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CLIMATE CHANGE: A CHALLENGE TO SUSTAINABLE LAND RESOURCE MANAGEMENT IN AGRICULTURE AND THE EXTENSION OF ARABLE CROPS MECHANIZATION IN NIGERIA

Paul Osu SIMEON, Hemen Emmanuel JIJINGI, Nyam Joseph APAJI

Federal University Wukari, P.M.B 1020, Wukari, Taraba State – Nigeria Postal Code; 67001
Department of Soil Science and Land Resources Management, Phones: +2348062536780, +2348069451802, +2348065476027, Emails: posimeon@yahoo.com, hijijingihemen@live.com, apajij82@outlook.com

Corresponding author: posimeon@yahoo.com

Abstract

In agriculture, farm land is any space or medium that supports agricultural practice/production. This is in tandem with economics which has land as one of the four main factors of production. But ecologically, land can be said to be the solid part of the 'Earth' along with its components in the interior, on the surface (ground level) and above the ground level. These are respectively the rocks and minerals including underground water; the soil and biological matters within and upon it; and the atmosphere. The interactions and interdependency of these factors made land and climate inter-twined and have created series of dynamics and phenomena which have influenced and shall continue to influence all forms of existence on earth. Agriculture which is a principal branch of any national economy is tied in major part to the soil which is the topmost part of land and therefore, farm is tied to ecology and its factors (which include climatic factors). The limit in the size of land available for farming and the continuous decline due to other competing needs of humanity together with the ever-increasing population of the world have made efficient mechanization the panacea for intensification of production to cope with the ever-increasing demand for food and raw materials. The path to overcoming the looming danger is sustainable management, which is present beneficial exploitation, utilization, maintenance, co-ordination and control of resources that ensures the continuous existence / availability for future needs. Certainly, it is now a known fact that changes in climatic conditions/ factors have brought about either positive or negative or both in the different parts of the world, and Nigeria is not an exception. This paper is an original scholarly inquiry based on review of related literatures (academic and public awareness information outlets), reports and physical observations of the authors. The results reveal that a worrisome land management culture and practices at present in Nigeria. This is being worsened by climate change effects of drier (including desert expansion) northern parts and wetter (including coastal erosion, ocean surge, swamp expansion and heavier erosion) southern parts of Nigeria. These coupled with poor handling of wastes, mining operations, pollution from oil spillage and gas flaring; wrong use of chemical (agro-related and environmental Sanitation related); reckless deforestation; etc constitute huge threats. The paper ends with propositions of mitigating actions and ameliorative measures to be taken by stakeholders in land holding and development.

Key words**:** *climate change, sustainable management, ecology, mechanization, farming, interdependency*

INTRODUCTION

Having regard to the format of papers/articles for Nigerian Journal of Soil Science, the introduction shall integrate the review of related literatures on which the scholarly inquiry /research is mainly based.

Over the years and centuries, human activities have been producing both negative and positive effects on man himself and his environment. While the positives, have contributed to development and better life-style, the negatives tend to fight against the gains or progress made. Overall, the positives have been superior to the negatives. One of the great worries of humanity today is climate change and its effects, which overall is of negative superiority.

Sustainable Management is the present beneficial exploitation, utilization, maintenance, coordination and control of resources that ensures the continuous existence/availability for future needs. Land is one (1) of the four (4) main factors of production and the two (2) most important features of existence on earth are Land and

human beings, with the land sustaining the human beings and their activities for their existence, well-being and continuous existence.

Land is a precious (very valuable) national asset for a country, community and individuals and for the farmer, it is an indispensable need and partner. Nations are known to have bitterly fought very deadly wars because of land; the threat and strife still exist and shall continue to exist, more so, that the ever-increasing population of the world is putting great pressure on the available land which is, unfortunately, in continuous decline due to several factors. Among these factors is Climate change.

