Northern New York Agricultural Development Program
2024 Project Report

Year 3: On-Farm Evaluation of the Value of Manure

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Collaborators:

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- Miner Institute: Allen Wilder, Forage Agronomist; Laura Klaiber, Research Scientist
- Campus: Juan Carlos Ramos, Manuel Marcaida, Carlos Irias, Subha Srinivasagan (NMSP) and Kirsten Workman (PRO-DAIRY)
- Northern New York dairy farms

Background:

Manure contains all seventeen nutrients a plant needs, making it a tremendously valuable nutrient source. In addition, when appropriately used, manure can help build soil organic matter, enhance nutrient cycling, and improve soil health and climate resilience.

Not all the nitrogen (N) in manure is plant-available at land application. Organic N is released into plant-available forms over multiple years, while inorganic N availability depends on the application method and timing, with more N becoming plant-available when injected in spring versus surface applied in fall. A manure N crediting system was developed in New York in the late 1990s that credits N from manure based on manure's composition and application timing and method. With advances in farm management, the manure that dairy farms land-apply now may be very different from the manure sources used to develop that crediting system.

The Value of Manure project was initiated in 2022 to update New York State's manure crediting system. The project evaluates different manure sources, application methods, and timings that commercial farms use today. Additionally, we are documenting how manure increases yields beyond what can be obtained with fertilizer to inform the crediting system. Between 2022 and 2024, five dairy manure trials were conducted on Northern NY farms, complementing nineteen trials completed on farms in other regions of NY.

Methods and Materials:

This project included two main components: (1) N rate field studies, and (2) development of a manure calculator app user guide.

(1) Field N Rate Trials

In 2024, we implemented two N rate trials in Northern NY (NNY) with NNYADP funding, and six other trials in other parts of NY, funded by New York Farm Viability Institute. Both NNY

locations were "carry-over" sites, where we tested the N contribution of 2023 manure in 2024 corn N needs. The results of these sites were added to three N rate studies conducted between 2022 and 2023 in NNY. Each 2024 trial had a split-plot design with manure (with or without) applied in 2023 as the main treatment strips, and sidedress N rate as the subplot treatments (Figure 1). The length and width of the strips varied depending on each farm's equipment.

