Story by Kathy Wythe

Turning a negative into a positive

Researchers find promising use for excessive nitrate

For 30 years, farmers in northwest central Texas have known that high level of nitrates in irrigation water from the Seymour Aquifer is a problem. Now, with research conducted by Texas AgriLife Research scientists, that problem may turn into a benefit.

Nitrate is the most common chemical contaminant in groundwater. For the Seymour, a shallow aquifer underlying about 300,000 acres in 20 counties, more than 50 percent of groundwater nitrate measurements exceed the federal drinking water standard of 10 parts per million, according to Texas Water Development Board data.

Although that level is too high for drinking water, AgriLife researchers recently found that excess nitrate in irrigation water can be a source of nitrogen for crops in place of fertilizer.

"Water in the Seymour that is high in nitrates and does not meet water quality standards for domestic use can be considered a valuable resource for agriculture," said Dr. John Sij, professor at the Texas AgriLife Research and Extension Center at Vernon.

Sij and AgriLife Research scientists Dr. Cristine Morgan and Dr. Paul DeLaune have studied nitrates levels in irrigation water from the Seymour Aquifer for three years.

Sij said 90 percent of the water pumped from the Seymour in Knox, Haskell, Baylor, Wichita, Wilbarger, and Fisher counties is used for irrigation.

Based on estimates prepared by DeLaune, each part per million of nitrate/nitrogen in irrigation water will add 0.23 pounds per acre of nitrogen for each inch of water applied. ⇨

Dr. Cristine Morgan, Texas AgriLife Research soil scientist, takes soil cores for nitrate analysis before the drip irrigation system was installed.

"Assuming the irrigation water has a 20 parts per million nitrate concentration and 12 inches of irrigation water per acre is applied over the growing season, approximately 55 pounds per acre of usable nitrogen can be applied to a cotton crop," said DeLaune, assistant professor at the Vernon center. "This is more than the nitrogen requirement for a bale of cotton. At nearly $1 per pound for fertilizer nitrogen this past year, 55 'free' pounds of nitrogen can add up to significant cost savings for producers who irrigate their crops with high nitrate groundwater.

"It is important to note that other nutrients like potassium and phosphorous must also be adequate to take full advantage of nitrates in the irrigation water and any applied fertilizer nitrogen," he said. "Nitrate crediting is a sound economic and agronomic practice. By taking credit for the free nitrogen in irrigation water, farmers may be able to reduce nitrate in groundwater while maintaining yields and realizing significant financial benefits over time."

"We don't know what percentage of the nitrate is geologic in nature or what percentage is due to farming operations," Sij said. "But if we take it into consideration in our fertility programs, we can mine the nitrogen and use it as a resource."

"Producers should have their irrigation water analyzed for nitrate annually and make allowance for this free nitrogen source when determining crop fertilizer needs," DeLaune said.

The researchers compared the amount of nitrate in water from center pivot and subsurface drip irrigation systems. Subsurface drip irrigation systems provide water and nutrients directly to the plant root zone by applying small amounts of water frequently to maintain soil moisture content at an optimal level for plant growth and root development.

According to Sij, previous research has shown that properly designed and managed drip irrigation systems reduce deep percolation losses and runoff, and drip irrigation improves crop yields and quality and saves water, fertilizer, energy, and money.

Morgan, assistant professor in Texas A&M University's Department of Soil and Crop Sciences, compared the nitrate balance in drip and pivot irrigation to determine whether drip irrigation helped nitrate stay in the soil profile instead of leaching into the soil and aquifer. For three years, she monitored three fields of drip and three fields of pivot irrigation.

Morgan said her fieldwork showed no significant difference between subsurface drip irrigation and pivot irrigation in reducing nitrates. "Model results, however, suggest that leaching into the groundwater is approximately twice as likely under pivot irrigation."

"Based on results of this project, conversion from pivot to drip irrigation without better nutrient management will not significantly affect nitrate levels in the aquifer," she said. "To reduce inorganic nitrogen in the Seymour Aquifer, the inorganic nitrogen being delivered to the field through irrigation must be accounted for in nutrient management plans."

Morgan said soil water storage, not irrigation method, was a dominant factor influencing leaching potential of a given area.

"The sandier soils store less water and have higher leaching potentials," she said. "This finding suggests that future implementation of best management practices, such as drip irrigation, should be prioritized towards those soils with low water storage capacity and high leaching potential."

Project participants also conducted water quality education and provided technical assistance to irrigators. With financial and technical assistance offered by local soil and water conservation districts, 17 farmers installed drip irrigation systems through the project. Irrigation management was implemented on more than 1,800 acres and nutrient management was implemented on about 2,500 acres. More than 670 participants attended education program and demonstrations.

"This project served as a catalyst to encourage the installation of subsurface drip irrigation systems," said Kevin Wagner, associate director for Texas Water Resources Institute (TWRI). "Considerable interest has been generated in drip irrigation and other more efficient irrigation methods through the efforts of project partners."

Continued work, however, is needed to improve conditions in the Seymour Aquifer, Wagner said. "Educational programs on irrigation and nutrient management are needed to encourage regular soil testing, better managed irrigation systems, and account for nitrate levels in irrigation water when determining nitrogen fertilization needs."

Other agencies involved in the project were local soil and water conservation districts, U.S. Department of Agriculture's Natural Resources Conservation Service, the Texas AgriLife Extension Service, and Rolling Plains Groundwater Conservation District. The project was managed by TWRI and funded by the Texas State Soil and Water Conservation Board through an Environmental Protection Agency §319(h) grant.

(Portions of this story were from an AgNews release.)

Omar Harvey, graduate student in the Department of Soil and Crop Sciences, creates a bulk soil electrical conductivity survey to identify soil variability in one of the fields used in the Seymour Aquifer Water Quality Improvement Project. Photo by Cristine Morgan.