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Environmental Effects of Chemical Fertilizer Production in Nigeria

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ABSTRACT

The production of chemical fertilizers increases agricultural productivity but it have many environmental effects. These environmental effects take places in natural environment. These environmental effects result in green-house effect, acidification of soil and water ecosystems, and gaseous pollution of the air. Statistical methods are deplored to show the increase in consumption of fertilizers in Nigeria. The water related environment costs are change in quantity and quality of water as a consequence of human activities, contamination with biological and chemical wastes and water related diseases such as malaria, typhoid and cholera. Soil related environmental costs are altering soil constituents. Air related environmental costs are altering the air composition whereas the biological human related environmental costs are the altering of living conditions.

Keywords: **Chemical Fertilizer, Environmental Costs, Green-house Effect, Water Ecosystems, Gaseous Pollution, Soil Acidification.**

Introduction

The environmental costs are the costs which resulted due to the damages done to the environment through harmful substances (Oko-Lexikon, 1994). These costs resulted due to the environmental effects of producing fertilizer by the chemical plants/industries. The effects can be in atmosphere and stratosphere, terrestrial, marine and costal environment as well as fresh water bodies.

Encyclopedia Britannica (1989) stated that environmental effects is created when the addition to the environment of any substance or energy form (e.g. heat) is at faster rate than the environment can accommodate it by dispersion, breakdown, recycling or storage in some harmless form.

Types of Environmental Costs

The types of environmental costs depend on how one uses the criteria to divide them. There are different criteria that can be used to typify environmental costs and they are:

a. Based on two categories of environmental costs, environmental defensive costs, and environmental damage costs. The environmental pollution damage costs are divided into internal and external costs. The environmental defensive costs on the other hand are divided into avoidance, reduction, utilization and disposal costs as shown in table 1. When the environmental effects are new and no measures are taken to internalize them within 5 years (stage 1) it is referred to as external costs (stage 2).

Table 1: Environmental Costs Based on the Two Categories

Environmental pollution costs	Internalized stage 0	External < = 5 years stage I	External > 5 years stage 2	
Environmental defensive costs	Avoidance	Reduction	Utilization	disposal
	Preventive		Usable or disposal	

Source: Matschke, 1996.

b. On environmental pollution damage costs, one can classify them according to the medium where their effects are impacted. They can be water related environmental costs, air related environmental costs, biological/ animal related costs and soil related environmental costs as shown in table 2 below. Effects that are impacted on water are the contamination of water, lakes and rivers. Others are flooding of habitats, salinations, eutrophications, and water temperature changes.

Soil related environmental effects are erosion and the chemical contamination of soil through radioactive and chemical materials, water retention capacity of the soil, soil aggregates, and the effects on the soil flora and fauna. Air related environmental effects are the green house effects, climate change, thermal pollution and acidification of precipitation. Animal/human related environmental costs are the costs of changes in species diversity i.e. reduction in species, treatment costs of illness like stomach cancer, skin diseases, respiratory tract diseases and others.

Table 2: Environmental Costs Based on Pollution Costs, Characteristics and Examples

S/N	**Types of Environment Costs**	**Characteristics**	**Examples of Related Environmental Effects**
1.	Water related environmental costs	1. Change in quantity and quality of water as a consequence of human activities. 2. Contamination with biological and chemical wastes. 3. Water related diseases such as malaria, typhoid and cholera.	Contamination of rivers, lakes and aquifers, eutrophication, salination, water temperature change, altered water chemicals, and stream temperature change
2.	Soil related environmental costs	Altering soil constituents	Removing nutrients more than are replenished, adding toxic material, accelerating erosion, excavating, reducing organic content of soil through burning, harvesting, adding radioactive substances.
3.	Air related environmental costs	Altering air compositions	Climate change, green house effects, thermal pollution, acidification of precipitation, dangerous gaseous emission.
4.	Biological\human related environmental costs	Altering living conditions	Changes in genetic and species diversity, respiratory tract diseases, stomach problems, cancer and extinction of animals, skin diseases, fish migration and flooding of habitat.

Source: Personal Drawing.

Environmental effects caused by production of chemical fertilizers. The environmental effects caused by the production of chemical fertilizers are divided into four sub topics as shown in table 3. They are gas emission, water pollution, thermal pollution and biological effects.

