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Research Article

An Assessment of Soil Fertility and Capability Potentials of Derived Savanna Landscapes in Delta State: Implication of Suitability for Arable Farming

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Abstract
This research paper examined the soil fertility and capability potentials of derived savanna landscapes in Delta State: implication on suitability for food security. The derived savannas of Delta State are vegetation with peculiar land cover because they are adjudged as alien vegetation that exists within the rainforest which is outside the domain of "savanna" grasslands which occurs in the middle belt as Guinea savanna Sudan and Sahel savanna in northern Nigeria. They are termed derived savannas because they are environmental derivatives of anthropogenic disturbances and other factors of nature within the rainforest. Over the years, the derived savannas have either been marginalized, idle or underutilized, as they are either touched by wild bush fires, during the dry seasons or flooded during the wet seasons. The assessment of the soil fertility and capability status of the derived savanna therefore confirmed that they are rich in major soil parameters such as organic carbon content, nitrogen, potassium and others. They are also suitable for hydrotolerant plants. The study justified the derived savanna of Delta State as having the fertility and capability potential to support sustainable ventures for arable farming and general agricultural land use. This is especially true for short-term crops that can mature before the annual flood regime. Also, their usage for arable farming practices will ameliorate food insecurity in the area based on the recommendation of the soil suitability for arable farming.

Keywords: Soil Fertility Assessment, Soil Capability, Derived Savanna

1. Introduction

The dynamism of the soil ecosystem is usually a reflection of the land cover or vegetation cover present in the environment. In other words, vegetation cover or the plant cover community that exists in a particular environment is certainly expected to exercise an overwhelming influence on the nature of soils found within the specific location (Aweto & Areola, 1979). Environmental factors that influence the nature of soils generally include; edaphic factors, rainfalls in the region, and to some extent, topography. All these factors have localized influence. Stockdale et al. (2013) opined that soil fertility and capability are a function of the nature of vegetation cover that exists within the ecosystem. In related research. Okiemute and Orovwigho (2021) also justified the role of soil physiochemical parameters in boosting soil fertility and capability in the maintenance of a healthy soil nutrient regime.

The grasslands of Delta State otherwise referred to as "derived savanna" are distinct and unique from those found in the middle belt and the core Northern part of Nigeria. The derived savannas of Delta State exist within the rainforest vegetation belt. Therefore, the derived savanna vegetation is an alien type of vegetation that exists within the tropical rainforest belt. Aweto and Areola (1979), studied the evolution of derived savanna enclaves of Urhobo plains and traced the existence of the derived savanna landscapes to anthropogenic factors, such as annual fires from bush burning that ravage the forest during the dry seasons, exploitation and other extreme factors from nature. This dismissed the

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allusion on the evolution of derived savanna of Delta State that they are courses of silted rivers; as there appears to be a total absence of features of silted or captured rivers such as wind-gap misfit, elbow of capture and other relic features of a captured or silted river course. They are therefore adjudged to be vegetation in their secondary stage of succession (Aweto, 1987). The derived savanna landscape is usually a reflection of the vestiges of its past vegetation as a few resistant trees and shrubs including oil palm trees are found within the grassy landscapes (Cole, 1986). Okiemute and Orovwigho (2021), further opined that derived Savannas are viable sources of ecosystem services.