According to [6] "Climate change is a long term significant change in weather pattern of an area. The alteration of weather and subsequently climate change arises from global warming that is considered to be the most serious threat facing the world today. This has necessitated the Kyoto protocol, which is the international agreement to cut greenhouse emission that causes climate change. Climate is the most crucial factor which determines nature of natural vegetation, soil characteristics, the crops that can be grown and farming practice in a region. Climate has implication on soil productivity, human and animal nutrition, employment and human development. The northern part of Nigeria is confronted with high temperatures and lower precipitation leading to increased desertification. The south is challenged with increased and more frequent rainfall resulting in increased flood occurrences and erosion. Soil productivity and organic matter are affected by climate change". This is an open knowledge which is also in tandem with the position of the authors of this paper.

Climate has been simply defined as the average weather conditions of a place observed over a long period of time of minimum of thirty-five (35) years. Weather is the atmospheric conditions of a given place at any given time, usually daily, but can be weekly, monthly or annually. The atmosphere is the air space above the surface of the earth and it is made up of gasses, vapour and floating particles which receive solar energy from the sun. And weather is confined within the troposphere, which is the lower part of the atmosphere from the surface of the earth. The measurable elements of weather are Rainfall (and other forms of precipitation), Temperature (heat level), Sunshine (duration and intensity), Pressure, wind (direction and velocity/speed) and Humidity (absolute and relative). They are influenced by latitude. Altitude, Continentality, Ocean/Sea breeze, Ocean Currents Natural Vegetation and Soil Relief and Cloud Cover [3]. All these elements and climatic factors are also part of ecological factors. Due to their permanent interactions and interdependency, any change in anyone translates to (bring about) change(s) in others, and eventually on land resource.

Over the last decades, the observed change in the rise of global temperature is producing negative effects of such great magnitude that it has become a cause of concern for safety and security of man, his means of lively-hood and the entire earth itself (particularly the land and the environment) in the present and in future. According to [4] cited in Ojeniji (2014) "warming of the climate is irrequivocal as is now evident from observations of increases in global air and ocean temperature, widespread melting of snow and rising global average sea level". [6] stated further that "well drained soil of humid tropics are expected to reduce in fertility and stability when subjected to continuous leaching arising from increase in rainfall; temporary flooding results to decline in organic matter decomposition in depressions; and runoff is expected to occur on slopes resulting to loss of top soil which causes sedimentation downstream and down slope. In subtropical and semi-arid environments, more rain had been predicted for some places and less rain in other places. Soils of low rainfall areas are expected to produce less dry matter and soil organic matter. These are the obvious reasons climate change has become a challenge to sustainable development and sustainable management of all kinds of earthly resources.

Whatever it is that challenges land resource development and management also challenges agriculture which is based principally on land as medium of production. And due to decline

in the land available for agriculture and the increasing demand for food (qualitatively and quantitatively) and primary raw materials, coupled with the declining and ageing population in the farms due to youth migration to urban centres, farm mechanization has been found to be the panacea for increase production and supply because it provides more power in the hand of farmers, the intensification of production and thus, the maximization of the productive capability of the land/soil and the raised material (crops and livestocks).

According to [2]. "the continuous increase in both human and animals population is responsible for the progressive development of agricultural methods and techniques for overcoming the challenges of producing enough food, feeds and fibres for both human and animals consumption. Every stage in agricultural production involves work and power performs the work. Because of the ineffectiveness of hoe, cutlass and other related hand tools for meaningful food production, the use of animals power was invented, but was soon found to have brought in negligible increase to food and reduction of drudgery in agriculture. The shortcoming led to the invention of tractor, farm machinery, fertilizers, improved seeds and other related developments to increase farm size and food production capacity of farmers when the techniques are fully and effectively used on the farms. Most of the techniques employed in the tropics gradually destroy the ecosystems when agricultural soil is **bare**. As a result, there is severe erosion and fertility status of the arable soil is depleted continually".

The possibility of practice and extension of mechanization are regulated by the existence of favorable environmental conditions, principally, the climatic conditions and the nature of land/soil. Here, we talk about the type of soil, the nature of land (topography/relief), rainfall pattern, depth of soil and its drainage feature, and the level, quantity and quality of the underground water.

