

Nitrogen Optimization Pilot Program Trial Protocols

Manure nitrogen management

Study Overview

Manure management including source, application method, rate and timing can influence nitrogen availability and the need of synthetic nitrogen for the crop. The goal of this study is to assess the effect of a manure management practice across a standard and reduced commercial nitrogen rate, and the interaction of the two on yield, marginal net return, nitrogen use efficiency, and potentially leachable nitrogen. Investigating a manure management practice across a standard and reduced nitrogen rate will allow us to better understand how the practice impacts both yield and nitrogen need of the crop and what this means for nitrogen management. Since the trial only uses two nitrogen rates, it is not designed to determine the optimum nitrogen rate for this system. If that is the goal of a trial, a full nitrogen rate study with 6 or more N rates is recommended (NOPP Option 1).

While research allows opportunity to explore nitrogen management, manure should still be applied in accordance with NRCS Conservation Practice Standard Nutrient Management (Code 590).

As you develop specific project details including your research question, treatments, and trial layout, we recommend that you connect with the UW team to develop a project that best meets your interests and goals. If you're applying for a NOPP grant, specific project details can be discussed with UW NOPP Research Director Monica Schauer (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).

Projects derived from this protocol are designed to answer producer driven manure nitrogen management questions. The project requirements described in this protocol align with the research requirements of the DATCP's Nitrogen Optimization Pilot Program (NOPP) grant Option 3 but can be used independently on your own farm to investigate manure nitrogen management. 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.



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Selecting manure management treatments

This protocol allows you to investigate manure management practices most relevant to your operation. Some examples are included below.

- Manure source (i.e. raw liquid dairy manure vs. composted manure)
- Manure application method (i.e. surface application vs. low disturbance injection)
- Manure rate (i.e. high vs. low manure application rate, standard manure rate vs. no manure)
- Manure timing (i.e. fall vs. spring application)

Selecting nitrogen rate treatments

Identifying a standard commercial nitrogen rate should be based on the rate you would normally apply under the manure management practice. Considering the project will have two manure management scenarios, the standard rate should be based on the manure management treatment expected to provide the lowest N credit/availability. For example, if you are comparing surface application vs low disturbance injection, your standard rate should be based on the synthetic N you would normally apply following surface application. Based on project goals, the reduced N rate can be 0 N or standard rate – 50 lb-N/ac. Commercial nitrogen is a required N source if using this protocol for NOPP Option 3. Chosen rates are going to vary based on specific project details so please reach out to the UW team to fine tune rates used to match your project goals.

Project design

Given that nitrogen dynamics are variable within a given field, a well-structured project design provides confidence in the results of the project. Replication, or repeating each treatment multiple times in the field, and randomization, or assigning treatments to plots with no particular order, make it possible to account for the natural field variation that occurs. Using a well-structured design and statistical analysis, we can determine if any differences in yield effects were due to the treatments, or random chance and variability. For this study, a minimum of four replications is required. Complete randomization of plots is recommended but not required, since it can be difficult due to limitations in manure application, but trials can be designed to work around these limitations. See example plot layouts at the end of this protocol.

- Field selection: Select a field that is uniform, relevant to the research question, and accessible for ease of data collection (or outreach). Avoid headlands and any known areas with in-field variability when laying out plots.
- Strip width: Determined based on equipment width. It is important to consider the size and capability of manure application, nitrogen application, and harvester. Strip width should be at least the width of the harvester (preferably two or more combine header widths).
- Strip length: Recommended that strips are the length of the field for ease of implementation. Strips can be shorter if desired but should be >350 ft if using a yield monitor and >150 ft if using a weigh wagon.

- Buffer: A buffer strip may be needed between manure treatments depending on application method. For example, a slinger manure spreader may not precisely apply manure to plot boundaries so a buffer area may be needed.
- Field management: All other in-season field management outside of manure and nitrogen application (i.e. herbicide, other fertilizer, tillage) should occur uniformly across the field and trial area.

Data collection

Required data and sampling

- Field history & management records (survey to collect this information will be provided)
- Manure sample and analysis taken at time of application (must include analysis on ammonium-N, most labs refer to as “nitrogen management” or “comprehensive”)
- Routine soil (pH, OM, P, K, etc.) sampled across trial area as one composite sample prior to manure application.
- Cover crop sample if field has cover (see UW sampling resources linked in the NOPP protocol library). Sample at time of termination (prior to killing frost if cover winter kills) in each replicate. If manure is applied before time of termination, sample by manure treatment in each replicate.
- Soil nitrate and ammonium sampled prior to nitrogen rate treatment applications at 0-1' & 1-2'. For example, if all synthetic N is going out pre-plant, sample by manure treatment in each replicate.
- Yield data from calibrated yield monitor or weigh wagon.

