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COMPARISON OF PHYSICAL AND CHEMICAL PROPERTIES OF SOILS UNDER FORESTED AND CROPPED LANDS

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ABSTRACT

A study was conducted in the Department of Range and Wildlife Management, University for Development Studies, Faculty of Renewable Natural Resources, Nyankpala Campus, Tamale, Ghana during the year 2012. The aim was to assess the fertility status of cropped and forested land soils. The soil chemical and physical parameters determined were pH, organic carbon, available phosphorus, total nitrogen and texture (sand, silt and clay). A grid sampling was employed for collection of soil samples from one hectare each of cropped and forest lands. The results revealed higher levels of total nitrogen (0.22%), available phosphorus (11.09 mg/kg) and organic carbon (2.41 mg/kg) under forested land as compared to cropped land which had total nitrogen (0.07%), available phosphorus (4.67 mg/kg) and organic carbon (0.68 mg/kg) with significant differences ($p<0.05$). However, soil pH of under forested land (pH 5.28) was significantly ($p<0.05$) lower (acidic) compared to cropped land (pH 6.8). The textural class of forested land was clay loam and that of cropped land was loam. It is recommended that farmers in study area should adopt tree retention land use system that will help improve the nutrient status of their cropped lands

KEYWORDS: Chemical properties; physical properties; soils; cropped land; forested land, Ghana.

INTRODUCTION

Soil, a major part of earth surface serves as a source of food for many living organisms. The soil serves as a source of support for plant (14). Fertility is the ability of soil to provide nutrients to plants in sufficient quantity and in suitable proportions (18). In Africa, soil productivity is declining as a result of soil erosion, nutrient and organic matter (OM) depletion (2). Soil depletion in sub-saharan Africa is the basic cause for declining per capital food production as crop lands have a negative nutrient balance, with annual

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losses ranging from 1.5 - 7.1 tons per hectare of nitrogen, phosphorus and potassium mainly due to crop harvest, leaching and low inputs applied to the soil (3).

The majority of people living in sub-saharan Africa depends on natural resources in particular lands, which provide them with income and food through agricultural undertaking (21). Agriculture production, which also provides a significant contribution to most GDP of Africa reported to be 21 percent on average but ranging between 10 and 70 percent country. It is challenged by several factors including climate change, variability and declining soil fertility (23).

This study focused in Wasa Amenfi East District being among the areas in Ghana for producing different food crops. Over the years, human population increase and increased human demand associated with development, have led to continuous cultivation of land and intensified agriculture on densely populated land (15). It has also led into changes in farming practices resulting into land degradation like in other similar areas of Ghana. In response to declining soil fertility a number of studies for improving land productivity have been conducted in the past (27) which have established that productivity of different soils occurring in a wide range of ecological systems depended on how different soils are managed (13). Such kind of research allows for a scientific community to share knowledge on management aspects and hence up-scaling promising practices. For example, continuous cultivation of agricultural crops such as maize and tobacco, without the additions of fertilizer in the soil in many cases, have led to depletion of soil nutrients resulting in crop productivity decline in many parts of sub-saharan Africa (12).

The objective of present research was to assess the fertility potentials of forested land over cultivated soils to recommend suitable land management practices compatible to the study area.

MATERIALS AND METHODS

This study was conducted in the Department of Range and Wildlife Management, University for Development Studies, Faculty of Renewable Natural Resources, Nyankpala Campus, Tamale, Ghana during the year 2012. The area selected for this study was at Wasa Mampong in Wasa Amenfi East district. The district is located in the middle part of the Western Region of Ghana. It lies between latitudes 5° 30’ N, 6°, 15’ N and longitudes

1° 45’ W and 2° 11’ W. It has an estimated total land area of about 16000 square kilometers, which is about 8 percent of the size of the region. The district falls within the wettest part of the country. Average annual rainfall ranges 1400-1730mm. The occasional extremes may reach 2110mm. The district experiences two main rainfall regimes. The first rainfall starts from March and ends in July while second starts from September to early part of December. Temperatures are generally high in most parts of the year ranging 23°C-28°C. Maximum temperatures are experienced in March and the minimum in August.

The semi-deciduous forest covers the northern parts of the district, while tropical rain forest is to the south and in between is the transitional zone. The area is dominated by many tree species such as odum (*Milicia excelsa*), mahogany (*Khaya anthotheca*), wawa (*Triplochiton scleroxyron*), sapele (*Entandrophragma cylindricum*), and bamboo (*Bambusa striata*). The common tree crops cultivated include coffee (*Coffee arabica*), cocoa (*Theobroma cacao*) and oil palm (*Elaesis genensis*). The main food crops grown are plantain (*Musa sapientum*), cassava (*Manihot spp*), rice (*Oryza spp*), maize (*Zea mays*) and vegetables like tomato (*Lycopersicum esculenta*), pepper (*Lycopersicum spp*), and garden eggs (*Solanum melongena*).

