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NIGERIAN AGRICULTURE AND THE CHALLENGES OF THE 21ST CENTURY: NIGERIAN SOILS

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ABSTRACT

The cardinal roles of agriculture in Nigeria, her landmass, approximate hectares under different land uses, the national average cultivated land ratio per caput, soil studies, government policies on agriculture, soil constraints and problems and technologies of soil conservation and management in the 20th century were reviewed. Their implications on soil and agriculture are discussed. Nigerian soils are found to be of medium to high potentials. There is no class one soil and class two soils account for 5.5% of the total land area. Class three soils constitute 46.5% and they are of medium productivity and have a good potential for agricultural development. Over 48% fall into classes four and five and they generally have low productivity. Soil constraints and problems that militate against high crop yields are soil erosion, salinization, flooding, declining fertility, desert encroachment, mismanagement and misuse etc. Conservation and management measures include adoption of minimum tillage, crop rotation, fallowing, fertilization, mulching etc.

The expectations and approaches for the study and use of Nigerian soils in the 21st century are discussed. Some of them include establishment of soil research institutes, detailed characterization and mapping of the soils, production of land capability maps, zoning of crops based on land capability and the suitability of the soils; use of modern methods of acquiring, storing and retrieving data; proper formulation and use of inorganic and organic fertilizers etc. New technologies must be sought to handle the cultivation of the fragile soils. Irrigated agriculture and water conservation techniques should be encouraged at small to medium scale farming. Soils study should be approached from a multi-disciplinary viewpoint for sustained productivity and environmental harmony.

INTRODUCTION

In Nigeria, agriculture is ascribed the roles of:

i) providing adequate food for an increasing population;

ii) supplying adequate raw materials to a growing industrial sector;

iii) constituting the major source of employment;

iv) constituting a major source of foreign exchange earnings; and

v) providing a market for the products of the industrial sector (*Fed. Min. of Agric. Water Res. and Rural Dev 1988*).

The agricultural sector has generally not fulfilled these expectations. The per capita food production has not kept pace with the growing needs of the population. Agricultural exports contributed nearly 62% of total exports in the early seventies, but now these account for less than 10%. As a result, the Nigerian economy is totally dependent on oil for export earnings (FMANR, 1997).

Nigeria's land mass is 924,000km^2 and this does not hope to increase rather it is most likely to decrease. Sixty eight million hectares are under crops, pasture and forest, and only 31 million hectares are arable land. Currently, the national average ratio of cultivated area per caput is only 0.35ha. By the year 2010, and with a projected population of 162 million (World Population Bureau, 1996), the national average ratio of 0.19ha of cultivated area per caput shall be expected. The reduction in the land to man ratio will seriously impair the capacity of the

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agricultural sector to achieve food security, produce raw materials for industry and raise the level of foreign exchange earnings, unless there are substantial increases in agricultural productivity and an expansion in the area under cultivation in the near future.

The exploitable natural resources of soil, forest, water bodies and the environment have suffered serious mismanagement and misuse that have caused land degradation, erosion, deforestation, desert encroachment, salinization, pollution and loss of bio-diversity. Climate change and global warming are here with us.

SOIL

Soil is variously defined by different disciplines but the most common definition is that it is a 3-dimensional living entity that provides nutrients and anchorage for plants. It is the thin layer of earthy materials that cover the earth's crust. This thin layer of about 1 – 2m thick is the life-sustaining layer of the earth. Soil is a social good; it represents the physical, chemical and biological base of agricultural production. It is the legacy from the past to the future generations (Reale *et al.*, 1995). The formation of soil is conditioned by the factors of parent rock (parent material), organism (flora & fauna and man), relief (topography), climate (rainfall, radiation, etc.), which interact over a long period of time to result in a group of soils. Soil forms at a very slow rate and under natural conditions, about 2.5cm of soil will take between 300 to 1000 years to form. Soil therefore is a complex entity and as a living entity, it can be literally "killed" by misuse. The soil is a natural sink, taking charge of wastes, poisonous chemicals and even our dead bodies.

Soil study in Nigeria can be traced back to the work of Doyne, Hartley and Watson (1938) who introduced the term "Acid sands" to describe the soils occurring in the regions of Nigeria where the mean annual rainfall is 2000mm and above; and Vine (1948) who prepared what was described as a "provisional soil Map" and illustrated that the features of soil profiles in Nigeria are mainly determined by the nature of the parent materials and the history of weathering and local transportation of the soil material.

Nigerian soils are of medium to high potentials. However, in productivity potential, there are no class one soils of high productivity. Class two soils account for only 5.5% of the total land area of Nigeria, and comprise the alluvial (fadama) soils. Class 3 soils constitute 46.5% of the total land area and the soils are of medium productivity and have a good potential for agricultural development because of their depth and relatively heavy nature. Over 48% of Nigerian soils fall into classes four and five, and they generally have low productivity due to inadequate moisture retention capacity and low organic matter content (FMANR, 1997).

