SOLVING THE NITRATE POLLUTION PROBLEM

by Sharon Forrest

A woman walks over to the sink to add some tap water to her baby's formula. About half-way through the feeding, the mother watches in horror as the pink-white skin of her child rapidly becomes a lurid blue. She rushes to the phone to call Emergency. An ambulance arrives just in time to give the baby oxygen and save its life, but brain damage is still a possibility.

The villain in this case is nitrate - a major component of plant **fertilizers**, and an increasingly prominent source of water pollution.

Nitrate itself is not lethal. But once it gets into a living organism, certain **enzymes** change nitrate to nitrite. In addition to being linked to cancer, nitrite can damage **hemoglobin**, the oxygen-carrying constituent of blood. "Nitrite alters hemoglobin so that it is no longer able to transport oxygen in the body," says Donald Smith, Professor of Plant Science at McGill University.

The result is equivalent to being smothered-from the inside. Human infants under three months of age are the most vulnerable to this type of poisoning. Infants have special fetal hemoglobin which is particularly sensitive to the action of nitrite. The "blue baby" scenario described above has been documented in dry, agricultural areas which use well water.

Nitrate-containing fertilizers are used by farmers and gardeners everywhere. It used to be that nitrate water pollution was of little threat to Canada - a country which has nine percent of the world's fresh water supply. But with global warming and intensive use of fertilizers, nitrate pollution may become a big problem in the twenty-first century, according to a recent report by the Science Council of Canada.

Nitrate Linked to Cancer and to Algal Blooms

Living organisms, including humans, will be the ones to bear the brunt of fertilizer-induced damage to the environment. In addition to damaging hemoglobin, nitrites can undergo conversion to N-nitrosocompounds, which have been linked to cancer.

On the larger scale, nitrates and phosphates (also from fertilizer) are the two major constituents of chemical fertilizers contributing to the eutrophication of lakes. Eutrophication means the nutrient level of lake water is increased to such an extent that the population of algae dramatically increases (algal bloom). When these algae die, they are decomposed by bacteria—a process which requires oxygen. The oxygen in the water is then rapidly depleted, resulting in the death of fish and other aquatic life.

Over-fertilization makes it necessary for farmers to use more **pesticides**, which also damage the environment. "The reason we have to use **herbicides** (weed-killers) is because nitrate-containing fertilizers are vastly over-used," says Stuart Hill, Professor of Ecological Agriculture at McGill University.

"Mixtures of fertilizers and pesticides do not make a happy couple," he adds. Certain fertilizers, when combined, do more damage to the environment than others applied separately.

Seemingly unrelated factors such as deforestation also contribute to nitrate pollution. In one American study presented in the March 1989 issue of *Technological Review*, removal of trees caused the field run-off to increase by two to

Vocabulary

fertilizer

enzyme

hemoglobin

eutrophication

pesticide

herbicide

organic fertilizer

rhizobia

eight times. In a heavily cultivated area, nitrate pollution would also be increased proportionately.

