), the soils will be assigned to productivity class as indicated below:

Class 1 – 65 - 100 % (Excellent)
Class 2 - 35 – 60 % (Good)
Class 3 - 20 = 35% (Average)
Class 4 – 8 – 19 % (Poor)
Class 5 – 0 – 8 % (Extremely poor)

The productivity classes above also correspond with the FAO land suitability classes of S1 (high), S2 (moderate), S3 (marginal), N1(Not suitable) and N2 (permanently not suitable)

Laboratory Analysis

The following physical properties of the soils will be determined; Particle size distribution was determined using the hydrometer method and the proportion of sand, silt and clay were determined through the laboratory approach. The core sampler samples collected were weighed and oven dried to determine the bulk density. The percentage of soil volume occupied by pores spaces were known. Soil colour was determined using the Munsell Colour Chart (1992). Soil reactions (pH) determined by using glass electrode pH meter. Organic Carbon was determined by the Walkey and Black (1934) methods, while organic matter content of the soil was determined by wet oxidation method. (Walkey and Black 1934). Total Nitrogen was determined using kjedahl digestion distillation method, Available phosphorus was determined by using the Bray and Kurtz 11 method with a mixture of hydrochloric acid. Exchangeable Al and H were determined using NaOH titration method, Exchangeable bases (Ca, Mg, K and Na), were determined using leaching method 1m ammonium acetate at pH 7; Base saturation was calculated by dividing the sum of Exchangeable Bases (Na, K, Ca and Mg) by the ECEC and multiplying the quotient by 100.

RESULTS AND DISCUSSION

Morphological characteristics of the Study Area

Table 1 indicated the morphological properties of soils of the study area. Pedon 1 revealed that soil colour ranged between very, Dark Gray (7.5 YR, 3/1) at the surface to Grayish Brown (10YR, 5/2) at the sub-surface. Very dark grayish coloration was also observed in the surface horizons (0-20) indicating the presence of low organic matter. This is in conformity with the report of Peter and Aaron (2019) who reported that the dark coloration of soils in the surface level is due to the present of organic matter in the soil. The soil texture is sandy, while soil structure is granular, its consistency ranged from loose to friable. The soils were poorly drained with a diffused to clear boundaries with present of moderate to few roots. In pedon 2, soil colour varied from strong brown (7.5YR 4/6) to yellowish red (5YR 5/8); soil textures ranged from loamy sand to sandy loam, while soil structures are sub angular blocky (sbk). Its consistency ranged from non-sticky at surface level to sticky at subsurface horizons. The soil is well drained with clear boundaries. It includes moderate to no root presence. Soil colour in pedon 3 ranged from grayish brown (10YR 5/2) to dark gray, brown (10YR 4/2); soil textural class also shows that it is sandy in nature. The soil consistency ranged from non-sticky to sticky with a clear boundary.

Physical Characteristics

Table 2 revealed the results obtained on the physical properties of the soils in the study area. The results indicated that in pedon 1, sand had a constant value of 924g/kg. While silt contents ranged from 14 -24g/kg, and clay increased from 52 - 62g/kg. This indicated that the soils in pedon 1 are sandy in nature. The sandy nature of soils in Pedon 1 corroborated the report of Peter and Umweni (2020), who reported that soils of Khana are sandy in nature due to the parent materials, the sedimentary rocks from which the coastal plain sands common called Ogoni sands are formed, adding that, the high sand content also enhanced the rate of water infiltration in the soils as well as affecting soil water retentive capacity adversely. The soil also had low silt and clay content leading to poor water retaining properties not sufficient to minimize seepage or create a watertight pond bottom. Bulk density and total porosity increased from

Table 1: Morphological properties of the study area.

