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# MULTI-CROP LAND SUITABILITY ASSESSMENT USING GIS–AHP IN OSUN STATE, NIGERIA

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**ABSTRACT. – Multi-Crop Land Suitability Assessment Using GIS–AHP in Osun State, Nigeria**. The sustainable cultivation of arable crops in Nigeria is increasingly challenged by climate variability, land degradation, and inefficient land use practices. This study evaluates the land suitability of Osun State for multiple crops—cassava, maize, yam, rice, cocoa, plantains, and vegetables—using a GIS-based Analytical Hierarchy Process (AHP) approach. The research has been conducted to produce spatially explicit suitability maps to support climate-resilient agricultural planning and optimization of crop selection in the region. Seventeen environmental, climatic, and edaphic criteria-slope, elevation, rainfall, temperature, soil pH, organic carbon, macro-nutrients, proximity to roads, and rivers-were integrated using AHP, which derives weights from expert judgment. The weights were then used in a weighted overlay analysis to map the area according to the suitability classes: highly suitable, suitable, moderately suitable, marginally suitable, and unsuitable. The results revealed that cassava and maize have the highest proportions of highly suitable land in the state, with yam coming next. Spatial analysis sets out the top Local Government Areas such as Aiyedaade, Ife South, Ife North, Atakumosa West, and Obokun as highly preferable zones for multi-crop cultivation. This study draws attention to the usefulness of the GIS–AHP method for land evaluation at the regional scale and provides critical insight into data-driven agricultural policy, sustainable land use, and food security in sub-Saharan Africa.

***Keywords:*** *land suitability; GIS–AHP; multi-crop assessment; agricultural zoning; sustainable agriculture*

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## 1. INTRODUCTION

Agriculture acts in Sub-Saharan Africa as the backbone of some socio-economic development, along with food security and livelihood sustainability; it accounts for over 60 percent of the workforce while at the same time contributing to a very significant percentage of the national gross domestic product (Haggblade, 2013; Kray et al., 2018; Searchinger et al., 2023). In Nigeria, crops such as yam, maize, cassava, rice, plantain, cocoa, and vegetables keep the small-scale agriculture going and support household food systems and local markets (Olugbire et al., 2021; Chiaka et al., 2022). While the ecological and economic importance of these crops is well documented, their productivity differs depending on the region because there is a mismatch between their ecological requirements and the predominant land use patterns (Siptits & Evdokimova, 2020; Qiu et al., 2021).

That is a complication that is quite keenly felt in southwestern Nigeria, particularly in Osun State, where land use decisions are, until today, still regularly taken on informal or tradition-based grounds. Consequently, poor site selections become a hindrance to farm productivity as do resource misallocations and environmental degradation on a long-term basis (Oyekale, 2012a; Oyekale, 2012b; Alabi et al., 2024). Population pressure, climate variability, and the depletion of soil nutrients have added another layer of adversity to the problems of agricultural land management and planning, thus invoking the urgent need for data-based tools (Ezekiel et al., 2020; Kehinde et al., 2020).

In an answer to this urgent requirement, Geographic Information Systems (GIS) and Remote Sensing (RS) have been considered dynamic tools in the spatial land suitability evaluation and one that can layer and combine different environmental data sets like soil properties, topographies, rainfall, and infrastructure networks required in spatial decision-making (Partoyo, 2022; Alam et al., 2024; Yuliawan & Pusvita, 2024). To enhance objectivity and reproducibility in land evaluation, GIS is increasingly being paired with Multi-Criteria Decision Analysis (MCDA) methods, particularly the Analytic Hierarchy Process (AHP). AHP offers a robust and transparent framework for assigning weights to multiple biophysical and socioeconomic criteria, allowing for expert-driven prioritization (Rovai & Andreoli, 2018; Wotlolan et al., 2021; Nungula et al., 2024). Its flexibility in handling both qualitative and quantitative data makes it especially suitable for agricultural applications (Jozi & Ebadzadeh, 2014; Wijesinghe, 2024).

Several studies have demonstrated the application of GIS and AHP in agricultural land suitability assessments. In the Amhara Region of Ethiopia, land suitability for rice production was assessed through GIS-AHP, considering soil, climate, and topography. It was also noted that in more than 70% of the areas, either high or moderate suitability for rice production was indicated, presenting a great prospect for agricultural development in the region (Ayehu & Besufekad, 2015). In Ghana, 23.3% of land ranked as highly suitable for cocoa, whereas from 1.5 to 23% of the territory in Peru was identified by the AHP model as highly suitable, depending on the modeling approach employed (Rojas-Briceño et al., 2022; Bhat, 2023); meanwhile, a study in Egypt observed 36% suitability for maize, stressing the importance of the existing climate and soil conditions (Abuzaid & El-Husseiny, 2022). A few other assessments in Nigeria indicated land suitability for cassava up to the extent of 65.92% existing in the southern part of Adamawa State, thereby recognizing large areas for potential cultivation (Zemba et al., 2018) as well as rice in Oyo State (Ayoade, 2017) and soybean in Kaduna State (Sadiq et al., 2023). However, most of these studies are limited by narrow spatial coverage, focus on a single crop, or use of low-resolution datasets, limiting their relevance for broader agricultural policy and spatial planning.

