

## Opportunities for the development of agriculture in Nigeria

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### Abstract

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In the current study is presented data about soil samples taken from state Abia, south-eastern Nigeria. There has been carried out an investigation of agricultural areas from the region of Ariba, Bende, Ohafia, Agubi Ogbarali, Igoeke, Itsy Amaboru, with the purpose to be researched the opportunities about horticulture sector development. Seven terrains have been analyzed out of the investigated sites, as the samples are separated in two depths (0–30 cm and 30–60 cm). The carried out soil analyses have established that it is poorly supplied with the main nutrient elements. The content of total nitrogen varies from 2.50 mg/1000 g soil for the region of Bende up to 17.44 mg/1000 g soil (for Akanu Ohafia). Analogous results are reported for content of phosphorus, as the obtained values are from 0.88 mg/100 g soil (for the region of Agubi Ogbarali) up to 4.15 mg/100g (Bende). There has been reported content of absorbable potassium from 15.32 mg/100 g (for the region of Igoeke) up to 47.20 mg/100 g (for the region of Itsy Amaboru), which means that the degree of supply with potassium varies from poorly supplied to very good supply. The data is statistically proven.

On soils with low pH, forage crops such as perennial ryegrass (*Lolium perenne* L.), white clover (*Trifolium repens* L.) and red clover (*Trifolium pratense* L.), alfalfa (*Medicago sativa* L.), corn (*Zea mays* L.), soybean (*Glycine max* L.), pea (*Pisum sativum* L.), oats (*Avena sativa* L.) and others can be sown.

**Keywords:** Nigeria; Abia State; nitrogen; phosphorus; potassium

### Introduction

The interest to Nigeria as a third world country increases over the last several years. The interest is economical, as well as research one. In the scientific journals are published more and more articles connected with soil classification (Okorafor et al., 2017), opportunities for growing of vegetables – tomatoes (Esan et al., 2023), peppers (Udegbe et al., 2012; Dennis and Kentus, 2018; Adaigho and Kentus, 2018), watermelons (Adojutelegan et al., 2015), production of field crops – wheat (Alkali, 2024), maize (Oladejo and Adetunji, 2012), beans (Nurzyńska-Wierdak et al., 2019) and others.

The Federal Republic of Nigeria is situated in the tropical zone of western Africa and extends on area of 923 770 km<sup>2</sup>, which makes it one of the big African countries and the 32<sup>nd</sup>

as per area in the world. It has total length of the state boundaries of 4 047 km, as it borders with Benin, Niger, Chad, Cameroon, and its coastal line amounts to 853 km. The highest point is Chapal Wadi peak, rising at 2 419 m altitude (Nation, 2009; Ayinde et al., 2010; Olaniyi et al., 2014; Odunuga and Badru, 2015; Okoredzhior, 2021).

The climate is semidry in the northern part of the country, while in the southern parts it is characterized by high humidity (Haider, 2019). Except for the lands situated along the Atlantic coast, where the rains are steady during the whole year, the quantity of the precipitations in the rest part of the country have a strikingly expressed seasonal character with distinct wet and dry periods (Ayinde et al, 2010; Olaniyi et al., 2014; Odunuga and Badru, 2015). The heaviest rains are concentrated during the months June – September, as in the

southern regions these are 50 – 60 % of the whole amount of precipitations, and in the northern regions reaches 90 %. The average annual amount of precipitations varies from 500 mm to the north-east up to more than 3 000 mm at the lands on the coastal part (Okoredzhior, 2021).

In the country can be distinguished clearly three basic eco systems – semi-desert and savanna to the north, equatorial forests in the central and southern part of the country, and the coastal eco systems along the ocean coast or the river basins. The northern regions are poor of high vegetation, while the equatorial forests are predominantly rain and mangrove ones (Olaniyi et al., 2014).

In Nigeria important plant crops and widely used in agriculture are: sorgo, yam (tapioca), cashew, west African rice, maize, manioc, the oil palm, which are the main crops at the market.