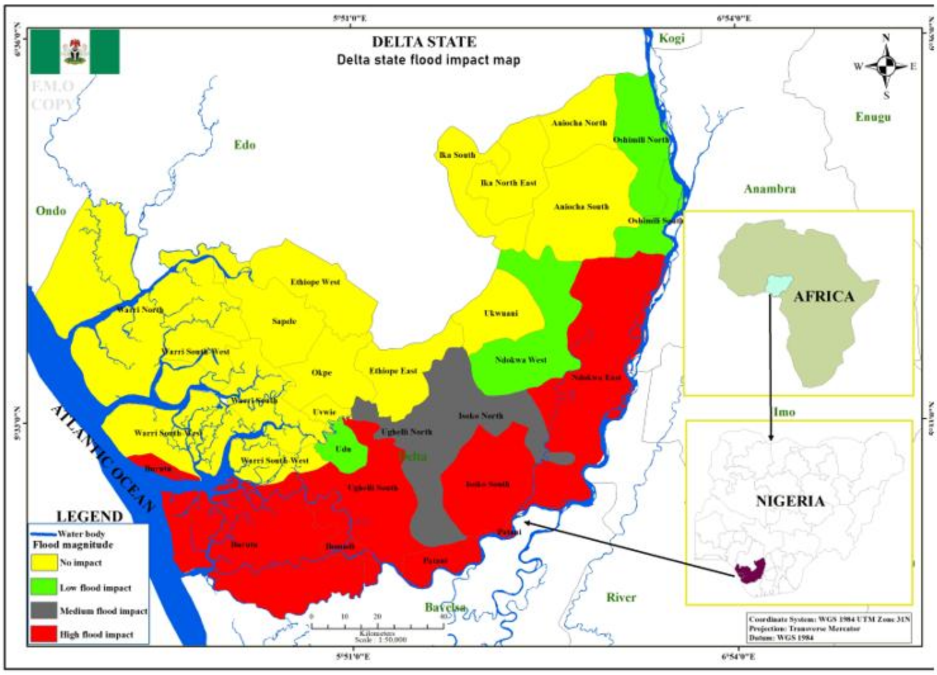

Figure 1. Nigeria showing Delta State. Source, Author's Fieldwork, 2025

Delta State has a geographical area of about 17,440 square kilometers (Orowhigo, 2021). Its nomenclature is a reflection of the Delta region of the River Niger. The State is located within the rainforest belt. However, there exists unique vegetation from anthropogenic disturbances arising from human activities. The grasslands and savanna are generally referred to as the "derived savanna" landscapes. The predominant physical features include swamps, creeks, rivers and coastlines extending from East to West for about 163 kilometers on the Atlantic Ocean. It is bounded by River Niger and Anambra on the East, Bayelsa State in the South, Edo State to the North, and the Southern flank by the Bight of Benin. Delta State has a wide coastal belt, inter-laced with complicated channels of water bodies such as rivulets, streams, and numerous tributaries which constitute part of the Niger Delta through which River Niger finds its way into the sea (Evans, 2012).

1.1. Geology and Soils

Delta State is a prominent part of the Niger Delta: it is underlaid by sedimentary rocks consisting mainly of yellow, white, and sand with pebbles, clay and sandy soils which occur in lenses (Peters & Mundial, 1996). Generally, Delta State falls within the Benin-Agbada formation with relatively uniform geology. The soils of the rainforest within which the derived savanna is situated are highly varied. The main widespread soil type is the tropical forensic soil spreading from Edo to Delta (Alakpodia, 2000). The geology and soils of the area have formed a basis for the sustenance of the forest vegetation and derived savanna landscapes over the years. The derived savanna landscape is also referred to as wetland grass vegetation because of its moisture.

2. Methods

The field survey method was adopted for this study. Thirty soil samples were collected from selected derived savannas in the three Senatorial zones of Delta State. A total of thirty samples were tested and analyzed. They were compared with the threshold soil parameter values of soil physio-chemical properties as developed by Sanchez et al. (1982), and Miller and Donahue (1990). Results obtained were then used to draw inferences from the threshold table values to ascertain the suitability of the derived savanna soils for arable farming, and sustainability of the environment. This is to mitigate crises that could occur from food security.

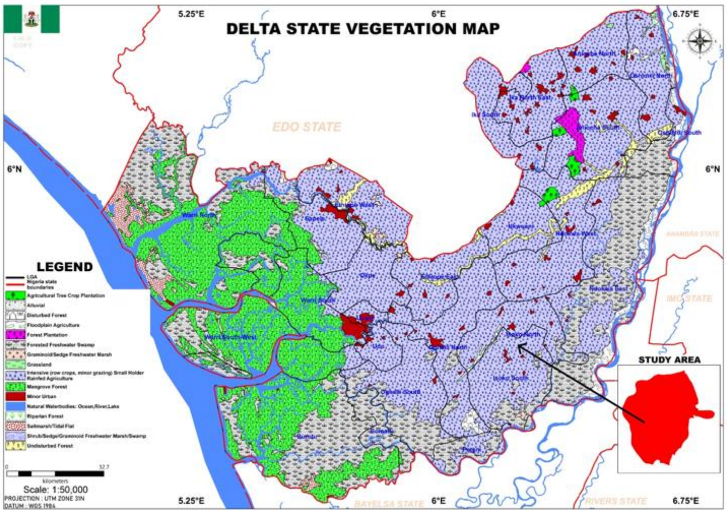

Figure 2. Map of Delta State showing vegetation in Delta State.
Source, Author's Fieldwork, 2025

3. Results and Discussion

3.1. Soil Fertility and Capability Potentials in Derived Savannas in Delta State

Most studies on soil fertility and capability in Delta State have been on the effects of petroleum oil exploitation, land pollution, deforestation, effects of excessive cultivation and others. The derived savanna landscapes are landscapes of "Environmental Revolts". This unique vegetation landscape occurs in nearly every part of Delta State. In the wake of land scarcity, land grabs due to land scarcity, food crises and insecurity, there calls for an urgent need for scientific enquiry into the soil fertility and capability potential of physio-chemical parameters of soils in the derived savanna landscapes to ascertain their suitability for sustainable ventures. Most derived savannas are either left Marginalized, abandoned, Idle or Under-utilized. There is therefore need to explore the soil fertility and capability potentials of this peculiar vegetation type to ascertain its suitability for sustainable staple food crop production. Fajobi et al. (2023) also remarked that the issue of food security could be addressed through the exploration of new idle or marginalized agricultural lands. Obayelu et al. (2024) further posited that soil quality evaluation is a major determinant of soil suitability and capability.

Ariyo et al. (2021) aptly defined soil capability as the ability of the soil to function within natural or managed ecosystem boundaries to sustain plant and animal production to enhance or maintain its fertility status for a conducive and healthy man and environmental interaction. It also takes cognizance of the availability of various soil physio-chemical properties in the right proportion and quality. It is also referred to as an expression of the physical and chemical condition of the land on total land sustainability for various uses.

