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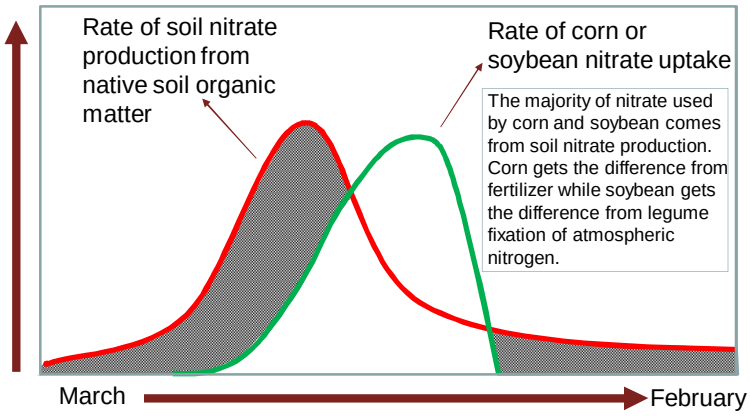
College of Agriculture and Life Sciences

Effectiveness of No-Till, Residue Management, Cover Crops and Crop Diversification on Reducing Downstream N&P Export

Matt Helmers – Director of the Iowa Nutrient Research Center, Professor in Dept. of Ag. And Biosystems Engineering and Dean's Professor in the College of Ag and Life Sciences

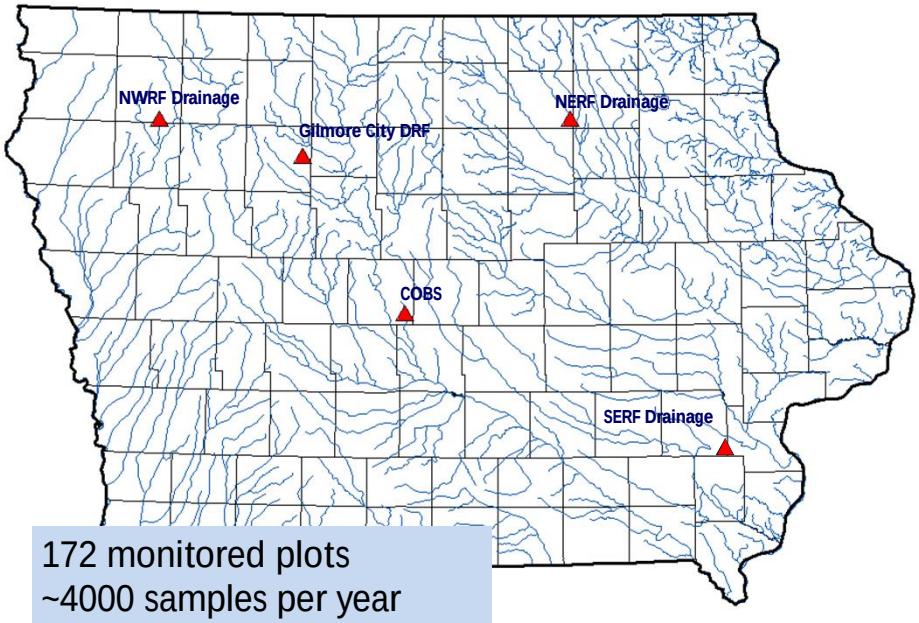
Soil Nitrate Production *vs.* Crop Nitrate Uptake



In the shaded areas, the soil produces nitrate, but there is no crop to use it. As a result, some nitrate is lost to waterways.

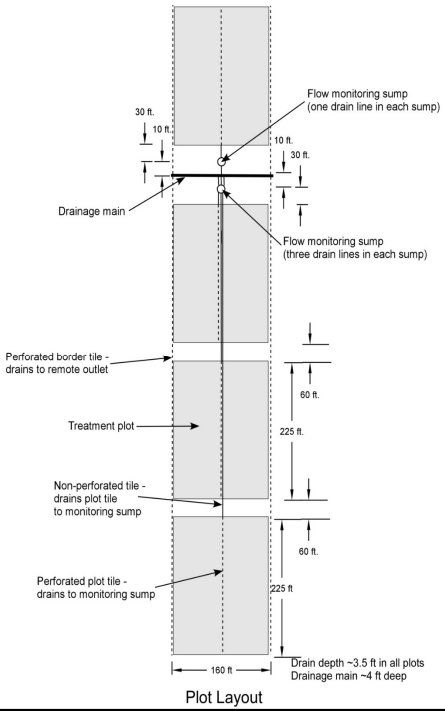
IOWA STATE UNIVERSITY Slide from M. Castellano - ISU

Replicated subsurface drainage plots to evaluate performance of various in-field management practices