A grid sampling was employed for collection of soil samples from one hectare each of cropped land (mixed cropping) and forested land (natural forest). At each intersection of grid lines, 10 soil cores were taken at 10 m radius at an equal interval of 50 m with a soil auger at a depth of 0-30 cm. The cores were bulked into one composite to make up the sample for each point. In all 10 composite samples were collected from each land use for laboratory analysis.

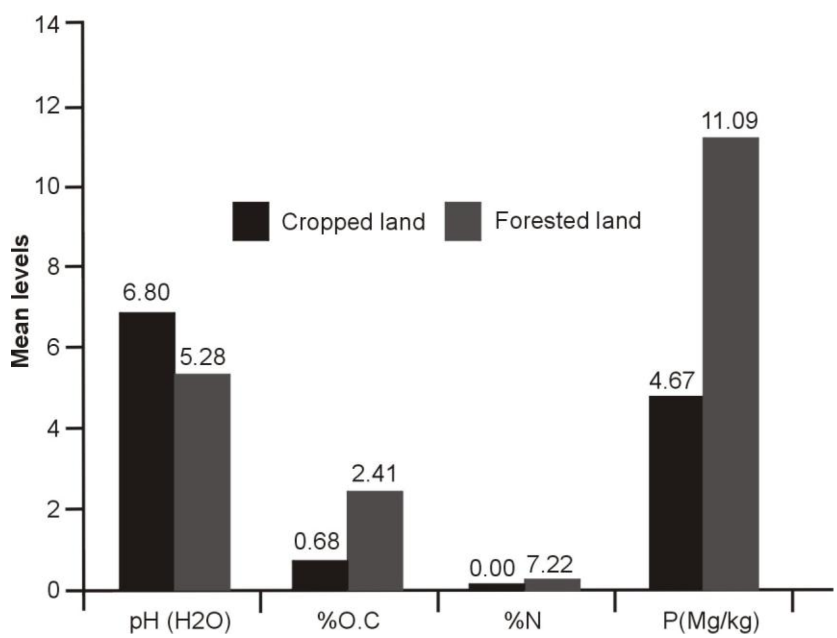
The soil samples were collected from two different land use types, thus forested and cropped lands for analysis of pH, organic carbon, available phosphorus (P), total nitrogen (N), and texture (sand, silt and clay) and by standardized methods used in SARI (Savannah Agricultural Research Institute) laboratory, Nyankpala. The samples were air-dried, ground, sieved to pass 2 mm size screen and stored in plastic bags and used for laboratory analysis.

The composite soil samples were analyzed for soil pH in a suspension of a 1:2.5 soil to water ratio as described by Jackson (8), particle size distribution or soil texture by the modified Bouyoucos hydrometer method described by Day (6) and soil nitrogen using Kjeldahl method (8). Organic carbon was determined following the wet digestion methods as described by Walkley and Black (24), available p by Bray 1 method (5).

The data collected from laboratory analysis were analyzed using Microsoft Office Excel for means and results presented in charts with error bars showing differences in the treatments.

RESULTS AND DISCUSSION

The mean levels of chemical and physical properties as determined are presented in Fig. 1 and 2.



Selected chemical properties of soils under cropped and forested land.

Fig 1. Means of some selected chemical properties of cropped and forested land soils

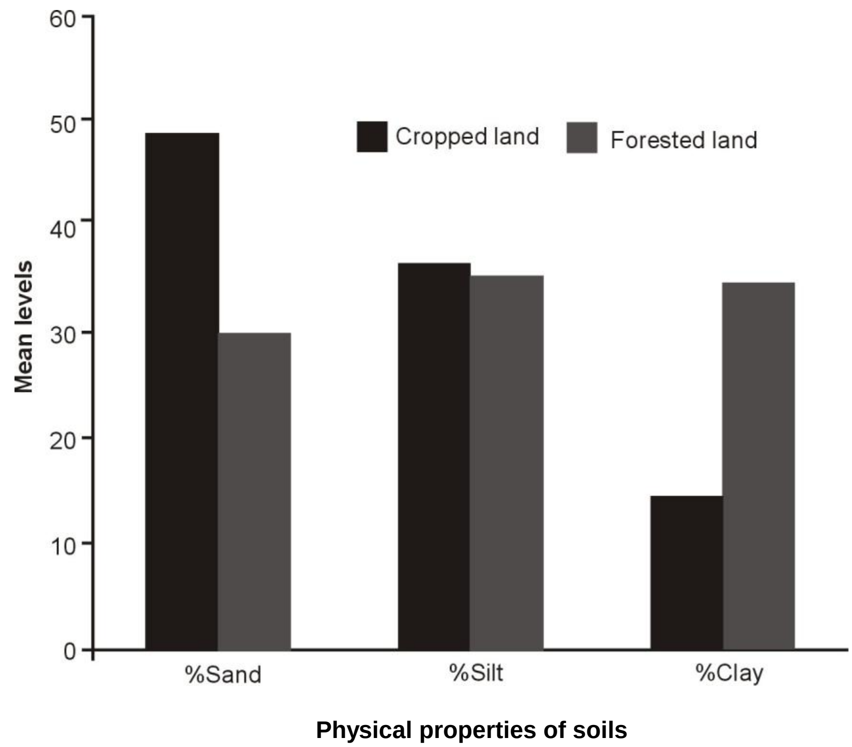


Fig. 2. Means of some selected physical properties of cropped and forested land soils.

