

Northern New York Agricultural Development Program 2022 Project Report

On-Farm Evaluation of the Value of Manure as a Nutrient Resource

Project Leader

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Collaborators

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- Miner Institute: Forage Agronomist Allen Wilder, Nutrient Management Researcher Laura Klaiber
- Cornell University: Juan Carlos Ramos, Kirsten Workman (PRO-DAIRY), Olivia Godber, Manuel Marcaida

Cooperating Producer

• Northern New York dairy farm

Background

Manure is a tremendously valuable nutrient source that can help build soil organic matter, enhance nutrient cycling, and in general improve soil health and climate resilience. Research in New York State over the past 10 years has illustrated the nitrogen (N) benefits of manure and a significant yield benefit, beyond what can be achieved with fertilizer only. One example is shown in Figure 1. A higher yield and reduced need (or total elimination) of N fertilizer when manure was applied in this example suggests great potential for lowering whole farm N mass balances with manure application, especially for fields that are N deficient and would otherwise have needed fertilizer N.

Recognizing the N value of manure, a manure crediting system was put in place more than 30 years ago. This crediting system recognizes that manure contains all of the 17 essential nutrients for crop growth and production and should be valued as a *nutrient source*, and not as a waste. At that time, the manure crediting system that was developed did not explicitly recognize a yield enhancement component beyond offsetting fertilizer needs. Furthermore, with advances in nutrition and overall farm management, manure produced on dairy farms in 2022 is no longer the





Figure 1. Corn grain yields as impacted by mid-season manure application, fertilizer sidedress N rate and variety. Yield data obtained with a yield monitor. Conditions were extremely dry in 2016 and wet in 2017.

This project was initiated to evaluate the N and yield-enhancing properties of different manure sources applied to corn fields. With advances in yield monitoring technology over the past years, conducting the types of "value of manure trials" as shown in Figure 1, is more feasible.

<u>Methods</u>

This project included three main components:

- (1) N rate field studies;
- (2) value of manure calculator; and
- (3) factsheets and extension articles on the value of manure.

Field Trials

Due to an ideal, but very short, window of manure applications in the spring of 2022, we were only able to implement three N rate studies: one in Northern NY, two in central NY (other funder). Each trial had a split-plot design with manure (with or without) as the main treatments strips, and sidedress N rate as the subplot treatments (Figure 2). These 12 combinations were each replicated 3 times in each field.

At the NNY farm, 7,525 gallons/acre of dairy liquid manure was broadcast over aerated treatment strips in the spring of 2022. Three manure samples were collected during the application and analyzed for nutrient content. The trial was planted to corn silage. At sidedress time, each strip was subdivided into six subplots that received sidedress N fertilizer rates ranging from 0 to 175 lbs N/acre. At sidedressing, we collected soil samples (0-8 and 0-12 inch depths) that were analyzed for the Pre-Sidedress Nitrate Test (PSNT) and extractable nutrients using the Cornell Morgan test. Forage quality and corn stalk nitrate test (CSNT) samples were taken at harvest. The crop was harvested using a yield monitor. The same approach was taken at the other two sites, although manure and fertilizer rates differed to adjust to site-specific crop N needs.



Figure 2: Value of Manure study plot design. Each trial had three strips that received manure versus three no-manure strips (left picture). Manure was applied before planting. At sidedress time, each strip was subdivided into six subplots with sidedress N rates ranging from 0 to 175 lbs N/acre (right).

Value of Manure Calculator Evaluation

To check the efficiency of a "Manure Value and Cost Calculator tool developed in 2011, we entered new farm data into the tool to evaluate any need for updating.

In-Field Manure Calculation Phone App Development

We began development of a phone-based app for quick in-field calculations on the nutrient benefits of manure. Once completed, this tool will be available as an app on cell phones, to be used to quickly determine the nutrient and dollar value of manure to be applied at a given rate and method.

Factsheets and Extension Article Priorities:

To help farmers make decision about the nutrient value of the manure produced on their farms, we targeted development of two agronomy factsheets: one to help producers interpret manure analyses, converting from one unit system to another; and one on the sulfur value of manure.

<u>Results</u>

<u>Field Trials</u>

For the Northern NY on-farm trial, there was no yield response to sidedress N application, reflecting high N credit levels from previous sod and soil N supply. The yields averaged 26.5

tons/acre in both manured and no-manure plots, showing no yield response to manure application (Figure 3).



Figure 3: Effect of manure application and different nitrogen sidedress rates on corn silage yields. Error bars are standard deviations.

The site showed optimal to high levels for soil fertility, suggesting sufficient fertility to support the crop without the need for additional phosphorus (P), potassium (K), magnesium (Mg), etc. (Table 1). Soil PSNT-N results suggested no need for additional N in the manured strips (PSNT = 23 ppm nitrate-N), while in the strips without manure the PSNT was lower (PSNT = 15 ppm nitrate-N) and would suggest a possible response to sidedress N.

Manure application increased forage lignin contents and decreased crude protein (CP) and zinc (Zn) levels of the forage but did not impact any of the other forage quality parameters measured. Ash was the only silage quality parameter impacted by the application of different N sidedress rates, where higher ash levels were present at higher N rates. The CSNT values were at the optimum or excess levels for all the plots (Table 2). Manure addition increased CSNTs, reflecting that manure contains N that is plant-available with levels exceeding the 2000 ppm separation between optimal and excess N.

