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Review article

The Challenge of Agronomists Working in SSA: the use of mineral fertilizers has not been able to solve the problem. A Review

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Abstract

As a matter of fact, indiscriminate use of fertilizers has created a great menace because these products finally find their ways into the food chain therefore having direct implication on human health. The pollution of the lithosphere due to fertilizers is so widespread in the rural areas that in an agricultural country like Nigeria, is almost impossible to control it. It has much other ramification than other kinds of pollution. Therefore attention needs to be paid considerably to mitigate this soil pollution, in the quest to increase the yield of crops and food production. Understanding the effect of modern agricultural technologies on the poor and hungry is important because it belies the primary justification of these technologies. Under natural conditions, low levels of nitrogen limit aquatic algae growth, especially in salty and blackish water, which inhibits N- fixation algae. Increase human input of nitrogen can remove this constraint. The resulting degradation of the aquatic ecosystem; particularly estuaries and coastal waters is undoubtedly the most widespread water quality problem induced by nitrogen pollution.

Key words: fertilizer, eutrophication, runoff, ecosystem, pollution, nutrients

Background

Food security is a major issue in tropical developing nations of the world as a result of unreliable rainfall, marginal soil fertility and low input level, causing declining crop yields (Andraski *et al*., 2003). Efforts aimed at obtaining high yield of crops necessitated the augmentation of the nutrient status (Breuer, *et al*., 2006) of the soil to meet the crop's requirements for optimum productivity and maintain soil fertility. Increasing the nutrient status of the soil is achieved by boosting the soil nutrient (Brady and Weil, 2013) content either with the use of inorganic fertilizers such as NPK or through the use of organic materials such as poultry manure, farm yard manure (FYM) or the use of compost. According to Diels *et al*., (2004), this extended practice in Sub-Saharan Africa (SSA) have left the environment impoverish.

The invention of chemical fertilizers has allowed man to raise soil productivity higher than could be attained under the natural climax vegetation (Lehmann and Rondon, 2006). Many studies of various crops have shown significant yield advantages while applying inorganic fertilizers. However, excessive application of mineral fertilizers has been reported to have deleterious effects on crop growth and yield increase. Therefore, reliance on chemical fertilizers to increase crop yields has generally led to a decrease in soli organic matter and an increase in soil erosion (Dorna *et a/*. 1999).

Effect of acidify fertilizer application

The use of mineral fertilizers alone has not been able to solve the problems of crop production in the tropics due to the adverse side effects of continuous application of acidifying fertilizers (e.g. sulphate of ammonia) on acid soils as revealed from the work of Agboola *at al*. (1975). It was revealed that a research field subjected to 10 years of continuous maize and cowpea cropping and with regular use of NPK fertilizers resulted into a situation where about 75% soil organic matter was lost and exchangeable K reduced by 13% and P content was reduced to one half of the original value.

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Fertilizer utilization efficiency

The fertilizer not recovered by the crop does not disappear; rather, it ends up in the environment (Andraski and Bundy, 2003). One of the primary reasons why chemical fertilizers pollute the environment is that crops use them inefficiently. Less than half of the nitrogen fertilizers applied to the soil is recovered by crops in dry land cropping systems, such as rainfed maize. For wetland agriculture such as paddy rice, the utilization efficiency is even lower, averaging 35% or less (Brady, 2013). Although there are many reasons for this inefficiency, perhaps the most important is that crop-yield response to fertilizers typically obeys the law of diminishing returns. At low levels of soil nutrient, it may increase grain yield by 25 to 50 kilograms, whereas at high nutrient levels, kilograms of fertilizer may only bring about 5 to 15 kilograms yield increase. Because farmers use fertilizers to achieve near-maximum yields, their fertilizer utilization efficiency is very low. As a result, much of the fertilizers remain unused by the plant.

