

ASSESSMENT OF CHANGES IN SELECTED SOIL PROPERTIES UNDER DIFFERENT LAND USE IN OBAFEMI AWOLOWO UNIVERSITY COMMUNITY, ILE-IFE, NIGERIA

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KEYWORDS

Soil, Obafemi, *Theobroma cacao*.

ABSTRACT

The changes in selected soil properties under different agricultural land use were examined. Six observation sites were chosen at the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, Nigeria.

Composite soil samples were taken from each of the observation sites. Changes in soil properties under these various agricultural land uses were assessed.

Secondary forest; planted fallow with legume; bush fallow with predominantly herbaceous species; the continuous cassava cowpea plot, a plot of continuous maize-soya bean; and a tree crop plantation with *Theobroma cacao*, selected soil properties assessed were: bulk density, gravel content, organic matter content, soil pH and available phosphorus. The result indicated that the soil pH, organic matter content and available P were significantly lower in soils under the continuous arable cropping compared to planted legume and secondary forest. From the study, the main sources of soil degradation were water erosion, leaching and low level of organic matter.

The practice of mixed cropping and cultivation of cover crops over the soil and protection against rain drop and erosional impact, should be encouraged to reduce water erosion and increase both organic matter and available phosphorus content of the soil

INTRODUCTION

Soil, to different people mean different things. Geologists recognize soil as a product of weathering in relation to its composition or mineral resources while civic engineers take soil to be the materials that supports and influences the behavior of earthen structure such as buildings, bridges, pavements etc. Yet sanitarian knows soil as sewage and waste disposal medium. Whereas, housewife understand soil to be mere dirt. The soil scientists on the other hand perceive soil as unconsolidated mineral matter on the

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surface of the earth that has been subjected to and influenced by genetic and environmental factors such as climate, vegetation and topography acting over a period of time and producing a product soil that differs from the material from which it was derived (Aduayi, 1985).

Soil properties depend on a number of factors. The factors (parent material, organism, relief, climate and time) though, operating independently, the combine effect over a period of time gives rise to distinct soil type. Knowledge of soil with respect to its properties is of utmost importance in determining the agricultural, engineering or any other use to which it may be put. For instance, soil characteristics such as texture show the proportion of the soil separates.

This in turns shows the water holding capacity of the soil. Sanchez (1940) noted that many soil physical properties deteriorate with cultivation rendering the soil less permeable and more susceptible to run-off and erosion losses. The ability of soil to retain water and supply it to plant is one of the main limiting factors in tropical agriculture. The changes in soil that decrease its productivity for crop plant may follow from three processes: cropping, erosion and leaching (Sanchez 1940). This may adversely affect the physical condition or the chemical composition of the soil or both.

The soils are made up of materials in three different states – solid, liquid and gaseous. Proper proportion of each of these constituents is necessary if the soil is to be a good medium for growth of plants. Rice and Alexander (1938) noted that the in-organic proportion of the solid material is in size, ranging from stone to gravel down to colloidal particle of clay with diameter of less than one-hundred thousand of an inch the proportion of coarse, medium and fine particles determine the texture of the soil. Rice and Alexander (1938) also noted that coarse and medium materials are comparatively in-active, serving mainly as a supporting frame work of the rest soil.

The overall movement of water in the soil is influenced largely by the physical nature of the soil. Aduayi and Ekong (1981) noted that gravelly and sand soils, which have large pores, allow free movement of water without retaining much for plant-use. The soil is a porous body made up of discrete particles of irregular shapes and various sizes. The spaces between these particles form a complicated network of connected cavities of almost every conceivable shape and size, from those that too large for the effective operation of capillary forces to those too small to be seen with a microscope (Aina 1994).

