**Protocol for On-Farm Research (OFR):**

**Manure’s Fertility and Soil Quality Value**

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**Objective:** To evaluate the effect of manure application versus the application of commercial fertilizer. Specifically, this protocol will attempt to determine the fertilizer replacement value and soil quality benefit from animal manure.

**Treatment Design:** The following is the proposed treatment design. A total of 4 replications is recommended for this trial. A minimum of 3 replications is needed at harvest for adequate statistical analysis. Four replications are encouraged to avoid loss of all research if one replication is lost due to unforeseen circumstances. The same hybrid, crop protection, tillage and other management practices should be used across the entire study area.

Treatment 1: Manure applied at a rate to meet 75 to 100% of crop N requirement and supplemented with inorganic N for the balance of the crop N requirement. Total crop available nitrogen should match Treatment 3.

Treatment 2 (optional): Manure applied at a farmer’s preferred rate or at a rate determined by crop phosphorus requirements.

Treatment 3: Commercial Fertilizer – Rate applied to meet crop nitrogen requirements as typically used by the farmer or recommended by a Land Grant University or reputable service.

**Treatment Layout:**

Buffer Rows (minimum of 4 rows in each treatment)

Buffer Rows

Harvested rows: one combine width

|  |  |
| --- | --- |
| Replication 1 (enlarged to show buffer and harvested areas) | Treatment 1 |
| Treatment 2 (optional) |
| Treatment 3 |
| Replication 2 | Treatment 2 (optional) |
| Treatment 3 |
| Treatment 1 |
| Replication 3 | Treatment 2 (optional) |
| Treatment 1 |
| Treatment 3 |
| Replication 4 | Treatment 3 |
| Treatment 1 |
| Treatment 2 (optional) |

Yield should be collected from center of plot (one combine header width) for each treatment. Treatment plots will have a minimum of 4 additional rows as a buffer to each side of the rows used for yield measurement. For surface applied manures that spread manure laterally, a greater buffer may be needed to avoid manure application on adjoining treatments.

For a two treatment design, follow the same layout as shown above minus treatment 2.

|  |  |  |
| --- | --- | --- |
| **Information to be Collected[[1]](#footnote-1):** | Grower | Advisor |
| Standard soil test including residual soil nutrients, soil EC, soil pH, CEC and total soil organic matter (0-6” or 0-8”). * Minimum: One soil test representative of the field to be used for OFR. Better: One soil test for each treatment.
* Timing: Prior to any fertilizer and manure applications.
* Nutrient recommendations for field.

Soil quality/health measures: * Soil biological test: Permanganate Oxidizable Carbon – POXC) would be a first choice since materials can be ordered and done locally without involving lab. Other options may be available through soil testing laboratories.
* Soil physical characteristics: Options include bulk density (surface 0-3” and 3-6”), soil aggregate stability, infiltration rate and soil penetration resistance measurements. Discuss final choice with advisors.
* If identification of statistical differences is not the end goal, then application of these measures might be made only at representative locations based upon available resources. If valid claims are to be made about differences in treatment, then tests should be completed at least 3 locations for each treatment.
* Timing: Discuss with advisor.
 | XXX | XXXXX |
| Manure applied:* Manure application rate for individual treatments (see application rate discussion)
* Representative manure sample (prefer sample taken shortly before manure application to determine and adjust manure-N rate)
* Date of application, type of manure, method of application (injected, incorporated, surface applied).
 | XXX | X |
| Fertilizer applied: Date of application, fertilizer type and amount applied for each treatment | X |  |
| Harvested Crop: Yield for individual treatments, moisture content (prefer for individual treatments), harvest date, and protein content for wheat only. | X |  |
| Other: * Estimate of crop nutrient requirement and method for estimating requirement (or service used).
* Crop stand counts for each treatment (<https://cropwatch.unl.edu/evaluating-corn-stands> )
* Dig three shovel pits and do the physical estimates section in Section 11 of soil quality kit guide manual “Soil Physical Observations and Estimations” (add link to Kucera document later)
 | X | XXX |

**Additional Grower Requirements:**

1. Flag or mark GPS location of each treatment.
2. Provide all necessary inputs for crop production.
3. Complete background agronomic form about site and practices.
4. If using yield monitor, please designate a separate “load” for each treatment and set up separate “products” names for each treatment harvested. Yield monitor must be **well calibrated**. Contact \_\_\_(advisor/organization providing assistance)\_\_ if assistance with this process is needed.
5. Submit harvest data to \_\_\_(advisor/organization providing assistance)\_\_ within 30 days of harvest or by Dec. 15.
6. Allow \_\_(advisor/organization providing assistance)\_\_ to use submitted and collected data for research, educational, and informational purposes.

