Minnesota Department of Agriculture
Agricultural Fertilizer Research and Education Council
Written Project Update

PROJECT DESCRIPTION: Updating nitrogen and phosphorus credits from manure to maximize fertilizer use efficiency in row crops
REPORT DUE DATE: September 30, 2022
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Objectives:

Our goal is to verify and/or update N and P credit recommendations from manure so that farmers are able to make better decisions when purchasing and applying commercial fertilizers in following years.

The objectives of this study are to use laboratory and field studies to: 1) estimate N and P mineralization from a variety of manures and soil types and 2) determine the best calculation for plant available N (PAN) and plant available P (PAP as P_2O_5).

Current Research Findings:

The field studies are being conducted at the Southern Research and Outreach Center (SROC) in Waseca, MN and the Southwestern Research and Outreach Center (SWROC) in Lamberton, MN. Site 1 at each location began in 2018 and Site 2 began in 2019. We have completed three years of the site 1 field study at both locations, and two years of the site 2 field study at both locations. The treatments were as follows in the first year of each site (all manures were applied to supply 140 lbs of first-year available N):

1. Swine finishing manure (swine)
2. Bedded beef pack manure (beef)
3. Dairy manure, raw, untreated (dairy)
4. Dairy manure, liquid-separated (sep. dairy)
5. Composted chicken manure pellets (chicken layer)
6. Turkey litter (turkey)
7. Fertilizer: 0 lb/A N (full P, K)
8. Fertilizer: 42 lb/A N (full P, K)
9. Fertilizer: 84 lb/A N (full P, K)
10. Fertilizer: 126 lb/A N (full P, K)
11. Fertilizer: 168 lb/A N (full P, K)
12. Fertilizer: 0 lb/A P (full N, K)
13. Fertilizer: 30 lb/A P (full N, K)
14. Fertilizer: 60 lb/A P (full N, K)
15. Fertilizer: 90 lb/A P (full N, K)
16. Fertilizer: 120 lb/A P (full N, K)

The manure treatments were only applied in year 1 of the study at each site. After that, potassium and sulfur fertilizers were applied to all plots (including fertilizer or manure plots) in following years to ensure they were not deficient. Nitrogen and phosphorus fertilizers were applied at the appropriate rates to the fertilizer only plots in all years, however. This allowed us to compare the nitrogen and phosphorus supplied by the manure in years 1, 2, and 3 after application to a nitrogen-rate and phosphorus-rate curve.

Grain yields averaged over four site-years for each year of the rotation are shown below (Figures 1-3). Though we recorded yield responses to N and P fertilizer in all years, corn was more responsive to N fertilizer. We noted yield increases in response to almost all manure types in the first year after application, though bedded beef pack was the exception as yields were similar to the 0 N control plots. Yield response to manure decreased in years 2 and 3, though bedded beef pack and composted chicken layer manure tended to have the most response (still minimal, though).

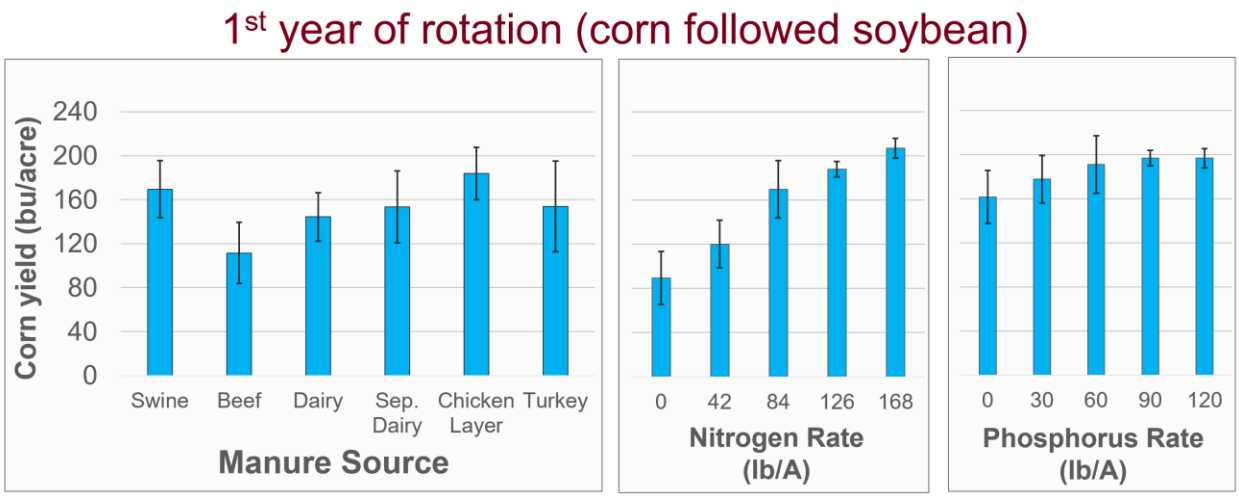

Figure 1. Average corn yield over two years and two sites when 140 lbs of plant available N was applied in spring via manure versus commercial nitrogen applied at several rates.