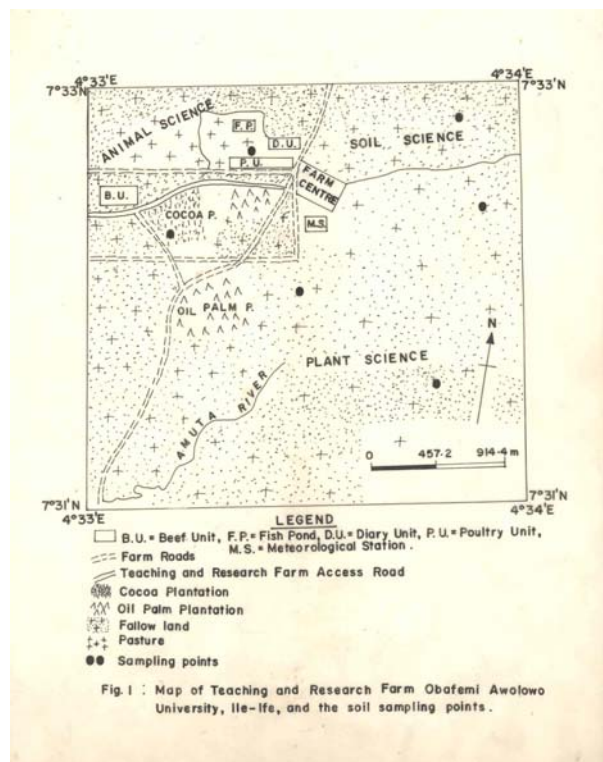
The major contribution factor to the increasing rate of soil degradation in West Africa is said to be a shortening of the fallow period in the traditional shifting or bush fallow agriculture (Brown and Flaving, 1988; and Lal, 1973). At high population density, fallowing may be abandoned altogether. (Brown and Flaving, 1988). Attempts at finding out the changes in soil properties under different agricultural changes in land use types inform this study.

The main objective of this study therefore, is to examine the changes in selected soil properties, which have been brought about due to differences in land use over a period of time. The soil investigated is coarse texture granite gneiss and were mapped as Iwo Association (Symith and Montgomery, 1962).

MATERIALS AND METHODS

Study Location

The experiment was conducted at the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, lying on approximately latitude 7°28¹N and longitude 4°33¹E with an altitude of about 244m above mean sea level. The project site falls within the tropical rainforest belt with mean annual rainfall of about 1,350mm and the rainfall pattern is bimodal. The study area and soil sampling points are indicated in Fig. 1.



Observation Area

A total of six observation sites were selected. The sites were: Cacao plantation, a fallow planted with legume (*centrosema pubes cence*) a bush fallow with predominantly herbaceous weed species (*chromolaena odoratum*) cassava-cowpea intercropped plot, plot of continuous maize-soyabean cropping and secondary forest. Six soil samples were collected from each experimental site. For the first sample, three core soil samples taken at 0-15cm were collected by soil auger, bulked and carefully mixed before sub-sampled. The same techniques were used for 15-30cm and 30-50cm soil depths.

Laboratory Analysis

Soil samples collected were air-dried, pulverized and passed through 2 mm sieve. The two separates i.e. coarse fragment (fraction that is greater than 2mm size) and the fine earth (those less than 2mm size fraction) were weighed separately. The percentage gravel content was then calculated as follows:

$$\% = \left(\frac{\text{Weight for the gravel fraction}}{\text{(Weight of the grave + soil particle)}} \right) \times 100$$

Soil pH determination was at a ratio of 1:1

Soil: water suspension using a pH meter. Organic carbon was determined by dichromic oxidation (Walkley and Black, 1934) and available p by Bray P-1 method (Bray and Kurtz, 1945). Bulk density of whole soil was determined by core method (Blake, 1965).

RESULTS AND DISCUSSIONS

To assess the changes in soil properties under different land use types, five soil properties were considered. The different land use types were: continuous cultivation which comprises; cassava/cow plot and maize/soya bean plot, fallow site comprising; planted legume plot and bush fallow plot, tree crop (*Theobroma cacao*) and secondary forest. The soil properties examined were bulk density, gravel content, soil pH, organic matter content and available phosphorus.

Table 1. Variabilities in Soil Properties Under Different Land Use Type Soil Properties

Land use	Gravel content (%)	Bulk density (g/cc)	pH in H ₂ O	Organic matter (g/kg)	Available P (mg.kg)
CONTINUOUSCULTIVATION					
Cassava/Cowpea	32.47d	1.54a	6.15a	3.00d	1.28ab
Maize/Soya bean	28.24e	1.50a	5.89a	12.80c	1.38ab
FALLOW					
Planted legume	57.66a	1.40b	5.23b	23.00a	1.11ab
Bush fallow	37.32c	1.52a	5.97a	19.10ab	0.75b
TREE CROP					
	53.86b	1.32c	5.85a	16.70bc	2.04a
SECONDARY FOREST					
	26.47a	1.49a	6.38a	12.20c	0.79b

Means within the same column and with the same letter are not significantly different according to DMRT ($\alpha < 0.5\%$).