Notwithstanding the growing corpus of GIS–AHP literature, only a few studies have developed comprehensive, multi-crop, land suitability maps at sub-national scale in Nigeria capturing the seven crops this study is examining. Another major gap in research is the relative inter-crop suitability studies across entire state territories using fine-scale data that have been validated using expert opinions and empirical observations.

The proposed study is set to create a large-area scale (30 m), multi-crop land-suitability model using a GIS–AHP approach for seven major arable crops of Osun State. The thrust will then be to produce spatially explicit suitability maps that can be employed in the pursuit of precision agriculture, sustainable land management, and zoning policy decisions at the local government area (LGA) level. The inclusion of various environmental variables and stakeholder knowledge in the decision-making process aims to support sub-national planning frameworks that might enhance food security and resource optimization in southwestern Nigeria.

## 2. MATERIALS AND METHODS

**Study Area.** The study was undertaken in Osun State (Southwestern Nigeria) located between latitudes 7°30′N and 8°10′N and longitudes 4°00′E and 5°05′E. Osun State covers an area estimated at 9,251 km² and comprises 30 Local Government Areas. The region has a tropical climate and four distinct seasons of bimodal rainfall, with rainfall ranging from 1,100 mm to 1,400 mm, and temperature ranges between 25°C and 31°C. The topography varies from lowland plains to undulating hills, with the land predominantly used for smallholder rain-fed agriculture. Because of this diversity of ecological features, Osun State supports varied arable crops, making it a fair latitude land suitability analysis location. The study area is shown in figure 1.

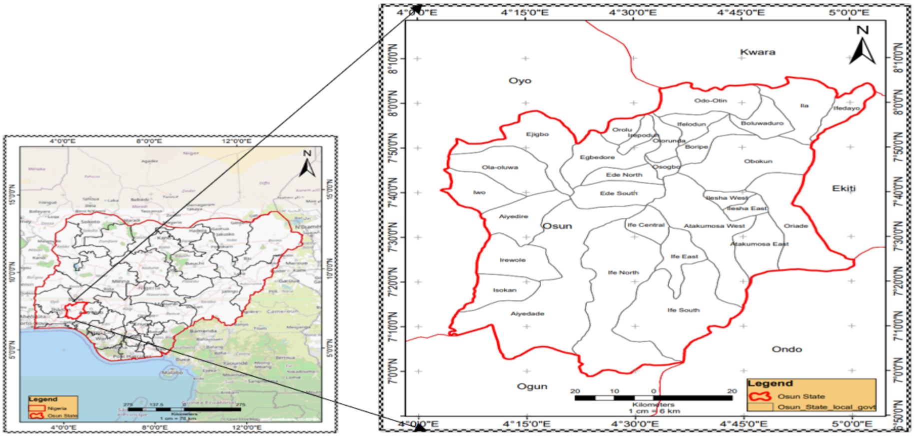


**Fig. 1.** Map of the study area.
*Source: the authors*

**Data Sources.** The land suitability assessment incorporated a range of geospatial datasets relevant to crop growth, including climatic, topographic, edaphic, and infrastructural variables**.** The data sources are listed in table 1.

**Table 1.** Spatial datasets and metadata used to derive suitability layers in the multi-criteria evaluation model

| S/N | Data | Name | Resolution | Sources |
|---|---|---|---|---|
| 1 | Land use and land cover | Landsat 8 & 9 | 30m | *https://earthexplorer.usgs.gov/* |
| 2 | Elevation & slope | SRTM | 30m | *https://earthexplorer.usgs.gov/* |
| 3 | Climate (Precipitation) | CHRS | 4km | *https://chrsdata.eng.uci.edu/* |
| 4 | Climate (Temperature) | MODIS Global LST | 1km | *https://earthexplorer.usgs.gov/ (Google Earth engine)* |
| 5 | Climate (Humidity) | NASA | 2m | *https://power.larc.nasa.gov/data-access-viewer/* |
| 6 | Soil | ISRIC | 250m | *https://data.isric.org/geonetwork/srv/eng/catalog.search#/home* |
| 7 | Rivers / surface water | OSM | 250m | *https://download.geofabrik.de/africa.html* |
| 8 | Roads | OSM | 250m | *https://download.geofabrik.de/africa.html* |

*Source: the authors*

**Data Acquisition and Processing.** Environmental and spatial datasets were integrated to analyze land suitability for seven major arable crops throughout Osun State. Land use/land cover data were procured from Landsat

8/9 (30 m), while terrain data such as elevation and slope were extracted from SRTM. Climate variables of precipitation, temperature, and relative humidity were derived from CHRS, MODIS, and NASA POWER, respectively. Soil characteristics of pH, organic carbon, texture, and water holding capacity were collected from ISRIC SoilGrids. Distances to infrastructure were calculated using road and river vector datasets from OpenStreetMap and HydroSHEDS.

All the layers were reprojected to WGS 84 / UTM Zone 31N and resampled to a common 30-m resolution. Geospatial preprocessing steps were rasterization, Euclidean distance analyses (for proximity variables), image classification (for LULC), and interpolation (for climate and soil surfaces). Elevation and slope layers were derived from the DEM using standard geoprocessing tools. Each layer was reclassified into five suitability classes based on crop-specific ecological requirements and standardized for integration into a weighted overlay analysis using AHP-derived weights.