### ***Characteristics of Abia State***

State Abia is located in eastern-central Nigeria. Created as an administrative centre in 1991, Abia includes regions with oil palm bushes and tropical rain forests in its southern part and woody savanna in the hilly north. The bigger part of the population is occupied with agriculture – yam, taro, maize, rice and manioc are the main crops, and the oil palm is the basic market crop (Ibeabuchi, 2023; Jackson et al., 2021).

The state is characterized predominantly by tropical climate. During the most of the months of the year there are significant precipitations, and the short dry season has a slight influence. The weather in the region is classified as a tropical monsoon climate (Am) in the system for the climate classification Köppen. The average annual temperature of Abia is 25,6 °C. The temperature rarely falls under 16 °C or rises above 33 °C during the whole year, varying between 20 and 31 °C. The annual precipitations in the city clocks are around 2 747 mm (Ibeabuchi, 2023; Ifeanyi-obi et al., 2016).

State Abia occupies area of approximately 4 902 km<sup>2</sup>, borders to north and north-east on the states Enugu and Ebonyi, state Cross River and State Akwa Ibom. The southernmost part of the state is located in the marshy forests of the Niger delta, while the rest part of the state is situated in the forests of the passage Cross-Niger. The south part obtains abundant precipitations of approximately 2 400 mm millimetres annually, and they are intensive between the months April until October. The most significant rivers in the state of Abia are the Imo and Aba rivers, which flow into the Atlantic Ocean through the state of Akwa Ibom (Ibeabuchi, 2023; Jackson et al., 2021).

In geological aspect the territory of Nigeria enters in the structure of the African platform. The metamorphic rocks of

the platform foundation occupy more than 50% of the area of the country, forming Dahomey-Nigerian mass to the west and the Cameroon mass to the east. In their structure participate Precambrian gneisses, magmatites, amphibolites, quartzites and slates, pierced by granites.

From south to north in Nigeria are taking turns: red-yellow laterite soils, occupied by permanently wet equatorial forests; red laterite soils, occupied by tropical forests and tall-grass savannas and red-brown soils, occupied by dry savannas. According to Fauck (1974) and Lal (1968), the soils are average mighty leached, which leads to forming of clay illuvial horizon. They distinct by a red-brown colour and strongly differentiated profile (Maignien, 1966), with low content of dusty particles. In some zones of the laterite soils are observed leached and non-leached areas of the soil, and also gleying with comparatively high content of iron. Over the time are formed tropical iron-containing gley soils. The releasing of iron in the conditions of tropical climate leads to wide distribution of the laterite crusts (Maignien, 1966) on the surface of the soil. This releasing of the iron is due to result of the complete decomposition of the breed, which leads to accumulation of the hydroxides of iron, aluminum and titanium (Lobova and Habarov, 1983).

In the northern parts, to the south and west of lake Chad are wedged in areals of black soils, occupied by dry tropical savannas, marshy soils and salt marshes. Along the coast of the Gulf of Guinea expands a narrow stripe of soils occupied by mangrove forests, and along the valleys of the rivers are developed alluvial soils (Muhammad and Ryabinina, 2022).

The red earth soils expand in the areas with hot and wet climate, where there is forest vegetation. The red-brown soils are spread in the subequatorial areas.

The purpose of the present study is to be investigated the opportunities for crop production in state of Abia, Nigeria through agrochemical analysis, which shall give recommendations for growing of appropriate crops.

### **Material and Methods**

The investigated areas are situated in state Abia, which is characterized by fertile lands, rivers and forests, because of which agriculture is a main part of its economy. Seventeen sites were walked and 55 soil samples were taken from trenches at depths of 0–30 and 30–60 cm, the parent rock being a very strong cement between sand, clay and iron compounds. Ten samples were analysed for nitrogen, phosphorus, potassium and pH at the suggestion of the hosts. The samples have been selected and stored in compliance with accepted by the Food and Agriculture World Organization (FAO) methods (FAO, 2006). Seven terrains have been an-

alyzed out of the investigated terrains, as the samples are separated in two depths (0–30 cm and 30–60 cm).