172 monitored plots
~4000 samples per year

Subsurface Drainage Layout



Plot Layout

Flow Monitoring System

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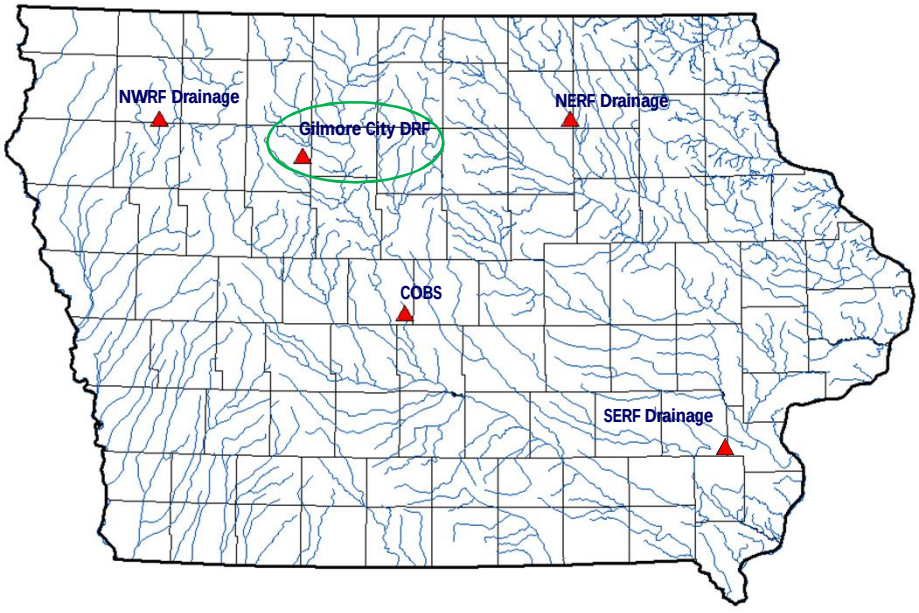
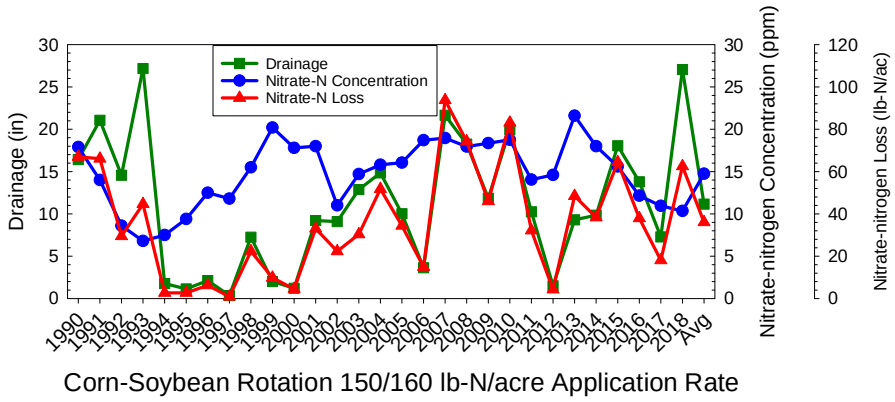
Replicated subsurface drainage plots to evaluate performance of various in-field management practices



Twenty-Nine Year Summary



Corn-Soybean Rotation 150/160 lb-N/acre Application Rate

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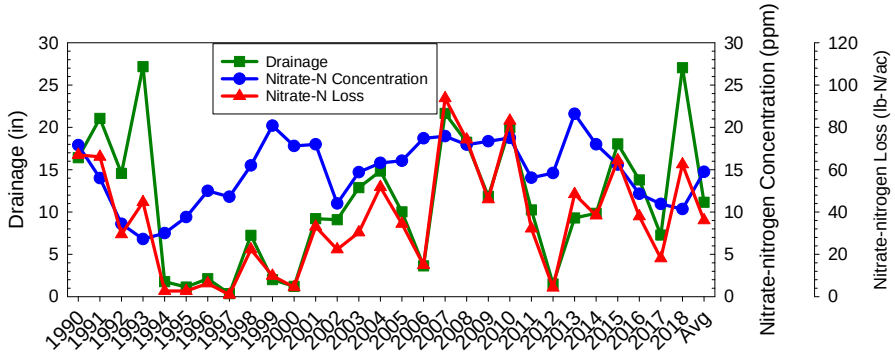
Twenty-Nine Year Summary



Corn-Soybean Rotation 150/160 lb-N/acre Application Rate

Combined Corn-Soybean System – Same N management – Early Spring Sidedress at 150-160 lb-N/acre

