CASE STUDY Agricultural Reviews, Volume 47 Issue 3: 490-495 (June 2026)

Appraisal of Soil Fertility: A Case Study of Okpare-olomu Farm Settlement in Ughelli South Local Government Area, Delta State

S.A. Ojobor[1], G.O. Okogu[1], O.F. Elike[2]

10.18805/ag.RF-387

ABSTRACT

Background: Fertilizer application without soil test has resulted to nutrient imbalance and toxicity leading to widespread yield depletion. Appraisal of soil fertility status of Timpher Farms Limited in Okpare-Olomu, Ughelli-south local government area of Delta State.

Methods: Soil samples and their coordinates were taken and soil quality indicators were analyse using standard procedures. Soil fertility index and Soil evaluation factor were calculated and used to delineate the arable farm area into nutrient management zones. Data were analyzed with descriptive statistics and correlation coefficient was used to establish the relationship among soil variables.

Result: The soil is loamy sand, strongly acidic with an average soil organic matter while total nitrogen was low. Available P was moderate, exchangeable bases were low except for Ca that was moderate. Base saturation was low whereas CEC was moderate but dominated by non-basic cations. The micronutrients were adequate for crop production. Larger proportions of the farm falls within the low soil organic matter and total nitrogen management zones; indicating that the farm had low soil fertility.

Key words: Crop production, Nutrient appraisal, Nutrient management zones, Okpare-olomu, Soil fertility assessment.

INTRODUCTION

In the current unprecedented food challenges, soil fertility synthesis could be a potent tool for improving crop production (Dandasena *et al.,* 2024 and Sachan *et al.,* 2022). Nutrient management practices adopted to produce economic yield and at the same time maintain minimal nutrient leakage can only be achieved through timely evaluation of soil fertility (Dandasena *et al.,* 2024 and Sachan *et al.,* 2022). Soil quality indicators that determined the fertility and are evaluated after analysis. Soil fertility evaluation measures the availability of plant nutrients and also estimate the capacity of the soil to supply crop the elements (Ayodele *et al.,* 2019 and Ojobor *et al.,* 2021). Up-to-date information on soil characteristics is essential in sustaining production of crops. Lack of basic information on the levels and management of soil properties has led to continued yield decline (Nwawuike, 2023 and Iraiyanban *et al.,* 2025). The limited information on site-specific fertilizer amendment arouses the need for assessing the nutrient status of soil. This will aid in developing appropriate management policy as the soil resources (Ayodele *et al.,* 2019). Cropping sustainability requires frequent evaluation of soil quality as different land uses change the properties.

Soil is indispensable natural resource that plays a relevant role in improving crop production however, inadequate information about the potential uses are lacking. Soil fertility assessment will provide useful data on the nutrient and their distribution that are crucial for implementation of sustainable management (Ofem *et al.,* 2023). Understanding soil fertility variation could be tools in decision making (Okebalama *et al.,* 2024). Therefore, background information about the soil fertility is required before soil amendment (Delsouz *et al.,* 2017). A basic aspect of sustainable crop production is monitoring of soil fertility (Dandasena *et al.,* 2024) and this helps to provide key information on how to improve the soil because, limiting factors will be identify that will enable management guideline implementations (Hadole *et al.,* 2019 and Iraiyanban *et al.,* 2025).

Okpare-Olomu is a notable farming community in Ughelli south local government area under Delta central agricultural zone. The community is predominantly known for cultivation crops and houses different farm settlements. Timpher Farms Limited (about 40 hectares) is one of such that was newly established. For proper planning for various uses, there is need to critically identify the limiting nutrients,

[1]Department of Agronomy, Faculty of Agriculture, Delta State University Abraka, Nigeria.
[2]Department of Soil and Land Resource Management, Faculty of Agriculture, Dennis Osadebay University, Asaba, Nigeria.