From table 1, percent gravel content of planted legume was the highest (57.66%) while secondary forest plot had the lowest value (26.47%). Percent gravel content of other plot > bush fallow plot > cassava/cowpea plot. The reason might be due to selective erosion of fine earth fraction, leaving behind the coarse gravel fraction following continuous cultivation over a period of time. The observation is similar to what Aina (1994) noted, that in a given situation, erosion is characterized by land use among other factors. The mean bulk density of cassava/cowpea plot was the highest (1.54g/cc) while tree crop had the lowest value (1.32g/cc). All the soil sampled had values that fall below the 1.63g/cc critical value which reported, hence problems of high bulk density which can hinder root penetration is not likely to occur.

The pH values were statistically the same for the different land use considered with the exception of planted legume plot which had lower value of 5.23b. The soils are moderately acidic, the values ranged between 5.23 and 6.38 (probability level). They tend to remain constant among the land use type considered. Planted legume plot had the highest organic matter content of 23.00g/kg while cassava/cowpea plot had the least value of 3.00g/kg. Organic matter content of bush fallow plot, tree crop plot, secondary forest and maize/soya bean plot decreased in that order. The reason is due to higher litter being produced in planted legume plot and also improved microbial activities in the planted legume. Available P for tree crop had the highest value of 2.04mg/kg and secondary forest plot of 0.79mg/kg showed the lowest. For all the soils sampled, available P was generally low and far below the critical value of 18-15mg/kg reported by Sobulo and Osiname (1982).

Table 2 shows the selected soil properties at various soil depths. Percent gravel content of 30-50cm was the highest, 43.44% and the lowest value was recorded for 0-15cm soil depth, 35.59%. The sub-soil high gravel content is best explained genetically rather than as bulk density for the three soil depths were statistically the same and generally low. Soil pH values and available P which had little variations from depth to depth were not significantly different from one another. Organic matter content of 0-15cm, which was 19.40g/kg, was the highest and almost double the value obtained for 30-50cm soil depth 10.00g/kg. 15-30cm-soil depth had 13.90g/kg. The values obtained for all the soil depth are above the critical value of 10.00g/kg that was reported by Ogunwale and Olaniyi (1981).

Table 3 shows the variability in topsoils 0-15cm, properties due to differences in land use. Planted legume plot had mean gravel content of 61.89%, which is almost four times as high as that of secondary forest, 16.58%. Tree crop plot, cassava/cowpea plot, bush fallow and maize/soybeans had 42.98%, 35.05%, 32.61% and 24.42% gravel content respectively. Bulk density of continuous cultivation and bush fallow plots are statistically the same with the value of 1.54g/cc respectively. Secondary forest, planted legume plot and tree crop plot had bulk density of 1.49g/cc, 1.40g/cc, 1.32g/cc, respectively. The reason for higher bulk density in cassava/cowpea plot and maize/soy bean plot especially is due to the use of heavy machinery on these plots, although pose no threat to root penetration, De Gens (1973).

Table 2. The Selected Soil Properties at Various Soil Depths

SOIL (CM)	DEPTH	SOIL PROPERTIES				
		Gravel content (%)	Bulk density g/cc	PH in H ₂ O	Organic matter g/kg	Available P mg/kg
0-15		35.59c	1.44a	5.99a	19.40a	1.35a
15-30		38.98b	1.48a	5.99a	13.90b	1.08a
30-50		43.44a	1.46a	5.75a	10.00c	1.25a

Means within the same column and with the same letter are not significantly different according to DMRT (at P<0.5%).

Table 3: Variabilities in Top Soil (0-15cm) Properties Due to Differences in Land Use

Land use Types	Gravel content (%)	Bulk density(g/cc)	PH in H ₂ O	Organic matter g/kg	Available P (mg.kg)
CONTINUOUS CULTIVATION					
Cassava/Cowpea	35.05c	1.54a	6.24a	1.70c	1.06a
Maize/Soya bean	24.42d	1.50a	5.94a	16.10b	2.34a
FALLOW					
Planted legume	61.89a	1.40b	5.39b	29.20a	1.28a
Bush fallow	32.61c	1.52a	6.14a	22.50ab	0.78a
TREE CROP	42.98b	1.32c	6.17a	28.20a	1.88a
SECONDARY FOREST	42.98b	1.49a	6.09a	19.20ab	0.76a

Means within the same column and with the same letter are not significantly different according to DMRT (at P<0.5%).