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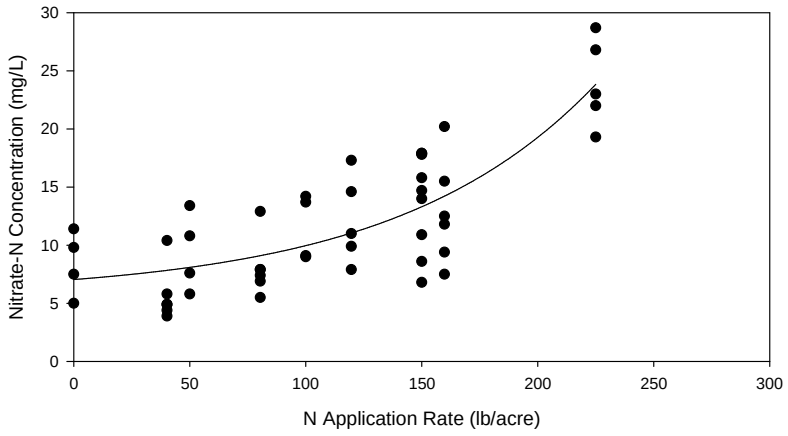
N-Rate versus Concentration



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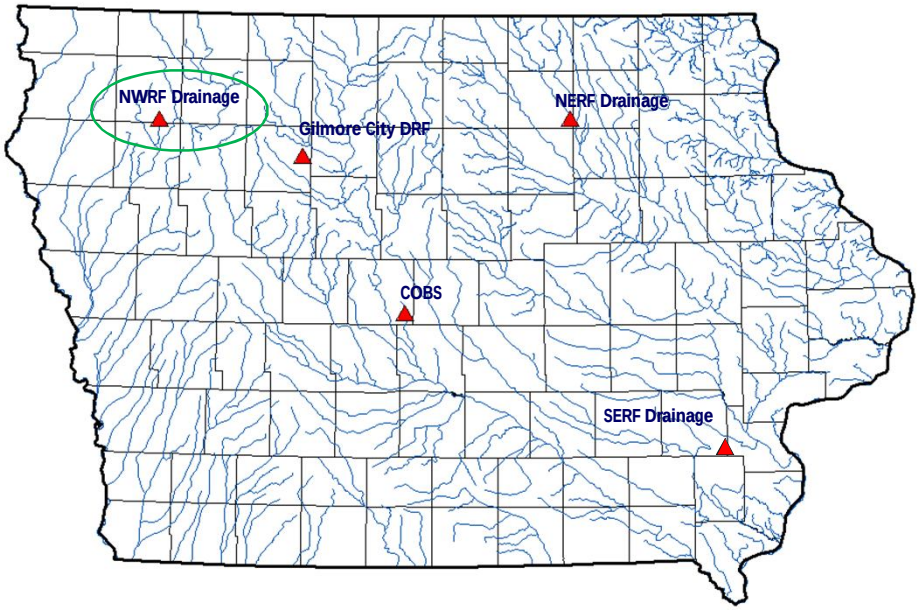
Replicated subsurface drainage plots to evaluate performance of various in-field management practices

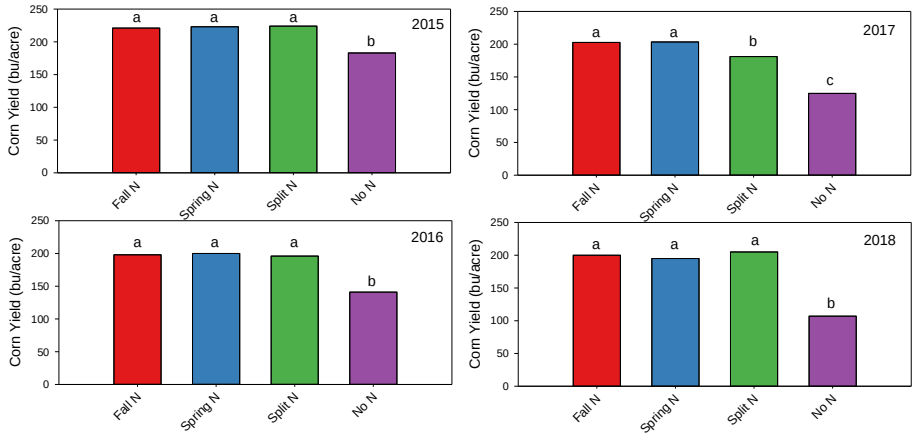


Treatments

Treatment Number	Tillage	Nitrogen Application Time	Nitrogen Application Rate (lb N/acre)*
1	Conventional tillage*	Fall (anhydrous ammonia with nitrapyrin)**	135
2	Conventional tillage	Spring (anhydrous ammonia)	135
3	Conventional tillage	Split with variable N at sidedress (40 lb/acre of urea 2x2 starter at planting plus in-season agrotain treated urea)	135
4	Conventional tillage	None	0

