

# Nitrogen Optimization Pilot Program Trial Protocols

## Nitrogen Use Efficiency & Partial Nitrogen Balance Assessment: for corn grain & silage

### Study Overview

Efficient use of nitrogen (N) is essential for crop production, whether the nitrogen source is commercial fertilizer, manure, legumes, or some combination. Assessing the efficiency of N applications on a per field basis is a valuable first step in evaluating your N fertilizer management. Metrics such as Nitrogen Use Efficiency (NUE) and partial N balance can be relatively simple and offer insight into how N is currently being managed and implications for productivity, profitability and water quality.

This protocol provides an easy and effective entry point for farmers interested in investigating the agronomic, economic, and water quality impacts of their current nitrogen management. Through this assessment, participants will:

- Receive resources, tools and guidance to support on-farm data collection and sampling.
- Investigate nitrogen cycling and management on their farms.
- Receive an individualized report with nitrogen use efficiency and nitrogen balance indicators, how they compare to statewide benchmarks, and what these signify for agronomics, economics and water quality.
- Learn together with other NOPP participants about strategies to optimize nitrogen management

If you're applying for a NOPP grant, specific project details can be discussed with UW Research Director Monica Schauer ([monica.schauer@wisc.edu](mailto:monica.schauer@wisc.edu)). If interested in implementing this research protocol independently on your own farm, reach out to UW Extension On-Farm Research Coordinator Abby Augarten ([aaugarten@wisc.edu](mailto:aaugarten@wisc.edu)).

Projects derived from this protocol are designed to provide insight to field specific nitrogen use efficiency. The project requirements described in this protocol align with the research requirements of the DATCP's Nitrogen Optimization Pilot Program (NOPP) grant Option 2 but can be used independently on your own farm to investigate nitrogen use efficiency. Current funding opportunities for NOPP can be found [here](#).

This protocol was developed by the UW-Madison Department of Soil and Environmental Science and Division of Extension.



## Project design

**Overview:** With the Nitrogen Use Efficiency and Partial Nitrogen Balance protocol, i) investigate nitrogen metrics as a group of 3 or more farmers across 2 years, ii) track nitrogen throughout the season through N inputs, exports and soil and plant analyses, iii) implement a zero-nitrogen test strip, which is a test strip that does not receive any synthetic N (besides from starter, if < 40 lb N/ac), iv) calculate field-level nitrogen use efficiency and partial nitrogen balance for corn grain or silage fields.

**Collaboration:** Participants may benefit from collaborating with local partners for assistance in implementing the zero-N test strip and/or collecting samples throughout the season. Consult with your agronomist, local land and water conservation departments, or UW Extension regional educators or outreach specialists about collaborating on this project prior to applying.

This assessment will provide information on the following metrics:

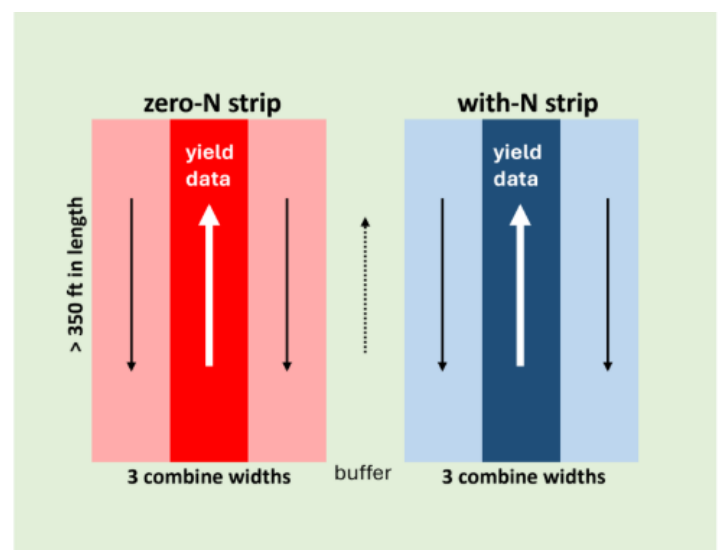
- Yield produced per pound of N (partial factor productivity)
- Fertilizer use efficiency: How efficiently the applied nitrogen was used to increase yields
- Yield with zero synthetic nitrogen inputs: How much the soil (and organic N sources, if applicable) can yield without any N inputs
- Partial N balance: An estimation of N that could potentially be leached to groundwater
- How these metrics compare to other fields in WI and implications

This protocol is based on Discovery Farms Program's *Nitrogen Use Efficiency: A guide to conducting your own assessment*. Read more about Discovery Farms NUE Project and explore Wisconsin-specific benchmarks of Nitrogen Use Efficiency [here](#).

**Field Selection:** Participants should select corn grain or corn silage fields to monitor. Ideal fields will be relatively uniform, accessible for routine data collection and scouting, and representative of other fields/management histories on the farm. If using a yield monitor to determine yield, fields need to be at least 350 ft long. However, selecting a field that isn't too long (ideally 350-750 ft long) will make it easier to implement a field-length zero-N test strip without incurring too much yield loss.