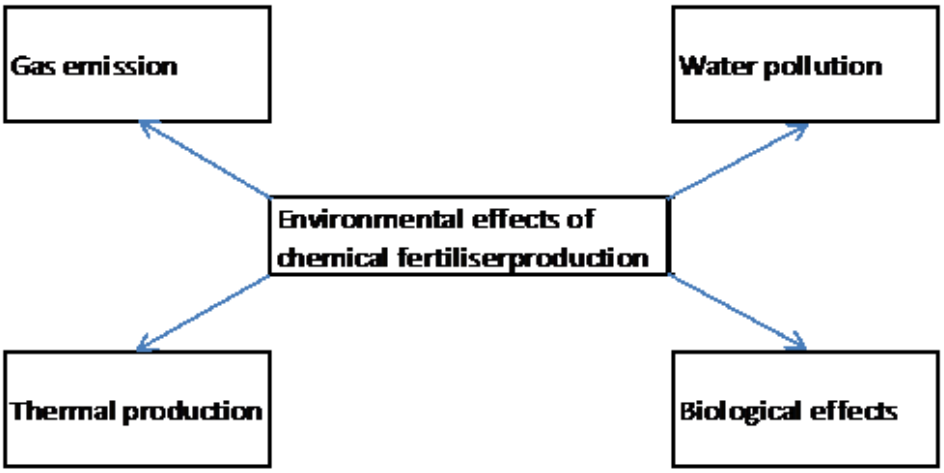

Figure 1: Environmental Effects Caused by Production of Chemical Fertilizer

Environmental Effects Caused by Production of Fertilizers

Gases Emission during Fertilizers Productions (Green-House Effect)

The carbon dioxide emission of chemical industries and other gaseous emission contribute to global warming. Other gaseous emission includes methane, nitrous oxide, sulphur dioxide and water vapour. These gases effect the incoming solar radiation. Since the beginning of industrial age, emission associated with human activities has risen rapidly. Agriculture, industry, waste disposal, deforestation and especially fossil fuel use have been producing increase amounts of CO_2, methane, nitrous oxide and other important gases (Wuebbles *et al.,* 1999). The Wiley Encyclopedia of environmental pollution and cleanup indicated that N_2O is a by product of nitric acid production (fertilizer) as industrial sources. (The Wiley Ency. of environmental pollution and cleanup, 1999).

Carbon dioxide in the atmosphere is virtually transparent to incoming solar radiation but on the other way absorbs outgoing terrestrial infra-red radiation. This radiation supposes to escape to the space and result in the heat loss from the lower atmosphere. As a result, through the mechanism of this green-house effect, low level of CO_2 in the atmosphere would be expected to lead to cooling, and high level would be expected to produce a heat trap. The same thing is applied to levels of methane and nitrous oxide.

Specifically, light and ultra-violet radiations from the sun are able to penetrate the atmosphere and warm the earth's surface. This energy is re-radiated as infrared radiation, which because of its longer wavelength, is absorbed by CO_2, water vapour and other gases. This causes the average temperature of the earth's surface and atmosphere to increase. If the quantities of all substances

in the atmosphere are increased, then the greenhouse effect will become enhance (Hansen *et al.,* 1981).

Water Pollution (Acidification of Soil and Water Ecosystems)

The term acid deposition refers to the transfer to acidic substances from the atmosphere to the surface of the earth and includes a variety of processes that can be broadly classified as either dry deposition or wet deposition (Law, 1993). Soil acidity is caused by a preponderance of hydrogen ions in the soil. The degree of acidity or alkalinity is expressed in pH value.

Excessive rainwater can drain away some dissolved cations, while some will accompany the percolating water which can accumulate in deeper layers below the reach of plant roots. Carbonic acid will ionize to furbish hydrogen ions. These ions could replace the alkali and the alkaline earth ions which are present in the weathering mineral because hydrogen ions are more strongly held by clay adsorption complex than the other cations. These displaced cations wander with the percolating water. This process will lead to a preponderance of hydrogen ions in the soil which will make it acidic. Other acidifying compounds are sulphur dioxide (SO_2), nitrogen oxides (NO_x) and ammonia. In a study carried out by Schmiena (1999), he noted that acidifying compounds such as SO_2 and nitrogen oxide (NO_x) are often produced together, most typically by the burning of fossil fuels. Ammonia (NH_3) causing acidification and eutrophication, is usually emitted by agricultural activities (Schmiena, 1999).

Again, the industrial plants used in production of fertilizers do emit SO_4, NO_x and other gases. These gases in combination with rainfall and spark off through thunders form acidic rain which falls and tend to increase soil acidity.