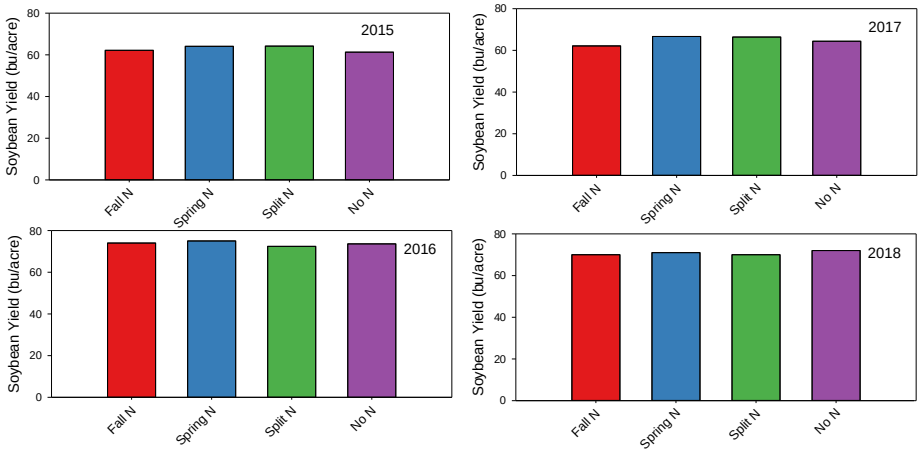
* Fall chisel corn stalks with spring disk/field cultivate, and spring disk/field cultivate soybean stubble.
**In fall of 2014 freezing conditions occurred early and prevented fall application. Application occurred in early spring 2015.

Corn Yield



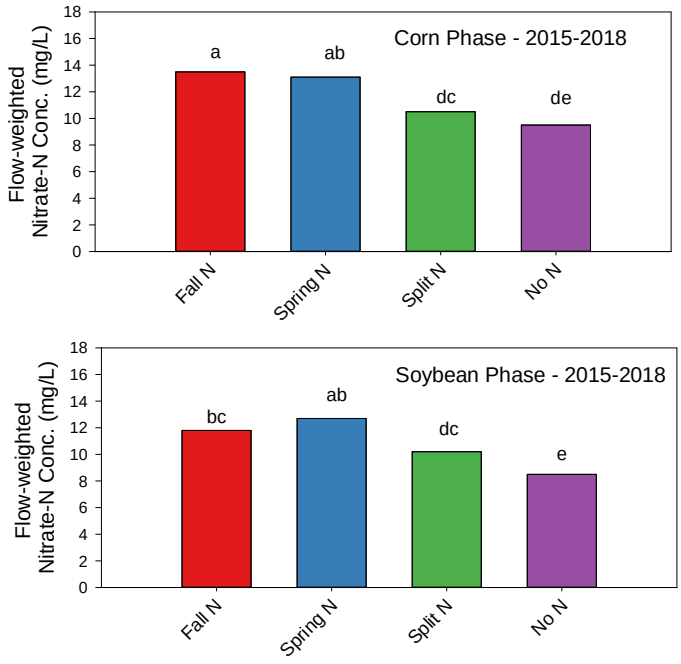
*Means with the same letter in the same year are not significantly different, *P*=0.05.

Soybean Yield



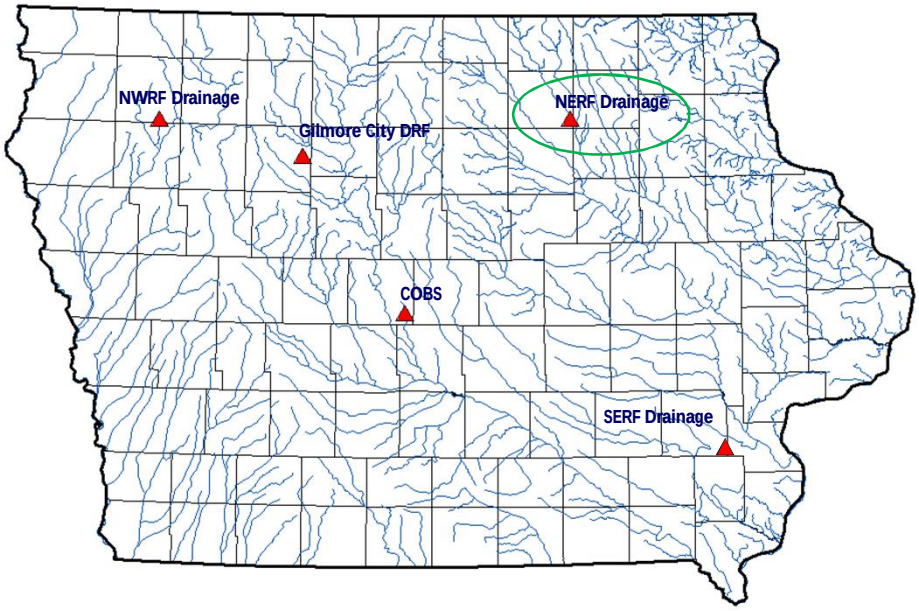
*Means with the same letter in the same year are not significantly different, *P*=0.05.