Pedon Designation	Horizon Depth (cm)	Colour (MOIST)	Textural class	Structure	Drainage	Boundary	Roots	consistence
PEDON 1								
Ah	0 -20	7.5YR 3/1 V.D.G	Sandy	Granular	PD	diffused	Mrts	loose
AB	20 – 58	10 YR 4/2 D.G.B	Sandy	Granular	PD	diffused	Frts	loose
Bw	58 – 112	10YR 5/2 GB	Sandy	Granular	PD		Nrts	friable
PEDON 2								
AB	0 – 25	7.5YR 4/6 S.B	Loamy Sandy	Sbk	WD	clear	Mrts	Non sticky
B	25 – 90	5YR 5/8 Y.R	Sandy loam	Sbk	WD	clear	Nrts	Slightly sticky
PEDON 3								
AB	0 – 23	10YR 5/2 G.B	Sandy	Sbk	WD	clear	Frts	Non sticky
Bw	23 – 90	10YR 4/2 D.G.B	Sandy	Sbk	WD		Nrts	Slightly sticky

Table 2: Physical characteristics of soils in the study area

Pedon Designation	Horizon depth (cm)	Sand	Silt g/kg	Clay	Textural class	Bulk density (g/cm3)	Total porosity (%)
Pedon 1							
Ah	0 – 20	924	24	52	Sandy	0.935	64.7
AB	20 – 58	924	14	62	Sandy	1.3204	50.18
Bw	58 – 112	924	24	52	Sandy	1.3452	98.52
Pedon 2							
AB	0 – 25	844	24	132	Loamy sand	0.9548	63.97
B	25 – 90	804	24	172	Sandy loam	1.4550	45.1
Pedon 3							
AB	0 – 23	914	14	72	Sandy	1.3041	50.79
Bw	23 – 90	904	14	82	Sandy	1.3467	41.19

Table 3: chemical properties of soil in the study area

Pedon Designation	Horizon depth	pH (H20)	OC	OM g/kg	AV. P Mg/kg	Ca Cmol/kg	Mg	K	Na	EA	EH Cmol/kg	TEA	CEC	ECEC	BS	Zn	Fe
Pedon 1																	
Ah	0-20	5.28	2.14	3.69	8.77	2.6	0.4	0.18	0.06	0.24	2.96	3.2	3.24	6.44	50	8.8	4062.5
AB	20 – 58	5.41	0.56	1.08	6.31	1.4	1.0	0.19	0.06	-	1.26	1.26	2.65	3.19	67	1.3	224.3
BW	58 – 112	5.47	0.39	0.68	8.77	3.52	1.2	0.09	0.04	-	1.8	1.8	4.85	6.65	72	1.5	512
Pedon 2																	
AB	0 – 25	4.89	0.94	1.69	8.77	0.4	0.2	0.10	0.04	0.5	2.07	2.07	0.74	3.31	22	15.8	300.9
B	25 – 90	4.90	0.21	0.36	7.36	1.6	6.4	0.12	0.27	-	2.47	2.47	8.39	10.86	77	0.0	9196
Pedon 3																	
AB	0 – 23	5.34	0.57	0.97	6.67	1.6	0.8	0.09	0.07	-	0.28	0.28	2.56	2.84	90	2.6	361.9
BW	23 - 90	5.39	0.64	1.10	10.52	3	0.2	0.82	0.04	-	11.48	1.48	4.06	5.54	73	12.0	543

0.935 – 1.3452g/cm3 and 50.18-98.52g/cm3 respectively. In pedon 2, sand content also ranged from 804 - 844g/kg, silt percentage are the same (24g/kg) while clay ranged from 132 -172 g/kg. Its textural class ranged from loamy sand at the surface to sandy loam at the subsurface, whereas Bulk density ranged from 0.9548 – 1.455g/cm3, total porosity increased from 45.1-63.97g/cm3 effectively. In pedon 3, Sand ranged from 90 – 914g/kg, percentage of silt are the same, while the clay content of the soil ranged from 72 - 82g/kg. Therefore, the soil of Pedon 3 as indicated by the result is sandy, Bulk density ranged from 1.3041-1.3467g/cm3, while total porosity ranges from 41.19-50.79%. Soil porosity is important to conduct water, air and nutrients in the soil as reported by (Peter and Umweni (2020), he stated that particle size distribution provides the ability of soil to store root zone water and air necessary for plant growth.

