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### The relationship between soil management and food security in Nigeria

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#### Abstract

This paper discusses the factors militating against high crop yields, which led to high levels of food insecurity; the relationship between Soil Management and Food Security; and the strategies to improve soil productivity. Nigeria, as a country, generally depends on Agriculture as a source of food and income. Despite the potential to increase agricultural production, the performance has been continually low. The soil threats that militate against high crop yields, to low soil productivity include Soil erosion, Degradation of soil structure and physical properties, Deforestation and overgrazing. The relationship between soil management and food security in Nigeria can be seen in the fact that poor soil management leads to low agricultural productivity since agricultural productivity is fundamentally affected by the soil's productivity status. There are many success stories of the positive relationship between better soil management and crop yields which translates to improved food security in Nigeria. Strategies that can improve the productivity of Nigerian soils in support of food security include: Improving water productivity, Enhancing soil fertility and micronutrient availability, Adopting no-till farming and conservation agriculture, Adopting to climate change. Efficient Soil Management can achieve increased food and nutrition security in Nigeria.

**Keywords:** Soil Management; Food Security; Crop yields; Nigeria.

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#### 1.0 Introduction

Nigeria generally depends on Agriculture as source of food and income. Despite the potential to increase agricultural production, the performance has been continually low. This has been so because the annual growth rate of food production is lower than the population growth rate and this has led to high levels of food insecurity.

Interventions to reverse declining trends in food security must take into account the variable resilience and sensitivity of Nigerian soils. Also, in most agro-ecosystems, declining crop yield is exponentially related to loss of soil quality. Soil is an essential and non-renewable natural resource hosting goods and services vital to ecosystems and human life. Soil is the world's largest terrestrial pool of carbon and approximately 95% of global food is produced in soil. However, evidence recently provided shows that about 33% of global soils (Nigeria inclusive) are moderately or highly degraded to a point where their biotic functions have been totally damaged and resilience brought to a level that reversing the degradation to restore their productivity becomes uneconomical.

#### *Objective of the study*

As a targeted strategy to present the relationship between soil management and food security, the study seeks to achieve the objective of:

Presenting the problems affecting soil fertility

Presenting soil management strategy that can maintain soil fertility.

#### **2.0 Threats (factors) militating against high crop yields**

The identified key threats militating against high crop yields include:

##### *2.1 Soil erosion*

Soil erosion constitutes more than 80% of land degradation in Nigeria, affecting about 22% of agricultural land and all states in Nigeria. The majority of causes related to the exposure of the bare soil surface by cultivation, deforestation, overgrazing and drought.

Soil erosion causes the loss of surface soil layers containing organic and mineral nutrient pools, partial or complete loss of soil horizons and possible exposure of

growth – limiting subsoil. Soil erosion is accelerated by human activities through, amongst others, reduced plant or residue cover, tillage and other field operations. The type of tillage on agricultural land has a pronounced effect on water and soil conservation.

### 2.2 Soil Salinization and Alkalinization

Salinization is the accumulation of water-soluble salts of sodium, magnesium and calcium in the soil. It is the consequence of high evapotranspiration rates, inland sea water intrusion, and human-induced (eg. Improper irrigation) process. Salinization reduces crop yields and, above certain thresholds, completely eliminates crop production.

Alkalinization is the application of lime to acid soils to neutralize the effects of salinization and improve the fertility of the soils. The acid soils of Nigeria can be effectively managed by liming. The required quantity of lime that will correct the acidity to the expected soil, PH 4 – 5 is adopted. The following are common liming materials:

- ◆ Limestone
- ◆ calcium carbonate,
- ◆ Dolomite
- ◆ Hydrated lime
- ◆ Calcium hydroxide,
- ◆ Burnt lime.

### 2.3. Decline in Organic Matter and Soil Biological Activity

Soil organic matter plays a central role in maintaining soil functions and preventing soil degradation. Soil constitutes the largest organic carbon pool on earth and plays a critical role in regulating climate and mitigating climate change. Therefore, soil organic matter is strategic for climate change adaptation and mitigation. A loss of soil organic carbon due to inappropriate land use or the use of poor soil management or cropping practices can cause a decline in soil quality and soil structure, and increase soil erosion, potentially leading to emissions of carbon into the atmosphere. On the other hand, appropriate land use and soil management can lead to increased soil organic carbon and improved soil quality that can partially mitigate the rise of atmospheric carbon dioxide (CO<sub>2</sub>).