**Normalization and reclassification based on crop requirements.** Using ArcGIS Pro 3.2 for heavy assessment and for determining land suitability for arable crops, an integrated approach has been undertaken, starting with the accumulation of all the necessary data mentioned in objective one. These datasets include soil texture, temperature, relative humidity, rainfall, pH, slope, soil nutrient, proximity to roads and rivers, and land use/land cover data. The datasets are normalized and reclassified depending on each crop's special requirements.

**Minimum and Maximum Criteria Values in Osun state Nigeria.** The criteria required for crops in study farming in Osun state Nigeria are represented (table 2). Additional suitability tables are provided in the Supplementary list.

**Table 2.** Suitability criteria ranges (S1–N) for major crops in Osun State, Nigeria

| Criterion | Yam | Maize | Cassava | Rice | Plantain | Cocoa | Vegetables |
|---|---|---|---|---|---|---|---|
| LULC (S1) | Agricultural land | Agricultural land | Agricultural land | Agricultural land | Agricultural land | Forest | Agricultural land |
| Elevation (m, S1) | 68–155 | 68–155 | 68–155 | 68–155 | 68–155 | 68–155 | 68–155 |
| Slope (S1) | 0–5 | 0–5 | 0–5 | 0–5 | 0–5 | 0–5 | 0–5 |
| Precipitation (mm, S1) | 2600–2800 | 2801–3100 | 2600–2800 | 2517–2599 | 3401–3697 | 3401–3697 | 2801–3100 |
| Temperature (°C, S1) | 28–30 | 26–28 | 28–30 | 28–30 | 28–30 | 26–28 | 24.6–26 |
| Relative Humidity (% S1) | 70–75 | 70–75 | 70–75 | 70–75 | 65–70 | 80–82 | 65–70 |
| Soil pH (S1) | 6.13–6.17 | 6.13–6.17 | 6.13–6.17 | 6.13–6.17 | 6.13–6.17 | 6.13–6.17 | 6.13–6.17 |
| Soil Texture (S1) | Loam | Loam | Loam | Clay | Loam | Loam | Loam |
| Soil N (mg/kg, S1) | 450–599 | 450–599 | 450–599 | 450–599 | 450–599 | 450–599 | 450–599 |

| Criterion | Yam | Maize | Cassava | Rice | Plantain | Cocoa | Vegetables |
|---|---|---|---|---|---|---|---|
| Soil P (mg/kg, S1) | 500–676 | 500–676 | 500–676 | 500–676 | 500–676 | 500–676 | 500–676 |
| Soil K (mg/kg, S1) | 200–260 | 200–260 | 200–260 | 200–260 | 200–260 | 200–260 | 200–260 |
| Soil Ca (mg/kg, S1) | 1100–1493 | 1100–1493 | 1100–1493 | 1100–1493 | 1100–1493 | 1100–1493 | 1100–1493 |
| Soil Depth (cm, S1) | 40–58 | 36–46 | 40–58 | 23–36 | 40–58 | 40–58 | 0–23 |
| Soil Organic Carbon (g/kg, S1) | 428–698 | 428–698 | 428–698 | 428–698 | 428–698 | 428–698 | 428–698 |
| Soil Water Capacity (kPa, S1) | 263–336 | 263–336 | 263–336 | 263–336 | 263–336 | 263–336 | 263–336 |
| Distance to Rivers (m, S1) | 5000–9999 | 2000–4999 | 5000–9999 | 2000–4999 | 2000–4999 | 2000–4999 | 2000–4999 |
| Distance to Roads (m, S1) | 0–500 | 0–500 | 0–500 | 0–500 | 0–500 | 0–500 | 0–500 |

*Source: the authors*

**Analytical Hierarchy Process (AHP).** Analytic Hierarchy Process (AHP) is a method or a tool that aids in sorting and assessing complex decisions. Thomas L. Saaty was the developer of this tool in the 1970s and it has been used to establish a hierarchy of criteria and factors influencing land suitability. AHP techniques assign appropriate weights to each criterion based on its relative importance, so that crucial factors such as soil types, soil pH, climatic data, soil nutrients, land use, and soil depth are emphasized in the analysis, while other factors such as road and river proximity are given less importance. Because the AHP Excel file supports only 10 criteria, the free web-based decision-making tool AHP Online System (AHP-OS) from https://bpmsg.com/ahp/ahp.php was preferred. This is because 17 criteria were needed to be considered for the analysis.

If one clicks on AHP Priority Calculator and chooses the number of criteria (17), a new window opens where one can enter the criteria that were used in the analysis. Pairwise comparisons are then carried out to ascertain how important each criterion is relative to every other one. The AHP scale includes: 1- Equal Importance, 3- Moderate importance, 5- Strong importance, 7- Very strong importance, 9- Extreme importance (2,4,6,8 values in-between).

**The resulting weights for the criteria based on the pairwise comparisons.** The multi-criteria evaluation and expert judgment with the Analytic Hierarchy Process (AHP) guided the decision-making process. The derived priorities highlight the relative importance of each criterion in determining land suitability for crop cultivation in Osun State. A total of 136 pairwise comparisons were conducted to establish the weights, with a Consistency Ratio (CR) of 6.5%, which is below the 10% threshold, confirming that the expert judgments were consistent. The principal eigenvalue was 18.678, converging in six iterations with high precision (delta = $4.3 \times 10^{-8}$).