SOIL INFORMATION IN NIGERIA IN THE 20TH CENTURY

GOVERNMENT POLICIES AND NIGERIAN SOILS

A false impression had been created by those who did not know much about the qualities, kind and extent of Nigerian soils that Nigeria is endowed with "very fertile land" and all that was needed for successful agricultural production was caring for other inputs except soil. In the sixties, studies conducted by FAO (Agric. Development in Nigeria, 1965 - 1980) gave a generally favourable man to land ratio and this has continued to give our leaders and policy planners the false perception that Nigeria has an inexhaustible expanse of highly productive soil. This unfortunately is not true.

The FAO (1965- 1980) prepared document, Agricultural Development In Nigeria, did not discuss soils, rather it touched on a few issues relating to Fertilizer use and requirements, Agro-Chemicals, Land Tenure and Tractorization. The 1973 – 1985 Agricultural Development document published by the Federal Ministry of Agriculture and Natural Resources Joint Planning Committee in 1974, briefly enumerated a few soil constraints under Farming Systems, Land Tenure and Crop Ecological Zones. In 1988, the Federal Ministry of Agriculture, Water Resources and Rural Development announced with fanfare an Agricultural Policy for Nigeria. This policy

advocated that land should be allocated to its most suitable uses and that available land should be used in such a way that its quality is conserved so as to enhance its potential for continuous productivity. The 1989 National Policy on the Environment (FEPA, 1989), produced a more meaningful policy with fairly articulated strategies for its implementation.

Policies without proper implementation of the strategies to achieve the targets of the policies are as painful as having none at all. Various Governments of Nigeria have not understood the role soils play in the agriculture of the country. This is borne out by the fact that Nigeria has eighteen national agricultural research institutes. Six of these deal with arable crops, four deal with forestry and tree crops, three with livestock, two with fisheries, and one each with extension, processing and storage. Most agricultural production problems are soil- related, yet there is no research institute to investigate these soil problems.

Aspects of Soil Study

Soil study flourished in Nigeria during the 20th century.

The primary function of the soil is to provide nutrients and anchorage to plants hence in agriculture the first study of the soil was with respect to the fertility of the soil -the power of the soil to supply the needed nutrients to the crop plant in a balanced amount. Research in soil fertility has revealed that most Nigerian soils are deficient in certain major nutrient elements and the trace elements. The macro and micro – nutrient elements are usually supplied through the application of inorganic and organic fertilizers and lime. Research had also shown that many Nigerian soils are very low in the content of organic matter. Organic matter in the form of humus is a very important component of soil. It plays an important role in nutrient absorption and retention, aggregate formation and its stability.

Soil fertility is closely related to Soil Chemistry and the soil is a factory manufacturing many ingredients. The clay particles in the soil are also colloidal in nature. The study of the Nigerian soils has revealed the presence of two groups of clay minerals – the high activity and low activity clay types. The high activity clays retain more nutrients than the low activity clay soils. Some soils have chemical problems such as salinization and sodication especially in parts of the fadama lands in northern Nigeria. Use of low quality irrigation water can lead to similar problems in other parts of the country.

It was not possible during the 20th century to map the soils of Nigeria at a scale that the farmer can use to locate a hectare or more in an area that cannot be utilized because of its content of heavy metals or other undesirable quality. Soil characterization and mapping are generally recent compared to soil Chemistry and Fertility. The FAO (1964) produced a generalized soil map of Nigeria based on D' Hoore's Soil Map of Africa. This was at a scale of 1:5,000,000 and the information contained was not adequate for soil management practices. No attempt to build on this was made until 1979 when the Government of the United States of America offered a technical assistance to the Government of the Federal Republic of Nigeria to help in the production of a reconnaissance soil map of Nigeria. The map was published in 1990 at two scales of 1:650, 000 and 1:1000,000.

Detailed soil surveys for specific projects have been executed in Nigeria, for example, those for irrigation schemes in parts of northern and central Nigeria and along several flood plains for the River Basin Development Authority. Methods for surveying Nigeria's soils include the conventional traversing and the application of satellite imageries. Both have revealed the enormous ecological problems of desert encroachment, erosion, deforestation, sodication, flooding, etc. that beset the agricultural environment of the country.

More emphasis is usually paid to the chemical fertility of the soil than to its physical state. This is not the best approach since the physical state of the soil is very important in the response of the soil to types of manipulation. Several studies have been conducted on Nigerian soils with respect to their physical and structural properties. The soil water management holds the key to successful soil management particularly for irrigation schemes. Reclamation of soil from natural swamps is one way of increasing cultivable land and its success depends on good knowledge of the principles of drainage.

The fragile nature of Nigerian soils has led to fears that the use of the ordinary tractor to cultivate the soil shall lead to soil loss through both wind and water erosion and also to compaction. Research into tillage systems has proposed such systems as zero tillage, minimum tillage, conservation tillage etc. But there are still some doubts about the applicability of these with respect to agroecologies and soil types of Nigeria.