Corresponding Author: S.A. Ojobor, Department of Agronomy, Faculty of Agriculture, Delta State University Abraka, Nigeria.
Email: smartojobor@gmail.com
ORCID: https://orcid.org/0000/0002-6835-6797

How to cite this article: Ojobor, S.A., Okogu, G.O. and Elike, O.F. (2026). Appraisal of Soil Fertility: A Case Study of Okpare-olomu Farm Settlement in Ughelli South Local Government Area, Delta State. *Agricultural Reviews*. **47(3):** 490-495. doi: 10.18805/ag.RF-387.

Submitted: 30-04-2025 **Accepted:** 21-10-2025 **Online:** 26-11-2025

this will guide the implementation of management options for the area. On this premise, the study tends to investigate the nutrient status and create nutrient management zones for the farm.

MATERIALS AND METHODS

The study area

The study was conducted at Okpare-Olomu in Ughelli North Local Government Area, Delta state. It is situated between latitude N 5°25′56″ and Longitude E 5°54′50″, 21.1 meters elevation above sea level and falls within the rainforest agro-ecological zone of Nigeria. The land is relatively flat with different areas planted to Oil palm, Cassava, sparse distribution of Maize, several grasses and shrubs.

Soil sampling, handling and laboratory analyses

Soil samples were collected with an auger at 0-15 cm depth, air dried and taken to the laboratory for analysis. Standard laboratory methods were determine the soil properties. Sampling points and their coordinates were taken.

Soil fertility index and soil evaluation factor (SEF)

The SFI and SEF were examined and used to categorize the farm into nutrient management zones.

Data analysis

All data generated were subjected to simple descriptive statistics while correlation analysis was used to show their relationships.

RESULTS AND DISCUSSION

Particle size distribution, pH, organic matter and macronutrients of the farm

The soil particle size fractions indicate mean clay content to be 9.1%, silt was 8.7% and sand was 82%. The values ranged from 7.0-13±1.9% with coefficient of variation (CV) of 2.1% clay, 5.0-13±2.9% with CV of 30% silt and 78-86±2.4 with CV of 2.9% sand, indicating dominance of sand with low spatial heterogeneity (Table 1). Considering the textural class of the area, the soils are relatively not compacted.

pH, organic matter and macro nutrients of the farm

pH

The farm area fell within the strongly acidic category with a mean value of 4.9, the range was 4.2-5.4±0.3 with CV of 6.2. The pH of the study area is not considered suitable for most crops, tough the variability was low (Table 3).

Organic matter

The mean soil organic matter was 1.8% and the range was 0.89-3.58±0.70% with CV of 41.5% (Table 2). About 60% of the study area was low, 26.7% was moderate whereas, only 13.3% of the total area of the farm was high, showing that the study area was highly variable in organic matter content.

Average TN was 0.15%, the values ranged between 0.11-0.23±0.04% with a CV of 23%. Higher per cent (60%) of the farm was low, only 26.7 and 13.3% were medium and high, respectively. The mean available P was 10.4 mg/kg, it ranged from 7.5-14.9±2.1 mg/kg with CV of 19.7% (Table 3). About 46.7% of the farm area was low whereas, 53.3% were moderate that is, no area was found to be high. All parts of the farm had low Na and had similar value of 0.08 meq/100 g in the entire farm. Potassium was also generally low, only less than 10% of the land was high in available K. The mean value was 0.08 meq/100 g, it ranged from 0.03-0.39±0.08 meq/100 g with a very low CV of 0.06%. Mean mg value was 1.5 meq/100 g, it ranged from 0.34-3.4±0.78 mg/kg with a high CV of 53%. The values of exchangeable Ca were moderately variable (19%) and medium rating, except about 13.3% of the area that was low, this means that no part of the farm had high value of exchangeable Ca. The mean value was 2.20 meq/100 g, it ranged from 1.0-2.7±0.42 meq/100 g. Mean CEC value was 12.8 meq/100 g, the values varied from 10.4-15.0±1.6 meq/100 g and a low CV of 11.4%. Al 3+ values ranged from 0.5-1.81±0.36 meq/100 g with CV of 33% whereas, H^+ had a mean value of 0.86 meq/100 g and ranged from 0.02-1.40±0.41 with a CV of 47%. The EC mean value was 2.9 ms/cm, it varied between 1.0-8.0±2.1 ms/cm and a high CV of 60%. The percentage base saturation was generally low, the values ranged from 16.89-37.12 with a mean of 26.2±4.22 and CV of 37.12%.