According to [8] mechanization is basically the exploitation and management of machines, engines and mechanical aggregates/installations in replacement of manual and draught animals works in agricultural production, in this way, it includes the efficient selection, operation, repair, maintenance, and the replacement of machinery. The wetter and drier is the soil, the softer and harder the soil is respectively, and beyond certain limits of wetness/softness and dryness/hardness field mechanization of crop husbandry operations become impossible in the absence of high capital, high technical skill and high managerial expertise. This is another reason the climate change which has been creating extreme wetness and extreme dryness in various parts of the world and in Nigeria, is a challenge to the extension of farm mechanization. These are respectively happening in the southern part (which lies within the equatorial rain forest area) and in the far northern part (which lies in the sahel Savannah/semi-arid area).

In agriculture, the introduction of mechanization has created the challenge of sustainable management of the soil due to compaction on one hand as a result of tractor-machine (mechanical aggregates) traffic, and loosening of the top soil with tillage implements which makes the soil to be easier eroded by erosion agents and also expose the soil to quick degrading when left bare under reasonably high temperatures of the Nigerian tropical weather conditions. Such land can not be excluded from the damaging effects of climate change if proper managerial expertise is not employed efficiently.

According to [5] "*the most common causes of soil compaction are agricultural machines such as tractors, harvesting machines/equipment and implement wheels travelling over moist loose soil*". He cited [5] stated further that soils tend to be more compacted deeper into the soil profile due to the weight of overlying soil. [6] he stated that "soil compaction occurs when soil particles are pressed together, reducing pore space between them. Heavily compacted soils contain few large pores, less total pore volume and consequently a greater density. Agricultural machines traffic is the main cause of decreased structural soil macro-porosity. A compacted soil has a reduced rate

of both water infiltration and drainage. This happens because large pores are more effective in moving water downward through the soil than smaller pores. For this [6] stated that "heavier and more powerful tractors and machines have been used on farms throughout the world". This is increased load on the soil promoting greater challenge to soil/land management.

Climate change is a concept emanating from global warning as a result of rise/increase in the average global temperature and this rise together with the different environmental conditions it has created (especially in rainfall quantity duration, intensity, frequency and distribution pattern) have occurred over the past five (5) decades (50 years) that they have become permanent features/conditions such that the rise in temperature now constitute change in climatic conditions/weather elements. The regular flooding in Europe and Asia together with vexacious over flow of banks by rivers, seas and ocean water current worldwide) the wild fire in America, Canada and Australia, expansion of desert in Africa as well flooding, erosion of sea and ocean coastlines worldwide, the melting polar ice and glacier, rise in sea water level, etc. are all pointers of changes.

The earth's surface is shared by two (2) great bodies; the body of water and landmass. The sharing proportion which was in favour of water taking up 60-67% had, is and shall continue to change constantly to the detriment of land, hence the land available worldwide is decreasing being lost to the more powerful body of water. This is worsening the adversities brought upon land by climate change. Therefore, sustainable land resource management for agriculture and the extension of farm mechanization from the middle belt of Nigeria to the far northern and southern parts with respective increase in hard soil and alluvial deposits, is very seriously and greatly challenged by climate change. It is a known fact that no land no agriculture and no farm mechanization no modern agriculture and no sufficient production and supply of food and basic raw materials, no socio- economic stability and development.

Taken from another perspective, sustainable land management is a challenge in agriculture in Nigeria. Major agricultural practices/activities take place in an open field and are subjected to direct influence of climatic conditions and day to day atmospheric conditions of weather elements. Contending with the sustainable managements of exposed vast expanse of arable land/soil against rapid degradation in structure, fertility, stability and erosion under tropical climatic conditions that prevail in Nigeria is a very huge/massive challenge.

In bush clearing for agricultural purpose, the top soil must be preserved. The top soil contains nutrients needed by crops for optimum performance. Agricultural bush clearing is therefore defined as the process of scientific removal and disposal of existing materials, vegetation, rubbish and other obstructions from the land by manual, mechanical and chemical means for agricultural production. This according to Anazado (1986), NALDA (1992). Adama (2013) cited in Adama (2013) cited in [1].