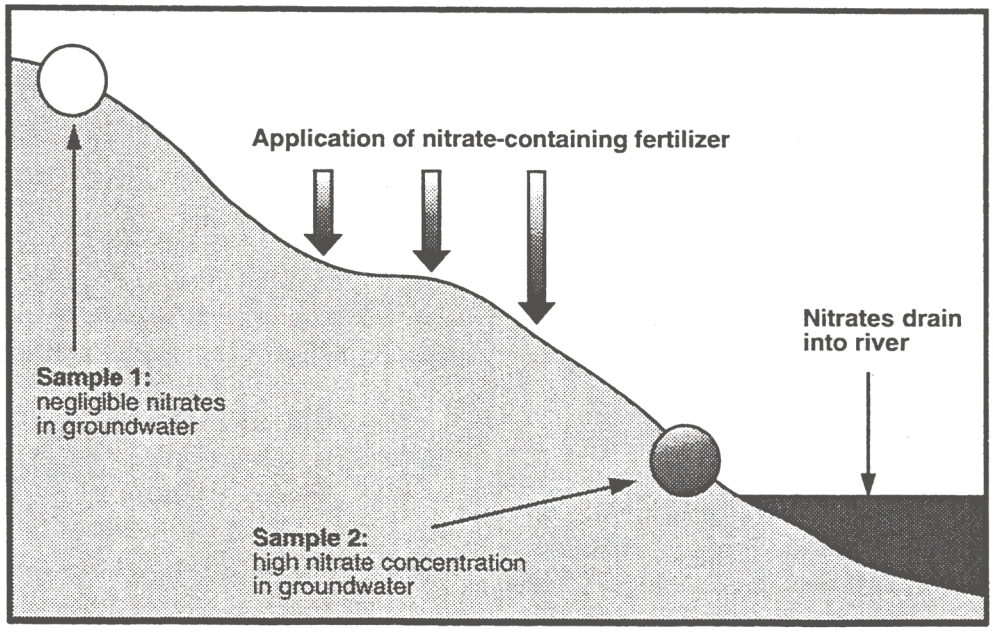
Nitrate Removal Prohibitively Expensive

Awareness of the problem of nitrate pollution is one thing, but actually doing something about it is another. In Denmark, a nitrate and phosphate removal plan has been set up, but this type of last-ditch implementation is prohibitively expensive.

Agriculture Canada wants to avoid the trouble before it happens by replacing chemical fertilizers with something else. Organic or "natural" fertilizers such as manure or compost were once considered to be the solution. However, some so-called **organic fertilizers** can be just as harmful as chemicals. "When organic fertilizers are broken down in the soil, the nutrients they release are rapidly converted to nitrate by bacteria. Therefore, the application of high levels of organic fertilizers brings about the same problems as chemical fertilizers," says Professor Smith.

"The change away from chemical fertilizers will have to be long term and subtle," says Charles Crober, Associate Director of the Fertilizer Division of Agriculture Canada. According to Crober, much of the movement from chemical to more natural fertilizers has not progressed beyond the level of research.

Many scientists domestically and internationally are examining pre-Green Revolution methods of crop fertilization. Rotating or growing different crops together are two traditional approaches currently being studied by Agriculture Canada and McGill's Macdonald College. "If crops are grown in combination with legumes (soybeans, for example), it increases the nitrogen content of the soil and adds organic matter, leading to a higher retention of water and nutrients," says Crober. He admits that mixing crops is as yet not suitable for large-scale commercial production. According to Smith, however,



Nitrates from fertilizer leach into groundwater and are washed into rivers and lakes.

this will soon be changing.

Bacterial Fertilizers

Bacterial nitrogen fixation is another alternative to chemical fertilizers now under scientific scrutiny. Eighty percent of the Earth's atmosphere consists of nitrogen, in a form unusable to plants. Certain bacteria known as **rhizobia** are able to convert (fix) atmospheric nitrogen into a rough equivalent of nitrate, and they do it inside the plant.

Soil rhizobia infect the roots of certain types of plants and together they construct root nodules in which the "natural fertilizer" is made. Other crops, when grown in the same area as nodulated plants, benefit from diffused "organic nitrogen" produced by living and dead nodules.

Agriculture Canada has an on-going program aimed at developing better strains of rhizobia which make greater amounts of fertilizer for the plant. Unfortunately, this biologically produced fertilizer is limited to legumes—a group of plants which includes soybean, alfalfa and clover. Agriculturalists aspire to put fertilizer-making nodules on the roots of corn, rice and wheat plants, which make up 70 percent of all crops grown in the world. According to Smith, biological nitrogen research is moving into these cereals. Progress is slow, however, due to the highly complex nature of the plant-bacteria interaction.

This article originally appeared in the Fall 1988 issue of the Pugwash Papers.

Further Reading

Heaton, Greg, "Hormone Deficiency", *Alberta Report* v.17, no.23, May 21, 1990, p.30.

Barash, Leah, "Making Your Yard Less Toxic", *International Wildlife* v.20, no.4, Aug. 1990, p.29.

Vocabulary

Use a dictionary (or encyclopedia) to find the meaning of the words or terms in the vocabulary column.

Checkback Questions

Answer the following questions after you have carefully read the article:

1. In what ways is nitrate dangerous to living organisms?
2. Why are human infants particularly vulnerable to nitrate poisoning?
3. How does nitrate get into our water supply?
4. How do nitrates and phosphates damage lakes?
5. Organic fertilizers can be just as harmful as chemical fertilizers. Why?
6. What method can farmers use as a substitute for using fertilizers?
7. How do rhizobia help plants?
8. Why is it so important to get rhizobia to make nodules on corn, rice, and wheat plants?

Follow-up Questions & Library Research

a. How does crop rotation work? Give examples.
b. Have chemical fertilizers increased agricultural production in Canada? Find some statistics to support your answer.