Story by Alejandra Arreola-Triana

GROUNDWATER NITRATES IN THE SEYMOUR AQUIFER: PROBLEM OR RESOURCE?

In the Rolling Plains of Texas, the Seymour Aquifer is the major source of water for Haskell, Jones and Knox counties. The water from the Seymour Aquifer, however, contains nitrate levels that often exceed the federal safe drinking water standard of 10 milligrams per liter of nitrate-nitrogen. Scientists at the Texas A&M AgriLife Research and Extension Center at Vernon and the University of Texas Bureau of Economic Geology are working on ways to manage the nitrate levels in this aquifer.

Tracking the source

Nitrates in groundwater can come from runoff, fertilizer use, leaks from septic tanks, sewage and erosion of natural deposits, according to the U.S. Environmental Protection Agency (EPA).

Nitrates can also come from plants—legumes such as mesquite, alfalfa or bluebonnets—that contain nitrogen-fixing bacteria in their roots. Plants use only the exact amount of nitrates needed, and no more. What remains in the soil eventually ends up in the groundwater.

Dr. Bridget Scanlon, senior researcher at the Bureau of Economic Geology, is working with AgriLife Research scientists on the *Groundwater Nitrogen Source Identification and Remediation in the Texas High Plains and Rolling Plain project*. The aim of this project is to understand how nitrates move through the soil and how they can be managed to improve water quality in underlying aquifers.

"I am looking at the fate of nitrates in the High Plains as an analog for the Seymour Aquifer," Scanlon said. "Previous studies by the Bureau of Economic Geology suggest that 75 percent of the nitrogen found in the soil is associated with initial cultivation.

"In the Texas High Plains, some of the nitrates come from organic nitrogen that was in the soil before the land was cultivated," she said.

Clearing native vegetation and tilling the land for cultivation changes the structure of the soil and aerates it, she said. This increases the soil wetness and oxygenation, which turns organic nitrogen into nitrate. After cultivation, under both dryland and irrigated conditions, increased water movement through the soil causes the highly soluble nitrates to enter the aquifer below.

To track the source of nitrates in the Seymour Aquifer, Scanlon applied a bromide tracer on the land's surface and will drill boreholes this winter to see how deep the bromide has traveled. "This will give us an idea of how rapidly water moves through

the soil and how long it takes for the aquifer to recharge," she said.

According to the U.S. Geological Survey, the Texas High Plains south of Lubbock and the Rolling Plains are particularly vulnerable to groundwater contamination because of their well-drained, sandy soils, higher percentage of croplands than grasslands, and high nitrogen inputs from agriculture. Agricultural regions have the highest levels of groundwater nitrate pollution. "Nitrate is the most widespread contaminant in groundwater in Texas and in the United States," Scanlon said.

And in the Rolling Plains, nitrate concentrations in the groundwater are rising.

Rising concern

The Seymour Aquifer has always had high groundwater nitrate levels. Records show that the water from the aquifer already exceeded recommended nitrate concentrations in 1936, before the use of nitrogen fertilizers became widespread. The reason why the aquifer has such high concentrations of nitrates is still unknown.

According to Dr. Srinivasulu Ale, AgriLife Research geospatial hydrologist at the Vernon center, and his postdoctoral research associate, Dr. Sriroop Chaudhuri, the high nitrate levels can be attributed in part to the Rolling Plains region's soil characteristics.

"Basically whatever you throw on the ground will soak in pretty fast," Chaudhuri said.

This region is a recent geological formation composed mostly of sand and gravel, and the high porosity and water conductivity of these soils favor groundwater movement.

Ale and his team studied the long-term trends of nitrate groundwater contamination across Texas and recently published their results in the *Journal of Environmental Quality*. The team analyzed 213 wells from the Seymour Aquifer and found that "over the past 50 years, the concentration of groundwater nitrates has been increasing in the Rolling Plains region," he said.

According to Chaudhuri, the rising nitrate levels in the Seymour Aquifer can be attributed to several factors, including the soil's characteristics, the nitrates naturally present in the soil and in the irrigation water, and nitrates used in agriculture. "We found that irrigation with high-nitrate groundwater coupled with nitrate fertilization is one of the major pathways through which nitrates enter the aquifer."

Regardless of the source, the nitrate levels in the Seymour Aquifer are still increasing. "All I can say is, any contaminant rising eternally is quite aggravating to our environment," Chaudhuri said.

But, according to Ale, a possible solution exists.

"The implementation of best management practices on a large-scale could reduce the amount of nitrates leaching to the groundwater and thus improve groundwater quality," Ale said, "but it is a slow process and it may take several years before we see improvement."

Putting nitrates to work

AgriLife Research environmental soil scientist Dr. Paul DeLaune is exploring one of these best management practices.

Last July, Ale and DeLaune welcomed members of the Rolling Plains community to the Chillicothe Research Station to discuss a technique that allows producers to take advantage of the nitrates already available in the Seymour Aquifer. They call this method nitrogen crediting.

"With nitrogen crediting, producers take the nitrate in irrigation water into account (when fertilizing their crops)," DeLaune said. "By using the nitrogen that is naturally available, a producer can reduce the use of commercial fertilizer."

At the field day, DeLaune showed the results of his demonstration. When taking into account the nitrogen in the groundwater, fertilizer applications were reduced by 73 percent in furrow irrigation and 42 percent in pivot and subsurface drip irrigation, without affecting crop yields. In some cases, nitrates in the well water provided more than enough of the crops' nitrogen needs.

Applying less nitrogen fertilizer to the crops could mean significant monetary savings to the producers, DeLaune said.

"The average nitrate concentration in the Seymour Aquifer is 13.5 milligrams per liter," he said. "If a producer applies 12 inches of this water, he is applying 37 pounds of nitrogen per acre. If nitrogen costs $0.79 per pound, then the producer will save $29 per acre."

In addition to the economic incentives, nitrogen crediting also offers an important ecological benefit.

"Accounting for this available nitrogen in irrigation water has the potential to reduce nitrate levels in local groundwater resources," DeLaune said. "Properly managing what we can control, with nutrient management and nitrate crediting, will only aid in protecting our water resources."

The *Groundwater Nitrogen Source Identification and Remediation* project is managed by the Texas Water Resources Institute and funded by the Texas State Soil and Water Conservation Board through a Clean Water Act grant from the EPA. To learn more about the project, visit *groundwatern.tamu.edu.*

Some information from news releases.

Through nitrogen crediting, producers can take the nitrate in irrigation water into account when fertilizing their crops, including cotton. Photo by Lucas Gregory