**WATER MATTERS**

Lower Loup NRD
2620 Airport Drive
Ord, Nebraska 68862

info@llnrd.org
(308) 728-3221
FAX (308) 728-5669
www.llnrd.org

LOWER LOUP NATURAL RESOURCES DISTRICT

**WATER MATTERS** is edited by Alan Bartels, Information and Education Coordinator.

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# WATER MATTERS

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LOWER LOUP NATURAL RESOURCES DISTRICT

## Simulating Nitrate Movement with Bromide

In October 2023, the Lower Loup Natural Resources District partnered with the United States Geological Survey (USGS) to assess the influence of different fertilizer application practices on nitrate movement. The three primary nitrogen application methods studied are: fall applied anhydrous ammonia, fall injected hog manure, and in-season side-dress applications.

LLNRD is thankful to have 10 willing producers within the study area, which is in the eastern portion of the District. Soils in this area are deep, well-drained, and located in upland areas. Loess soil is wind-blown silt deposited during the last glacial period and is known to have higher infiltration rates, primarily due to large macropores (voids and cracks) that are present throughout the entire soil profile.

Soil samples were collected multiple times during the growing season to track the movement of nitrate and ammonium. In addition, a bromide tracer was applied to the land surface as a control to estimate the infiltration rates of solutes through the soil. Bromide, a negatively charged ion which mimics the characteristics of nitrate, is an ideal conservative tracer as it will not bind to soil particles or be lost by plant uptake.

The bromide tracer was applied to one 10' x 10' plot in each study field in June. Repeated soil coring tracked movement and provided a max rate of water transport. Soil cores that were collected approximately nine weeks later showed bromide infiltration. Samples were also collected in non-treated areas to determine background bromide concentrations. The time elapsed from application to sampling, total precipitation, and irrigation water applied affect the depth that bromide has reached.

Preliminary data collected from the first growing season show bromide movement that exceeded the crop's root zone. Below is a breakdown of the data. Maximum rate of movement indicated that in some cases the bromide tracer moves over one inch per day in loess soils. Sites will continue to be sampled to determine bromide infiltration into the soil profile.

"Our early findings show that water and dissolved substances like nitrate move quickly through the silt loam soil under irrigated cornfields in our area," said Chris Hobza, Lead Hydrologist, P.G. with USGS. "While we're still early in our research, these initial findings indicate some nitrogen from fall-applied fertilizers moves past the root zone before crops can use it in the following growing season. This matters because the loss of nitrogen past the root zone will affect groundwater quality. We're continuing to analyze data to better understand these processes and help inform future decisions that benefit both agriculture and groundwater quality in the Lower Loup Natural Resources District."

**Bromide tracer result summary**

| Fertilizer practice | Date Applied | Date sampled | Depth bottom Br- (inches) | Days elapsed | maximum rate of movement (inches per day) | Est. precip (@ Columbus) | Irrigation applied (inches) | Total water |
|---|---|---|---|---|---|---|---|---|
| Anyhydrous | June-11 | August-29 | 60 | 79 | 0.76 | 10.09 | 4.55 | 14.64 |
| Anyhydrous | June-11 | August-23 | 84 | 73 | 1.15 | 9.81 | 3.52 | 13.33 |
| Anyhydrous | June-21 | August-08 | >48 | 48 | >1 | 5.94 | NA | >5.94 |
| Manure | June-10 | August-05 | 48 | 56 | 0.86 | 7.98 | 6.15 | 14.13 |
| Manure | June-10 | August-05 | 48 | 56 | 0.86 | 7.98 | 4.21 | 12.19 |
| Manure | June-14 | August-05 | >48 | 52 | >0.92 | 7.98 | 7.56** | 15.54 |
| Manure | June-21 | August-08 | >48 | 48 | >1 | 5.94 | 4.74 | 10.68 |
| Side dress | June-11 | August-08 | 48 | 58 | 0.83 | 8.36 | 4.17 | 12.53 |
| Side dress | June-14 | August-05 | 60 | 52 | 1.15 | 7.98 | 2.98 | 10.96 |
| Side dress | June-14 | August-08 | >48 | 55 | >0.87 | 8.33 | 5.73 | 14.06 |