### 2.4. Degradation of Soil Structure and Physical Properties

Soil degradation has negative impact on human nutrition and health through its adverse effects on quantity and quality of food production. It reduces soil aeration by destroying soil aggregates and collapsing macropore density, and reduces water drainage and infiltration, generating higher runoff.

### 2.5. Soil Acidification

Over 20% of soils in Nigeria are acidic. Most of these occur in the wetter parts of the country. It poses a serious chemical problem and the greatest production – liming factor.

### 2.6. Nutrient Imbalance

Nutrient imbalance, which is generally manifested by the deficiency of key essential nutrients is mainly due to the fact that fertilization has not been soil and crop specific, farmers are unable to pay the price for fertilizers and the inability to follow the rates that are recommended.

### 2.7 Loss of Soil Biodiversity

Soil provides one of the largest reservoirs of biodiversity on earth, and soil organisms play key roles in the delivery

of many ecosystems services. Little is known about the degree of biodiversity required to maintain core soil functions, but new tools for biochemical techniques and DNA analysis suggest significant progress in this area is possible.

### 2.8 Soil Compaction

Soil compaction is related to the degradation of soil structure due to imposed stresses by machinery and livestock trampling. Soil compaction reduces soil aeration by destroying soil aggregates and collapsing macropore density and reduces water drainage and infiltration, generating higher runoff. Compaction limits root growth and seed germination by high mechanical impedance, affecting soil biodiversity and causing surface soil crusting.

### 2.9. Deforestation and Overgrazing

Deforestation is the act of cutting down or burning of trees. Deforestation and overgrazing cause removal of surface cover and loss of soil carbon. Therefore, they should be avoided or carefully planned and appropriately implemented if unavoidable.

## 3.0 Relationship between soil management and food security

The relationship between soil management and food security in Nigeria can be seen in the fact that poor soil management leads to low agricultural productivity, since agricultural productivity is fundamentally affected by the productivity status of the soil.

“Soil management is sustainable if the supporting, provisioning, regulating, and cultural services provided by soil are maintained or enhanced without significantly impairing either soil functions that enable those services or biodiversity. The balance between the supporting and provisioning services for plant production and the regulating services the soil provides for water quality and availability and for atmospheric gas composition is of a particular concern”.

Indeed, changes in crop yields measured over several decades reflect changes in soil conditions and management strategies. Large food crop yields increases have been reported when integrated soil management practices were used in many yield experiments (Eswaran *et al.*, 1990). Maize yields increase due to NPK fertilizer application was as high as 150%, but increased to 184% when the soil was amended with lime and manure.

There are many success stories of the positive relationship between better soil management and crop yields which translates to improved food security in Nigeria.

## 4.0 Strategies to improve the productivity of Nigerian soils

Strategies that can improve the productivity of Nigerian soils in support of food security include:

### 4.1. Improving water productivity

A well-managed soil has rapid water infiltration, optimal soil water storage, and efficient drainage when saturated. However, when these conditions are not met, water logging and water scarcity problems arise. Water logging which is related to the saturation of soil with water, creates rooting problems for many plants, thereby reducing yields. On the other hand, water scarcity occurs in areas where water is lost by evaporation, surface runoff and percolation thereby causing crop failure.

#### 4.2. *Enhancing Soil Fertility and Micronutrient Availability*

Enhancing soil fertility is the only way to a profitable use of land durable food production. Soil fertility management redresses nutrient imbalance and environmental degradation by promoting the use of economically attractive soil fertility enhancing techniques and sustainable land use.

According to Akilapa (2010) “Soil Fertility is the inherent capacity of the soil to supply nutrients to plants in adequate amounts and in suitable proportions.