Chemical characteristics of the study area

Table 3 shows the results of the chemical properties of soils of the study area. Soil reacttion (pH) in pedon 1 was slightly acid and ranged from 5.28-5.47. In pedon 2, the pH varied from 4.89-4.90 (strongly) acidic, while it varied from 5.34- 5.39 (slightly acidic). Organic carbon in the soil decreased from 2.14-0.39 g/kg in pedon 1. In pedon 2, it decreased from 0.94-0.21g/kg. Soil organic carbin in pedon 3 decreased from 0. 64-0.57 g/kg. The results observed generally showed that organic carbon was very high at the surface horizon than the subsurface level of the soils in the study area. Decrease in soils organic carbon content with depth also collaborates with the reports of Peter and Nwidae, (2025). Available phosphorus varied from 6.31-8.77 m/kg in pedon 1, pedon 2 and 3 ranged from 7.36 - 8.77 and 6.67-10.52, respectively. Acidic soil typically increases phosphorus fixation, reducing availability in the soils may be due to the acidic condition. Magnesium in the soil also varied from 0.4-1.2 Cmol/kg in pedon1, 0.2 -6.4 Cmol/kg in pedon 2, and 0.2- 0.8 Cmol/kg in pedon 3. Calcium varied from 1.4-3.52 in pedon 1, 0.4-1.6 Cmol/kg and 1.6 -3 Cmol/kg in pedon 3, while potassium increased from 0.09-0.19 in pedons 1 and 0.10-0.12 Cmol/kg in pedons 2 while in pedon 3 it increased from 0.09 – 0.82 Cmol/kg. Sodium (Na) also ranged from

0.04 -0.06 Cmol/kg in pedon 1, in pedon 2 and 3, it ranged from 0.04 -0.27 Cmol /kg and 0.04 -0.07 Cmol/kg, respectively. Cation Exchange capacity in the soil ranged from 2.65 -4.85Cmol/kg in pedon 1, 0.74 – 8.39C in pedon 2 and ranged from 2. 56 -4.06Cmol/kg in pedon 3. The very low cation exchange capacity of the soil may be attributed to the lower clay content and organic carbon contents of the soil and leaching of cations might have been more in the top soils with more sand fractions (Peter and Agbogun (2025) ; Peter and Nwidae (2025). Exchangeable Aluminum (Al)) were more at the surface soils of pedon 1 and pedon 2 (0.24 Cmol/kg and 0.5 Cmol/kg) and was negative at subsurface level of the soils. In pedon 3 it was negative at both the surface and subsurface horizons. Exchangeable hydrogen also varied from 1.8 -2.96 Cmol/kg in pedon 1, 2. 07 -2.47Cmol/kg in pedon 2 and 0.28 -11. 48 Cmol/kg in pedon 3. Effective Cation Exchange Capacity (ECEC) varied from 3.19 - 6.65Cmol/kg in pedon 1, 3.31-10 .86 Cmol/kg in pedon 2, and 2.84 -5.54cmol/kg in pedon 3. Base Saturation of the soils increased down the profile in pedon 1 and 2, 50-72 Cmol/kg, 22-77Cmol/kg, and decreased down the profile in pedon 3, 90-73 Cmol/kg.

Suitability and Evaluation the Study of Soils in the Study Area

Soil factor rating requirements for freshwater fish farming using earthen ponds as revealed (Table 1) were `matched with the properties of the studied soils (Table 4) to determine the suitability of the soil for freshwater fish farming. This was obtained by using the optimum land qualities guideline for fish farming recommended by Balarin (1980), Cole and Rogers (1985), Andriesse and Fresco (1991), and suitability rating were interpreted with regards to the number and intensity of limitation. Results of land suitability assessment indicated that pedon1 was currently not suitable (N1) for fresh water fish farming with limitations of in climate, wetness and fertility From the summary of the table above, it indicate that currently the soils of the study area are not suitable for fresh water fish farming due to some limitations in nutrient availability such as available phosphorus, the CEC of the study area in pedon 1 and Exchangeable Ca and phosphorus in pedon 2, CEC, Mg, Ca and phosphorus in pedon 3, this may be as a result of the type of parent material from which the soils of the study area were formed, but potentially these soils can be suitable if adequate supply of fertilizer are added to the soil in the required proportion. Pedons 1 was not suitable (N1) fresh water farming with limitations in fertility (Available Phosphorus); while pedon 2 and 3 were not suitable (N1) for fresh water fish farming due to limitation in wetness (Oxygen availability), fertility (Available P, Exchangeable calcium and Nutrient retention (CEC).