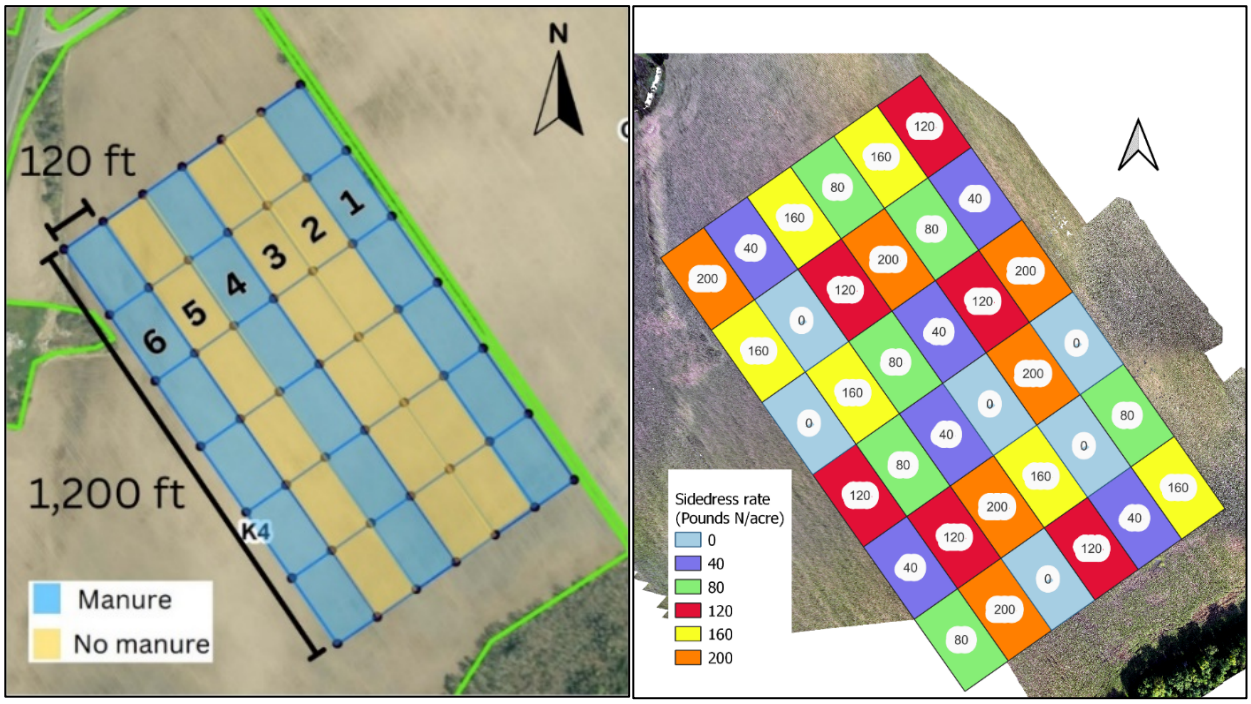

Figure 1: Left: Plot design of the N rate studies for one of the northern NY farms in 2024. Each trial had three strips that received manure in spring 2023 versus three no-manure strips. Right: At sidedress time in 2024, strips were subdivided into six subplots with N rates ranging from 0 to 200 lbs N/acre.

In these carry-over studies, manure was applied in 2023 at a rate of 10,370 gallons/acre of dairy liquid manure, injected in April 2023 for farm A and at a rate of 30 tons/acre of semi-solid dairy manure were broadcasted and incorporated six days after application in farm B. Both trials were planted to corn silage in 2023 and 2024. At sidedress time, each strip was subdivided into six subplots that receive sidedress N fertilizer rates ranging from 0 to 200 lbs N/acre at both farms. We collected soil samples just before sidedressing and analyzed them for the Pre-Sidedress Nitrate Test (PSNT; 0-12 inch depth) and Morgan extractable nutrients (0-8 inch depth). Forage quality and corn stalk nitrate test (CSNT) samples were taken at harvest. Both trials were harvested using a yield monitor. The same approach was taken at the other six 2024 sites, although manure and fertilizer rates were site specific. The most economical rate of N (MERN) was calculated for both manured and non-manured scenarios. A fertilizer price of $0.73 and a silage value of $55/ton (at 35% DM) were assumed. Farm B received a whole-field application of 100 lbs K_2O/acre in May 2024 as the 2023 results suggested a possible potassium (K) deficiency.

(2) Manure Calculator App Manual User Guide

We developed a User's Guide for our user-friendly app, which has been designed to estimate N, P and K credits from various manure sources, based on manure analysis (user input) and a user-defined application rate, method, and timing.

Results:

(1) Field N Rate Trials

The most economic rate of N (MERN; N rate that would give the maximum economic return) for farm A was 124 lbs N/acre when no 2023 manure was applied versus 130 lbs N/acre where manure had been applied, suggesting limited carryover of N from the 2023 manure application into 2024 (Figure 2a). However, when no sidedress N was applied (zero-N fertilizer subplots), the average yield in the manured plots was 1.6 ton/acre (at 35% DM) higher than when no manure was applied. Similarly, the yield at the MERN was 17.3 tons/acre when manure had been applied versus 16.5 tons/acre without manure. The predicted return at the MERN (not including cost of application) was $658/acre when manure was applied versus $616/acre without manure use, assuming a fertilizer price of $0.73/lb of N, and a $55 per ton silage value (at 35% DM). These results (Figure 2a) reflect substantial carry-over yield benefits of the 2023-applied manure.

For farm B, the MERN was 132 lbs N/acre when no manure was applied versus 128 lbs N/acre where manure had been applied in 2023 (Figure 2c). When no sidedress N was applied (zero-N fertilizer subplots), the average yield in the manured plots was 4.7 ton/acre (at 35% DM) higher than when no manure was applied. Similarly, the yield at the MERN was 23.6 tons/acre when manure had been applied versus 20.9 tons/acre without manure. The predicted return at the MERN (not including cost of application) was $1004/acre when manure was applied versus $852/acre without manure use. These results also reflect substantial carry-over yield benefits of 2023 manure.

