Northern New York Agricultural Development Program
2025 Project Report

Cultivating Soil Nitrogen Supply with Manure (Power 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, Kirsten Workman (PRO-DAIRY), Manuel Marcaida, Aidan Villanueva, Subha Srinivasagan
- Northern New York dairy farms

Background:
In 2022, a statewide project was initiated to evaluate the impact of manure on fertilizer nitrogen (N) needs and corn yields using different manure sources. This project, initially funded by NYFVI expanded to also include two field trials per year in northern New York (NNY) through Northern New York Agricultural Development Program (NNYADP) funding. Trial results to date show that manure can replace fertilizer N and increase yields (Ramos Tanchez et al., 2023, 2024, 2025).

The same project allowed us to document the N-supplying capacity of soils from 2022-2024. Soil is an important source of N for forages. The Cornell N guidelines recognize the N-supplying capacity of a soil (SoilN) and list book value for SoilN for each soil type in New York (Ketterings and Workman, 2023), ranging between 40 and 80 lbs N/acre. In the statewide project, SoilN averaged 132 lbs N/acre, with a range between 30 and 281 lbs N/acre. The ranges reflected differences in manure history, crop rotation, cover crops, and soil types and highlighted the key role of soil supplying N for plant growth.

Based on those results, we launched the Cultivating Soil Nitrogen Supply project (Power of Manure for short) in 2025 to expand the database on soil N supply for agricultural fields (zero N fertilizer) and the impact of current and past manure on crop production sustainability. As part of the project in 2025, we continued trials in two fields that were part of the Value of Manure project (NNYADP) in earlier years. In the trials, we measured yield, soil microbial activity, and soil nitrate content, and documented the field agronomic management history. Additionally, we conducted laboratory soil incubation studies testing different manure sources to better understand soil N mineralization and further availability for plants.

Methods and Materials:
This project included two components: (1) N rate field studies, and (2) soil incubation studies.

(1) Field N Rate Trials
In 2025, we implemented two N rate trials in NNY with NNYADP funding. Both trials were "carry-over" trials, where we tested the N contribution of 2023 manure in 2025 corn N needs. The results of these sites were added to five N rate studies conducted between 2022 and 2024 in NNY. Each 2025 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).

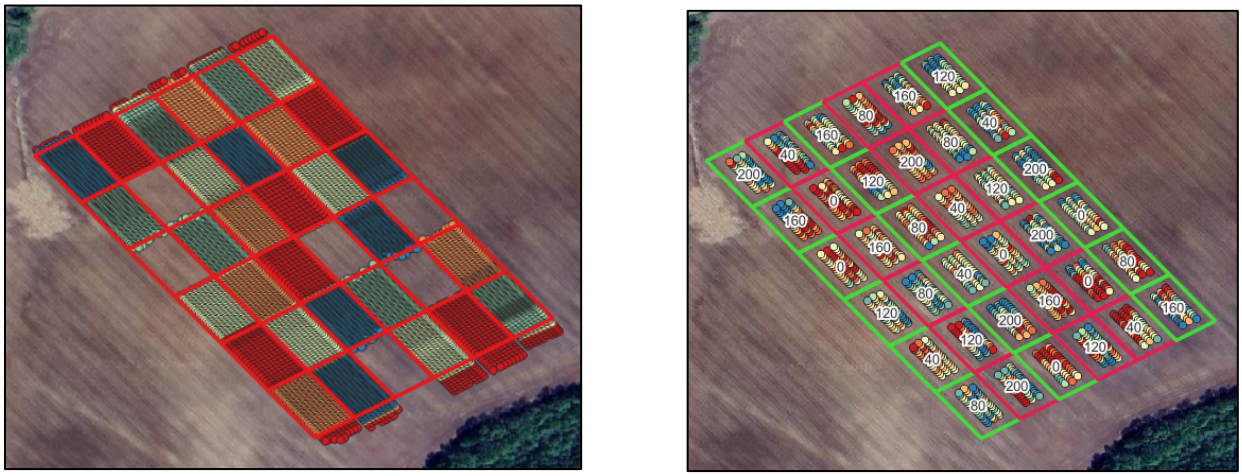

Figure 1. Left: As-applied nitrogen sidedress map for farm A, where strips were subdivided into six subplots with N rates ranging from 0 to 200 lbs N/acre. Right: Cleaned and processed yield map used for statistical analysis in farm A.