The results show that rainfall, soil characteristics, slope, and land use/land cover had the highest influence on suitability outcomes, while lineament density and NDVI contributed less significantly. These priorities were computed from the decision matrix through eigenvector calculations and were applied in the weighted overlay analysis to produce the final suitability maps. The Pairwise Comparison matrix of land suitability for farming in Osun state, Nigeria is presented in fig. 2.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1.00 | 2.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 3.00 | 1.00 | 2.00 | 5.00 |
| 2 | 1.00 | 1 | 1.00 | 1.00 | 2.00 | 2.00 | 1.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 1.00 | 3.00 | 3.00 | 2.00 | 4.00 |
| 3 | 0.50 | 1.00 | 1 | 1.00 | 1.00 | 1.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 2.00 | 3.00 | 4.00 | 4.00 | 4.00 |
| 4 | 1.00 | 1.00 | 1.00 | 1 | 3.00 | 4.00 | 5.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 5.00 | 4.00 | 5.00 | 5.00 | 5.00 |
| 5 | 1.00 | 0.50 | 1.00 | 0.33 | 1 | 1.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 4.00 | 4.00 | 3.00 | 4.00 | 5.00 |
| 6 | 1.00 | 0.50 | 1.00 | 0.25 | 1.00 | 1 | 1.00 | 1.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| 7 | 1.00 | 1.00 | 0.33 | 0.20 | 0.33 | 1.00 | 1 | 1.00 | 2.00 | 2.00 | 2.00 | 2.00 | 3.00 | 3.00 | 2.00 | 4.00 | 4.00 |
| 8 | 1.00 | 0.50 | 0.33 | 0.25 | 0.33 | 1.00 | 1.00 | 1 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 4.00 | 4.00 | 3.00 | 4.00 |
| 9 | 1.00 | 0.50 | 0.33 | 0.25 | 0.33 | 0.50 | 0.50 | 0.33 | 1 | 1.00 | 1.00 | 1.00 | 2.00 | 3.00 | 4.00 | 4.00 | 2.00 |
| 10 | 1.00 | 0.50 | 0.33 | 0.25 | 0.33 | 0.50 | 0.50 | 0.33 | 1.00 | 1 | 1.00 | 1.00 | 2.00 | 3.00 | 4.00 | 4.00 | 2.00 |
| 11 | 1.00 | 0.50 | 0.33 | 0.25 | 0.33 | 0.50 | 0.50 | 0.33 | 1.00 | 1.00 | 1 | 1.00 | 2.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| 12 | 1.00 | 0.50 | 0.33 | 0.25 | 0.33 | 0.50 | 0.50 | 0.33 | 1.00 | 1.00 | 1.00 | 1 | 2.00 | 3.00 | 4.00 | 4.00 | 3.00 |
| 13 | 1.00 | 1.00 | 0.50 | 0.20 | 0.25 | 0.50 | 0.33 | 0.33 | 0.50 | 0.50 | 0.50 | 0.50 | 1 | 3.00 | 3.00 | 4.00 | 5.00 |
| 14 | 0.33 | 0.33 | 0.33 | 0.25 | 0.25 | 0.33 | 0.33 | 0.25 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 1 | 1.00 | 3.00 | 3.00 |
| 15 | 1.00 | 0.33 | 0.25 | 0.20 | 0.33 | 0.33 | 0.50 | 0.25 | 0.25 | 0.25 | 0.33 | 0.25 | 0.33 | 1.00 | 1 | 1.00 | 3.00 |
| 16 | 0.50 | 0.50 | 0.25 | 0.20 | 0.25 | 0.33 | 0.25 | 0.33 | 0.25 | 0.25 | 0.33 | 0.25 | 0.25 | 0.33 | 1.00 | 1 | 3.00 |
| 17 | 0.20 | 0.25 | 0.25 | 0.20 | 0.20 | 0.33 | 0.25 | 0.25 | 0.50 | 0.50 | 0.33 | 0.33 | 0.20 | 0.33 | 0.33 | 0.33 | 1 |

**Fig. 2.** Pairwise Comparison matrix of land suitability for farming in Osun State, Nigeria.
*Source: the authors*

The Weighted Sum Analysis (WSA) procedure found within ArcGIS was used for integrating together the reclassified raster datasets, with some weights obtained through the AHP method. Using the slope as an example, general land parameters like slope, soil pH, and rainfall affecting crop growth were multiplied by their respective weights and accumulated to derive the composite land suitability index. The output raster was then converted into integers and classified into five suitability ranges: Highly suitable- S1, Suitable-S2, Moderately suitable- S3, Marginally suitable- S4, and Unsuitable-N. These maps serve as a guideline in selecting prime areas for growing cassava, maize, yam, rice, cocoa, plantains, and vegetables in Osun State. Criteria rank and weighted values are presented in table 3.