For determining the acidity and the main nutrient elements in the laterite soils of the state Abia have been used the following methods:

The content of total nitrogen is determined altogether as the quantity of ammonium nitrogen ( $\text{NH}_4\text{-N}$ ) and nitrate nitrogen ( $\text{NO}_3\text{-N}$ ) is determined through a spectrophotometric analysis, as a result of extraction with solution of calcium dichloride ( $\text{CaCl}_2$ ) (Tomov et al., 1999; Ruseva, 2011).

The content of phosphorus and potassium is determined as per the double-lactate method of Egner-Riehm (Tomov et al., 1999; Ruseva, 2011).

The values of the soil reaction are measured potentiometrically by a pH-meter, in compliance with the requirements of the methods for measuring pH of soil as per the international standard ISO 10390.

The hygroscopic moisture and the absolutely dry mass of the soil samples are determined.

The results are processed through a comparative analysis as per the method of Duncan's multiple range test by a programme product SPSS for Windows.

## Results and Discussion

It is necessary to be noticed that the carried out analyses of the selected soil samples cannot be representative about the whole investigated territory. They correspond for one

small part of the indicated populated points from the state Abia.

Abriba is located at an elevation of zero meters above sea level. It is characterized by a tropical monsoon climate (Classification: Am). The annual temperature in the area is  $28.48^\circ\text{C}$  and is  $-0.98\%$  lower than the average for Nigeria. Abriba usually receives around 272.55 mm of precipitation and has 262.62 rainy days (71.95% of the time) annually.

The soil diversity is represented predominantly by red laterite (feralite) and red-brown soils, and because of the strong influence of the Sahara desert they are: strongly sandy, sandy clay, clay and rocky. In the sandy clay ones is observed a humus horizon, which reaches depth of 10–25 cm. It is established by the carried out studies for soil acidity that these soils are appropriate for agricultural production, as the soil acidity is from slightly acid to neutral and varies from 5.0 up to 6.9 (Figure 1).

Regarding the basic nutrient substances in these soils, after the carried out analyses was established that the soils are slightly supplied with nitrogen (Table 1). With eventual crop growing, it is necessary to be applied agricultural technics, which shall supply the plants with maximum quantity of the nutrient elements.

Out of the carried out analyses (Table 1) is observed low content of nitrogen and phosphorus, which is normal for virgin soils without using agricultural technics. The content of total nitrogen varies from 2.50 mg/1000 g soil up to 17.44 mg/1000 g soil. Analogous results are reported for content of phosphorus,



**Fig. 1.** Part of the surveyed sites

Source: Authors' own elaboration

as the obtained values are from 0.88 mg/100g soil up to 4.15 mg/100g. The data is statistically proven.

The Bende region is characterized by the dry season being hot, muggy and usually cloudy, while the wet season is warm, oppressive and cloudy. The average annual temperature varies between 19.4 °C and 30.5 °C, rarely falling below 15.5 °C or rising above 32.2 °C. Bende has agricultural climatic conditions typical of the tropics. Bounded to the north by Cross River State, Afikpo and Ohaozara, and to the south by Arochuku and Ohafia, while to the east and west by Ikwuano LGA and Umuahia LGA, respectively. Agriculture is a broad occupation of the people and it is a major rice production area in the state of Abia. The soils of the Bende region are characterized by a profile depth of up to about 40–80 cm, in the process of forming an illuvial horizon, characterized by weak water permeability and accumulation of illium particles. This type of soil is characterized by good fertility (similar to leached chernozems). At depth of the nitch, a solid base of the mother rock is observed. Soil treatment can be carried out at a depth of up to 15–20 cm. From the analyzes carried out, it was found that the soils from this area have a weak supply of basic nutrients.