In both carry-over studies manure was applied in April 2023. On farm A, dairy liquid manure was injected at a rate of 10,370 gallons/acre. On farm B, semi-solid dairy manure was broadcasted and incorporated six days after application at a rate of 30 tons/acre. Both trials were planted to corn silage in 2023, 2024, and 2025. At sidedress time, each strip was subdivided into six subplots that received sidedress N fertilizer rates ranging from 0 to 200 lbs N/acre at both farms. After planting and before sidedressing, we measured soil microbial biomass. Additionally, we collected soil samples before sidedressing 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 three 2025 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. An N fertilizer price of $0.73 per pound and a silage value of $55/ton (at 35% DM) were assumed. Farm A received a whole-field application of 30 lbs P_2O_5 and 45 lbs K_2O/acre in May 2025, and farm B applied 60 K_2O/acre also in May 2025. Both applications responded to 2024 results suggesting potential P or K deficiencies in farm A and B, respectively.

(2) Soil Incubation Studies

We incubated 216 soil containers with different manure sources using a silt loam soil. The experiments had a control (soil only, no manure) and five manure sources: Our five treatments were:

1) dairy digestate (DI),
2) dairy digestate separated solids (DSS),
3) dairy separated digestate (SD),
4) raw dairy manure (RM), and
5) raw dairy separated solids (RSS).

All sources were applied at a fixed total-N rate of 100 lbs N/acre. Soil inorganic N (NO_3^- and NH_4^+) was tested after 0, 2, 4, 8, 12, 14, 28, 42, and 74 days of incubation at room temperature and optimal moisture conditions.

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 0 lbs N/acre for both manure and no manure plots, reflecting a challenging growing season (wet spring and dry summer) (Figure 2a). In the zero-N fertilizer subplots, the average yield in the manured plots (16.8 tons/acre) and the no manure plots (16.6 ton/acre) were similar. The predicted return at the MERN (not including cost of application) was $728/acre with manure versus $724/acre without manure, 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 limited carry-over yield benefits from the 2023-applied manure into the 2025 growing season.

For farm B, the MERN was 84 lbs N/acre without manure versus 71 lbs N/acre with manure (Figure 2c). In the zero-N fertilizer subplots, the manured plots averaged 2.4 ton/acre (at 35% DM) more than the no-manure plots. Similarly, the yield at the MERN was 23.3 tons/acre when manure had been applied versus 21.7 tons/acre without manure. The predicted return at the MERN was $1,029/acre when manure was applied versus $930/acre without manure use. These results reflect both the yield and fertilizer benefits of manure across three years.