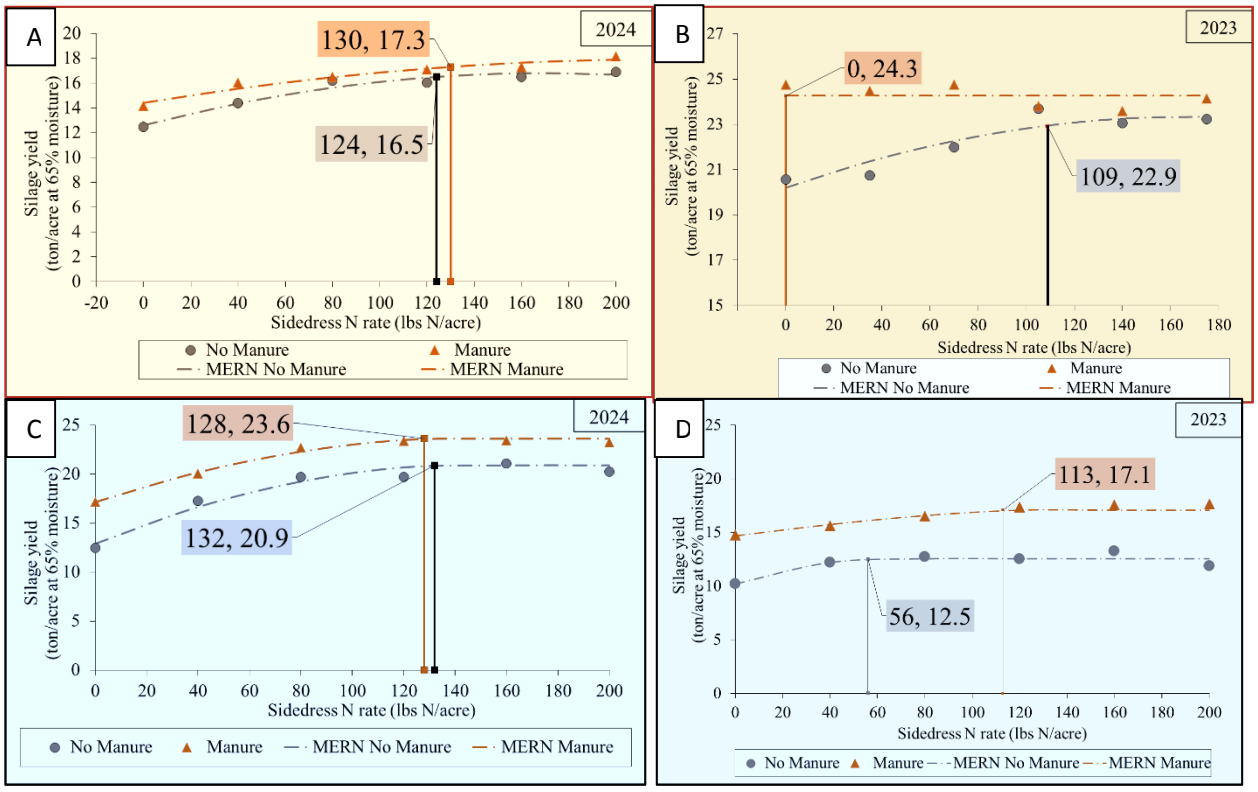

Figure 2. Effect of manure and nitrogen (N) sidedress rates on corn silage yields at farm A in 2024 (A, yellow) and 2023 (B, yellow) and in farm B in northern New York in 2024 (C, blue) and 2023 (D, blue). Text boxes show the most economical rate of N (MERN) and yield at the MERN for manure (brown) and no manure plots (grey).

In farm A, the plot had medium P levels in no-manure strips and optimum levels in manure strips (Table 1). In farm B, soil P level was in the medium category in no manure plots and optimum level in manured ones, while K and Zn levels were in the medium category for both manure and no manure plots, even though the site received a blanket application of 100 lbs K_2O/acre in May of 2024 (Table 1). In farm A, manure application increased soil test K. In farm B, manure application increased soil test P. The PSNT results for farm A suggested no need for sidedress N in either manure or no manure plots in farm A. In contrast, in farm B, PSNT results were low both with and without manure application.

Table 1. Soil fertility status (0-8 inches) at PSNT sampling time in farms A and B in northern New York in 2024 and 2023. The predominant soil types were in soil management group 4.

Farm / Year	Treatment	pH	NO_3+NO_2-N (0-8 inches)	PSNT (0-8 inches)	P	K	Mg
			--------- ppm ---------		-------- lbs/acre --------		
A liquid 2024	Manure	6.3	41	34	12	297	604
	No Manure	6.1	44	36	7	203	618
	P-value	0.18	0.49	0.54	0.08	0.04	0.44
A liquid 2023	Manure	6.5	68 a	76 a	16	405 a	631
	No Manure	6.5	26 b	21 b	12	252 b	553
	P-value	0.42	0.01	0.02	0.20	0.05	0.25
B solid 2024	Manure	6.4	8	6	14	116	629
	No Manure	6.2	5	6	7	94	592
	P-value	0.42	0.39	0.82	0.04	0.29	0.65
B solid 2023	Manure	6.2	17	15	14	138 a	569
	No Manure	6.1	56	20	10	97 b	564
	P-value	0.82	0.43	0.47	0.17	0.04	0.94

For farm A, manure decreased forage's neutral detergent fiber (NDF) content but did not impact any other forage quality parameter. Crude protein and soluble protein contents were lower in the zero and low N sidedress subplots than in the higher N rate subplots. The CSNT values were optimum for all the subplots that received 80 lbs N/acre of sidedress plus manure, and for the ones that received at least 120 lbs N/acre of sidedress in the no manure plots (Table 2).