Around the settlements AGA Umuaweji and Uzuakoli are spread predominantly laterite soil with predominance of sand fraction, which are appropriate for growing fodder crops. Out of the soil analysis is visible that pH varies from 5.4 up to 6.8, appropriate for growing of alfalfa, vetch, peas, pasture ryegrass and other fodder crops. If the soil is cultivated at bigger depth up to 20–25 cm, there may be cultivated wheat, maize, barley and other character crops for the region.

Regarding the basic nutrient elements nitrogen, phosphorus and potassium (NPK), they are poorly supplied except for potassium, which is unevenly distributed in the soil (Table 1) and when introduced under processing, the carrying

out of an appropriate agricultural technics and fertilization is necessary.

Located at an altitude of 103.0 m above sea level, Ohafia experiences a tropical monsoon climate (Designation: Am). The average annual temperature in the area is 30.8 °C, which is slightly 1.36% higher than the national average in Nigeria and an average humidity of 59%, the region experiences two different seasons: dry and rainy. Ohafia typically receives approximately 294.96 mm of precipitation with 284.21 rainy days, representing 77.87% of the year. Ohafia covers twenty-six villages with populations between 300.000 and 400.000 as of 2022. And it is at a distance of 50.1 km from the capital Umuahia in the state of Abia. Villages in Ohafia are Elu, Ibina (Ihenta), Nde Okala, Nde Anyaorie, Amuma, Amaekpu, Ebem, Nde Amogu, Okagwe, Nde Uduma Ukwu, Oboro, Nde Nku, Nkwebi, Amuke, Asaga, Ndi Uduma Awoke, Amankwu, Nde Ibe, Nde Oriek, Okon-aku, Amangwu, Ufiele, Eziafor, Abia, Akanu, Isiugwu. Soils from the Ohafia region of Abia State, Southeastern Nigeria are characterized by the presence of a high percentage of sand as well as the presence of clay. From the conducted study, it was found that the total nitrogen content was 17.44 mg/1000 g soil, potassium 15.66 mg/100 g soil. Very poor phosphorus reserves (0.89 mg/100 g soil) were reported. According to a study by Njoku et al., (2017), differences exist in the thickness of horizons. The percentage of sand is highest in the upper layers and decreases in depth, while the values of silt, clay and total porosity are highest in the lower horizons and decrease towards the surface ones. Appropriate agronomic practices are therefore recommended to improve the physical properties of the soil.

In the region of Agubi Ogbarali and Igoeke the soil is characterized by a plough layer up to approximately 40 cm, but in depth the soil hardens. The typical pH is around 4.8–5.8, poorly supplied with N and P. It is very well supplied

**Table 1. Analysis of soil samples from Abia State, Nigeria**

№	Terrain	Depht, cm	pH		Total N mg/1000 g		P <sub>2</sub> O <sub>5</sub> mg/100 g		K <sub>2</sub> O mg/100 g	
			H <sub>2</sub> O							
1	Abriba	0–30	6.2	a	8.58	e	2.24	d	33.77	c
2	Abriba	0–30	4.9	dc	6.62	g	2.32	cd	21.35	d
3	Iazo Item Bende	0–30	5.2	ade	2.69	h	3.54	b	16.99	g
4	Iazo Item Bende	30–60	5.1	ab	2.50	h	4.15	a	18.93	f
5	AGA Umuaweji	30–60	5.4	bcd	10.74	d	2.46	c	19.49	e
6	Uzuakoli	30–60	6.8	a	7.49	f	2.22	d	10.64	i
7	Akanu Ohafia	30–60	5.0	de	17.44	a	0.89	g	15.66	h
8	Itsy Amaboru	0–30	4.7	e	12.33	b	1.67	e	47.20	a
9	Agubi Ogbarali	0–30	4.8	de	7.34	f	0.88	g	35.18	b
10	Igoeke	0–30	5.8	abc	11.54	c	1.31	f	15.32	h

a, b, c, d, e, f, g, h, i – Duncan's multiple range test ( $p < 0.05$ )

Source: Authors' own elaboration

with potassium. On these areas can be grown cereals (Figure 2). The obtained results are statistically proven.