The evaluation of soils in the study area, as presented in (Table 5), demonstrates that while climatic conditions are favorable, physical and chemical limitations constrain agricultural suitability. Rainfall levels of 2000–2500 mm and average temperatures of 25–28 °C fall within suitable ranges for crop growth. These values correspond with the findings of Jia and Luo (2006), who modeled net water requirements for wetlands in semi-arid regions, and Jia and Luo (2009), who further demonstrated the importance of rainfall and temperature in maintaining water balance. Yokoo, Sivapalan, and Oki (2008) also emphasized that climate seasonality and landscape characteristics strongly influence water balances, reinforcing the observation that climate is not a limiting factor in this context.

Drainage conditions vary across the profiles, with P1 being poorly drained and P2 and P3 excessively well drained. Poor drainage reduces oxygen availability for plant roots, while excessive drainage promotes nutrient leaching. Damian (2021) highlighted that poor water management contributes to soil degradation and reduces carbon accumulation, underscoring the importance of balanced drainage conditions. Water retention capacity is low in P1 and P3, with only P2 showing moderate retention due to higher clay content. Although shallow water tables suggest moisture availability, they also raise risks of waterlogging. Borse (2015) demonstrated that clay content and water table depth are critical for sustaining fertility, and the results here confirm that soils with low retention capacity are less productive.

Fertility indicators reveal significant challenges. Soil pH values range from 4.89 to 5.34, indicating acidity that limits nutrient solubility and availability. Zwetsloot (2013) explained how phosphorus fixation is exacerbated in acidic soils, and this is evident in the low phosphorus values recorded across the profiles. Organic carbon levels are consistently low, ranging from 0.57 to 2.14, reflecting poor organic matter accumulation. Mgelwa et al. (2025) reported that deforestation induces profound changes in soil organic carbon accumulation, while Al Shoumik et al. (2025) showed that continuous land use reduces soil organic carbon and nitrogen stocks. Luo et al. (2025) further argued that stoichiometric imbalances hinder carbon sequestration in agricultural soils, which is consistent with the low organic carbon values observed here. Exchangeable potassium and calcium are deficient, while magnesium is adequate in P2 and P3. Dhakad (2017) emphasized the importance of micronutrient evaluation for crop productivity, and the deficiencies observed highlight the need for targeted fertilization. Phosphorus availability is also low, confirming the challenge of phosphorus fixation in tropical soils, as noted by Zwetsloot (2013).

Nutrient retention capacity is limited, with low cation exchange capacity in P1 and P3, and only moderate values in P2. This indicates poor ability to retain nutrients, leading to leaching losses. However, base saturation is relatively high across all profiles, suggesting that the proportion of exchange sites occupied by basic cations is favorable. Electrical conductivity values remain within acceptable limits, indicating no salinity hazard, while active iron levels are adequate but could interfere with

Table 4: Factor rating for land use requirements for fresh water fish farming.