On the other hand, soil fertility is the ability of soil to sustain plant growth (Javed et al., 2022). The fertility status of a particular soil is a major determinant of its suitability and productive capacity. Low soil fertility and soil capability index of soils often pose a general constraint to the sustainable use of soil resources. Derived savannas over the years from observation are generally undermined despite their being prone to flooding during the wet season, they possess cultivable potential that could sustain crops during the period when the floods recede.

Figure 3. Derived Savanna at Delta South (Kiagbodo), 2018, Fieldwork

Figure 4. Derided Savanna at Delta Central (Samagidi), 2018, Fieldwork

Figure 5. Derived Savanna at Delta North (Ugbolu-Asaba), 2018, Fieldwork

Table 1. Soil parameter thresholds for soil fertility and capability

	Soil parameter	Standard/ thresholds	Source
1.	pH	Between 5 – 6 in 1:1 H2o	Soil Fertility Capability Classification (Sanchez et al., 1982)
2.	Organic Carbon/ Matter	3 – 8% or higher	Miller and Donahue (1990)
	Cation Excahngeable Capacity	4 meq/100g	Soil Fertility Capability Classification (Sanchez et al., 1982)
	Potassium	0.20 meq/100g	Soil Fertility Capability Classification (Sanchez et al., 1982)

Source: Sanchez et al. (1982)

The threshold values were developed by Sanchez (1982) and Miller and Donahue (1990) are as follows:

s – high rate of infiltration, low water retention capacity
g – denitrification frequently occurs in the anaerobic sub-soils; tillage operation and certain crops may be adversely affected by excess rain drainage. This could be improved by tilting of other drainage procedures which could be a good soil moisture regime for rice production.
e – low ability to retain nutrients against leaching, mainly potassium (K) calcium (ca) and magnesium = adequate application of k, ca and mg would salvage the soil for sustainable use under effective soil management conditions.
k – low ability to supply k (potassium) frequent application of k fertilizer would act as a remedy for the soil posed by low potassium in derived savannas.

3.2. Soil Parameter Values for Derived Savannas in Delta State

Table 2. Soil parameter mean values for Derived Savannas

	Delta Central	**Delta North**	**Delta South**	
Soil Parameters	**D.Savanna**	**D.Savanna**	**D.Savanna**	**Standard**
pH	5.22	4.48	4.18	5-6
OC (%)	2.17	4.29	2.41	3-8
Total Nitrogen (%)	0.24	0.48	0.27	
Avail. Phosphorus (ppm)	7.25	7.64	33.8	
Calcium (cmol/kg)	0.42	0.31	0.27	> 0.20 meq/ 100g
Sodium(cmol/ kg	1.57	1.60	1.93	
Magnesium (cmol/kg	0.46	0.36	0.55	
Potassium (cmol/kg)	0.10	0.10	0.11	
Sand (%)	78.20	84.80	77.20	
Silt (%)	11.40	9.40	10.20	
Clay (%)	10.40	5.80	12.60	
ECEC	2.56	2.37	2.90	> 4 meq/ 100g
SFI	10.00	10.14	12.22	

Note: The soil parameter standard is profile by Sanchez et al. (1982) and Miller and Donahue (1990).
Source: Fieldwork, 2024

Scientific enquiry into the soil fertility potentials of the derived savanna established their similar fertility and capability potential when compared with the standard threshold values of the rain forest. This was in terms of availability of macro and micronutrients, organic matter content in the right quantities suitable for soil fertility. The study thus confirmed that the soils of the derived savannas of Delta State are suitable for arable farming and their idle or marginalized states should be dismissed. Adebayo and Ojo (2012) opined that food is life, and soil management in an underutilized landscape is a panacea for food insecurity. The study confirmed the soil suitability, sustainability and capability potential of Delta State derived savanna. They are therefore veritable landscape suitable for crop production and precision agriculture whose cultivation will ameliorate food insecurity.

4. Conclusion

The paper is on the assessment of soil fertility and capability status of derived savanna landscapes for sustainable arable farming. The findings from the study posit that the derived savanna landscapes are cultivable lands following the availability of the various macro and micro soil physio-chemical properties in the right quantities. They are therefore suitable for arable farming and should not be marginalized. Thus, their use for agricultural purposes will mitigate issues of land scarcity and land grabs and also mitigate the issue of food security. This will in turn yield food availability and food accessibility which will positively enhance the wellbeing of citizens and the nation at large.

For future researchers, it is recommended to conduct longitudinal studies to monitor changes in soil fertility and productivity in derived savanna landscapes under continuous arable cultivation. Investigating the impact of different land management practices, crop rotation systems, and organic amendments on soil health in these regions will provide deeper insights into sustainable utilization. Additionally, integrating geospatial analysis and remote sensing technologies could enhance the precision of soil capability assessments. Comparative studies across various agro-ecological zones would also be valuable in validating the broader applicability of these findings and guiding region-specific agricultural policies.

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