Distribution of micro-nutrients

The micro-nutrients exhibited low and high spatial variability (Table 3). The nature of the spatial variability observed, justifies the adoption of site-specific nutrient management

Table 1: Particle size distribution.

S/N	Clay	Silt	Sand
1	9.0	7.0	84
2	9.0	7.0	84
3	7.0	13	80
4	7.0	13	80
5	9.0	11	80
6	9.0	11	80
7	11	11	78
8	11	7.0	82
9	11	7.0	82
10	7.0	7.0	86
11	9.0	5.0	86
12	13	5.0	82
13	7.0	9.0	84
14	7.0	11	82
15	11	9.0	80
X	9.1	8.7	82
Min	7.0	5.0	78
Max	13	13	86
SD	1.9	2.7	2.4
CV	21	30	2.9

Textural class: Loamy sand.

to ensure balanced nutrient supply. Mean Cu content value was 0.32 mg/kg, the values ranged between 0-0.17±0.17 mg/kg and CV of 53.8%. Manganese ranged from 0.68-3.40±0.09 mg/kg with a mean value of 1.25 mg/kg and a low CV of 0.09%. Nickel had a mean value of 0.71 mg/kg, the values ranged from 0.58-0.88±0.58 mg/kg with a CV of 12.1%. The Mo values ranged from 0-1.74± mg/kg with a mean of 1.14 mg/kg and a high CV of 40.8%. Whereas, Fe had a high CV of 60.5% with a mean value of 5.64mg/kg that ranged from 2.80-9.15±2.15 mg/kg. Chlorine had a

Table 2: Particle size distribution, pH, organic matter and macro nutrients of the farm.

	pH	OM	TN	Av. P	Exch. Bases (me/100 g)				Exch. Ac			EC	PBS
	H_2O	%		mg/kg	Na	K	Mg	Ca	CEC	Al	H	ms/cm	%
1	5.4	2.1	.19	10.3	.08	.08	3.4	2.4	10.4	10.3	.50	2	35.6
2	4.4	2.2	.13	11.1	.08	.07	2.0	2.0	11.6	11.2	.90	2	25.5
3	5.0	2.0	.13	10.3	.08	.06	1.4	2.4	12.4	10.3	.80	2	26.0
4	4.9	2.0	.13	8.1	.08	.08	2.0	2.1	12.0	8.1	.70	2	32.6
5	4.8	1.2	.16	7.5	.08	.05	1.7	1.7	11.6	7.5	1.0	2	29.4
6	5.0	1.2	.16	9.8	.08	.05	1.0	2.4	13.6	9.8	.80	2	24.9
7	5.2	1.2	.17	8.4	.08	.03	1.0	2.4	12.4	8.4	1.3	1	26.6
8	5.0	1.7	.11	12.1	.08	.04	.34	2.4	11.6	12.1	1.5	2	17.4
9	4.9	1.7	.11	11.2	.08	.06	.34	2.0	11.2	11.2	1.0	2	16.9
10	5.2	2.6	.13	9.3	.08	.04	.68	2.4	12.6	9.3	.80	2	24.0
11	5.2	1.7	.15	8.4	.08	.06	1.7	1.0	14.8	8.4	1.0	2	37.1
12	4.2	0.9	.15	9.3	.08	.06	1.7	2.7	13.0	9.3	1.8	7	28.8
13	4.7	3.6	.22	12.1	.08	.06	2.0	2.4	15.0	12.1	1.3	3	25.3
14	4.8	3.0	.23	13.0	.08	.06	1.4	2.7	14.4	13.0	1.4	5	24.0
15	4.9	0.9	.14	14.9	.08	.39	1.4	2.4	14.8	14.9	1.5	8	19.1
X	4.9	1.8	.15	10.4	.08	.08	1.5	2.2	12.8	1.1	.86	2.9	26.2
Min	4.2	.89	.11	7.5	.08	.03	.34	1.0	10.4	0.5	.20	1.0	16.9
Max	5.4	3.5	.23	14.9	.08	.39	3.4	2.7	15.0	1.8	1.4	8.0	37.1
SD	0.3	.70	.04	2.1	.00	.08	.78	.42	1.60	.36	.41	2.1	4.2
CV	6.2	42.	23.	19.7	2.6	.06	52	19	11.4	33.0	47	60	65.2