Table 2. Corn Stalk Nitrate-N Test (CSNT-N) at farms A and B in northern New York in 2024 and 2023. 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. Samples analyzed in the NMSP Laboratory, Cornell University.

Farm		---------- Corn Stalk Nitrate-N (ppm) ----------					
A liquid 2024	Sidedress N rate (lbs/acre)	0	40	80	120	160	200
	Manure	126	306	775	1,296	2,518	4,243
	No manure	64	79	295	1,160	1,921	1,568
A liquid 2023	Sidedress N rate (lbs/acre)	0	35	70	105	140	175
	Manure	9,011	8,217	8,818	9,291	11,067	9,887
	No manure	89	123	140	2,989	2,791	4,917
B solid 2024	Sidedress N rate (lbs/acre)	0	40	80	120	160	200
	Manure	75	76	83	150	845	1,045
	No manure	65	65	58	50	75	136
B solid 2023	Sidedress N rate (lbs/acre)	0	40	80	120	160	200
	Manure	63	68	78	99	614	1,304
	No manure	44	38	40	37	139	102

For silage quality on farm B, manure application decreased forage NDF digestibility rate, and increased K and copper (Cu) levels. Crude protein and soluble protein contents were lower when no or low rates were used to sidedressed the corn. The CSNT values were optimum or higher in the plots that received 160 and 200 lbs N/acre plus manure, and all the values were low for all sidedress rates in the plots that did not receive manure (Table 2).

At the other locations in western NY, central NY, and eastern NY (NYFVI-funded), five sites showed the yield-enhancing properties of manure (yield increases between 2 and 13%) while one site showed no response to manure or N sidedress applications reflecting high N supply from past credits (past manure, cover crops, and/or sods).

(2) Manure Calculator App Manual User's Guide:
We developed a user-friendly Value of Manure Calculator User's Guide (http://nmsp.cals.cornell.edu/publications/extension/ValueManure2025.pdf) for our web app (https://valueofmanure-nmsp.glideapp.io/) The guide explains how to access and use the calculator, enter manure analysis, calculate past and current N credits, and calculate the break-even hauling distances based on crop needs and fertilizer values. The guide was added on our website (http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/Value_of_Manure.html).

Conclusions/Outcomes/Impacts
Both N rate studies showed limited N carryover from 2023 manure application into 2024 but presented significant yield bumps, not just in the first but also in the second year after manure application. In 2024 (year 2), yield in manure strips was 0.8 ton/acre (5% increase) higher at farm A, and 2.7 ton/acre (13% increase) higher in farm B. These results inform our larger state-wide database, including the agronomic management and growing conditions of northern NY. We will continue to add field trials in 2025 varying in manure source used (liquid, solid, digestate, etc.), rates and timings of application (fall, spring, in-season) to expand the NY database.

Outreach:
Value of Manure project website, flyer, protocols:
- http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/Value_of_Manure.html.
- http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/Protocols/NMSP_Value_of_Manure_Flyer2025.pdf.
- http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/Value_of_Manure.html.

Extension articles:
- Ramos Tanchez, J. C., K. Workman, A. Wilder, J. Degni, P. Cerosaletti, D. Dewing, and Q. M. Ketterings (2024). Manure Can Offset Nitrogen Fertilizer Needs and Increase Corn Silage Yield – Value of Manure Project 2023 Update. What's Cropping Up? Blog. March 2024. https://blogs.cornell.edu/whatscroppingup/2024/03/28/manure-can-offset-nitrogen-fertilizer-needs-and-increase-corn-silage-yield-value-of-manure-project-2023-update/