**Advisor will:**

1. Provide technical assistance in setting up replicated and randomized experimental design.
2. Provide assistance upon request with treatment implementation, flagging, and recording yield.
3. Final plan for soil testing, costs, and source of funding for soil testing.
4. Analyze raw data using statistical analysis and provide this information to the grower.
5. Assemble final report and share what was learned with local farmers and advisors.

**For more information about this study, contact Name at Phone or**

 **Email Address .**

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This guide originated from the Nebraska On-Farm Research Network

**Disclaimer:** The Nebraska On-Farm Research Network does not endorse the use of products tested in on-farm replicated strip trials. While treatments are replicated within trials and may be replicated across multiple sites under various conditions, your individual results may vary.

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**Supplemental Information or Extension/NRCS Professional/Crop Advisor**

**Key to Success:**

Key to Success is communication, communication, communication. When working with a farmer cooperator hosting on-farm research, recognize that collecting quality and timely data is not often their priority especially as when other farm requirements become critical. Identify critical times to the success of an OFR initiative, communicate with the farmer prior to those times, and find out what assistance is needed to insure the success.

**Soil Fertility Conversation Topics with Farmer:**

* Will manure treatments include supplemental fertilizer? See “Supplement Inorganic Fertilizer in Manure Plots” discussion.
* Soil sampling procedures to be followed? [Nebraska Guidelines for Soil Sampling](http://extensionpubs.unl.edu/publication/9000016364877/guidelines-for-soil-sampling/) or other state specific recommendations.
* What method will be used for estimating crop nitrogen recommendation? Would deep soil sampling for residual soil nitrates or other tests offer value for improving recommendation?
* What do you hope to accomplish with testing of soil health? Is your intent to demonstrate changes to local farmers in soil health by testing for soil biological and physical properties? Selecting measures important to regional soils should be reviewed with local NRCS staff or soil testing services. Timing of these measures to evaluate soil properties before and after manure and fertilizer application may be valuable (see <http://soilhealthnexus.org/manure-impact-soil-aggregation/> for ideas on timing or other articles at <http://soilhealthnexus.org/category/manure/>). For making statistically valid claims about measured changes in soil quality, visit with state or regional land grant university soil scientists.

**Crop Available Manure Nitrogen:**

Estimating crop available nitrogen should consider the availability of both ammonium nitrogen (originating from the urine) and organic-N (originating from the feces). Availability factors can be applied to each source of nitrogen following a procedure similar to the following from the University of Nebraska. If you state land grant university or environmental agency follows a procedure specific to your state, we would recommend following that state procedure.



A fact sheet, [Determining Crop Available Nutrients from Manure](http://extensionpublications.unl.edu/assets/pdf/g1335.pdf), and simple calculator (last page of fact sheet) is a resource for additional information, <http://extensionpublications.unl.edu/assets/pdf/g1335.pdf> .

**Supplement Inorganic Fertilizer in Manure Plots:**

Some research has demonstrated that peak yields are often received for manure application at a rate replacing approximately 75% of the crop N requirements with manure-N and supplementing with inorganic nitrogen for the balance. This is especially important for manure’s with minimal ammonium-N or manure’s surface applied. Since organic nitrogen is a slow release nitrogen, a fertility program that supplements manure organic-N with inorganic fertilizer can assist with early season crop vigor.

Manure’s with significant ammonium-N content (and injected) may have less need for supplemental fertilizer for the early season vigor.

Manures with minimal ammonium-N (feedlot manure, broiler and turkey litter): Supplemental inorganic fertilizer may be added to a manured treatment to promote early season crop vigor. To meet the early season needs of the crop:

* This fertilizer should be applied pre-plant or at planting time. Starter fertilizer would be a good way to get early season growth response. With starter fertilizer, care should be taken to ensure fertilizer is applied far enough away from the seed to avoid germination issues.
* Timing of application for the commercial fertilizer plot should match that of the supplemental nitrogen applied to the manure strip to eliminate the effect of nitrogen application timing. This can always be adjusted given current farmer practices (i.e. If farmer currently side dresses), just understand this introduces the variable of timing into the research.
* Surface applied pre-plant or starter fertilizer should be incorporated with tillage or irrigation (1/2” recommended).