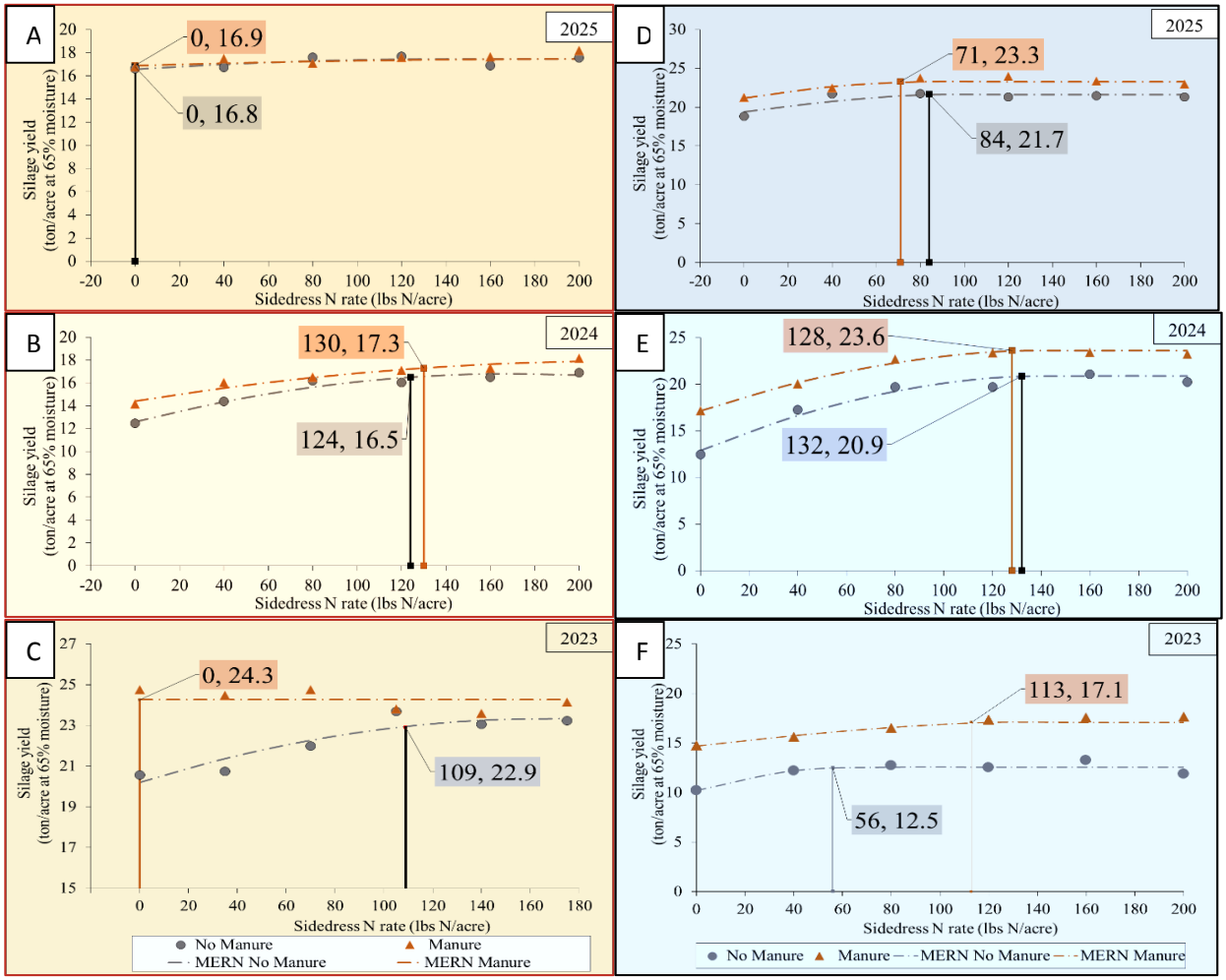

Figure 2. Effect of manure and nitrogen (N) sidedress rates on corn silage yields at farm A in 2025 (A, yellow), 2024 (B, yellow) and 2023 (C, yellow) and in farm B in northern New York in 2025 (D, blue), 2024 (E, blue) and 2023 (F, blue). Text boxes show the most economical rate of N (MERN) and yield at the MERN for manure (brown) and no manure plots (grey).

In 2025, soil fertility levels for farm A were optimal to high while at farm B, soil phosphorus (P) levels were medium and potassium (K) levels were low in no manure plots and medium in manure ones (Table 1).

Table 1. Soil fertility status (0-8 inches) at PSNT sampling time in farms A and B in northern New York in 2025, 2024, and 2023. The predominant soil types were in soil management group 4.

Farm / Year	Treatment in 2023	pH	NO_3+NO_2-N (0-8 inches)	PSNT (0-12 inches)	P	K	Mg
			--------- ppm ---------		-------- lbs/acre --------		
A 2025	Manure	6.4	16	11	13	217	6.4
	No Manure	6.4	16	17	10	180	6.4
	P-value	0.80	0.87	0.25	0.10	0.09	0.80
A 2024	Manure	6.3	41	34	12	297 a	604
	No Manure	6.1	44	36	7	203 b	618
	P-value	0.18	0.49	0.54	0.08	0.04	0.44
A 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 2025	Manure	6.3	17	14	8 a	113 a	600
	No Manure	6.1	14	12	4 b	91 b	597
	P-value	0.49	0.19	0.33	0.02	0.01	0.96
B 2024	Manure	6.4	8	6	14 a	116	629
	No Manure	6.2	5	6	7 b	94	592
	P-value	0.42	0.39	0.82	0.04	0.29	0.65
B 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

Table 2. Soil nitrogen supply and yield with no sidedress and at the Most Economic Rate of Nitrogen (MERN) in farms A and B in northern New York in 2025, 2024, and 2023.