Table 3: Detrimental heavy metals and micro-nutrient contents of the farm.

S/N	Detrimental heavy metals (mg/kg)						Micronutrient (mg/kg)						
	Se	Cd	Pb	As	Cr	Hg	Cu	Mn	Ni	Mo	Fe	Cl	Zn
1	.205	7.37	.053	.111	39.5	3.03	0.45	1.36	0.65	1.74	2.80	2.52	3.74
2	.137	6.98	.028	.129	42.1	4.04	0.56	1.02	0.65	1.74	5.04	2.52	3.06
3	.114	3.37	.053	.129	43.2	5.05	0.56	2.04	0.76	1.05	5.60	2.52	3.06
4	.137	8.15	-	.111	42.1	6.06	0.45	0.68	0.76	1.39	2.80	2.52	2.38
5	.091	8.53	.028	.166	44.2	3.03	0.23	1.02	0.65	1.05	5.60	2.52	3.40
6	.159	7.37	.028	.111	39.0	5.05	0.34	1.36	0.76	0.69	3.92	2.47	1.36
7	.068	6.59	.028	.129	41.6	4.04	0.34	1.02	0.65	-	5.06	2.47	1.02
8	.046	6.98	.053	.129	32.3	3.03	0.56	0.68	0.76	1.05	4.48	2.52	1.70
9	.068	8.15	.080	.166	39.0	4.04	0.23	0.68	0.82	0.69	8.96	2.52	1.70
10	.091	8.15	.080	.166	38.0	4.04	0.11	1.36	0.70	1.38	4.48	2.47	1.36
11	.068	9.31	.035	.111	40.6	5.05	0.11	3.40	0.70	1.39	6.16	2.61	1.02
12	.137	14.7	.028	.129	36.4	4.04	0.11	0.68	0.88	1.05	5.60	2.61	2.38
13	.137	10.5	.028	.111	35.9	4.04	0.34	0.68	0.65	1.74	6.72	2.52	2.72
14	.159	10.1	.080	.129	34.3	6.06	0.34	1.02	0.53	1.05	7.84	2.50	3.06
15	.137	9.31	.053	.111	27.6	4.04	0.23	1.70	0.65	1.05	9.52	2.47	3.06
X	.012	8.64	0.05	.120	38.4	4.31	0.32	1.25	0.71	1.14	5.64	2.52	2.53
Min	.046	6.59	0	.111	27.6	3.03	0	0.68	0.58	0	2.80	2.47	1.02
Max	.205	14.7	.08	.166	44.2	6.06	0.56	3.40	0.88	1.74	9.52	2.61	3.74
SD	.044	2.05	.02	.010	4.50	0.97	0.17	0.72	.058	0.46	2.15	0.45	0.91
CV	37.5	23.7	54.2	14.8	11.7	22.5	53.8	0.09	12.1	40.8	60.5	1.78	38.9

mean value of 2.52 mg/kg and ranged from 2.47-2.61±0.45 mg/kg with a low CV of 1.78% while, Zn had a high CV value of 38.9% with a mean of 2.53 mg/kg and the values ranged from 1.02-3.374±0.91 mg/kg.