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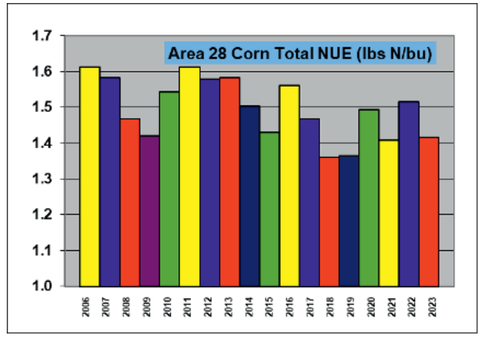
## Identification of Fields Susceptible to Nitrogen Leaching

In January 2023, the LLNRD Board of Directors voted to allow identification of fields within Water Quality Management Phase (WQMA) II Areas that have high nitrogen characteristics. The LLNRD currently has three Phase II WQMAs, one located south of the Loup River between Palmer and Columbus, another located northeast of Columbus, and one located in northeast Wheeler County. Producers in those areas are required to report nitrogen and irrigation decisions to the LLNRD each year. Those identified with high potential for nitrogen leaching are required to develop a Nutrient Management Plan (NMP) with their nitrogen advisor. That plan is due Dec. 1 each year. The plan is subject to approval by the LLNRD.

Averages from three years of data are used to calculate a ranking from five factors. Those are concentration of nitrate in the irrigation water and soil, manure application, amount of irrigation water applied, and organic matter. The concentration of nitrates in the 0"-36" soil sample is weighted three times more than the other characteristics.

Fields identified with more than 75 lbs. of residual soil nitrate typically end up in the high category. Scores are currently being reviewed for 2021-2023 and operators and landowners with high scores will be notified soon. After notification, meetings will be scheduled to develop NMPs with implementation to begin in 2025. Plans may include irrigation and soil sampling improvements, nitrogen limits, satellite imagery, use of fertigation, reduction of preemergent N, and accurate measurements of manure.

The chart shows the Nitrogen Use Efficiency ($NUE_T$) for the area between Palmer and Columbus on the south side of the Loup River. We have reduced $NUE_T$ from about 1.55 lbs of N/bu to the 1.45 lbs of N/bu range and yield has continued to increase. A bushel of corn contains about 0.7 lbs N. This identification, plan development and implementation require more time from those involved. Failure to implement a plan may result in Cease and Desist notification. Accurate soil sampling and maintaining a low soil sample nitrate level is the first step to reduce leaching of nitrates into groundwater.



# In-Season Nitrogen Management

Multiple university studies in recent years have shown that in-season Nitrogen application greatly improves your economic optimum fertilizer N rate (EONR), while reducing environmental impacts.

In-season application, as opposed to fall or spring front loading, allows producers to apply nitrogen when crops need it instead of risking leaching or volatilization over the fall or a wet spring like we had in 2024. Once corn has reached growth stage V6 (2024 average V6 timing was June 10), it has only taken up about 10% of the total N it will require for the season.

There are multiple crop sensing technologies available to help time your N application during the growing season and reduce the risk of losing costly inputs in these tough economic times. Every dollar counts, so timing your N application to when crops need it while reducing the risk of N loss not only helps your bottom line, but also keeps N from leaching out of your root zone and into the aquifer.

## Harnessing Residual Soil Nitrogen Following a Dry Season: The Key to Smarter Fertilizer Planning for the Coming Season

*University of Nebraska-Lincoln/ CropWatch*

### Why Residual Soil Nitrogen Increases After a Dry Year

Dry conditions limit nitrogen uptake in crops, as water is essential for nutrient transport and absorption. Without adequate moisture, nitrogen applied through fertilizers or naturally present in the soil often remains unused. Additionally, drought potentially reduces nitrogen losses from leaching and denitrification, allowing residual nitrogen — particularly nitrate — to accumulate in the soil profile, especially within the root zone.

Harnessing this residual nitrogen can provide a natural nutrient source for crops in the 2025 season, helping reduce the need for additional fertilizers, lowering costs, and preserving soil and water quality.

*Lower Loup NRD technicians taking soil samples in a soybean field near Monroe.*

### The Importance of Soil Sampling for Residual Nitrogen Assessment

To accurately gauge residual nitrogen levels, soil sampling is essential. Sampling the soil allows for a comprehensive view of nitrate levels across the soil profile. Here's how soil sampling can help in optimizing nitrogen application:

1. Timing of Soil Sampling: After a dry season, soil sampling is ideally conducted in the spring before planting. This timing accounts for any winter nitrogen losses from leaching, ensuring a more accurate picture of available nitrogen. However, if conditions allow and you prefer a preliminary view, fall sampling can be useful — particularly in low-leaching soils.