The 20th century soil studies in Nigeria, witnessed the emergence of many types of soil conservation measures. These measures include terracing, chemical land clearing, conservation tillage, crop rotation, mulching, contouring, fallowing, alley cropping, fertilization etc. These conservation measures are necessary because the Nigerian man has abused and misused the soil which is a non-importable commodity.

SOIL CONSTRAINTS AND PROBLEMS

Soils developed on steep slopes are too shallow and probably stony for arable agriculture. Others developed in sandy materials hardly retain moisture and are excessively leached. Yet others developed over heavy clay parent materials are difficult to cultivate and manage. The sandy soils can be found in parts of southeastern Nigeria, the so called "acid sands", parts of central and northern Nigeria where the soils developed from aeolian deposits and kerri-kerri sandstones are mainly sandy in texture. Those developed over heavy clay parent materials are also clayey and are mostly found around Maiduguri and Gombe. These different soil types suffer from a series of constraints and problems as earlier mentioned in the "introduction". Others include declining soil productivity, soil compaction, alkalisation and acidification, coastal erosion, sand dunes movement etc. Land tenure system is a problem and a constraint.

Land degradation in the form of erosion affects all parts of the country. Over 5% of the country are affected by severe erosion in one form or another. It is most dramatically seen in the gullies of southeast Nigeria and on the Jos plateau (World Bank, 1992). The devastations brought about by gully erosion in Abia, Imo, Anambra, Enugu, Ondo, Edo, Delta, etc. are alarming and the coastal areas of Ogun, Ondo, Rivers, Bayelsa, Akwa Ibom, Cross River States etc, have lost a great quantity of their land to coastal erosion. Sheet (inter-rill) erosion is less visible and spectacular but of more widespread occurrence, affecting virtually the whole country (see table 1 below). A bare soil on a gentle slope in the Nsukka environment can lose up to 150 tons of soil material per hectare per year.

Table 1: Types of Erosion and Areas Affected.

Type of Erosion	Area Affected (000km^2) in Nigeria			
	North	Central	South	Total
Wind Erosion	65	-	-	65
Gully Erosion	18	74	23	115
Sheet Erosion	190	410	110	710
Other	-	4	30	34
Total	273	488	163	924

Adapted from World Bank Report No. 10694 – UNI, 1992.

To summarize, soil studies in the 20th century Nigeria have witnessed tremendous achievements. Yet, we cannot claim complete understanding of the soil behaviour when subjected to various types of manipulation. We have not fully characterised our soils physically, chemically and biologically. We have not mapped our soils at the detail that the farmer, the engineer and the entrepreneur can pick up a soil map and be able to make it answer his questions concerning a certain tract of land of interest to him.

EXPECTATIONS FOR SOIL IN THE 21ST CENTURY

The study of Nigerian soils requires sustained attention from Government in terms of policy and release of fund. A policy on agricultural soils must be different from the land use decree of 1978, which dwells more or less on sharing land. Soils must be recognized as a major contributor to agriculture and treated as a resource that must sustain the country whether there are petroleum and other solid minerals or not.

Research institutes must be created on agro-ecological basis each with a mandate to research all aspects of soil. Detailed soil

characterization and mapping of our soils must be undertaken urgently. Land use maps and land capability maps should be produced. Crop production should be zoned based on the capability of the land and the suitability of the soil to such crops. Use of modern methods of acquiring, storing and retrieving data must be employed; for example, satellite imageries should be acquired on a continuous basis for soil and environmental study. Geographic information system (GIS) should be used to prepare resource maps and Land Information System (LIS) created in every agro-ecology.

Both organic and inorganic fertilizer formulations should be made for specific agro-ecologies and land utilization types (LUTs). Government must make the procurement of adequate quantities of fertilizers and lime feasible to the average small-scale farmer. Organic farming should be encouraged at least at home gardens for homes in the south and along fadamas in the north. Mixed farming should be encouraged for the small scale farmers so that both animal and crop wastes are ploughed back into the soil to enrich the nutrient status of the soil and reduce environmental degradation.

New technologies must be sought to handle the cultivation of the fragile soils. Although, the use of the conventional tractor for tillage is in the decline, smaller machines that are cheaper, equally efficient and easy to operate will have to be designed, manufactured and used in the 21st century. More lands shall be put under irrigated agriculture and use of water conservation techniques shall be encouraged. Small earth dams and dug-out wells are needed in farms to give supplemental irrigation during the short periods of drought that beset rain fed farming. Irrigation of arable crops and horticultural crops will increase the number of times the crops are grown in a year, thereby increasing the yield per hectare per year. Small to medium scale irrigation systems are recommended.

The study of soil should be approached from the multi-disciplinary view point so that the target of farming the soil on a sustained basis shall be achieved. Efforts must be made to remove the constraints and solve the problems of our soil whether they are anthropogenic or natural. Declining soil fertility must be tackled with a view to reversing the situation in the first quarter of the 21st century.

Finally, soil scientists, earth scientists and agronomists must be encouraged to remain in the profession. More should be trained and the old retrained to cope with the new technological development of the 21st century.

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