Additional sampling is encouraged as your budget allows. Examples include:

- In-season soil nitrate and ammonium (0-1' & 1-2')
- Post-harvest soil nitrate and ammonium (0-1' & 1-2')
- Soil health analysis
- Plant tissue nutrient analysis
- Forage quality analysis
- Corn ear leaf
- Stalk nitrate
- Grain %N

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Plot plan examples

Plot plan A

Complete randomization and replication of manure and N rates. This is the preferred plot plan if achievable by equipment and field size.

Plot ID

101	150 lb-N/ac	Rep 1
102	100 lb-N/ac	
103	150 lb-N/ac	
104	100 lb-N/ac	
201	150 lb-N/ac	Rep 2
202	150 lb-N/ac	
203	100 lb-N/ac	
204	100 lb-N/ac	
301	100 lb-N/ac	Rep 3
302	150 lb-N/ac	
303	100 lb-N/ac	
304	150 lb-N/ac	
401	150 lb-N/ac	Rep 4
402	150 lb-N/ac	
403	100 lb-N/ac	
404	100 lb-N/ac	

Manure treatments

	Liquid manure (LM)
	Composted manure (CM)

Nitrogen rate treatments

N1	100 lb/ac synthetic N
N2	150lb/ac synthetic N

Treatment code

LM-N1	Liquid manure, 100 lb/ac synthetic N
LM-N2	Liquid manure, 150 lb/ac synthetic N
CM-N1	Composted manure, 100 lb/ac synthetic N
CM-N2	Composted manure, 150 lb/ac synthetic N

Plot plan B

Complete replication of manure and N rates with manure plots grouped and not fully randomized. This allows for a wider manure pass.

Plot ID

101	150 lb-N/ac	Rep 1
102	100 lb-N/ac	
103	150 lb-N/ac	
104	100 lb-N/ac	
201	100 lb-N/ac	Rep 2
202	150 lb-N/ac	
203	150 lb-N/ac	
204	100 lb-N/ac	
301	100 lb-N/ac	Rep 3
302	150 lb-N/ac	
303	100 lb-N/ac	
304	150 lb-N/ac	
401	150 lb-N/ac	Rep 4
402	100 lb-N/ac	
403	100 lb-N/ac	
404	150 lb-N/ac	

Manure treatments

	Liquid manure (LM)
	Composted manure (CM)

Nitrogen rate treatments

N1	100 lb/ac synthetic N
N2	150lb/ac synthetic N

Treatment code

LM-N1	Liquid manure, 100 lb/ac synthetic N
LM-N2	Liquid manure, 150 lb/ac synthetic N
CM-N1	Composted manure, 100 lb/ac synthetic N
CM-N2	Composted manure, 150 lb/ac synthetic N

Plot plan C

Complete replication of manure and N rates with manure plots grouped and not fully randomized. This allows for a wider manure pass.

Plot ID

101	150 lb-N/ac	Rep 1
102	100 lb-N/ac	
103	150 lb-N/ac	
104	100 lb-N/ac	
201	100 lb-N/ac	Rep 2
202	150 lb-N/ac	
203	150 lb-N/ac	
204	100 lb-N/ac	
301	100 lb-N/ac	Rep 3
302	150 lb-N/ac	
303	100 lb-N/ac	
304	150 lb-N/ac	
401	150 lb-N/ac	Rep 4
402	100 lb-N/ac	
403	100 lb-N/ac	
404	150 lb-N/ac	

Manure treatments

	Liquid manure (LM)
	Composted manure (CM)

Nitrogen rate treatments

N1	100 lb/ac synthetic N
N2	150lb/ac synthetic N

Treatment code

LM-N1	Liquid manure, 100 lb/ac synthetic N
LM-N2	Liquid manure, 150 lb/ac synthetic N
CM-N1	Composted manure, 100 lb/ac synthetic N
CM-N2	Composted manure, 150 lb/ac synthetic N

Plot plan D

Complete replication of manure and N rates with manure applied to half of the field. This plot plan is conducive with operations that cannot apply manure in strips (i.e. diagonal drag lines). Note: Fields with any sort of gradient (change in soil type, fertility, slope), would not be a suitable location for this sort of plot plan, since you could unintentionally favor one of the manure treatments.

Plot ID

101	150 lb-N/ac
102	100 lb-N/ac
103	150 lb-N/ac
104	100 lb-N/ac
201	100 lb-N/ac
202	150 lb-N/ac
203	150 lb-N/ac
204	100 lb-N/ac
301	100 lb-N/ac
302	150 lb-N/ac
303	100 lb-N/ac
304	150 lb-N/ac
401	150 lb-N/ac
402	100 lb-N/ac
403	100 lb-N/ac
404	150 lb-N/ac

Manure treatments

	Liquid manure (LM)
	Composted manure (CM)

Nitrogen rate treatments

N1	100 lb/ac synthetic N
N2	150lb/ac synthetic N

Treatment code

LM-N1	Liquid manure, 100 lb/ac synthetic N
LM-N2	Liquid manure, 150 lb/ac synthetic N
CM-N1	Composted manure, 100 lb/ac synthetic N
CM-N2	Composted manure, 150 lb/ac synthetic N