"The basic objectives of agricultural bush clearing and land development are to remove unwanted materials from the land and to increase the size of the land to be cultivated" stated [1].

MATERIALS AND METHODS

Study Area

Nigeria lies within the tropics and therefore has the tropical climate. While the tropics are latitudes $23^1/_2$ degrees North and South of the Equator (zero degree), Nigeria lies within latitude 3^0 and 15^0 North of the Equator and Longitude 4^0 and 14^0 East of the Greenwich Meridian

Method

This work is an original scholarly inquiry based on review of related literatures (academic and public awareness information outlets), reports and physical observations of the authors.

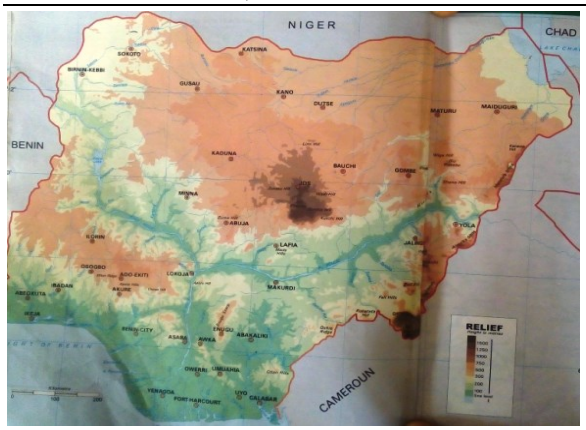

Fig. 1. Map of Nigeria showing the Physical Features
Source: [7]


Fig. 2. Vegetation Map of Nigeria
Source: [7]

RESULTS AND DISCUSSIONS

During the visits to the field for first time observations by the researchers, some pictures which reflect the effects of climate were taken and are presented below.

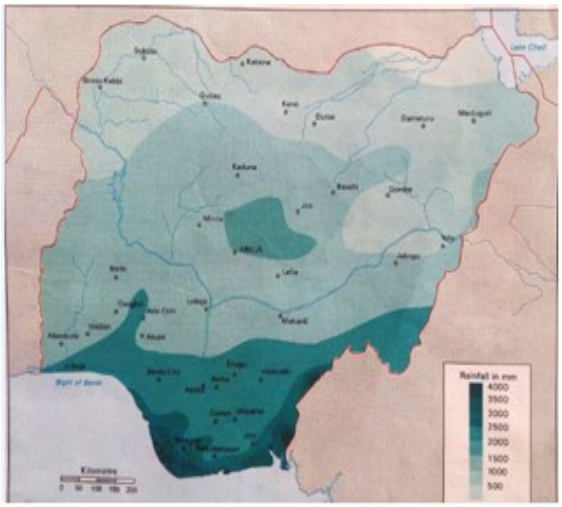
Fig. 3, Map of Nigeria showing the Geology
Source: [7]

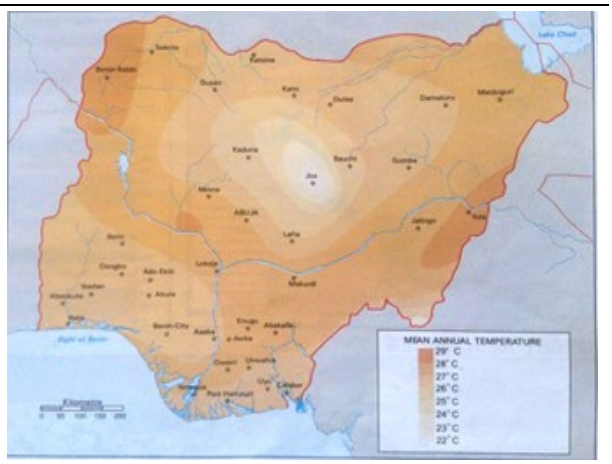

Fig. 4. Map of Nigeria showing Mean Annual Temperature
Source: [7]