Land Quality Group	Land Characteristics	S1 95% (1)	S2 85% (2)	S3 60% (3)	N1 40% (4)
Climate (c):					
Water Availability	Mean Annual Rainfall (Mm)	>1500	1100-1500	500-1100	<500
	Average Temperature (0C)	29-32	21-29	18-21	<18
Wetness (w):					
Oxygen Availability	Soil drainage	Very poorly drained	Poorly Drained	Imperfectly drained	Well drained
Topography (t):	Slope (%)	0-2	2-4	4-6	>6
Physical Characteristics (s):					
Water retention capacity	Clay (%)	25-50	15-25	5-15	<5
Dry season water table	Water Table Depth (Cm)	< 30	30-60	60-90	>90
Fertility (f)					
Nutrient Availability	Ph	7.0 -7.5	5.2-75	4.5-5.2:7.6-8.5	Any
	Organic Carbon (gkg-1)	30-20	20-10	<10	>30
	Total Nitrogen (gkg-1)	>2	2-1	1-0.5	<0.5
	Available P (mgkg-1)	>20	20-15	15-10	<10
	Exch. K (cmol/ kg-1)	>0.2	0.1-0.2	0.05-0.1	<0.05
	Exch. Ca (cmol/ kg-1)	10-15	5-10	1-5	<1
	Exch. Mg (cmol/ kg-1)	6-12	3-6	<3	Any
Nutrient retention	CEC (Soil) (cmol/ kg-1)	>16	10-16	5-10	<5
	Base Saturation (%)	>50	50-35	10-35	<10
Salinity (n)					
	Electrical Conductivity (EC) (dS-1)	0-4	4-6	6-8	>8
Toxicity (n)	Active Fc (mgkg-1)	<7.5	7.5-10	10-12.5	>12.5

Source: Balarin (1980); Cole and Rogers (1985); Andriesse and Fresco (1991) and Peter and Umweni (2022).

Table 5: Suitability and Evaluation of Soils in the Study Area

Land Requirement	P1	P2	P3
Climate			
Mean Annual Rainfall(mm)	2000-2500(S1)	2000-2500(S1)	2000-2500(S1)
Average Temperature(oc)	25-28(S2)	25-28(S2)	25-28(S2)
Wetness(W)			
Oxygen Availability	Poorly drained(S2)	Well drained(N1)	Well drained(N1)
Topography(t)			
Physical Characteristics(S)			
Water retention capacity(clay)	6.2(S3)	13.2(S2)	7.2(S3)
Dry season water table	0-20(S1)	0-25(S1)	0-23(S1)
Fertility(f)			
Nutrient Availability			
pH	5.28(S2)	4.89(S3)	5.34(S1)
Organic Carbon	2.14(S3)	0.94(S3)	0.57(S3)
Total Nitrogen			
Available P	8.77(N1)	8.77(N1)	6.67(N1)
Exch.K	0.18(S2)	0.10(S3)	0.09(S3)
Exch.Ca	2.6(S3)	0.4(N1)	1.6(N1)
Exch.Mg	1.0(S3)	6.4(S1)	6.3(S1)
Nutrient retention			
CEC	3.24(N1)	8.39(S3)	2.56(N1)
Base Saturation	50(S1)	77(S1)	90(S1)
Salinity(n)			
Electrical Conductivity	1.1(S1)	5.5(S2)	3.3(S1)
Active Fe	4.06(S1)	3.0(S1)	5.4(S1)
Aggregate Suitability Class	N(f)	N(w,f)	N(w,f,)

phosphorus availability, as Ma et al. (2025) observed in alpine soils. The consistently low organic carbon values across the profiles underscore the need for management interventions. Chen et al. (2025) demonstrated that grass coverage in orchards enhances organic carbon and nitrogen accumulation, while Abrar et al. (2025) showed that long-term fertilization regimes significantly improve soil organic matter. Similarly, Manzeke-Kangara et al. (2025) found that conservation agriculture increases soil organic carbon compared to conventional practices, and Fartyal et al. (2025) reported that land-use changes from forests to grasslands alter soil nutrient stocks, reinforcing the importance of sustainable practices.The aggregate suitability classes for all profiles are not suitable, with constraints arising from fertility, wetness, and nutrient limitations. This classification reflects the combined effects of poor drainage, low organic carbon, acidic pH, and nutrient deficiencies. Table 5 therefore highlights that while

climatic conditions are favorable, the soils are constrained by chemical and physical limitations that must be addressed through sustainable land management strategies to achieve long-term agricultural suitability.

Conclusion

The soil of the study area, Beeri in Khana L.G.A., Rivers State have some suitability qualities for freshwater fish farming using earthen pond special in terms of annual rainfall, Base Saturation, Electrical Conductivity, Toxicity (Fe) but in terms of clay content, pH, k, mg, organic carbon it was moderately suitable. The study area could become suitable for profitable aquaculture with targeted soil fertility interventions.

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