Detrimental heavy metals

Heavy metals were found in the farm (Table 3), the mean value of Se was 0.121 mg/kg with a high CV of 37.5%, the values ranged from 0.046-0.205±0.44 mg/kg. Cadmium was moderately variable (23.7%), the values ranged from 6.59-14.7±2.05 mg/kg with a mean of 8.64 mg/kg whereas, Pb was highly variable (54.2%) with a mean value of 0.05 mg/kg while the values ranged from 0-0.8±0.02 mg/kg. The mean value of As was 0.120 mg/kg with a CV value of 14.8%, the range was 0.111-0.166 0.01 mg/kg whereas, Cr had a mean value of 38.4 mg/kg with CV value of 11.7%, the values ranged from 27.6-44.2±4.5 mg/kg. Mercury had a mean value of 4.31 mg/kg, the range was between 3.03-6.06±0.97 mg/kg with a moderate CV value of 22.5%.

Correlation

All the basic cations were negatively and slightly correlated with soil pH (Table 4a). However, Na was moderately correlated with K. Table 4b showed that electrical conductivity and K were strongly and positively correlated (r=0.69) whereas, K and Na were moderately correlated (r=0.5). There was positively and strongly significant correlation between Na and P (r=0.6) and K and P (r=0.61) (Table 4c).

Table 4a: Correlation between pH and basic cations.

	Ph	Na	K	Ca	Mg
pH	1				
Na	-0.08	1			
K	-0.03	0.5	1		
Ca^2	-0.23	-0.02	0.07	1	
Mg^2	-0.02	-0.003	0.08	-0.09	1

Table 4b: Correlation between electrical conductivity and basic cations.

	EC	Na	K	Ca	Mg
EC	1				
Na	0.31	1			
K	0.69*	0.5	1		
Ca	0.41	-0.02	0.07	1	
Mg	0.05	-0.003	0.08	-0.09	1

Soil evaluation factor of the farm

Table 5 presented soil fertility index (SFI) and Soil evaluation factor (SEF) of the farm. Nutrient management zone (NMZ) one, had the highest values of both the SFI and SEF followed NMZ 2 and 3 respectively.

Categorization of the farm into management zones

Fig 1 and 2 showed both the soil organic matter and total nitrogen management zone of the farm. Larger proportions of the farm falls into the low soil organic matter and total nitrogen management zone while the smaller areas were found to be moderate and high. This indicates that the farm has low level of soil fertility.

The high sand content of the farm could be linked to the ploughing and consequent exposure of the surface soil to harsh climatic condition that led to continuous leaching of the colliodal particles (Amonmide *et al.,* 2019). The pH values were strongly acidic which could be due to the use of inorganic fertilizers, the optimal pH levels ranges from 6.0-7.0. The acidic condition definitely could translate to low nutrient availability (Shaaban, 2024). To sustain good yield of crops in the farm, appropriate soil pH is relevant in view of its effect on nutrient availability and mobility as well as the microbial community that will decompose the organic matters in the soil (Shaaban, 2024). This is paramount for fertilizer programming for the newly established farm.

The values of EC for crop production ranges from 0.8 to 1.8 ds/m and according to Okoror and Amanze (2024), it should not be above 2.5 ds/m. But in this situation of the farm, about 73% falls within the range, whereas the remaining 27% of the area had higher EC. As has been reported, EC value of loamy sand tends to range from 0-1.2 dS/m, this is applicable in this farm with similar soil texture (Okoror and Amanze, 2024). Sampling points with the highest soil organic carbon also had the highest value of EC; indicating that an increase in organic matter has a positive influence on soil nutrient availability for crop as it had higher EC (Yang *et al.,* 2024). A CEC value below 10 cmol/kg will result to severe yield reduction as nutrient availability will be low

Table 4c: Correlation between soil organic matter and major elements.