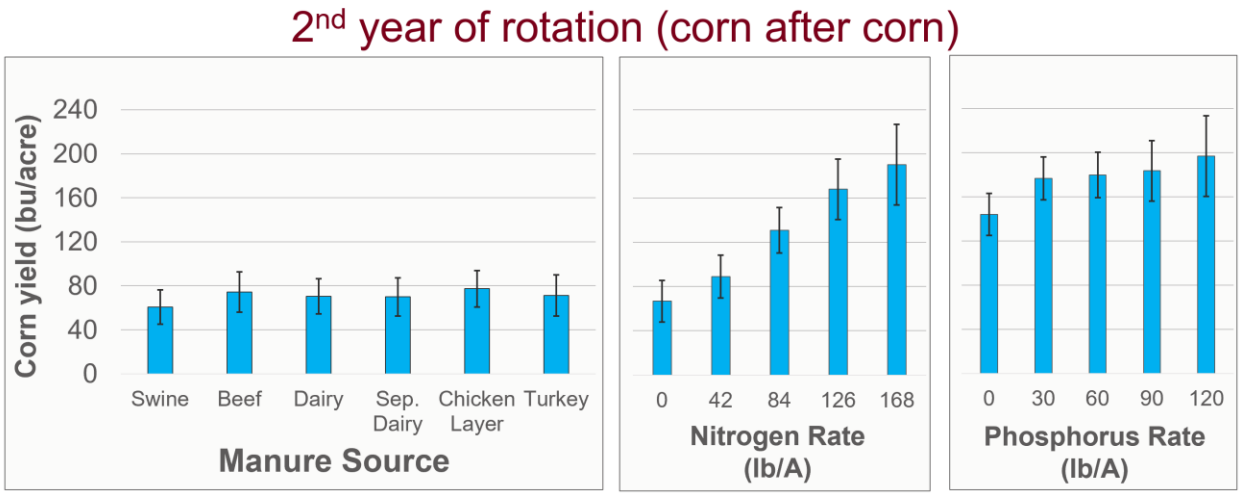

Figure 2. Average corn yield over two years and two sites the second year after manure application versus commercial nitrogen applied at several rates.

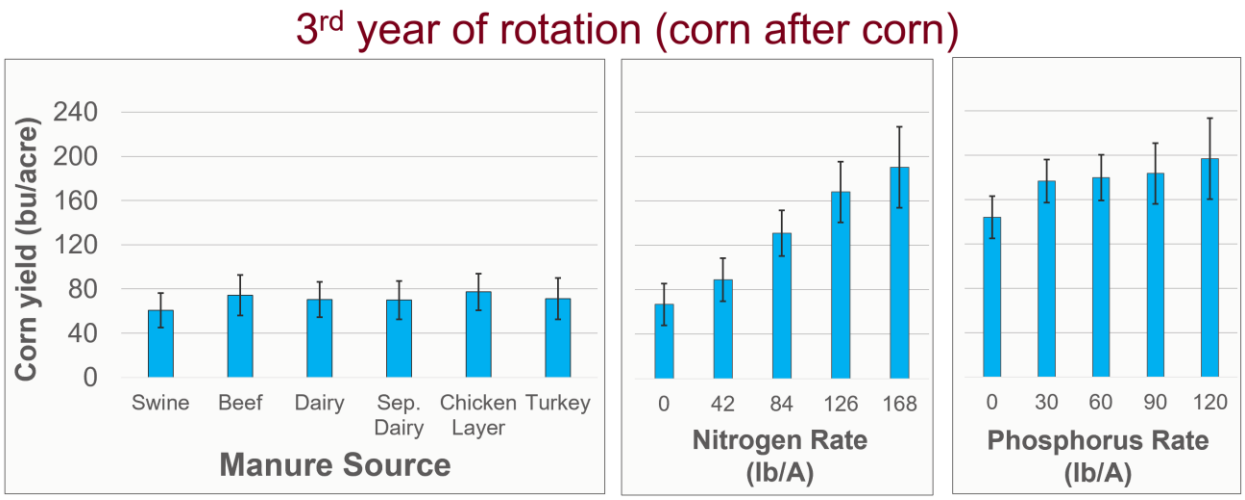

Figure 3. Average corn yield over two years and two sites the third year after manure application versus commercial nitrogen applied at several rates.