**Table 3.** Criteria rank and weighted value of land suitability for farming in Osun state, Nigeria

| Criteria | Priority (%) | Rank | (+) | (-) |
|---|---|---|---|---|
| LULC | 6.6 | 6 | 4.0 | 4.0 |
| Elevation | 8.4 | 4 | 3.8 | 3.8 |
| Slope | 9.9 | 2 | 4.4 | 4.4 |
| Precipitation | 15.3 | 1 | 7.5 | 7.5 |
| Temperature | 9.8 | 3 | 4.5 | 4.5 |
| Relative Humidity | 6.5 | 7 | 1.7 | 1.7 |
| Soil pH | 6.3 | 8 | 2.2 | 2.2 |
| Soil Texture | 7.3 | 5 | 3.4 | 3.4 |
| Soil Nitrogen | 4.4 | 10 | 1.9 | 1.9 |
| Soil Phosphorus | 4.4 | 10 | 1.9 | 1.9 |
| Soil Potassium | 4.3 | 12 | 1.5 | 1.5 |
| Soil Calcium | 4.5 | 9 | 1.8 | 1.8 |
| Soil Depth | 4.0 | 13 | 2.2 | 2.2 |
| Soil Organic Carbon | 2.3 | 14 | 1.1 | 1.1 |
| Soil Water Capacity | 2.3 | 15 | 1.3 | 1.3 |
| Distance to Rivers | 2.0 | 16 | 1.0 | 1.0 |
| Distance to Roads | 1.5 | 17 | 0.6 | 0.6 |

*Source: the authors*

## 3. RESULTS AND DISCUSSION

**Land use and land cover dynamics in Osun State.** The land use/land cover (LULC) analysis studied the agricultural landscape of Osun State. Forest areas, as of 2023, are the dominant landscape, covering 37.53% (fig. 3), a proof of the region's ecological richness. Agricultural lands cover 15.23% while shrublands and bare lands take 19.81% and 22.69%, respectively. Built-up areas considered less for development cover 4.53%, and water bodies cover 0.20%. These spatial patterns point towards the land being a bit of everything: conservation and agricultural land.

**Elevation and slope as determinants of suitability.** Elevation analysis (fig. 3) indicates that Osun State's terrain spans from 68 to 773 meters. Most agricultural activities occur in areas with low to moderate elevation (Low: 26.25%, Moderate: 29.45%). High and very high elevation zones (26.75% and 12.05%, respectively) are limited in agricultural viability. Slope, a critical determinant of runoff and erosion, shows that 71.7% of the state has very low slope (fig. 3), ideal for crop farming, while only 0.10% is categorized as high slope terrain.

**Climatic patterns: precipitation, temperature, and humidity.** Rainfall patterns range from 2,516.73 mm to 3,697.17 mm (fig. 3), supporting diverse crop types. The northwestern regions exhibit high rainfall suitable for plantain and cocoa, while areas with lower rainfall (southwest) suit yam and maize. Temperature ranges from 24.61°C to 35.14°C (fig. 3), with central zones experiencing optimal crop temperatures (28-30°C). Relative humidity varies between 60.49% and 82.14%, contributing to moisture availability for crops like vegetables and rice.

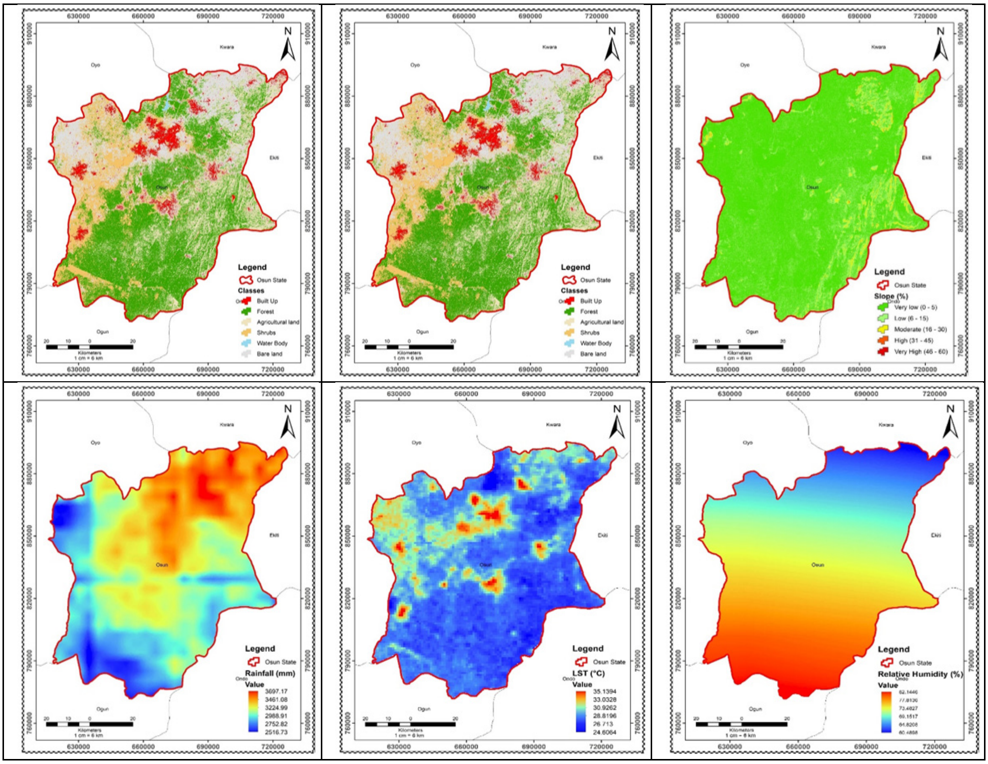


**Fig. 3.** Land use and land cover map, elevation map, slope map of Osun state, rainfall map, temperature map and relative humidity of Osun State, Nigeria (2022).
*Source: the authors*

**Soil suitability indicators.** Soil pH in Osun State varies slightly from 5.87 to 6.17, suitable for most crops (fig, 4). Nutrient content such as nitrogen (0-599 mg/kg), phosphorus (75.71-675.60 mg/kg), and potassium (76.92-260.43 mg/kg) shows a moderately rich nutrient profile (fig. 4). Organic carbon (0-698 g/kg) and calcium (488.01-1,493.08 mg/kg) indicate fertility variation (fig. 4). Soil texture includes loam, sandy loam, and clay, influencing crop-specific performance (fig. 4).