Farm	Year	Manure in 2023?	Soil N Supply (lbs N/acre)	Yield (ton/acre at 65% moisture)	
				No sidedress	At the MERN
A	1	No	161	20.4	22.9
		Yes	243	23.6	24.3
	2	No	90	12.5	16.5
		Yes	104	14.1	17.3
	3*	No	143	16.6	16.8
		Yes	150	16.8	16.9
B	1¶	No	67	10.4	12.5
		Yes	98	14.7	17.1
	2	No	76	12.4	20.9
		Yes	105	17.1	23.6
	3*	No	119	18.8	21.7
		Yes	145	21.2	23.3

*Wet spring, dry summer; ¶ excessively wet summer.

The PSNT results in 2025 for farms A and B suggested a need for sidedress N in both manure and no manure plots (Table 1). Over the three years of the studies in farm A, soil supplied between 90 and 161 lbs N/acre without manure, and 104 to 243 lbs N/acre with manure applied in 2023 (Table 2). In farm B, soil supplied 67 to 119 lbs N/acre without manure, and 98 to 145 lbs N/acre with manure. The effect of manure increasing soil N supply compared to the control was more prominent in the first year after the application at farm A, while at farm B the benefits were measured for all three years. Similarly, manure plots showed higher yields in the first two years after application at farm A, while for farm B the benefits lasted through the 3rd year.

(2) Incubation Study

Figure 3 shows nitrogen mineralized at contrasting speeds within the tested manure sources. Cumulative nitrate (NO_3, left) and ammonium (NH_4, right) were higher for manure sources with less dry matter (separated digestate, digestate, and raw manure), and considerably lower in solid manure sources (digestate separated solids and raw separated manure).

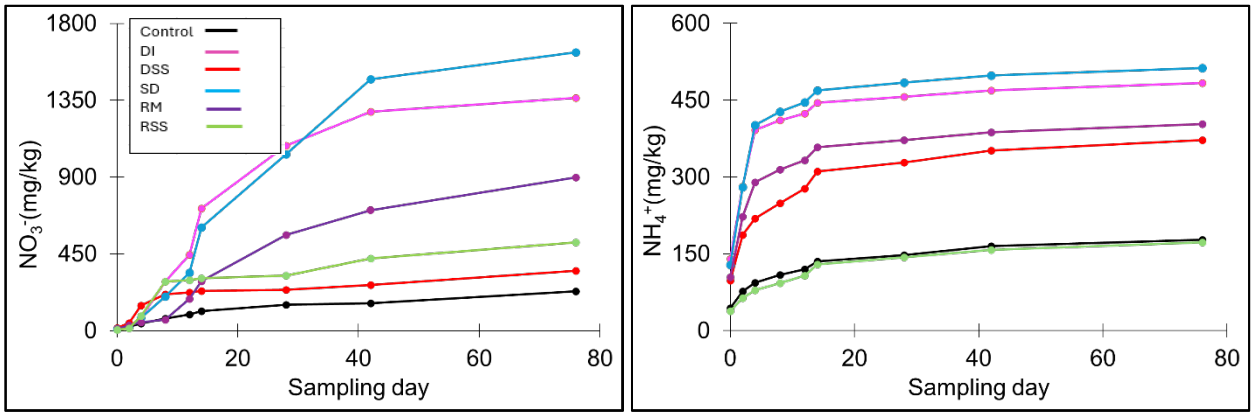

Figure 3. Cumulative NO_3 (left) and NH_4 (right) levels over time in the soil incubation study. DI: Digestate, DSS: Digestate separated solids, SD: Separated digestate, RM: Raw manure, RSS: Raw separated solids.

Conclusions/Outcomes/Impacts

The N rate study at farm A showed limited N carryover and yield benefits from 2023 manure application into 2025 corn. However, we documented a 1.6 ton/acre yield benefit three years after application for farm B. Soil N supply was higher in the manure treatments for two years after application in farm A, and in all three seasons in farm B. The incubation study showed that manure dry matter and composition affect N mineralization in soil. These results inform our larger statewide database. We will continue to add field trials in 2026 to expand the NY database and will conduct additional incubation studies with a wider range of manure sources with the overall goal to update our land grant university manure nitrogen crediting systems in future years.

