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**Review article**

## Mitigating the effect of climate change on Nigerian agricultural productivity

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### ABSTRACT

Advances in technology in addition to natural and other anthropogenic factors exacerbate global warming and triggers climate change. Climate changes have serious repercussion on rainfall pattern of a place and on other micro and macro factors on which agricultural production depends. Nigerian system of agricultural production is still outmoded and immensely depends on natural rainfall together with other climatic factors, and is therefore vulnerable to climatic changes. This paper examines the possible factors effecting climatic changes of the country and advances measures that could mitigate its impacts on the sector. The factors identified include deforestation, overgrazing, gas flaring, land clearing, bush burning, and measures advocated are selection of livestock's and crops that will adapt easily to the climate regimes of the country; use of drought resistant crops, healthy seedlings, and disease resistant animals and crops; adoption of practices to minimize CO<sub>2</sub> emission/ climate change; legislative acts that will minimize gas flaring, bush burning, excessive land clearing, among others.

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### 1. Introduction

Farming methods are influenced by the environment of a place. Agricultural production in Nigeria immensely depends on natural rainfall and this makes it vulnerable to climatic change. Therefore, any pronounced change in climate will have direct impact on the nation's agricultural productivity. For instance, a rise or fall in temperature

either will lead to increase or decrease of agricultural output depending on crop and cultural practices. The poultry epidemic in the south-west regions of Nigeria in 2004 was due to environmental heat stress associated with climate change (Adefolalu, 2004).

Livestock keeping and crop farming are vital pursuits in Nigeria. They provide food for the country's 160 million people and employs circa 70 % of its working population. Agriculture accounts for about 40 % of the country's Gross Domestic Product (GDP), although it contributes only about 4-10 % of the value of the country's exports (Ogbulafor, 2000). This low export figure is because much of the produce from the sector is utilized or consumed locally, and mineral oil assumes a dominant position in the country's exports.

Nigeria is in the tropics and its land mass consists largely of a low plateau of about 600 metres above sea level. The plateau surfaces are dotted with numerous hills, while low-lying region of swampy and coast characterise Nigeria's Delta areas (Iloeje, 1980). In the North, Nigeria has boundary with the Sahara Desert, and by the Gulf of Guinea in the South. Lying wholly within the tropics, therefore rainfall determines the rhythm of its economic activities. The farming calendar in various parts of the country is determined by the incidence and pattern of rainfall distribution as well as the length of the rainy season.

The rain-bearing South-West monsoon winds greatly influence Southern Nigeria. The far north by contrast is under the influence of the north-east trade winds from the Sahara Desert. It is therefore hot and dry for most part of the year and can only support open savannah vegetation.

## **2. Climate and vegetation**

The climate and vegetation of Nigeria on which agricultural production takes place are varied. This is because the distance from the South to North of the country is very great and it therefore, covers many of the climatic and vegetational belts of West African.

The sun's apparent journey north and south of the equator and a number of local factors, such as relief, the ocean current, the distribution of land, sea and ocean and man's activities combine to add some variations to Nigerian climate and weather pattern.

## **3. Elements of climate**

While climate refers to the average weather conditions of an area over a long period, weather, however, is the word used to describe the day to day change in the conditions of atmosphere. The chief elements of climate and weather are rainfall, temperature, winds, but humidity, pressure, and cloud cover are also important. These elements however, vary from place to place and at various times of the year.

## **4. Climate change, greenhouse effect and ozone layer climate change**

Nigerian ecosphere is large and complex, and subject to sudden and violent fluctuations. The weather is yet another many-body problem, and when such a problem has to deal with nearby-invisible bodies it becomes a daunting one to tackle. Climatic change is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years (IPPC, 1995; Wikipedia, 2011).

Climate change is response to changes in the global energy balance. Many factors such as solar radiation, greenhouse gases, volcanic eruption, changes in ocean temperature, and natural variations in the earth's rotation are responsible for climate change (Mayer, 2001).

## **5. Solar radiation**

Solar radiation comprises of a spectrum of electromagnetic wavelengths of three types of which is the force that energizes photosynthetic primary products, ultraviolet (UV) rays, and the infrared rays (IR) or heat rays.

As sunlight passes through the earth's atmosphere, about 30-36 % of its energy on average is scattered and reflected back into space by cosmic materials, clouds and parts of the earth's surface itself especially ice sheets, glaciers and oceans (Playfair, 1979). The remaining 64-70 % is absorbed by the troposphere and by the vegetation, soils, rocks and surface water, as in Fig. 1.