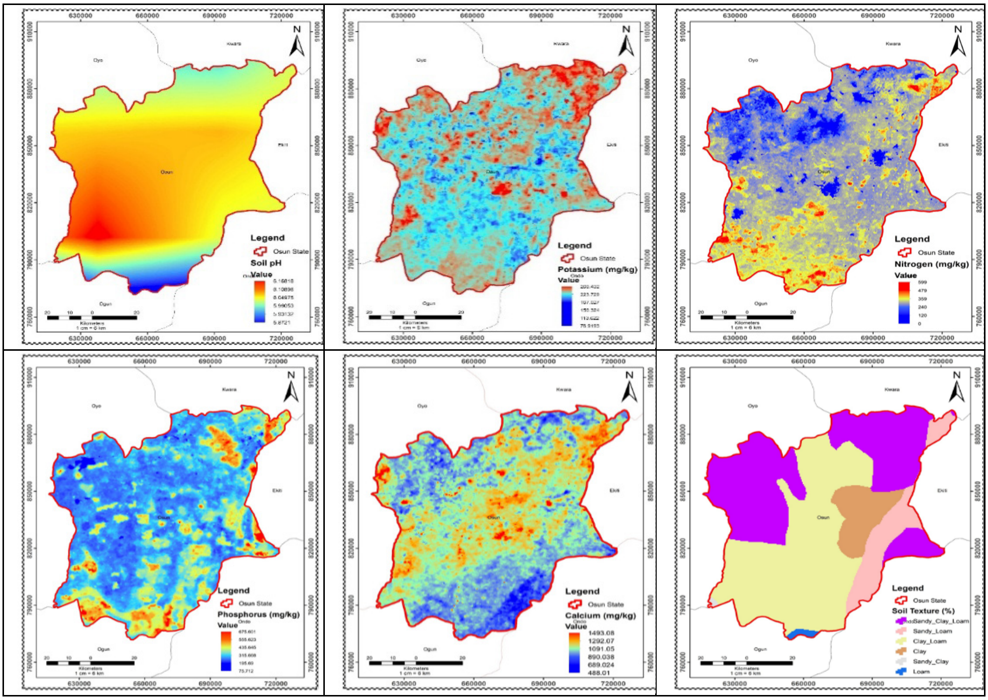

**Fig. 4.** Soil pH map, soil potassium map, soil nitrogen map, soil phosphorus map, soil calcium map, and soil texture map of Osun State, Nigeria. *Source: the authors*

**River and road accessibility.** Euclidean analysis of road and river networks (fig. 5) shows that most areas lie within 0 to 5,000 meters from water sources and roads. This proximity enhances irrigation potential and market access, especially vital for perishable crops like vegetables.

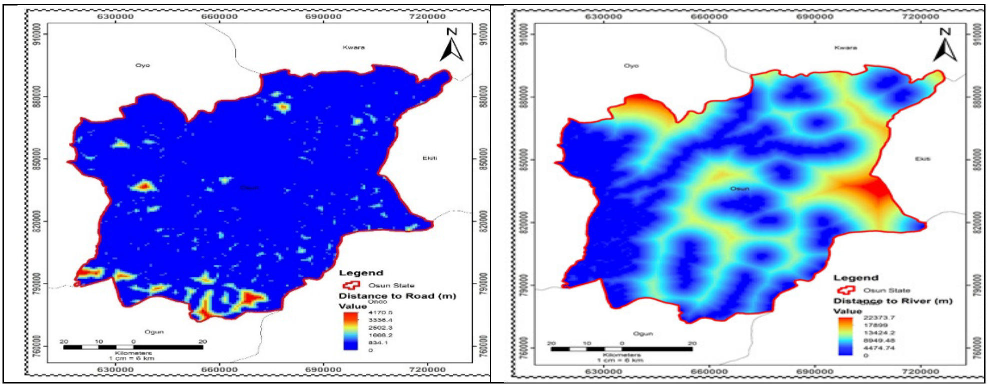


**Fig. 5.** Euclidean distance to road map and Euclidean distance to river map of Osun State, Nigeria. *Source: the authors*

**Suitability mapping and validation.** The final suitability maps were generated for seven crops: yam, maize, cassava, rice, plantain, cocoa, and vegetables. Each map was classified into S1–N zones using Jenks Natural Breaks to allow for data-driven interval segmentation. Output maps were normalized to a 0–1 scale for cross-crop comparability.