	C	N	Na	K	Ca	Mg	Me	P
C	1							
N	0.49	1						
Na	0.04	0.18	1					
K	-0.32	-0.09	0.5	1				
Ca^2	0.16	0.29	-0.02	0.07	1			
Mg^2	0.17	0.48	-0.003	0.08	1			
Me	0.18	0.43	0.12	0.35	-0.02	-0.09	1	
P	0.25	0.17	0.6*	0.61*	0.45	-0.13	0.35	1

and it is an important soil property that influences response to fertilizer (Yang *et al.,* 2024). Danindra *et al.* (2022), observed that soil with high concentrations of ECEC but dominated by Al, H (low base saturation), will contain low level of soil fertility, that was the case in this farm where Al and H were higher. Percentage base saturation (BS) is another important soil quality indicator and it is the proportion of the CEC that is occupied by basic cations (Ćirić *et al.,* 2023). Therefore, the low percentage base saturation indicated that the farm generally will not be fertile as it has acidic cations and Al^{3+}. As the soil contain lower BS, basic cations (Ca^{2+}, Mg^{2+}, Na^{+} and K^{+}) will be deficient in the soil (Leticia *et al.,* 2017). Soil fertility parameters were spatially distributed and the micro variability could be as a result of the influence of management practices. The micro variation could be influence by management practices in the farm. Available P has mean value of 10.4 mg/kg, this was moderately low and this could be as a result of the elevated soil pH level (pH<5.0) that probably reduced phosphorus availability as P is fixed in acidic soils (Bastin *et al.,* 2025 and Nwawuike, 2023).

Table 5: Soil fertility index soil evaluation factor rating and the management zones.

Management zones	Soil fertility index	Soil evaluation factor	Rating
1	19.4	4.25	High
2	14.2	4.11	Moderate
3	11.7	3.94	Low

The level of all the micro-nutrients measured were higher with reference to their critical levels (Mn =1.0 mg/kg, Cu = 0.2 mg/kg, Zn = 0.5 mg/kg and Fe = 4.5 mg/kg) (Ibia, 2012). The available Mn of the farm was therefore high given the fact that all the values recorded were above 1.00 mg/kg. The value within 1 mg/kg and higher but above 15 mg/kg could be harmful to crop (Ojobor and Aimufia, 2022). Similarly, Zn level within 4.5 mg/kg values are suitable for cropping whereas, if it is higher than 10 mg/kg, the crops would be at risk. Iron concentration was generally higher than other micronutrients evaluated. The high concentration of Fe could be due to abundance of sesquioxides (Ibia, 2012). This could also be linked to soils formed from basement complex rocks that contain high Fe compounds (Ojobor and Aimufia, 2022). Also, excessive use of mineral fertilizer most especially P fertilizers, could lead to deficiency of micro-nutrients (Nwawuike, 2023).

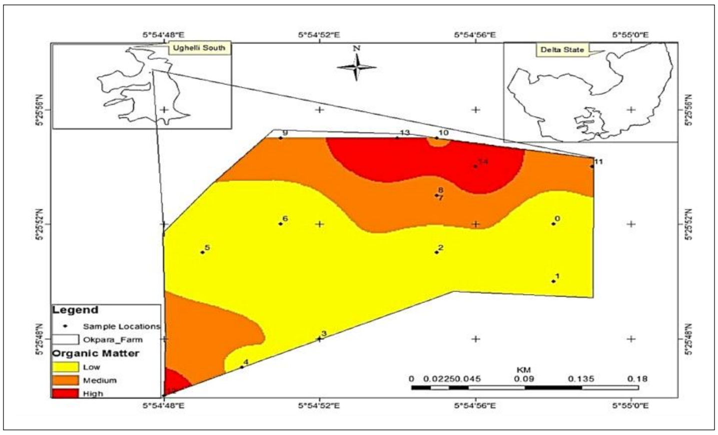

Fig 1: Map showing the three management for soil organic matter.