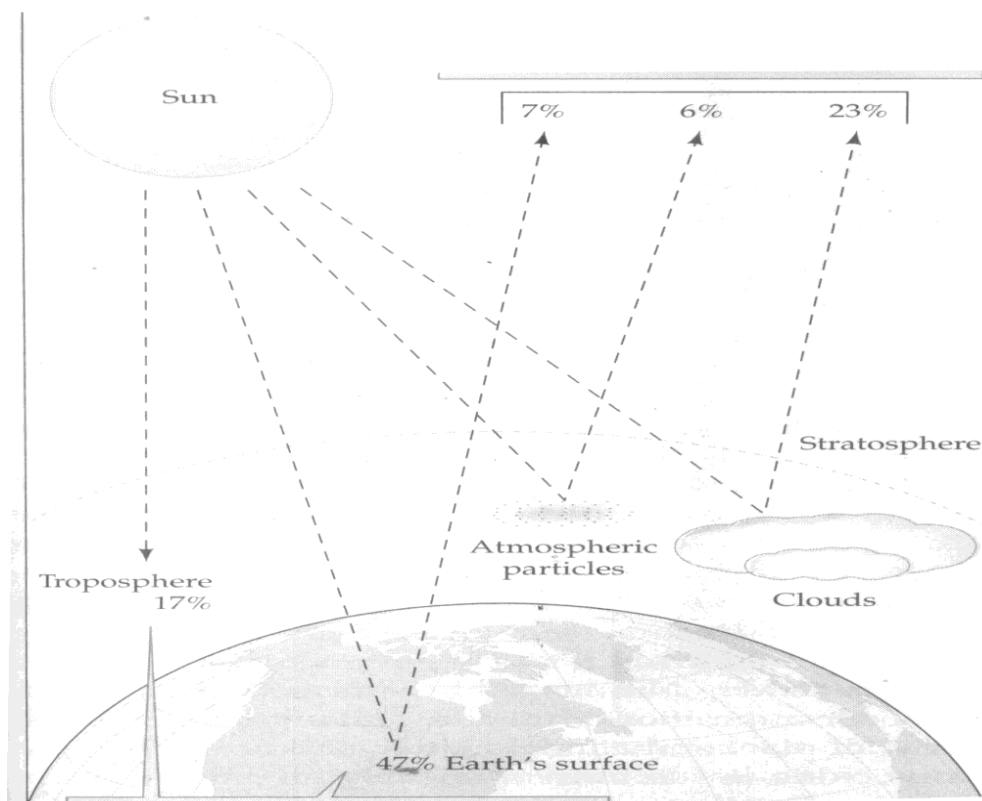
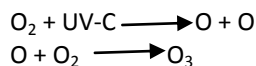


Fig. 1. Dispersion of solar radiation (Source: Mayer, 2001).

## 6. Greenhouse effect

Joseph Fourier discovered greenhouse effect in 1824. He observed that atmosphere captures and re-cycles energy emitted by the earth surface and this is the defining characteristics of the greenhouse effect. Solomon *et al.* (2007) defined greenhouse effect as a process by which thermal radiation from the planetary surface is redirected in all directions. Thus, solar radiation at higher frequencies of visible light passes through the atmosphere to warm the planetary surface which then emits the energy at lower frequencies of infrared thermal radiation. Infrared radiation absorbed by greenhouse gases (36-70 %), carbon dioxide (9-26 %); Methane (4-9 %); Ozone (3-7 %) which in turn re-radiates much of the energy to the surface and lowers temperature. The mechanism that produces the difference between the actual surface temperature and the effective temperature is due to the atmosphere and as known as greenhouse effect.

Earth's natural greenhouse effect makes life possible, however human activities primarily the burning of fossils fuel, clearing of vegetation and bush burning, greatly intensified the natural greenhouse leading to global warming (Solomon *et al.*, 2007). Global warming is being helped by continued increase of carbon dioxide being added to the atmosphere faster than natural sink are capable of removing (Pimentel, 1991; Daniel, 2010; Mbajorgu *et al.*, 2010). The most prevalent atmospheric greenhouse gas is CO<sub>2</sub> and its sources are both natural and anthropogenic (Mayer, 2001). Other greenhouse gases that play prominent parts in global warming are methane, nitrous oxide, chlorofluorocarbons, and ozone. Their molecular structures like that of CO<sub>2</sub> and water vapour allows them to absorb infrared energy and thereby trap heat. The atmospheric levels of all these gases are increasing ozone. Ozone is a naturally occurring form of oxygen (O<sub>2</sub>) whose molecule consists of three atoms of oxygen (O<sub>3</sub>) instead of two atoms of ordinary oxygen. High energy associated with short-wave length UV-C rays splits O<sub>2</sub> molecules in the stratosphere into oxygen atoms (O) individual oxygen atoms formed (Van der Leun, *et al.*, 1998).