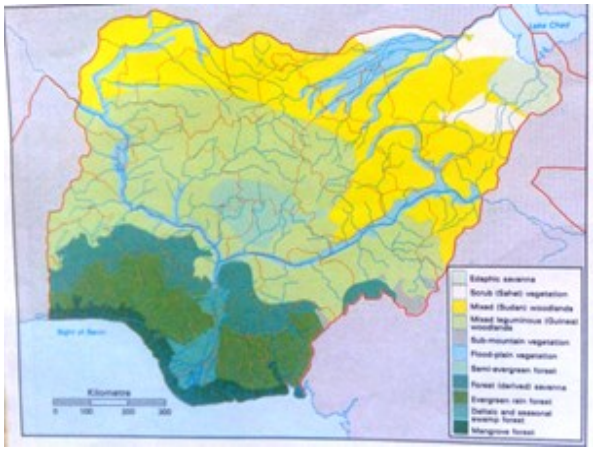
Fig. 5. Map of Nigeria Showing the Vegetation
Source: [7]

Fig. 6. Map of Nigeria showing the Population
Source: [7]

Fig. 7.Map of Nigeria Showing the Soil
Source: [7]

The effects of Gully Erosion Communties and Farmland across Nigeria are presented below in Photos 1-6.

Photo 1. Gully Erosion in Ondo State
Source: Gully Erosion in Imo State

Photo 2. Exposed Land in Edo State
Source: Researchers personal field photograph

Photo 3.Sheet erosion in Central River State
Source: Researchers personal field photograph

Photo 4.Gully Erosion in Imo State
Source: Researchers personal field photograph

Photo 5.Gully erosion in a farmland in Taraba State
Source: Researchers personal field photograph

Photo 6.Gully in abandoned farmland in Anambra State
Source: Researchers personal field photograph

The two extremes change to land resource that is easily physically observable are deep gullies which have happened at faster rate than previous in the southern part of Nigeria (flowing from the information gather from local residents), and the drier and harder soil/land in Northern part of Nigeria. The eroded soils have also been deposited in lower areas and in depressions and this makes the movements of mechanical aggregates (farm machinery) to become much more difficult. Deep devastating gullies are common features in the southern part of Nigeria.

There is need to urgently intervene with irrigation and drainage projects to contend with the dryness and flooding respectively. Other works such as land levelling, terracing, relay farming, mulching, strip cropping and incorporation of organic matter followed by light compression and avoidance of bush clearing by burning. The use of varieties of crops that are high water consuming and are needed to help in mitigating the effect of increased rainfall on land. No tillage or minimum tillage practice can also go a long way at helping the top of the land to remain cohensive and have greater strength to withstand light flood erosion. A drip from the roof of house neglected over a long time can eventually result in the formation of devastating gully.

Conservation measures have to be adopted (being never too early) and these include contour ploughing, strip cropping, the extended use of manures, the planting of new grasses such as vertiva grass, and soil binding leguminous plants, the transference of land from arable to pasture, the encouragement of mixed farming and the planting of trees, and most essentially **the erection of small dams across rain-carved gullies**. These measures have worked in advanced nations of today (United State of America and Europe) in their early developmental stages, and Nigeria can not be an exception except we have resolved to be indolent to be doomed.

The elimination of bush/land clearing by burning will eliminate the destruction of soil particles binding substances in the soil as a result of heat. The destruction of these substances often make the soil particles friable and therefore standing out individually at the detriment of their consistency and ability to withstand wind and water erosion.

CONCLUSIONS

Climate change is indeed a serious challenge to sustainable land resource management in agriculture and the extension of farm mechanization to the farther north and south of Nigeria. This challenge will worsen as time passes if the government at all levels do not change from their present non-challant approach to energetic mobilization of huge capital, skill and expertise (without tribal and religious sentimentality), and conscientious understanding of the pivotal position of capital and expertise in the success of well intended programmes of development. It is only hoped that the Federal Ministry of Agriculture and Rural Development implementation of a three phase “Nigeria Strategic Investment framework for sustainable Land Management (NSIF-SLM) aimed at promoting a multi-sector cooperation to reduce the risk posed by climate change on the livelihood of local farmer and ensuring the productive utilization of the nation’s resources would achieve the desired results and not fail like other projects by governments in Nigeria.

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