Soil pH of cropped and forested lands

The soils pH values were significantly affected by land use (P<0.05) (Fig. 1). The pH under the cropped land was slightly acidic (6.8), however, it fell within range of 6.5-8.5 adequate for most crop production (26). The forested land was acidic (5.3) and this may be attributed to its higher microbial oxidation that produces organic acids, which relase hydrogen ions to the soil solution and thus lowers soil pH, Nega and Heluf (16). Abad *et al.* (1) reported a higher soil pH under cultivation than soils under forest. Also Dengiz (9) research in Turkey showed significant increase in pH form 6.03 in natural forest to 7.71 in cultivated land.

Organic carbon of cropped and forested lands

The results revealed that organic carbon (OC) contents were significantly (p< 0.05) affected by land use. The mean organic carbon contents were recorded less under cropped (0.68%) than forested lands (2.41%) (Fig. 1). It may be due to the conversion of forest vegetation to crop land as indicated by Woldeamlak and Stroosnijder (25). High organic carbon contents under forested land confirms the findings of Miller and Gardiner (14) that uncultivated soils have higher organic carbon matter than those soils cultivated for years. Similarly Pal *et al.* (17) reported higher OC content in surface layer of forest land than cropped land.

Total nitrogen of cropped and forested lands

Total nitrogen contenst of the soils were also significantly ($p < 0.05$) affected by land use (Fig. 1). Mean percent nitrogen was higher (0.216%) under forested land than cropped land (0.066%) (Fig. 1). Following the rating of total nitrogen in soil by Landon (10), cropped land soils can be described as very low and forested land soils as medium in term of N level. These results confirm the works of Pal *et al.* (17) who recorded higher N contents under forested land as compared to grassland and cropped land. The low N estimates could be due to N mobility in tropical soils (20) or perhaps due to prolonged N uptakes by the plants without proper compensations with N enriching fertilizer sources (26).

Available phosphorus

Available phosphorus (P) was significantly ($p < 0.05$) affected by the land use. The level of available phosphorus under forested land was significantly higher (11.09 mg/kg) than cropped land (4.67 mg/kg) (Fig. 1). Available P of soils under forested land can be described as medium according to the soil P rating by Landon (10). However, available P of soils under cropped land was less than 5mg/kg hence described as low. According to Pal *et al.* (17), phosphorus contents are high in forested land as compared to cropped with non-significant depth effect. In contrast, Habtamu *et al* (7) reported a higher available P content on the surface layer of cultivated land but they attributed it to application of DAP fertilizer as phosphorus content decreased with depth.

Soil texture

Soil texture differed significantly ($p < 0.05$) in two land use systems in the study area. However, silt fractions were not significantly ($p > 0.05$) affected by land use. The mean percentages of sand and silt were higher in the soils under cropped land in contrast to clay which was higher in soils under forested land. The higher mean percentages of sand and silt recorded under cropped land may be attributed to continuous cultivation. According to Baskin and Binkley (4), the conversion of forest into cropland deteriorates soil physical properties and make the land more vulnerable to erosion since macro-aggregates are altered. Soil erosion can alter soil properties by reducing soil depth, altering soil texture, and loss of soil fertility (11).

In contrast, Abad *et al.* (1) reported a low percentage of silt in agriculture land as compared to forest and pasture lands in Jafarabad of Golestan province, Iran. However their research reported an increasing sand content with changing forest to cultivated land. The results showed that the textural class of cropped land was loam and that of forest land it was clay loam.

CONCLUSION

The results of study conclude that higher levels of total nitrogen, available phosphorus and organic carbon were noted in forested land as compared to the cropped land and the difference was significant ($p<0.05$). However, soil pH of the soils under forested land was significantly ($p<0.05$) lower (acidic) compared to the cropped land. The textural class for forested land was clay loam and it was loam for cropped land. Generally, forest land soil had an appreciable level of nutrient contents that can support the growth of plants as compared to the cropped land soil. The cropped land should be supplied with soil fertilizing sources, such as organic fertilizer, coupled with compatible crop husbandry practices capable of conserving the soils for sustainable crop production in study area. Also farmers should adopt tree retention land use system that would help to improve the nutrient status of their crop lands.

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Bismark Ansah	**:**	**Collected research data.**
Timothy Khan Aikins	**:**	**Analyzed the data and prepared writeup.**