Ozone is an occurring gas in the stratosphere and is vital for shielding life on earth from harmful ultraviolet radiation and plays no role in global warming. In the lower atmosphere, ozone formed from photochemical smog, trap infrared radiation and behaves as a greenhouse gas. However certain chemicals in the atmosphere stemming mainly in human activities (anthropogenic sources) are affecting the normal pattern by causing episodes of significant ozone depletion that could threaten life on earth if the problem is not tackled seriously.

### **7. Anthropogenic sources of climate changes in Nigeria affecting agricultural production**

Deforestation, overgrazing, gas flaring, land clearing for agricultural production are some of human activities that seriously affect climate change in Nigeria.

### **8. Deforestation**

Growing demand for food, biofuels and rising population, and poverty are some of the most important factors driving deforestation in Nigeria. Sanginga (2011) reported that an increase in the rate of deforestation, loss of biodiversity and soil degradation are all contributing to cut down farm produce yield in Nigeria's agricultural sector. Plant and animal species help provide benefits such as clean air from forests, watershed for rivers and mangrove which protect coastlines services that underpin economics. Kuta (2011) posited that deforestation can hamper effort to reduce CO<sub>2</sub> emission as forest play key role in mitigating global climate change through carbon sequestration. Forests soak up and lock away large amount of CO<sub>2</sub>, thus helping out as a break on climate change.

### **9. Over grazing**

Lake Chad was the largest of the four Sharan palaeolakes and once estimated to cover about 400,000 Km<sup>2</sup> reported by Drake *et al.* (2006). But today the lake has greatly varied in size. World Lake Database (1983) reported that the lake now covers about 10,000 - 25,000 Km<sup>2</sup>, had a maximum dept of 11 metres and a volume of 72Km<sup>3</sup>. The lakes retreat is blamed largely on overgrazing in the surrounding area; causing desertification and decline in vegetation cover.

### **10. Land clearing for agriculture and other ventures**

Land clearing for agricultural practices also contributes to higher temperatures, decreased rainfall and more droughts. Removal of vegetation damages the microclimate by removing shades and reducing humidity as well as diminishing the capacity of the vegetation to absorb CO<sub>2</sub> (Deo *et al.*, 2009). It also encourages soil degradation and accelerates erosion.

### **11. Gas flaring in the Nigerian Niger delta**

Idris (2009) reported that there are about 606 oil gas fields in the Niger Delta of which 193 are producing. Flaring natural gas (instead of re-injecting them into the soil as practiced in most oil rich countries of the world) from oil fields as a by-product of crude oil production is a characteristic feature of oil exploration and exploitation in the Niger Delta region of Nigeria, which covers about 70,000 Km<sup>2</sup>.

Friends of the Earth (2004) reported that the flares have contributed more greenhouse gasses than all of sub-Saharan Africa combined. This has contributed to climate change, the impact of which are already being felt in the Niger Delta region with food insecurity, increasing risk of disease, and the rising casts of extreme weather damage. The flaring has harmed people, wild life, marine ecosystem and the environment. Farming and fishing have become impossible or extremely difficult in oil affected areas, damage to flora and fauna, drinking water is scarce in the midst of water, malnourishment and disease appear common (Nelson 2006 and Idris, 2010). Recent Bonga oil leak in December 2011 has further heightened environmental degradation in the region.

### **12. Slash-and-Burn System of Bush Clearing**

The slash-and-burn method of clearing land for agricultural practices and the annual setting of the forest on fire at the onset of dry season to speed early growth of grasses for grazing of animals contributes to the build up of carbon dioxide in the atmosphere. This practice adds to global warming (Udo, 1980).

### **13. Use of chemicals in agricultural production**

The use of various chemicals in agricultural product in form of herbicides, pesticides that contain chemical substances that are not environment friendly aggravates environmental pollution.

### **14. Desertification**

Continuous felling of trees without replacement has been frequent and common amongst the rural dwellers. Excessive- cultivation, deforestation are flagrantly practised in Nigeria, and all these promote desert encroachment. Environmentalists have noted that the harmatan which usually lasts from November to March now lasts from January to February. This has serious impact on the climate of Nigeria and has negative consequences on agricultural production in the country, as it promotes frequency and severity of droughts that increase crop failure and subsequent famine. Many streams have dried up and some receding at an alarming rate.

### **15. Air Pollution**

The main cause of air pollution is generally associated with man's industrial and domestic activities which are more noticed in dense urban areas and large emission sources such as refuse burning, burning of forests, industrial and commercial process emission, and fossil fuel burning-producing pollutants such as Carbon, Sulphur, Nitrogen, Chlorine, and Fluorine. Oxidants of ozone (O<sub>3</sub>) and others like peroxyacetyl nitrate (PAN) and hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), organic gases, arsenic, and particulate.