Nitrogen and phosphorus uptake by corn will help to determine how much of the total N and P applied in the various manure types was available for uptake. Though we aimed to apply the manure at the same plant available N rate in the first year, N uptake varied greatly across treatments (Tables 1-3). Swine finisher and composted chicken layer manure had the most available N, though the percentage of the total applied was still lower than expected. The corn only took up approximately 10% of the N applied from the bedded beef pack. In the second year after application, most manure types released about 5-6% of the total N applied. Less was released in the third year, though the two poultry manures had the highest release rate at 4%.

The P fertilizer value (Tables 1-3) of swine and dairy manure was around 35 pounds of P_2O_5 per acre. Bedded beef pack manure was slightly lower, though yields were lower, so it makes sense that less P was taken up. Both poultry litters had higher P_2O_5 uptake that the other manure types. Interestingly, 145% of the total P applied in swine manure was taken up by the corn. This indicates that this manure type may have stimulated more P release from the soil than the other manure types. We will investigate this further as we analyze soil test P information. In the second and third years, P uptake was highest – by far – for the poultry manures. This is likely due to the high amounts of P that were applied at the N-based application rate. Soil testing regularly in fields where these types of manure are applied will be necessary to monitor soil test P levels.

Table 1. The first-year nitrogen (N) and phosphorus (P_2O_5) fertilizer equivalent values of several different manure types. The %N and %P availability (the fertilizer equivalent value divided by the total amount applied) is also shown.

Manure Source	1st year N Fertilizer Equivalent Value (lbs N/acre)	% N available (NFEV/Total N applied)	P Fertilizer Equivalent Value (lbs P/acre)	% P available (PFEV/Total P applied)
Swine finisher	102	46%	33	145%
Bedded beef pack	29	10%	21	32%
Dairy raw	67	24%	34	73%
Dairy Separated	73	28%	38	69%
Chicken layer (composted)	118	34%	77	39%
Turkey Litter	81	34%	47	46%

Table 2. The second-year nitrogen (N) and phosphorus (P_2O_5) fertilizer equivalent values of several different manure types. The %N and %P availability (the fertilizer equivalent value divided by the total amount applied) is also shown.

Manure Source	2nd year N Fertilizer Equivalent Value (lbs N/acre)	% N available (NFEV/Total N applied)	P Fertilizer Equivalent Value (lbs P/acre)	% P available (PFEV/Total P applied)
Swine finisher	7	3%	1	4%
Bedded beef pack	18	6%	5	6%
Dairy raw	14	5%	2	6%
Dairy Separated	14	5%	3	5%
Chicken layer (composted)	19	5%	17	14%
Turkey Litter	15	6%	10	10%

Table 3. The third-year nitrogen (N) and phosphorus (P_2O_5) fertilizer equivalent values of several different manure types. The %N and %P availability (the fertilizer equivalent value divided by the total amount applied) is also shown.

Manure Source	3rd year N Fertilizer Equivalent Value (lbs N/acre)	% N available (NFEV/Total N applied)	P Fertilizer Equivalent Value (lbs P/acre)	% P available (PFEV/Total P applied)
Swine finisher	6	1%	3	8%
Bedded beef pack	12	2%	1	2%
Dairy raw	15	3%	0	1%
Dairy Separated	10	2%	2	7%
Chicken layer (composted)	33	4%	6	8%
Turkey Litter	21	4%	7	11%

Project Schedule and Budget:

The field study portion of the project has been completed and most samples have been analyzed at this time. We continue to work on summarizing and statistically analyzing the data to prepare for publication. The lab study was initially delayed, but we are finalizing analysis of the data and preparing a manuscript that we plan to submit to a peer-reviewed journal. The budget is currently on track as well, though we occasionally have had to shift funds from one area to another. As an example, due to the COVID-19 pandemic, our lab analyses were delayed last year, and we asked for a no-cost extension.

Potential Project Results:

The main goal of this project is to determine if the University of Minnesota's current recommendations for manure N and P credits are still applicable. Our data showed that we may need to make adjustments to beef bedded pack and possibly dairy manure, but the last year of the experiment is needed to round out our dataset. In the end, if we are able to provide better recommendations for manure use, then farmers will be able to better maximize their commercial fertilizer purchases, increasing profitability.