Manure with significant ammonium-N (below barn pit manure from swine and beef, slurry manure storage from dairy). Supplemental fertilizer nitrogen may be left to the preferences of the farmer.

The UNL Nitrogen Calculator, <https://cropwatch.unl.edu/documents/unl_n_calculator_2008.xls>, or comparable state land grant university or environmental agency nitrogen recommendations should be encouraged to determine the total nitrogen requirement, including supplemental nitrogen, for the crop to achieve the farmer’s yields goal.

**Soil Quality Measures for On-Farm Demonstration**

* Soil Aggregation (Soil Glue): **NRCS Guidet: Soil Glue**. **Video:** [Soil Glue Demonstration](https://www.youtube.com/watch?v=zrE1QGdJ2gY)
* Soil Organic Matter: **NRCS Guide:** [Soil Organic Matter](https://cropwatch.unl.edu/documents/USDA_NRCS_OM_guide.pdf) . **Videos:** [Overview](https://www.youtube.com/watch?v=y-M23q6Hw58) | [Test](https://www.youtube.com/watch?v=0iYV0zzChzs)
* **Water Infiltration into Soil: NRCS Guide:** [Soil Infiltration](https://cropwatch.unl.edu/documents/USDA_NRCS_infiltration_guide6-4-14.pdf) **Videos:** [Overview](https://www.youtube.com/watch?v=nFf614XOiQQ) | [Test](https://www.youtube.com/watch?v=iz415J3AOI4)
* Soil Respiration: **NRCS Guide:** [Soil Respiration](https://cropwatch.unl.edu/documents/9%20Soil%20Respiration.pdf). **Videos:** [Overview](https://www.youtube.com/watch?v=be51efbavTo) | [Test](https://www.youtube.com/watch?v=RjnCf0weSUQ)
* [Tighty Whities soil](http://igrow.org/news/tighty-whities-soil-demonstration/) microbial demonstration [introduction video](http://www.farmersguild.org/soil-my-undies-challenge.html) , [results after two months video](https://www.manitobacooperator.ca/crops/holey-underwear-shows-soil-health/) and [fact sheet](http://www.soilcc.ca/soilyourundies/2017/Soil-Your-Undies-Protocol.pdf).
* Physical estimates section in Section 11 of soil quality kit guide manual “Soil Physical Observations and Estimations” (add link to Kucera document later)

**Calibrating Manure Application Rate**

Three references are provided to guide your calibration of a manure application rate:

A two-page [Manure Applicator Guide](https://water.unl.edu/documents/Calibration%20handout%20pp%2087-88%20workbook.pdf) is a field worksheet for making applicator calibration calculations. This is commonly laminated and placed in cabs of trucks and tractors. <https://water.unl.edu/documents/Calibration%20handout%20pp%2087-88%20workbook.pdf> .

[Calibration and Uniformity of Solid Manure Spreaders](http://www.extension.iastate.edu/Publications/PM1941.pdf), by Iowa State University Extension shows the relationship between swath width and application rate and uniformity for rear and side discharge spreaders, and gives calibration guidance.

[Calibration of Manure Application Equipment](https://articles.extension.org/pages/16350/calibration-of-manure-application-equipment) is a national eXtension web page discussing calibration of liquid and solid manure application equipment as well as irrigation equipment.

Caution: Side discharge and some rear discharge applicators can produce non-uniform application rates laterally across the spread pattern from a single pass through the field. Two overlapping passes along the sides of the manure treatment may provide a more uniform application.

Treatment

Surface applied manure plot

Buffer: Inorganic Fertilizer

Rear discharge spreaders that distribute manure laterally may also present uniformity challenges across the spread pattern. Overlapping application passes with measurement of yield and manure application rate from the center of the plot may provide the preferred manure application.

Surface applied manure plot .

Measure manure rate and yield from center rows of plot.

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1. This section assumes a limited $ and time resource for data collection, possibly limited to the resources of the sponsoring farmer and cooperating Extension or NRCS professional. Please review the suggestions presented with advisor within your state to determine a final Information Collection Plan. [↑](#footnote-ref-1)