At the two Central NY locations, one site showed a yield benefit of 1.5 tons/acre independent of sidedress N rate (yield increase not attributed to N supply with manure), while the 3rd location showed both the N value of the manure (offsetting 56 lbs N/acre) and the yield-enhancing properties of manure (0.6 tons/acre yield increase).

Value of Manure Calculator Evaluation

Work is ongoing to update the Value of Manure calculator that was developed in 2011, with more recent farm data. Evaluations are ongoing.

Table 1. Soil fertility status (0-8 and 0-12 inches) at sidedress time. All soils were analyzed at the Analytical Laboratory and Maine Soil Testing Service (using the Cornell Morgan test). Pre-sidedress nitrate N (PSNT-N) was determined at the Nutrient Management Spear Program laboratory. The soil type was Hogansburg.

Treatment	NH ₄ -N		NO ₃ +NO ₂ -N		ОМ		рН		buffer pH	
	0-8 in	0-12 in	0-8 in	0-12 in (PSNT)	0-8 in	0-12 in	0-8 in	0-12 in	0-8 in	0-12 in
	⁰ / ₀									
Manure	21	18	22	23	2.8	2.6	6.8	6.8	4.2	4.2
No manure	24	21	15	15	3.0	2.9	7.0	6.8	4.2	4.2
<i>P</i> -value	0.20	0.18	0.16	0.15	0.27	0.29	0.18	0.53	0.38	0.53
Treatment	P		K		Mg		Ca		Al	
	0-8 in	0-12 in	0-8 in	0-12 in	0-12 in	0-8 in	0-8 in	0-12 in	0-8 in	0-12 in
	lbs/acre									
Manure	15	13	192	157	420	430	2788	2805	19	21
No 	16	15	194	181	408	402	3146	2797	21	22
P-value	0.72	0.50	0.97	0.66	0.48	0.01	0.38	0.87	0.68	0.83

Table 2. Corn Stalk Nitrate-N Test (CSNT-N). The CSNT-N values are classified as deficient if <250 ppm, marginal if between 250 and 750 ppm, optimum if between 750 and 2000 ppm, and excess if higher than 2000 ppm.

	Corn Stalk Nitrate-N (ppm)								
Sidedress N rate (lbs/acre)	0	35	70	105	140	175	Average		
Manure	3,759	4,607	4,530	5,097	5,418	5,450	4,810		
No manure	1,462	2,601	2,022	2,921	2,431	1,944	2,230		

In-Field Manure Calculation Phone App Development

A draft phone-app is under development to facilitate in-field checking of the nutrient value of manure. The app allows a user to input manure analyses, costs of fertilizers, and crop N, P, and K needs, and then returns the balances given a certain application rate and method of application, as well as the total fertilizer dollar equivalent value of the manure.

Extension Documents

See Outreach section.

Conclusions/Outcomes/Impacts

Farms that hosted these trials received a study report. Across the three trials, soil and CSNT results, as expected, showed that manure supplied N. When N was limiting, adding manure increased yield and offset N fertilizer needs. At two locations, manure increased yield independent of N rate. At one location, manure supplied extra N but did not increase yield.

<u>Outreach</u>

- February 11, 2022: Northern New York Crop Congress Getting the best bang for your fertilizer buck presentation, Ketterings, Q.M. and K. Workman.
- November 16, 2022: Nutrient Management Update. Agriculture, Food & Environmental Systems In-service, Ithaca, NY; project presentation by Ketterings, Q.M. and Ramos, J.C.
- January 26, 2023: Cornell Cooperative Extension Winter Conference Call Series, Value of Manure Project presentation, Ramos, J.C. and Ketterings, Q.M.
- Scheduled: March 2, 2023: Value of Manure Told Through Five Stories presentation, Ketterings, Q.M., K. Workman and J.C. Ramos.

Agronomy factsheets (http://nmsp.cals.cornell.edu/guidelines/factsheets.html):

- Fact Sheet #120: <u>Sulfur Fertilizer Value of Liquid Dairy Manure</u>.
- Fact Sheet #122: <u>Reading and Interpreting Dairy Manure Analyses</u>.

Software Tools under Development (<u>http://nmsp.cals.cornell.edu/software/calculators.html</u>):

- Crop available nutrients from manure calculator.
- Value of manure calculator and phone app in development

Next Steps

Additional on-farm research trials will be conducted in 2023 involving more farms in Northern NY through NNYADP funding. Manure sampling will be conducted to better understand variability in manure sources across farms (in NNY and elsewhere in NYS) and across manure treatment systems on dairy farms (solid-liquid separation, storage, composting, digestion, etc.). An incubation study has been initiated to determine differences in N mineralization rates from one source to another.

For development of a revised manure crediting system, additional trials are needed in Northern NY and elsewhere in New York State. Sites can vary in manure source used (liquid, solid, digestate, etc.), rates, and application timing (fall versus spring or in-season). Active programming is ongoing to build an on-farm research network around the topic of value of manure; <u>http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/Value_of_Manure.html</u>.

For More Information

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Photos





Photo 1, left: Value of manure trial on Northern New York farm at sidedressing time (6/28/2022). Soil sampling was conducted that day. Photo: Juan Carlos Ramos. Photo 2, right: Miner Institute Forage Agronomist Allen Wilder, left, and NMSP visiting scholar Philip Coenen from Denmark, process silage quality samples for the Value of Manure study in Northern New York. Photo: Juan Carlos Ramos.



Photo 3: Philip Coenen processes CSNT samples collected for the Value of Manure research project for analysis in the NMSP Laboratory at Cornell University. Photo: Juan Carlos Ramos.