### **16. Effect of changes sea and ocean temperature**

Normal ocean- circulation pattern and temperature are altered when warm and cold ocean current meet. For example, El Nino phenomenon which elevates ocean temperature has been indentified to have been causing significant warming of coastal Pacific Ocean waters leading to catastrophic impacts on marine fisheries driving many species to cooler waters and sometimes causing increased mortality (Mayer, 2001).

El Nino events are also known to have led to torrential spring rains and mudslides in South California and horrific rain, wind, and tornadoes in central Florida. Also La Nina which refers to unusually cold ocean temperatures in the equatorial central and eastern Pacific, have caused sea surface temperature to drop as much as 4 °C (7 °F) This has considerable affect on global weather patterns by causing heavy monsoon rains in India, cool met winters in Southern, above normal rainfall in Australia (Zurer, 1995).

### **17. Volcanoes and climate change**

In greenhouse effect, CO<sup>2</sup> and other gases released by volcanoes absorb and reflect back the heat radiated from the Earth's surface, thus warming it. However, the dust particles and acid droplets released by volcanoes reflect incoming sunlight, thus lowering the Earth's surface temperature. Though the cooling effect of a volcanic eruption are short-lived than its warming effects. Tilling *et al.* (1987) posited that prolonged volcanism over a long periods may have cooled the Earth enough to cause the ice ages and mass extinctions of the past.

### **18. Impact of climate change on agricultural production in Nigeria**

Agricultural production will be mostly affected by the severity and place of climate change, not so much by gradual trends in climate Odigboh (2008) posited that gradual climate change may afford enough time for biota adjustment, while rapid climate change could harm agriculture more especially those that are already suffering from rather poor soil and climate conditions due to less time for optimum natural selection and adaptation.

### **18. 1. Effect of variation in temperature and day length on agriculture**

Duration of crop growth cycles is related to temperature (Okigbo, 1987; Matsushima, 1975). An increase in temperature will accelerate plant development, as the period or duration between sowing and harvesting will decrease. Also, day length is a key factor in breeding of animal breeding especially in sheep.

### **18.2. Effect on hydrological cycle**

Warmer atmospheric temperature may likely lead to more vigorous hydrological cycle, including more extreme rainfall. Erosion, flood, and soil degradation will likely occur. These are bad omen for agricultural crops and fields which could be washed away by flood.

### **18.3. Pest, diseases, and weeds**

Global warming would cause an increase in rainfall which would lead to increase of atmospheric humidity and the duration of the wet season, combined with higher temperature, development of fungal diseases will be encouraged. This has great on both animal and crop agriculture. In Nigerian rainforest zone where there abundances pasture, trypanosomiasis causes a great havoc to livestock industry. Similarly, higher temperatures and humidity could lead to an increased pressure from insects and disease vectors. (Mbajjorgu, et al., 2010)

Temperature rise was attributed to the poultry epidemic in western parts of Nigeria due to associated heat stress (Adefalolu, 2004). While Roessig et al. (2005) reported that rising temperature would affect marine and estuarine fish which include bleached coral reefs, high oxygen consumption rates in fishes.

### **18.4. Measures to mitigate effect of climate change on Nigerian agricultural productivity**

Adoption of various innovations will cushion the effect of climate change on agricultural production, in Nigeria. The following strategies have the prospect to boost the country's agricultural production.

1. Engagement on more irrigation schemes and proper water conservation strategies.

Nigeria is criss-crossed by uncountable rivers and streams, as well as large reservation of ground water that can be utilized for irrigation purposes. This will allow farmers raise crops such as cereals more than once annually, thereby, increasing agricultural productivity without depending much on natural rainfall.

Water conservation strategies must be adopted to reduce erosion and soil degradation. Maintenance of landscapes, revegetation of disturbed soils in dry areas and during periods of inadequate rainfall, and crops should be protected against frost.

2. Selection of crops that will adapt to soil and rainfall regimes of an area. Drought resistant crops, healthy seedlings, and disease resistant crops should be cultivated.

3. Adoption of best cultural practices will increase crops yields.

4. Farm operations should be properly timed especially in those areas where rainfall is erratic and undependable.

5. Re-organisation of agricultural research institutions to be in tandem with modern realities in agricultural sector.

6. Adoption of strategies that will accelerate food processing and storage industries in the country such as infrastructural amenities like roads, rural electrification etc.

7. Adopting policies that will compel rural farmers to accept new innovations in agricultural practices through promotion of capacity building.

8. Strategies that will minimize post harvest losses

9. Adoption of best practices to minimize CO<sub>2</sub> emission that can trigger off climate change. These could be achieved by legislative acts that will minimize gas flaring, bush burning, and excessive land clearing.

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