2. Depth of Sampling: Sampling to 2 or 3 feet is critical, as nitrate can accumulate in lower soil layers after leaching from the surface. This comprehensive sampling depth provides the data needed to calculate an accurate nitrogen credit.



3. Using Test Results for Fertilizer Adjustments: Soil test results will reveal the available nitrate concentration, allowing farmers to adjust their nitrogen applications accordingly. For example, if residual nitrate levels are high, farmers can reduce their spring nitrogen applications, minimizing both costs and the potential for nitrate leaching.

### Benefits of Using Residual Nitrogen in Fertilizer Planning

1. Cost Savings: By crediting residual nitrogen, farmers can significantly reduce the amount of nitrogen fertilizer applied. This is particularly valuable after a dry year, when fertilizer prices might fluctuate, and savings can help manage overall production costs.

2. Environmental Protection: Excessive nitrogen application can lead to nitrate leaching into groundwater, a major environmental concern. By crediting residual nitrogen, farmers apply only what the crop needs, reducing the risk of nitrogen pollution and promoting more sustainable agriculture.

3. Improved Crop Performance: Matching nitrogen applications to crop needs enhances nutrient uptake, which can improve crop health and yield. By accounting for residual nitrogen, plants receive adequate nitrogen without the stress of nutrient excess or deficiency.

### Planning for Spring Nitrogen Needs

Incorporating residual nitrate-nitrogen from soil sampling into nitrogen fertilizer prescriptions can significantly reduce fertilizer costs per acre.

While residual nitrogen after a dry year provides a valuable resource, farmers should approach nitrogen management for the new season with flexibility. Use the following guidelines to ensure nitrogen applications meet crop needs without excess:

- Conduct Spring Soil Sampling: Even if you sampled in fall, a spring follow-up test is beneficial. This accounts for any nitrogen movement or losses that occurred over winter.

- Limit Early-season Applications: Apply only enough nitrogen at planting to meet initial growth needs, then follow up with side-dress applications as the crop grows. This approach minimizes early nitrogen losses and provides nutrients when plants can most efficiently use them.

- Use Decision Support Nitrogen Recommendation Tools: The UNL digital nitrogen calculator, variable rate application, and sensor-based technologies can further refine nitrogen applications. These tools help distribute nitrogen only where needed, maximizing efficiency across variable field conditions.

### Summary

Following a dry season, residual soil nitrogen becomes a key resource for improving both economic and environmental outcomes in the next growing season. By measuring and crediting residual nitrogen through soil sampling, adjusting fertilizer applications, and adopting strategic nitrogen management practices, farmers can achieve a balanced approach that supports crop productivity and minimizes unnecessary fertilizer use. Harnessing residual nitrogen is a powerful tool for smarter fertilizer planning, ensuring each application maximizes benefit while protecting valuable soil and water resources.

# Nitrogen Reduction Incentive Act Program

The Lower Loup NRD and the Nebraska Department of Natural Resources have partnered to offer a new cost-share program to reduce nitrogen fertilizer inputs. The Nitrogen Reduction Incentive Act (NiRIA) established a state funded program that provides incentive payments to producers for reducing the use of commercial fertilizers. The requirements of NiRIA are that producers verify a reduction in nitrogen fertilizer application rates as the lesser of 40 pounds per acre or 15% of their baseline application rate. The payment rate is up to $15.00/acre limited to 280 acres per application/field. Eligible fields include those which will be planted to corn or potatoes in 2025.

To apply, landowners must submit:
1) a completed Nitrogen Reduction Incentive Act Program application with the method used to achieve nitrogen reduction,

2) documentation of the last yearly nitrogen fertilizer applications and sources for the applied field, and

3) a soil test for the applied field.

To receive payment, landowners must submit all documentation of nitrogen sources applied to the field, the method used for the nitrogen reduction, reported yield, and documentation of advanced technology practices, if applicable, by January 15, 2026.

Additionally, LLNRD is offering cost-share through the Advanced Soil Sampling Program for bonus ranking where a producer would perform one advanced soil health test and one 3-foot-deep soil nitrate test per 40 acres (limit 8 sample sets per landowner).

**The application due date is January 15, 2025**. Contact the Lower Loup NRD for more information on the Nitrogen Reduction Incentive Act Program or Advanced Soil Sampling Program. Applications are available at the Lower Loup NRD or at www.LLNRD.org.

SCAN FOR MORE INFORMATION