12-2013

# Crop Rotation Research Studies Residual Nitrate

Becky Ohrtman
*Iowa Department of Natural Resources*

# Crop Rotation Research Studies Residual Nitrate

**Abstract**
This fact sheet summarizes research that was part of a five-year project to explore residual nitrate in a variety of cropping systems. The experiment was conducted on a farm in an area where the City of Sioux Center owns several shallow wells that supply more half of the municipal water supplies.

**Disciplines**
Agricultural Science | Agriculture | Agronomy and Crop Sciences | Water Resource Management

Supported by E2009-22

# Crop Rotation Research Studies Residual Nitrate

SOURCE WATER PROTECTION PROGRAM


*Cropping systems research plots on AJS Farms 1/4 mile west of Sioux Center's well field.*

**Sioux Center's** water supply wells and wellhead protection areas are located among privately-owned farms. Additionally, city-owned land in the wellhead protection area has been rented for ag production. As a result, nitrate levels for three of the city's wells test above the health threshold established for drinking water (10 milligrams per liter). Two other wells have nitrate levels of concern — between five and 10 milligrams per liter. Fortunately, water from the remaining wells are quite low in nitrates. These are used to mix with water of higher nitrates to keep the levels below the standard. Water with nitrate levels above 10 milligrams are not safe for infants under six months of age and pregnant and nursing women to drink.

Concerned for the long-term safety of its source water, the Sioux Center community turned to DNR's Source Water Protection for Targeted Community Water Supplies program to determine the baseline nitrate concentration in the water from each well and in the streams that flow through the city's well field.

The DNR also identified potential contaminant sources for each well, and each source was prioritized by its vicinity to the water source and the velocity at which the water moves through the aquifer. Surface runoff areas were also prioritized by their mobility, strength and vicinity to the water source.

## Changes in Farm Practices

Next to the well with the highest nitrate level is a dairy operation with a manure storage lagoon. Historically the operator had consistently spread the manure on his own ground to manage lagoon levels. The owner wanted to expand his operation and build a new lagoon. He notified his neighbors, including the city, about his intentions. Members of the Sioux Center SWP Planning Team met with the dairy operator and explained the nitrate situation at the well. Once aware of how his operating decisions affected city water, he sited the new manure lagoon much further away from the well. He also applied manure to ground other than his own, and the old lagoon is serving his operation in a way that reduces the amount of nitrate in proximity of the city well.

During a meeting with surrounding landowners, the USDA's Conservation Reserve Program for Wellhead Protection (CRP-WHP) was suggested as an option to reduce nitrate. Deep-rooted prairie plants and grasses take up nitrate in the entire soil profile. The city and one landowner enrolled a total of 35 acres into CRP-WHP.

However, that option wasn't practical for most of the area landowners.

"As a farmer, it's important to get economic production from your land," says Matt Schuiteman of AJS Farms, who farms in the Sioux Center wellhead protection area. "This land provides my family's livelihood. CRP has a financial incentive built into the program, but it is not intended to compete financially with farm production. We need to seek farming methods that keep nitrate out of groundwater and in the top foot or two of soil where crops can use it."

## Cropping Systems Research Project

Robbert De Haan, professor of environmental studies at Dordt College, was interested in researching various cropping systems that could reduce nitrate leaching and be comparable economically with standard farming

# Research Outcomes May Influence Farming Practices

practices. Schuiteman was a proactive participant for this research on his land.

With the support of the DNR's SWP for Targeted Community Water Supplies program, the Sioux Center's SWP Planning Team, the Sioux County Soil and Water Conservation District and the USDA Natural Resources Conservation Service, De Haan submitted a grant application to Iowa's Leopold Center for Sustainable Agriculture to conduct a fiver-year research project to test various cropping systems and their effect on nitrate levels extending to six feet in the soil profile.

De Haan was awarded $50,000 to perform the research on 40 acres farmed by Schuiteman about 1/4 mile to the west of the Sioux Center well field along the west branch of the Floyd River. Acres were planted to corn on corn and continuous grasses to compare to combinations of double cropping corn with small grains, and growing alfalfa or red clover in between.

"The five years of data has been collected, but not processed yet," said De Haan. "We had three wet years and two drought years which definitely affected how nitrate moved through the soil. Final results, including financial results Matt collected, will be shared with area farmers."

## The Best and the Worst

Broadly, the best performer for removing nitrate was continuous grass (a mixture of brome and orchard grasses). Nitrogen fertilizer was not applied to this crop for the five measured years. By the end of the project, there was little nitrate left in each foot of soil depth.

Despite using only the recommended amount of fertilizer for continuous corn as well as other nitrate management practices, significant nitrate residual was documented each year in all six feet of the soil profile.

Alfalfa was quickly recognized as a front runner crop for removing nitrate from the soil profile, even at six feet deep. Schuiteman switched to alfalfa on land he rented surrounding Sioux Center's Well 5, and nitrate reduction showed up in well tests.

"Alfalfa has been a pretty decent cash crop the last few years. It was the natural step to take," said Schuiteman.

*Taking soil profile samples to measure residual nitrate.*

### SWP LOCAL PLANNING TEAM AND CONTRIBUTORS

City of Sioux Center
Local landowners
Sioux County Soil and Water Conservation District
Iowa Department of Natural Resources
USDA Natural Resources Conservation Service
Leopold Center for Sustainable Agriculture
Dordt College
AJS Farms
Iowa Association of Municipal Utilities

The crop rotation that included red clover dropped residual nitrate levels throughout the six-foot profile also, but not quite as well as alfalfa.

"It was surprising that nutrient management practices for continuous corn did not keep nitrate where the plants would use most of it," said De Haan. "At the end of the third growing season we had an average of 137 pounds per acre of residual nitrate in the top six feet of soil. Most of it was in the top two feet, but there were also accumulations in the five and six foot depths."

"I was struck initially by the inability of small grains to keep nitrate from moving downward in the soil profile on the double-cropped acres," said Schuiteman. "I assumed that no nitrogen applications meant it would be easy to keep nitrates up in the profile, but it's more complicated than that.

"One theory we are using is not burying alfalfa residue after that rotation, but allowing it to decay throughout the corn growing season. We think the nutrients in the residue can be more efficiently captured that way.

"Because we also feed cattle in our operation, we're thinking that cover crops will generate a very effective source of cattle feed. Essentially that could give us two incomes off the same acre," continued Schuiteman.

## Work Together for Mutually Beneficial Solutions

The Sioux Center SWP Planning Team is positive the research will influence the community to take steps to keep nitrate higher in the soil profile.

"It strikes me that it is time to start talking with our neighbors about how our operations can assist each other," said Schuiteman. "Provide acres to receive manure from the dairy and grow corn for their operation and encourage the dairy to rotate their corn acres with alfalfa to take up nitrate before it reaches groundwater."

"We believe the research results, when shared, will be reflected in nitrate reduction in years to come," said Sioux Center engineer Matt Van Schouwen. "Once landowners are provided viable options, we trust choices will be made that work for everyone.".

For more information email SWP Coordinator Becky Ohrtman at Rebecca.Ohrtman@dnr.iowa.gov or call her at 515-281-0932.