**Table 4.** Land suitability area covered for arable crops in Osun state, Nigeria

| Crop | Highly Suitable (S1) | Suitable (S2) | Moderately Suitable (S3) | Marginaly Suitable (S4) | Unsuitable (N) |
|---|---|---|---|---|---|
| Yam | 20.16% (1687.678 sq km) | 28.93% (2420.86 sq km) | 27.19% (2275.9 sq km) | 17.60% (1473.015 sq km) | 6.12% (511.9051 sq km) |
| Maize | 20.66% (1728.457 sq km) | 26.22% (2193.395 sq km) | 26.37% (2205.898 sq km) | 16.15% (1350.735 sq km) | 10.60% (886.8412 sq km) |
| Cassava | 22.41% (1870.042 sq km) | 27.98% (2335.098 sq km) | 23.61% (1970.261 sq km) | 19.68% (1642.066 sq km) | 6.33% (528.3051 sq km) |
| Rice | 16.44% (1375.83 sq km) | 27.51% (2302.94 sq km) | 26.11% (2185.75 sq km) | 20.96% (1754.37 sq km) | 8.99% (752.38 sq km) |
| Plantains | 12.83% (1071.64 sq km) | 28.15% (2350.83 sq km) | 26.30% (2196.03 sq km) | 24.22% (2022.26 sq km) | 8.50% (710.03 sq km) |
| Cocoa | 19.91% (1663.10 sq km) | 25.47% (2126.87 sq km) | 25.03% (2090.30 sq km) | 19.79% (1652.90 sq km) | 9.80% (818.58 sq km) |
| Vegetables | 16.43% (1372.38 sq km) | 22.90% (1912.27 sq km) | 26.80% (2237.69 sq km) | 23.97% (2001.22 sq km) | 9.90% (826.97 sq km) |

*Source: the authors*

**Land suitability for arable crops.** The land suitability analysis for various crops (table 4 and fig. 6) of Osun State, covering a total area of 8,549.21 square kilometers, shows varying degrees of suitability for yam, maize, cassava, rice, plantains, cocoa, and vegetables. The highly suitable areas (S1) for these crops range from 12.83% to 22.41% of the land, while the suitable areas (S2) span between 22.90% and 28.93%. Moderately suitable areas (S3) constitute 23.61% to 27.19%, and marginally suitable areas (S4) cover 16.15% to 24.22%. Finally, the unsuitable areas (N) make up 6.12% to 10.60% of the land, depending on the crop.

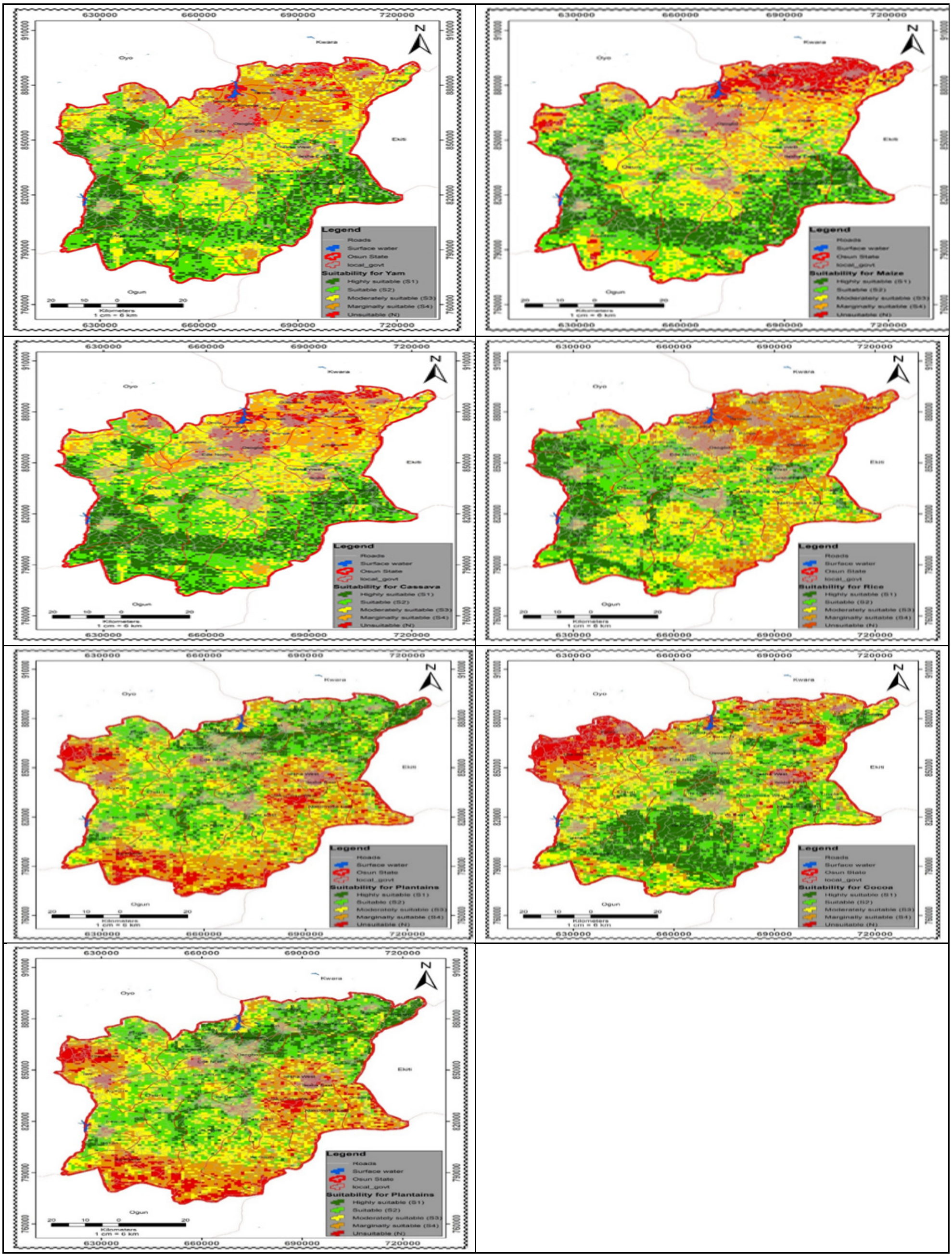


**Fig. 6.** Composite suitability maps of yam, maize, cassava, rice, plantains, cocoa and vegetables farming in Osun State, Nigeria.
*Source: the authors*

