

## The Nitrogen Cycle: Essential, Complicated, and Altered by Man

Mother Nature, unlike humans, recycles everything. Just how various things are recycled is illustrated by the Water Cycle or Hydrologic Cycle, the Carbon Cycle, the Nitrogen Cycle and the Phosphorus Cycle. Every farmer and every successful gardener needs to know something about these natural cycles. I have written about the water cycle before, and will discuss the carbon cycle in a later column.

Other than water, the most commonly limiting component of plant growth is nitrogen. This may seem strange, since almost 80% of our air is nitrogen and it is one of the more common elements. But the nitrogen in the air, molecular nitrogen, ( $N_2$ ) is relatively inert and cannot be utilized by either plants or animals to satisfy their requirements for this essential element. (Nitrogen is necessary for amino acids, proteins, nucleic acids, DNA, chlorophyll and numerous other components of our bodies and plant tissues.)

I wrote earlier about legumes, plants that have associated with their roots bacteria called rhizobia that have the ability to “fix” nitrogen. That is, to convert molecular nitrogen into forms that plants can take up and use to make nitrogen-containing compounds. In addition, there are nitrogen-fixing bacteria in healthy soil. These nitrogen-fixing bacteria are the first step in the nitrogen cycle, and they convert molecular nitrogen ( $N_2$ ) into ammonia ( $NH_3$ ).

Other bacteria in the soil then convert the ammonia into nitrates ( $NO_3^-$ ), which is the form plants can best use.

Animals then obtain their essential nitrogen-containing nutrients from these plants when they eat the plants, or from animal tissues when they eat animal products. When we digest either animal or plant proteins, these proteins are broken down into their constituent amino acids and then reassembled into proteins for our bodies.

When animals eliminate waste this material contains high levels of nitrogen-containing compounds. And when plants or animals die, their tissues contain nitrogen in many forms. Another group of bacteria and other simple organisms, called detritivores, then decompose this plant and animal material and make the nitrogen contained in these materials available for new plants to take up.

Finally, some nitrogen-containing materials in the soil are converted back to molecular nitrogen and it returns to the air, thus the cycle continues.

This nitrogen cycle has been in existence for millions of years, altered only by the relative numbers of plants, animals, bacteria, etc. But humans have significantly changed the cycle in the last 100 or so years since the discovery of the Haber process for artificially (chemically) converting molecular nitrogen into ammonia, and the

subsequent conversion of ammonia into urea and ammonium nitrate, all “chemical” fertilizers now made on a huge scale. The tragic explosion in West, Texas a few years ago was at one such facility. (As a chemist I dislike the use of the term “chemical” in that way—all matter is chemical, and the nitrogen-fixing bacteria process is certainly chemical.)

Modern agriculture, and the ability to feed as many people as we do, world-wide, is largely attributable to the use of nitrogen-containing “chemical” fertilizers. Unfortunately, the use of manufactured fertilizers has been and is still being greatly overused, and much of these highly-soluble fertilizers, instead of being recycled, are washing away from the farm fields, golf courses, and suburban lawns and into our creeks and rivers and into the ocean.

This causes lakes and parts of the ocean to grow vast quantities of algae because of the fertilization effect. The algae then dies and the decay process of the dead algae then uses up the dissolved oxygen in the water, killing fish and other marine organisms in a process called eutrophication. The “dead zone” in the Gulf of Mexico off the Louisiana and Texas coasts is one example.

I read an astonishing statement in a recent National Geographic magazine that, “Almost half of the nitrogen found in our body’s muscle and organ tissues started out in a fertilizer factory”.

One of the goals of “organic farming” is to eliminate the use of “chemical” fertilizers and instead rely on recycled nitrogen in the form of compost made from animal and plant waste and a more extensive use of legumes to fix nitrogen the natural way. We can help by doing essentially the same thing in our gardens and lawns. Native plants, having evolved before man-made fertilizers existed, do not need any “chemical” fertilizers. Collecting lawn clippings and throwing them away is throwing away nitrogen.

Until next time...

Jim Stanley is a Texas Master Naturalist and the author of the books “Hill Country Ecology,” “Hill Country Landowner’s Guide” and “A Beginner’s Handbook for Rural Texas Landowners.” He can be reached at [jstmn@ktc.com](mailto:jstmn@ktc.com). Previous columns can be seen at [www.hillcountrynaturalist.org](http://www.hillcountrynaturalist.org).