**Establishing a zero-N test strip:** A zero-N strip is a test strip that does not receive any synthetic nitrogen, besides from starter fertilizer, if less than 40 lb N/ac. Yield from this strip will inform how much nitrogen was supplied by the soil (and organic sources like manure or legumes if included in the system). Follow the guidance below on how to establish a zero-N test strip:

- Select a representative spot in the field with a uniform soil type.
- You will have a zero-N strip and a with-N strip, which is a nearby strip that receives the full N rate and will serve as a direct comparison to the zero-N strip.



\*arrows indicate direction of combine. Yield data from the middle combine pass is used to provide a buffer between treatments

- Zero-N strip width is dependent on your equipment, including N application and harvester widths. It is recommended that zero-N strips are at least 3 combine widths and a length of at least 350 feet. Note that the longer the length, the easier it will be to obtain accurate yield data, however be mindful of cost of potential yield loss.
- If you are equipped to do so, creating a GPS boundary or a prescription for the zero-N test strip can make it easier to avoid in-season N applications and obtain yield data from the monitor, if available.
- Additionally, or if you do not have GPS software, flag off the four corners of the zero-N strip using tall stakes and flags so that you can see the plot during in-season applications. This is especially important if you will not be the one applying N. Also, at the field's edge, mark off the strips where the zero-N is located, so you look out for the strip during applications.

As you consider how best to layout and mark the zero-N test strip, connect with the UW team to receive any assistance.

### ***Data collection***

Required sampling and data collection will provide crucial insights into how nitrogen is entering, cycling and leaving the field being monitored. Participants can investigate additional metrics of interest (see optional data below) as their budget allows. In the data collection information below, “treatment” refers to the “zero-N strip” and “with-N strip”.

#### Required data and sampling (all sites):

- Maintain zero-nitrogen test strip
- Field history & management data (data collection survey will be provided)
- Routine soil (pH, OM, P, K, etc.) sampled across trial area as one composite sample.
- Pre-plant soil nitrate and ammonium at 0-1’ and 1-2’ prior to nitrogen application, one each per treatment.
- Pre-sidedress soil nitrate and ammonium (or in-season sampling if all N was applied at plant) at 0-1’, one per treatment.
- Post-harvest soil nitrate and ammonium at 0-1’ and 1-2’, one each per treatment.
- Yield data from calibrated yield monitor or weigh wagon.

#### Required data collection, if applicable:

- Manure analysis (if manure applied during this crop year), 1 sample per application.
- Cover crop sample if field has cover (see UW sampling resources linked in the NOPP protocol library). One composite field sample at time of termination.
- Grain nitrogen content (for corn grain fields), one sample per treatment.
- Irrigation nitrogen content (for irrigated fields), one sample per field.

#### Examples of optional data collection:

- Soil nitrate and ammonium sampling the *following* spring: 0-1’ and 1-2’, one each per treatment. This sampling is highly recommended for those interested in investigating potential nitrate leaching risk during the shoulder season following corn
- Cover crop forage quality: 1 composite
- Whole plant nitrogen content (whole-plant silage or stover for grain fields): 1 per treatment just prior to harvest

- Corn silage forage quality: 1 per treatment just prior to harvest
- Leaf tissue samples: 1 per treatment
- Soil health metrics: Recommend 1 per field, prior to nitrogen application. Overview of common soil health metrics can be found [here](#).
- Other metrics of interest

## Project Timeline

| Timeline                 | Activities                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Winter-Spring            | <ul style="list-style-type: none"> <li>• Select field(s) you want to monitor</li> <li>• Cover crop biomass sampling/analysis (prior to winter kill or termination)</li> <li>• Manure analysis if manure is being applied</li> </ul>                                                                                                                                                |
| Spring (before planting) | <ul style="list-style-type: none"> <li>• Approximate test strip location (sampling will occur in this area)</li> <li>• Take a routine soil sample</li> <li>• Take a pre-plant soil sample for nitrate and ammonium</li> <li>• Flag out/implement zero-N and with-N strips with flags, or by using a shapefile</li> <li>• <i>Optional</i> sampling: soil health sampling</li> </ul> |
| In-season                | <ul style="list-style-type: none"> <li>• Pre-sidedress soil sample for nitrate and ammonium</li> <li>• Irrigation nitrate (if applicable)</li> <li>• Calibrate your yield monitor and review yield monitor data collection instructions</li> <li>• <i>Optional</i> sampling: leaf tissue sampling, soil health sampling</li> </ul>                                                 |
| Harvest                  | <ul style="list-style-type: none"> <li>• Harvest</li> <li>• Grain N content (for corn grain fields)</li> <li>• <i>Optional</i> sampling: whole plant N content, corn silage forage quality</li> </ul>                                                                                                                                                                              |
| Post-harvest             | <ul style="list-style-type: none"> <li>• <i>Optional</i>: post-harvest soil nitrate and ammonium</li> <li>• Submit soil, agronomic and yield data to NOPP team</li> <li>• Receive results (early spring)</li> </ul>                                                                                                                                                                |

## Budget

Complete your budget using the spreadsheet provided in DATCP's NOPP Request for Proposals. When completing your budget, eligible costs include:

- Required sampling: lab analyses, shipping, and time/equipment needed to sample
- Zero-N yield loss estimate for the zero-N test strip (maximum \$500/producer/year)
- \$100 stipend/producer
- Mileage (if needed)
- Any optional additional sampling costs