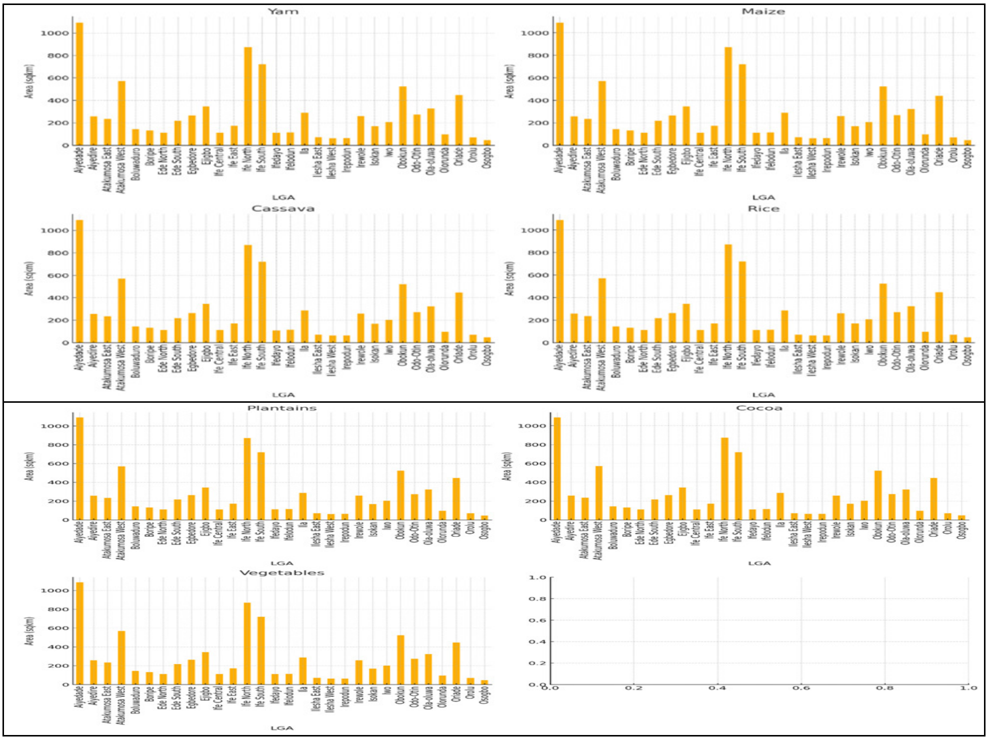


**Fig. 7.** Land suitability graph for arable crops in Osun State, Nigeria.
*Source: the authors*

## 4. CONCLUSIONS

This study performs a full-scale analysis of land suitability for arable crop production in Osun State, Nigeria, through an adapted GIS-based AHP procedural framework. Using spatial datasets for synthesis that include land use/land cover, topographic (slope, elevation), climatic (temperature, precipitation, relative humidity), edaphic (soil nutrients, pH, texture, depth, water-holding capacity), and infrastructural (roads and rivers) variables, it practically models spatial variability in the suitability of seven major crops: cassava, maize, yam, rice, cocoa, plantains, and vegetables.

Major findings show that the production of cassava and maize stands first in agronomic and spatial favorability throughout Osun State, where the highest proportion of land has been classified as highly suitable (S1). Yam also features many lands in the suitable to moderately suitable range, thereby reinforcing the local food economy. On the contrary, rice, cocoa, plantains, and vegetables show spatial selectivity in suitability, depending on various ecological restrictions, such as sensitivity to pH, elevation, or rainfall limits. These differences testify to the different agroecological requirements of the crop and bring to view the need for site-specific planning.

At the sub-regional level, spatial disaggregation across the thirty local government areas of Osun shows that those with the highest multi-crop suitability potential include Aiyedaade, Atakumosa West, Ife North, Ife South, and Obokun. With favorable terrain, good soils, and moderate climatic conditions, these areas are high priority zones for intensification in agriculture, resource allocation, and investment. This study, by adopting a data-driven, spatially explicit approach, asserts the usefulness of the GIS-AHP in precision agriculture, land-use optimization, and resource management. Thus, the methodology offers a scalable template that can be replicated in other agro-ecological zones within Sub-Saharan Africa, given land pressure, climate change, and suitable resilient food systems. More definitively, the outputs represent crucial inputs to policy formulation, thereby enabling various stakeholders-from government agencies to development partners and local farmers-to make informed decisions about land allocation, crop diversification, and agricultural zoning. Therefore, the study thereby adds to the discourse on sustainable agriculture, food security, and environmental stewardship across the region at large.

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