Although the occurrence of extra fertilizer nutrients in the environment is not necessarily a problem, some of these compounds may become pollutants when too much nitrogen fertilizer is applied (Eghball *et al*., 1996 and Rietra *et al*., 2001), for example, it can wind up elsewhere in the environment. While some of the extra nitrogen remains in the soil (it is absorbed by microorganisms and subsequently converted into soil organic matter), some of it gets converted to gaseous forms that escape into the atmosphere. The rest is washed away or percolates down through the soil profile (Edem *et al*., 2013). As long as the amount of nitrogen that enters the environment does little damage, the large quantities of nitrogen fertilizers that are a part of the modern agricultural package have caused residues of nitrogen fertilizers to become pollutants (USDA, 1987).

Water quality problem induced by nitrogen pollution

In Mexico, nutrient-rich (mainly N, but also P and Si) sediments carried by the runoff water from the farmland emptied into the water body (Eghball *et al*., 1996) which sink to the bottom stimulate explosive growth of algae when they die. In decomposing this dead tissue, microorganisms deplete the oxygen dissolved in the water to levels unable to sustain animal life (Brady, 2013). Fish, shrimp, and other aquatic species either migrate out of the zone or die. This state of low oxygen in the water lead to hypoxia (less than 2 to 3 O_2/L).

Concentration of N in Mississippi River have tripled in the past 30 years, were attributed to human activities especially those from agriculture. Critical assessments suggest that only about 11% of N delivered by the rest mainly from farmland runoff and manure. Major efforts are required to help farmers and others improve their N use efficiency and reduce the transformation of valuable nutrient into a pollutant.

Surface water nutrient enrichment

Even-though environmental scientists have traditionally pin-pointed human sewage effluents as the primary contributor of nutrients to surface water (phosphate detergents have been a particular problem). There is recent evidence indicating that in many farmlands, fertilizers contribute a substantial proportion of the total surface water nutrients enrichment. In a recent study of heavy metals from farmlands around Ikpa River Basin (Edem *et al*., 2014), it was reported that water quality problem induced by nitrogen pollution is very severe. Nitrates in runoff water flowing from agricultural farm resulted in the degradation of aquatic ecosystem of coastal water, thereby causing phytoplankton blooms that led to a significant declined in the estuary’s fisheries. They further averred that nitrate-N content assessed in runoff water accounted for 24 % of the nutrients input delivered from farmland into the rivers and streams.

Other estimates (USDA, 1987 and Islami *et al*., 2011) have attributed 50 to 70% of all nutrients that reach surface of the water as derived from fertilizer and animal waste. In South Florida, Rietra *et al*., (2001) reported that nutrient-rich run off from sugarcane plantations caused a rapid change in the native plant of the Everglades. In summary, fertilizer nutrients appear to be responsible for a substantial portion of the nutrient “load’ entering surface water in most cases.

In addition, the movement of soluble nutrient (Nitrogen) compounds from the soils to the aquatic systems can disrupt the balance of those hyperspaces, leading to algae blooms, declining levels of dissolved oxygen, and subsequent death of fish and other species. Yet another way in which nitrogen from fertilizer application links soils to the wider environmental is the ozone-destroying and climate-forcing action of nitrous oxide gas generated in soil.

Conclusion

Years of research and practice have repeatedly demonstrated that, more money and effort are spent on the management of soil nutrients than efficient soil conservation that guarantees food security. And for good reason. But one thing is certain, deficiencies or excesses of nutrient have major impacts on health and productivity of the world’s ecosystem. I therefore conclude that, fertilizer applications in agricultural farmlands can be boon or a curse to the society. If not properly handled it is health hazard. Clearly, soil processes are central to the global nutrient cycle and transport. The ecological, financial and environmental stake could not be higher. The challenge of agronomists working in this region is not to block this necessary evil, but to apply their science and the experiences gained to find ecologically acceptable ways in which this modern input can be integrated in soil conservation measures that guarantee sustainable and profitable farming for economic development.

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