



Institute for Environment and Sanitation Studies

UG.IESS.IB.005

October 2011

Fertilizer Use and Nitrate Contamination of Water Sources.

Background: Modern agriculture is noted for the production of good quality food for consumers. It is well known that fertilizers have played major roles in bringing about increased food production. When nutrients are applied in excess of plant needs, they have the potential to pollute surface and groundwater. Nitrogen applied to the soil as either chemical fertilizer or manure is converted to plant-available-nitrate by bacteria living in the soil. Growing plants consume part of these nitrates. Bacteria in soil can also consume parts of this nitrogen.

Under oxygen limiting conditions, some bacteria use nitrate as a substitute for oxygen and end up converting nitrate-nitrogen to gases such as nitrogen, nitrous oxide and nitrogen dioxide through a process known as denitrification. In soil, nitrate dissolve in soil water and therefore, will be in solution. Nitrate-nitrogen not utilized by any of the above processes may be carried in run-off to contaminate surface water and can also leach out of the root zone of plants and possibly end up in groundwater. This could lead to eutrophication.

Eutrophication: "Eutrophication" is the enrichment of surface waters with plant nutrients. Although the process is a naturally occurring one, it is normally associated with anthropogenic sources of nutrients. Nitrates are important nutrients for algae and phytoplankton growth in aquatic ecosystems.

Discharge of nitrates to surface water bodies however leads to accelerated eutrophication. This could eventually lead to depleted oxygen levels, fish kills, loss of riparian



A pond suffering from excessive algal growth as a result of nutrient enrichment

habitat, death of beneficial aquatic insects and taste and odor problems. In Ghana, contamination of surface and groundwater by nonpoint sources from agriculture has been of great concern to environmentalists. For instance, nitrate levels of water obtained from some bore holes in the Densu basin within the Accra plains have been found to exceed the maximum contaminant level allowed for drinking water. Also, there has been persistent complaints about the quality and cost of treatment of water from the Weija reservoir due to high levels of contamination nitrates and other nutrients.



Proliferation of aquatic weeds in the Volta Lake

Nitrate Toxicity: Once ingested into the human body, nitrates could be converted into compounds known as nitrosamines, which are known carcinogens. Additionally, nitrates could be chemically reduced in the bodies of human infants to nitrites, which reduces the oxygen-carrying capacity of haemoglobin. The current WHO public health standard for safe drinking water requires nitrate levels to be less than 50 mg L⁻¹. When nitrate levels in a public water supply system exceed the drinking water standard, costly measures have to be taken to make the water safe for drinking. Nitrate is present in water as highly soluble salt and standard water treatment practices such as sedimentation, filtration, chlorination or pH adjustment with lime application do not affect nitrate concentration in water. In most cases, specialized water treatment technologies may have to be employed to remove them. This is very expensive and results in substantial increase in water treatment costs.

How to Minimize Nitrate Contamination: Many factors should be considered when determining the vulnerability of water sources to nitrate contamination from agricultural practices. Nitrate contamination of surface and ground water depends upon climate, fertilizer or manure management, soil, crop, and farming systems. An area with rainfall exceeding evapo-transpiration often leads to the movement of rainwater to groundwater. The excess water that

Since nitrates are highly soluble salts, water moving on the surface of a soil dissolves some nitrates that are present in the surface layers of the soils. In areas where commercial or intensive agriculture produces serious risks of nitrogen pollution, the following measures should be noted.

- Nitrate leaching may be greater when nitrate fertilizers are used compared to the situations where ammonium containing fertilizers are used.
- Apply nitrogen fertilizers in split applications rather than one or single application.
- Avoid over-fertilization by calculating the nitrogen application rate on the basis of the "crop nitrogen balance". This takes into account plant needs and amount of nitrogen in the soil.
- Keep the soil covered with vegetation as much as possible. This inhibits the build-up of soluble nitrogen as the vegetative cover absorbs mineralized nitrogen and minimizes leaching and high nitrate levels in run-off during periods of rain.
- Nitrogen fertilizers applied on sandy soil are more vulnerable to leaching to groundwater than nitrogen used on a clay soil.
- Crops that have high nitrogen requirements or tend to be inefficient in nitrogen use are more likely to aid in nitrate leaching.

References and Further Reading

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