Thermal Production and Gaseous Pollution of Air

The cooling water of chemical industries is a source of pollution in aquatic environments. According to Encyclopaedia of Environmental Science, thermal pollution (increase in the temperature of water) results in rate of increase of plankton, causing a change in aquatic population. The change of temperature affects fishes which are accustomed to live at a certain temperature range. With an increase in seawater temperature, the oxygen saturation level of water is also decreased, thus the solubility of oxygen in the water is decreased. And with these, the anaerobic conditions are rapidly reached (Encyclopaedia of Environmental Science, 1999).

Thermal pollution processes also involve incineration and combustion. Solid or liquid organic wastes having low water content but high heat values are good candidates for thermal oxidation because they burn hotly enough to sustain the energy these processes require.

In addition, the agricultural practice of burning vegetation and crop residues, such as is done in many parts of tropical Africa, causes the loss in gaseous form of non-metallic nutrients such as carbon, nitrogen, sulphur and phosphorous. Fire also destroys soil organic matters whose colloidal components adsorb many plant nutrients. And those minerals left in the ash are easily carried away by erosion.

Most of the air we breathe is elemental oxygen (O_2) and nitrogen (N_2). About 1% is composed of naturally occurring constituents such as carbon dioxide (CO_2) and water vapour. A small part of this one percent may, however, be air pollutions, including gases and particulate matters (i.e. suspended aerosol composed of soil solids and liquids). Anthropogenic air pollution enters the atmosphere from both fixed and mobile sources. Fixed sources include factories (including the production of artificial fertilizers, electrical power plants, or smelters and farms) while mobile sources include all forms of transportation that burn fossil fuels. Mobile sources account for almost 50% of the pollutants emitted to the atmosphere in the developed countries.

A lost of heat application may be involved in the course of thermal production processes associated with conventional fertilizer industries. This is because chemical reactions and incinerations may be involved at one point or another. The effects of discharging hot water on receiving aquatic systems (surface and underground water) are many. It can cause thermal shock to micro-organisms and this can be lethal also for microorganisms. For many species, the chronic effect of a heat burden can result in death. Life spans can be dramatically shortened (Schmitz, 1996). The reproductive cycles of many species can be change, some species tends to migrate to other areas and elevated temperature can also cause water to hold less oxygen. The human activities, including clearing of land for agriculture and agricultural production systems themselves, have increased emissions of greenhouse gases to the extent that scientists are predicting an average increase in global temperature of 2-4°C by middle of the next century (Duxbury, 1994).

Economically, the pollution of water media will reduce the income of fishers, reduce crop yield and more precipitation may induce more erosion in tropical areas.

Empirical Evaluation

In Nigeria, the consumption of fertilizer is decreasing as shown in table 1.

Table 1: Consumption of Fertilizer in Thousand Metric Tones

	2007	2008	2009	2010
Nitrogen	70.1	140.9	44.9	80.1
Phosphate	39.9	63.8	11.2	10.8
Potash	45.6	78.6	16.1	9.8

Source: UN Statistical Yearbook.

The reason is because some farmers cannot afford the product unless subsidize by the federal and state government of Nigeria. From the three single fertilizers nitrogen, phosphate and potash, nitrogen is still increasing while the potash and calcium is decreasing as shown in the figure 3, 4 and 5.