The soil pH of the planted legume plot was the least 5.39, while those of other land use types were statistically the same. Organic matter content of the planted legume had the highest value of 29.20g/kg and the lowest value was recorded for cassava/cowpea plot, 17.00g.kg. The reason might be due to higher litter production in the former than the latter. Available P for all the land use were statistically, the same and generally low because it fell below 10g/kg critical value, which Uponi and Adeoye (2000) reported.

Table 4 shows variabilities in sub-soil (15-30cm) properties due to differences in land use types examined. Gravel content of tree crop plot, 65.52d%. Bulk density was slightly higher in continuous cultivation plot i.e. cassava/cowpea plot 1.54a g/cc, maize/crop with value of 1.37b g/cc recorded the least value. The reason for slightly higher bulk density in continuous cultivation plot compare to other land use types might be due to the use of heavy machinery on the plot. Soil pH values were statistically the same for all the land use types although secondary forest is slightly higher. The value obtained has no consequence toward the healthy growth of arable crop cereal and legumes which are well adapted to soil pH that ranges from 5.5 to 6.5.

Table 5 summarizes the variabilities in sub-soil (30-50cm) properties under different land use types. Percent gravel content of planted legume plot and tree crop plot were statistically the same and were the highest, while tree crop plot had the least. Bulk density of 1.26c g/cc was the least, this was recorded for

tree-crop plot and the highest bulk density of 1.54a g/cc, 1.52a g/cc, 1.50a g/cc and 1.50a g/cc were recorded for cassava/cowpea, bush fallow, planted legume and secondary forest respectively. The reason for lower bulk density in the former might be due to total avoidance of heavy machinery for a long period of time. The pH values were nearly the same with the exception of those under the tree crops with the soil pH of 5.58ab and planted legume of soil pH 5.17b which are slightly lower in value. Organic matter content ranged between 14.80a g/kg in bush fallow to 4.50c g/kg in cassava/cowpea plot. This is far below 20.00g/kg critical value reported by Sobulo (2000). Available P is generally low, ranged between 0.74b ppm in bush fallow to 2.20a ppm in tree crop plot.

Table 4. Variabilities in Sub Soil 15-30CM Properties Due to Differences in Land Use

Land use Types	Gravel content (%)	Bulk density(g/cc)	PH in H ₂ O	Organic matter g/kg	Available P (mg.kg)
CONTINUOUS CULTIVATION					
Cassava/Cowpea	35.14c	1.54a	6.09a	3.00d	1.28ab
Maize/Soya bean	25.15d	1.53a	5.88a	13.70bc	0.73b
FALLOW					
Planted legume	52.58b	1.40b	5.14a	24.90a	1.02ab
Bush fallow	33.26c	1.52a	5.91a	20.10ab	0.74b
TREE CROP	65.52a	1.37b	5.82a	12.5bc	2.049a
SECONDARY FOREST	22.25d	1.55a	7.13a	9.5cd	0.60b

Means within the same column and with the same letter are not significantly different according to DMRT (at P<0.5%).

Table 5. Variabilities in Sub-Soil (30-50CM) Properties Under Different Land Use Types.

Land use Types	Gravel content (%)	Bulk density (g/cc)	PH in H ₂ O	Organic matter g/kg	Available P (mg.kg)
CONTINUOUS CULTIVATION					
Cassava/Cowpea	27.23d	1.54a	6.12a	4.50c	1.50ab
Maize/Soya bean	35.16c	1.48b	5.86a	8.70bc	1.06ab
FALLOW					
Planted legume	58.50a	1.50b	5.17b	15.10a	1.02ab
Bush fallow	46.09b	1.52a	5.85a	14.80a	0.74b
TREE CROP	53.07b	1.26c	5.58ab	9.40b	2.20a
SECONDARY FOREST	40.59bc	1.50a	5.94a	7.90bc	0.96b

Means within the same column and with the same letter are not significantly different according to DMRT (at<0.5%).

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