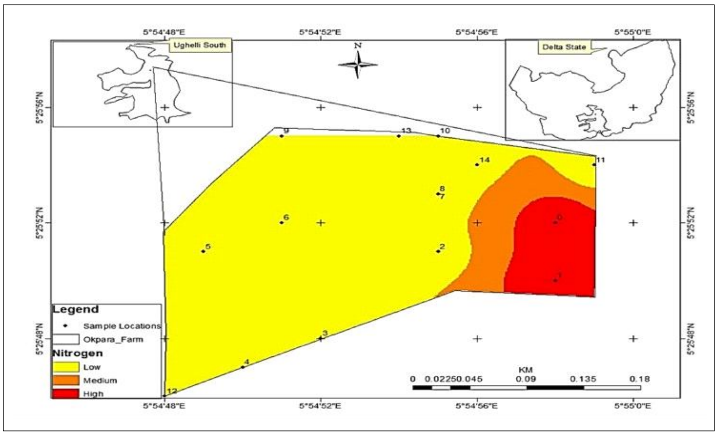

Fig 2: Map showing different nutrient management zones for nitrogen.

CONCLUSION

It can be concluded that due to the acidic nature of the soil, non-acid forming fertilizers should be applied at recommended rates to boost crop yield and should be applied according to the nutrient needs of the crops.

ACKNOWLEDGEMENT

The present study was supported by all the Authors.

Disclaimers

The views and conclusions expressed in this article are solely those of us the authors and not the views of our affiliated institution. We are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

No animal was used in this experiment.

Conflict of interest

There are no conflicts of interest regarding the publication of this article. No funding or sponsorship.

REFERENCES

Amonmide, I., Dagbenonbakin, G., Agbangba, C.E. and Akponikpe P. (2019). Contribution à l'eìvaluation du niveau de fertiliteì des sols dans les systèmes de culture à base du coton au beìnin. *Int J. Biol Chem Sci*. **13(3):** 1846-1860. doi: 10. 4314/ijbcs.v13i3.

Ayodele, F.G., Aina, O.A., Agboola, K. and Musa, M.B. (2019). Assessment of soil fertility status of some agricultural land use types in ayetoro-gbedeijumu local government area of Kogi State, Nigeria. *East African Scholars J Agri Life Sci*. **2(9):** 433-438

Bastin, B., Beena, V.I., Rajim, R.P. and Dey, P. (2025). Evaluation of soil fertility status of agro ecological zones of Kerala using nutrient index approach. *Agricultural Science Digest.* doi: 10.18805/ag. D-5509.

Ćirić, V., Prekop, N., Šeremešić, S., Vojnov, B., Pejić, B., Radovanović, D. and Marinković, D. (2023). The implication of cation exchange capacity (CEC) assessment for soil quality management and improvement. *Agriculture and Forestry*. **69(4):** 113-133. doi: 10.17707/AgricultForest.69.4.08.

Dandasena, N.K., Pal, P., Mollah, N., Das, S. and Bhattacharya, P. (2024). Soil fertility evaluation and mapping. *International Journal of Advanced Biochemistry Research*. **8(4):** 363-367.

Danindra, D., Setiawan, R.P.A., Desria, I., Solahudin, M., Astika, I.W. and Widodo, S. (2022). Mapping of Soil EC in Relation with Selected Chemical Properties of Soil. *IOP Conf. Series: Earth and Environmental Science*. pp. 1-8.

Delsouz, K.B., Honarjoo, N., Davatgar, N., Jalalian, A. and Torabi, G.H. (2017). Assessment of two soil fertility indexes to evaluate paddy fields for rice cultivation. *Sustainability.* **9(8):** 1299. https://doi.org/10.3390/su9081299.