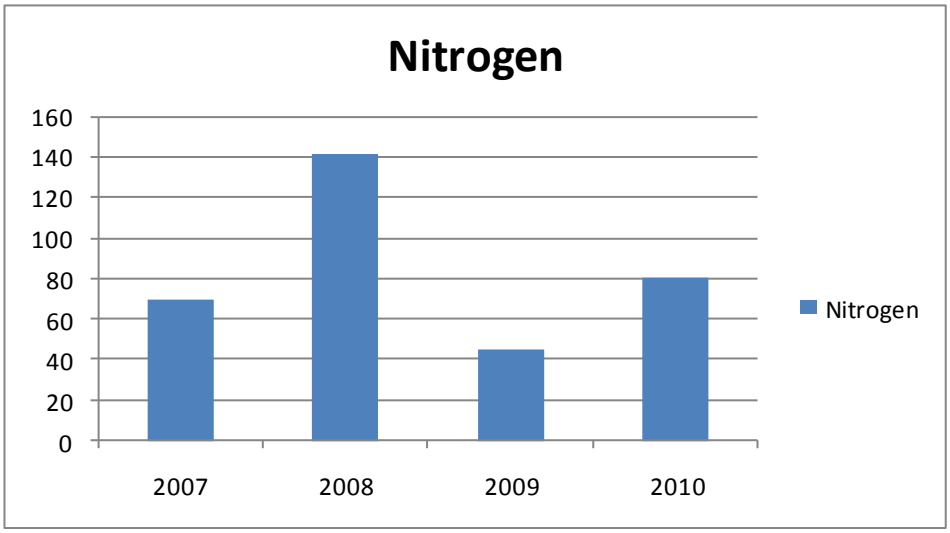

Figure 2: Nitrogen Fertilizer

Source: UN Statistical Year Book

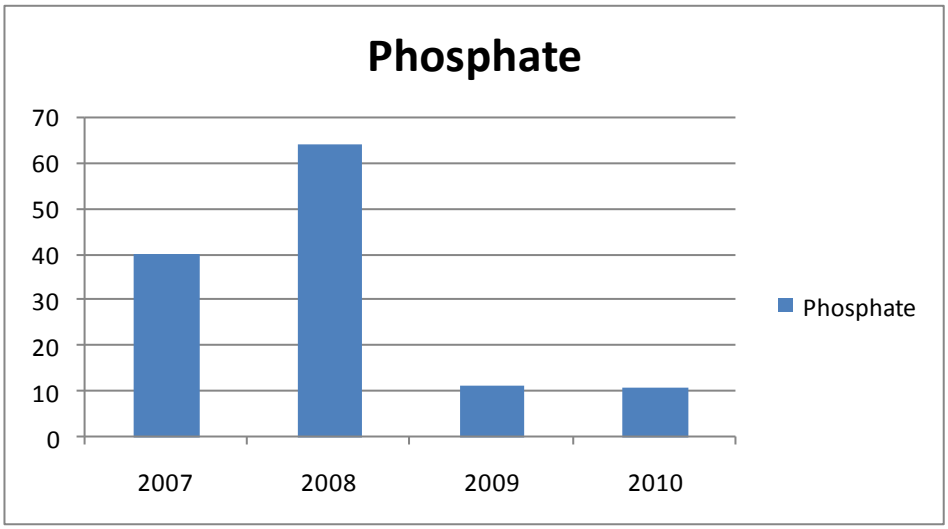

Figure 3: Phosphate Fertilizer

Source: UN Statistical Year Book.

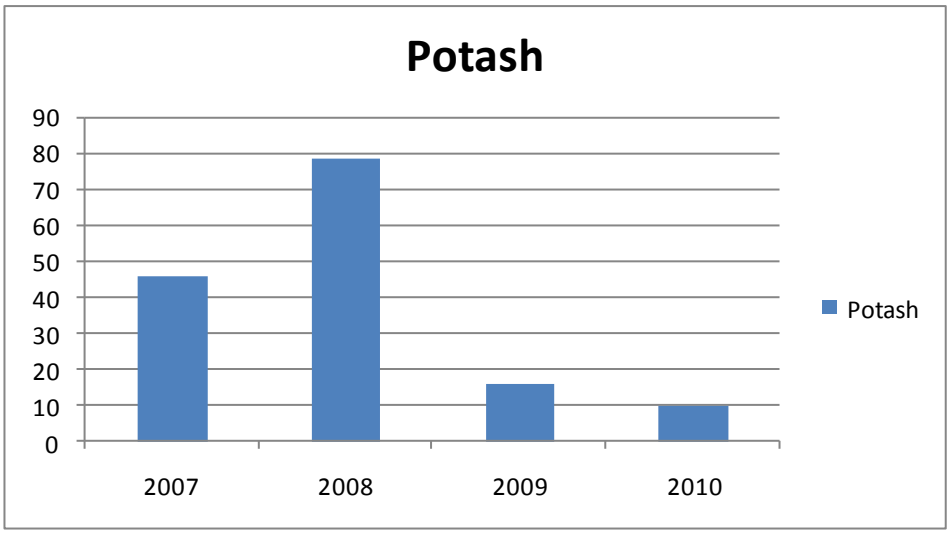

Figure 4: Potash Fertilizer

Source: UN Statistical Year Book

Conclusions

The production of fertilizers by chemical industries is not without environmental effects. These environmental effects took place in different environmental media. The environmental media are the atmosphere and stratosphere, terrestrial, marine and coastal environment and fresh water bodies.

There are gases emissions during the fertilizer production. This can lead to green house effect. Pollution of water which can lead to acidification of soil and water ecosystem is parts of environmental effects of fertilizer production.

Another affect of fertilizers production is that it can lead to thermal production and gaseous pollution of air.

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