Talks at Statewide Extension Events attended by farmers and farm advisors from NNY:
- Ketterings, Q.M., J.C. Ramos Tanchez, and C. Irias (2024). Managing Dairy Manure for Increased Soil Health and Forage Production Sustainability. Northeast Agribusiness & CCA Conference & Cornell Field Crop Dealer Meeting. Syracuse, NY. November 19, 2024.
- Ketterings, Q.M., J.C. Ramos Tanchez, and C. Irias (2024). Managing Dairy Manure for Increased Soil Health and Forage Production Sustainability. Livestock and Poultry Environmental Learning Community

Webinar Series. Online: https://lpelc.org/managing-dairy-manure-for-increased-soil-health-and-forage-production-sustainability/. October 18, 2024.
- Ramos, J.C., and G. Kaur (2024). Assessing the value of manure: Impacts on soil health and corn yield. North American Manure Expo. Auburn, NY. July 18, 2024.
- Ketterings, Q.M. (2024). Connecting the Dots: Dairy Sustainability, Value of Manure, Yield Stability Zones. NNYADP Research Update Meeting. Miner Institute, Chazy NY. March 13, 2024.

Value of Manure Project Field Notes by Interns
- Hanscom, M. (2024). Cornell CALS Newsletter. September 10. Striving for sustainable crop production: SuMAS intern Francisco Lopez; https://cals.cornell.edu/news/2024/09/striving-sustainable-crop-production-sumas-intern-francisco-lopez.
- Hanscom, M. (2024). Cornell CALS Newsletter. October 29. Zamorano interns tackle sustainability, support farmer livelihood; https://cals.cornell.edu/news/2024/10/zamorano-interns-tackle-sustainability-support-farmer-livelihood-1.

Next Steps:

Additional on-farm research trials will be conducted in 2025 involving farms in northern NY through NNYADP funding. These trials will look at both the fertilizer replacement value of manure and the soil N-supplying properties of soils under different agronomic management and manure histories. We will host similar trials throughout the state to continue to inform our manure crediting system. We will disseminate our findings through extension and farm meetings, extension articles, and scientific articles.

The New York On-Farm Research Partnership will start a new project in 2025 looking at the N-supplying properties of soils under different agronomic management and manure histories, building on our findings that manured fields tend to outyield non-manured fields. We are currently wrapping up the individual site reports and are working on the overall summary of the Value of Manure Project (What's Cropping Up? article). Future presentations will provide findings to date. and announce the availability of the manure calculator and user's guide and the new project on soil N supply

Acknowledgments:

We thank the farms participating in the project for their help and support in hosting the trials, and for providing valuable feedback on the findings.

For More Information:

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APPENDIX: Photos

Photo 1, left: Juan Carlos Ramos (NMSP On-Farm Research Coordinator) and Carlos Irias (NMSP research technician) flag a Value of Manure trial in April 2024 St. Lawrence County. Photo credit: Juan Carlos Ramos.

Photo 2, right: Francisco Lopez (NMSP intern) and Carlos Irias (NMSP research technician) take soil samples in a Value of Manure trial in July 2024 St. Lawrence County. Photo credit: Juan Carlos Ramos.

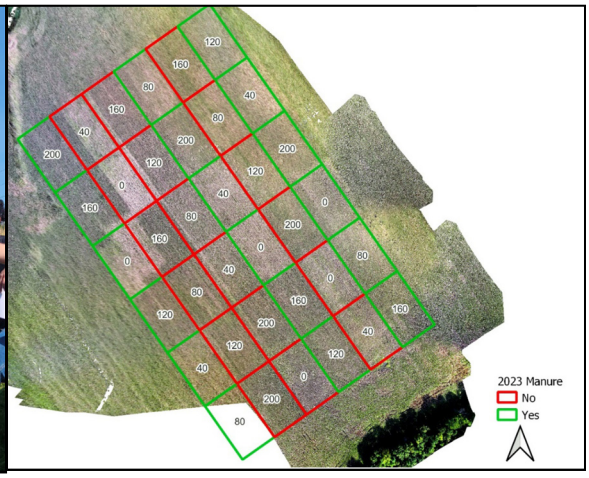

Photo 3, left: Subha Srinivasagan (NMSP postdoctoral associate) flies a drone in a northern NY Value of Manure plot in September 2024 in St. Lawrence County. Photo credit: Juan Carlos Ramos.

Photo 4, right: Drone picture of farm A in Northern New York in September of 2024 showing sidedress rates in pounds N/acre and manure strips location. Photo credit: Subha Srinivasagan.

Photo 5: Drone picture of Farm B Value of Manure trial in northern New York in September of 2024 in Clinton County. Photo credit: Subha Srinivasagan.