Outreach:

Power of Manure project website, flyer, protocols:

- http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/Protocols/NMSP_PowerOfManure_Protocol2025.pdf
- http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/Protocols/NMSP_PowerOfManure_Flyer2025.pdf
- http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/Value_of_Manure.html.

Extension articles:

- Ramos Tanchez, J. C., C. Irias, A. Wilder, J. Degni, P. Cerosaletti, D. Dewing, K. Workman, and Q. M. Ketterings (2025). Manure Continues to Offset Nitrogen Fertilizer Needs and Increase Corn Silage and Grain Yields: Value of Manure Project 2024 Update. https://blogs.cornell.edu/whatscroppingup/2025/03/04/manure-continues-to-offset-nitrogen-fertilizer-needs-and-increase-corn-silage-and-grain-yields-value-of-manure-project-2024-update/
- Villanueva, A., J.C. Ramos Tanchez, K. Workman, Q. Ketterings (2025). The Power of Manure: Boosting Yields for Multiple Years. https://blogs.cornell.edu/whatscroppingup/2025/06/11/the-power-of-manure-boosting-yields-for-multiple-years/

Talks at Statewide Extension Events attended by farmers and farm advisors from throughout New York

- Ketterings, Q.M, and J.C. Ramos Tanchez (2026). Value/Power of Manure. ***Northern New York Tri County Crop Congress***. Canton and Carthage NY. January 28 and 29, 2026.
- Ketterings, Q.M. and J.C. Ramos Tanchez, (2025). Value of Manure: Yield Data vs Book Value. 2025 ***4R NY Nutrient Stewardship Field Day***. Harford, NY. August 27, 2025
- Ketterings, Q.M., J.C. Ramos Tanchez, K. Workman, S. Srinivasagan, M. Marcaida, O. Godber (2025). NY On-Farm Research Partnership. ***Aurora Farm Field Day***. Aurora, NY. July 24, 2025.

Field notes on farm participant and intern experiences

- Hanscom, M (2025). Cornell CALS Newsletter. Jon Greenwood: Farmers and researchers tackle manure management together, by Madeline Hanscom. March 2025: https://cals.cornell.edu/news/2025/03/farmers-and-researchers-tackle-manure-management-together
- Hanscom, M (2025). Cornel CALS Newsletter. September 2025. Zamorano interns carry unique perspectives into NY ag research. https://cals.cornell.edu/news/2025/09/zamorano-interns-carry-unique-perspectives-ny-ag-research
- Hanscom, M (2025). Cornel CALS Newsletter. September 2025. Striving to support sustainable ag around the globe: Aidan Villanueva. https://cals.cornell.edu/news/2025/09/striving-support-sustainable-ag-around-globe-aidan-villanueva

Next Steps:

Additional on-farm research trials will be conducted in 2026. These trials will look at both the fertilizer replacement value of manure and the N-supplying properties of soils under different agronomic management and manure histories. More laboratory soil incubation studies will be conducted in 2026 as well, testing additional manure sources. At the time of this report, we are currently wrapping up the individual site reports and are working on the overall summary of the Value of Manure Project to be published in a future Cornell Field Crops newsletter "What's Cropping Up?" blog post.

Acknowledgments:

We thank the farmers 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, takes a soil sample for the Power of Manure trials in May 2025; photo: A. Villanueva. **Photo 2, right**: NMSP technician Aidan Villanueva takes soil samples for the Power of Manure trials in May 2025 in St. Lawrence and Clinton counties, New York; photo: J.C. Ramos Tanchez.

Photo 3, left: NMSP Technicians Itzel Calles, left, and Jamael Chan collect silage and CSNT samples for the Power of Manure trials in September 2025 in Clinton County ,New York. Photo: J.C. Ramos Tanchez.

Photo 4, right: NMSP post-doc Subha Srinivasagan, left, and NMSP Technician Juliana Lee prepare to fly a drone over the Power of Manure trial in September 2025 in Clinton County, New York. Photo: J.C. Ramos Tanchez.