Regarding the darker coloration of these soils, according to Singh (1956) (cited by Lobova and Khabarov, 1983), it is due to the peculiar forms of the relationship of organic matter with clay minerals. The type of humus in these soils is unique and differs from the humus of chernozem soils in the content of fulvic substances strongly bound to iron. The ratio of C-humic acids to C-fulvic acids is less than 1 (Ponomariova, 1956; Ponomariova and Plotnikova, 1980).

The content of soil moisture as a factor of the soil fertility, determines the intensity of the biological and eluvial processes in the soil (Sokolovska et al., 2021). The content of the absolute dry mass, calculated in percents varies from 54.90% up to 75.80%. The high percent of 75.80% for the region of Itsy Amaboru may be explained by the presence of more vegetation and increased conditions of plasmification

of the plant residia in connection with the high percent of moisturizing and temperature, the processes of decomposition of the plant residia are more intensive in comparison with the rest investigated terrains (Table 2). The content of hygroscopic moisture depends on the mechanical content of the soil. The hygroscopic moisture in the studied terrains is from 24.20% up to 45.10%. The high moisture values for the region of Bende are due to the fact that on the whole territory the underground water is comparatively close. The presence of close underground water, as well as the good content of potassium allow the growing of rice and soya in this region.

The low values of the carried out studies can be explained with the fact that these soils are formed under tropical vegetation in the conditions of tropical and subtropical climate. The processes of plasmification of the plant residia and microbiological processes are intensive. There is deficiency of plant material, which to be joined in the soil formation



**Fig. 2. Soils of the study area**

Source: Authors' own elaboration

**Table. 2. Absolutely dry mass and hygroscopic moisture in the surveyed terrains**

№	Terrain	Depth, cm	Absolute dry mass, %	Hygroscopic moisture, %
1	Abriba	0–30	56.20	43.80
2	Abriba	0–30	56.20	43.80
3	Iazo Item Bende	30–60	54.90	45.10
4	Iazo Item Bende	0–30	69.46	30.54
5	AGA Umuaweji	30–60	56.72	43.28
6	Uzuakoli	30–60	65.17	34.83
7	Akanu Ohafia	30–60	61.98	38.02
8	Itsy Amaboru	0–30	75.80	24.20
9	Agubi Ogbarali	0–30	70.60	29.40
10	Igoeke	0–30	66.07	33.93

Source: Authors' own elaboration

process. By the studies, which have been carried out in our country, has been established that for maintaining the soil fertility of alluvial soils are necessary approximately 800 kg average plant residia (Pachev, 1997). For the conditions of Abia this quantity is increased up to 950 kg/da. The high day temperatures form conditions for fast mineralization of the already plasmified plant and animal residia, and under the impact of the precipitations they are being washed with the descending water flow, and the obtained mineralized nutrient substances cannot be used by the plants and later to be included in the humus-formation process.

## Conclusions

The following conclusions can be generalized by the carried out study:

1. The nitrogen content in the studied soil samples ranges from 2.50 mg/1000 g to 17.44 mg/1000 g, with the highest content recorded in samples from Akanu Ohafia (17.44 mg/1000 g) and Itsy Amaboru (12.33 mg/1000 g).

2. All analyzed samples have a low phosphorus content, ranging from 0.88 to 4.15 mg/100 g of soil.

3. Soils from the Itsy Amaboru area are characterized by a good potassium content (47.20 mg/100 g of soil), followed by Agubi Ogarali (38.18 mg/100 g of soil) and those from Ariba (33.77 mg/100 g of soil).

4. The content of major nutrients in the studied soil samples is low, which corresponds to the natural.

5. Despite the low data on the content of essential nutrients in these soils, it is possible to cultivate cereal grains, legumes, vegetable, and oilseed crops with good agronomic practices.

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