Hadole, S.S., Katkar, R.N., Sarap, P.A., Lakhe, S.R. and Muhammed, S.K. (2019). Status of molybdenum in soils of Palghar district of Maharashtra. *Indian Journal of Agricultural Research*. **53(6):** 737-740. https://doi.org/10.18805/ IJARe.A-5057.

Ibia, T.O. (2012). Soil Chemistry, Soil Quality and National Development: The Nexus. 32rd Inaugural Lecture Series, University of Uyo, Nigeria, May 31. pp. 83

Iraiyanban, A.A.A., Manuel, I.R., Augustine, R. and Shiny, A.V.A. (2025). Evaluation on the influence of cropping systems and nutrient management practices in pearl millet (*Pennisetum glaucum*) growth, crop nutrient uptake and soil fertility status. *Indian Journal of Agricultural Research*. **59(7):** 1103-1111. doi: 10.18805/IJARe.A-6285.

Leticia, S.S., David, E.K. and Uttam, S. (2017). Cation exchange capacity and base saturation | UGA cooperative extension. Available at: https://extension. uga.edu/publications/detail. html?number=C1040andtitle=Cation%20Exchange%20 Capacity%20and%20Base%20Saturation.

Nwawuike, I.M. (2023). Fertility assessment of soils under different land use in Oguta, Nigeria. *Journal of Agriculture and Food Sciences*. **21(2):** 43-52

Ofem, K.I., Abam, P.O., Ediene, V.F., Aki, E.E. Afu, S.M. and Umeobi, E.C. (2023). Fertility implication of clay minerals in soils of three limestone geologic formations in southeastern Nigeria. *Arabian Journal of Geosciences.* **16:** 636.

Ojobor, S.A. and Aimufia, P.N. (2022). Fertility status of fadama soils in Asaba, Delta State, Nigeria: Nigeria *Journal of Soil Science*. Soil Science Society of Nigeria. **32(1):** 72-76.

Ojobor, S.A., Egbuchua, C.N. and Onoriasakpovwa, R.A. (2021). Assessment of soil fertility status using nutrient index approach of Ovu Sub-Clan, Delta State, Nigeria. *Agricultural Science Digest*. **41(2):** 282-288. doi: 10.18805/ag.D-5509.

Okebalama, C.B., Anih, F.C. and Awaogu, C.E. (2024). Morphology and fertility evaluation of soils from different geological materials for agricultural production in Southeastern Nigeria. *Technol. Agron*. **4:** e018.

Okoror, P.I. and Amanze, C.T. (2024). Electrical conductivity, basic cations and organic matter content of soils under different land use practices in Akwa Ibom State. *African Journal of Environment and Natural Science Research*. **7(2):** 74-83. doi: 10.52589/AJENSR WPXH0TUX.

Sachan, H.K. and Krishna, D. (2022). Assessment of soil fertility status using nutrient index approach in cassava farms of rewa province, Fiji. *Indian Journal of Agricultural Research*. **56(5):** 594-598. doi: 10.18805/IJARe.AF-680.

Shaaban, M. (2024). Acidic Soils. In: Núñez-Delgado, A. (eds) Planet Earth: Scientific Proposals to Solve Urgent Issues. Springer, Cham. https://doi.org/10.1007/978-3-031-53208-5_13.

Sikka, R., Singh, D., Deol, J.S. and Kumar, N. (2018). Effect of integrated nutrient and agronomic management on growth, productivity, nutrient uptake and soil residual fertility status of soybean. *Agricultural Science Digest*. **38(2):** 103-107. doi: 10.1880 5/ag.LR-3994.

Yang, Y., Xie, S., Cui, Y., Lei, W., Zhu, X., Yang, Y. and Yu, Y. (2004). Effect of replacement of dietary fish meal by meat and bone meal and poultry by-product meal on growth and feed utilization of gibel carp. *Carassius auratus gibelio*. *Aquac. Nut.* **10(5):** 289-294.