It is also, the ability of the soil to yield crops. In this sense, fertility is a function of both chemical and physical soil properties (soil-water and soil-air relationships). Crops yields, however, depend not only on soil conditions, but also on prevailing climatic conditions and on-farm practices as regards soil, water and crop management (use of fertilizers, control of erosion, weeds, pests, drainage, irrigation, etc).”

Improved soil fertility can be attained through soil conservation practices such as the use of crop rotations with legumes, green and animal manures and cover crops.

According to Odunze, and Ogunwole (2010), “Crop rotation attempts to optimally exploit soil resources by balancing crop nutrient demand with nutrient return through biodegradation of contributed biomass and nutrients contributed by the crop plant symbiotically or otherwise. For example, in a rotational practice involving sole maize, maize + cowpea, and sole Soyabeans cropping, sole maize; that is a high nutrient demanding crop is followed by Sole Soyabean that contributes nitrogen and below ground biomass to the soil.”

#### 4.3 *Adapting to Climate Change*

One of the strategies to improve the productivity of Nigerian soils in support of food security is adaptation to climate change.

Climate change refers to any long-term significant change in the average weather that a given region experiences. It upsets seasonal cycles, destroys ecosystems and water supply, causes sea levels to rise and affects agriculture and food production.

A variety of options for adaptation exist in agriculture. They include:

- ◆ Changing inputs such as crop varieties and/or species and using inputs with increased resistance to heat shock and drought; altering fertilizer rates to maintain grain or fruit quality consistent with the climate and altering amounts and timing of irrigation and other water management practices.
- ◆ Making wider use of technologies to harvest water, to conserve soil moisture (eg. Crop residue retention) and to use water more effectively in areas where there is a decrease in rainfall;
- ◆ Utilizing water management to prevent water logging, erosion and nutrient leaching in areas where there is an increase in rainfall;
- ◆ Altering the timing or location of cropping activities.

#### 4.4. *Other Strategies*

Other strategies include:

- ◆ Land – use changes such as deforestation or improper grassland – to cropland conversion that cause removal of surface cover and loss of soil carbon should be avoided or carefully planned and appropriately implemented if unavoidable;
- ◆ A cover of growing plants or other organic and non-organic residues that protects the soil surface from erosion should be maintained through implementation of appropriate measures such as mulching, minimum tillage, no-till by direct seeding with attention to reduced herbicide use, cover crops, and agro-ecological approaches;
- ◆ Increase organic matter content through practices such as: managing crop residues, using forage by grazing rather than harvesting, practicing organic farming, applying integrated soil fertility management and integrated pest management, applying animal manure or other carbon-rich wastes, using compost, and applying mulches or providing the soil with a permanent cover;
- ◆ Fire should preferably be avoided, except where fire is integral to land management, in which case the timing and intensity of burning should aim to limit losses of soil functions;
- ◆ Fertilizer application methods, types, rates and timing should be appropriate to limit losses and promote balanced crop nutrient uptake. This should be based on soil and plant analyses and be a long-term endeavour rather than short-term action;
- ◆ Natural soil fertility and nutrient cycles should be improved and maintained through the preservation or enhancement of soil organic matter. Improved soil fertility can be attained through soil conservation practices such as the use of crop rotations with legumes, green-and animal manures, and cover crops in combination with reduced – or no – tillage with attention to reduced herbicide use, as well as agro forestry. Nutrient cycles are best managed in integrated systems such as crop –livestock systems or crop – livestock–forest systems;
- ◆ Promote sustainable soil management that is relevant to the range of soils present and to the needs of the country;
- ◆ Participate in the development of multi – level, interdisciplinary educational and capacity-building initiatives that promote the adoption of sustainable soil management by land users;
- ◆ Support research programmes that will provide sound scientific backing for development relevant to end users.

#### 5.0 **Conclusion/Recommendation**

- i. The study recommends effective usage of mineral fertilizer and other organic amendments, for efficient soil management strategy.
- ii. Cultural practices like bush burning among other degrading soil practices should be avoided to keep the soil safe and healthy as Soil is key factor for national

development and international development

- iii. Strengthen of Land-use policy and act has been found to be one of the modalities for soil sustainability
- iv. Proper soil survey and land-use planning is also a key factor for the fertility sustainability of Nigerian sustainable soil management in Nigeria.

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