Flow-weighted Nitrate-N Concentration



*Means with the same letter in the same year are not significantly different, *P*=0.05. Analyzed across corn and soybean phase

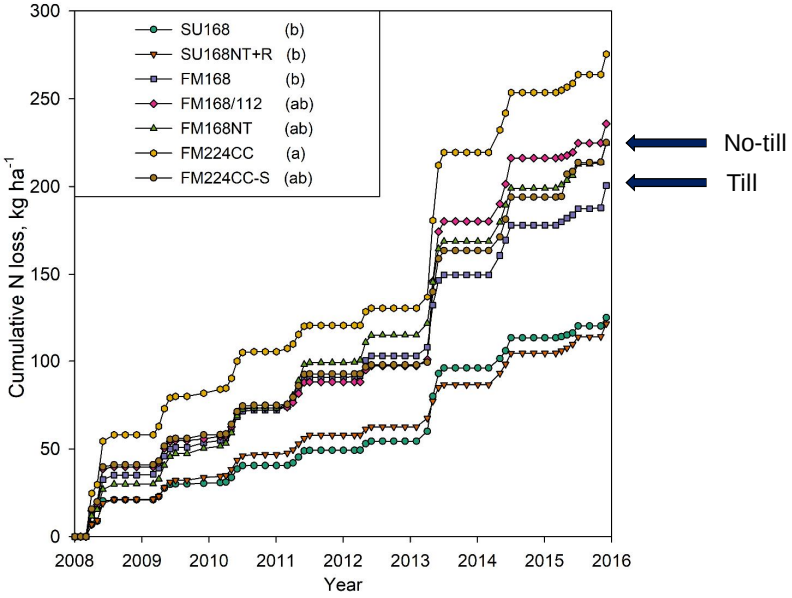
Replicated subsurface drainage plots to evaluate performance of various in-field management practices



Management Systems for 2008-2015 Study

Treatment	Timing and source of N	Target N Rate kg ha^{-1}	Crop rotation	Tillage
SU168	Spring UAN -	168 -	Corn Soybean	Chisel plow corn fall Field cultivate spring
SU168NT+R	Spring UAN -	168 -	Corn + Rye cover crop Soybean + Rye cover crop	No-Till No-Till
FM168	Fall Manure -	168 -	Corn Soybean	Chisel plow corn fall Field cultivate spring
FM168/112	Fall Manure Fall Manure	168 112	Corn Soybean	Chisel plow corn fall Field cultivate spring
FM168NT	Fall Manure -	168 -	Corn Soybean	No-Till No-Till
FM224CC	Fall Manure Fall Manure	224 224	Continuous Corn	Chisel plow fall Field cultivate spring
FM224CC-S	Fall Manure Fall Manure	224 224	Continuous Corn with Stover removal	Chisel plow fall Field cultivate spring

Nitrate-N Loss from 2008-2015 – Dougherty et al., 2020



Phosphorus in Drainage Water

Table 1. Selected phosphorus management systems summarized in this report.

Code	Source †	Crop	Tillage	Target N rate	Actual P rate
				lb N/ac/year	lb P_2O_5/ac/year
FP-CS	Fertilizer	Corn	Chisel/disk	150	52
		Soybean	Disk	none	none
MN-CS	Manure	Corn	Chisel/disk	150	50
		Soybean	Disk	none	none
MN-CSNT	Manure ‡	Corn	No-till	150	44
		Soybean	No-till	none	none
MN-2CSCC §	Manure	CS-CC	Chisel/disk	150-200	150

†Liquid swine manure always was injected.
‡Applied in spring from 1999 until 2006 and in the fall since then.
§Manure N-based to corn (150 lb N) and soybean (200 lb N) from 1999 to 2006 (CS) and to continuous corn since 2007 (CC).

Phosphorus in Drainage Water

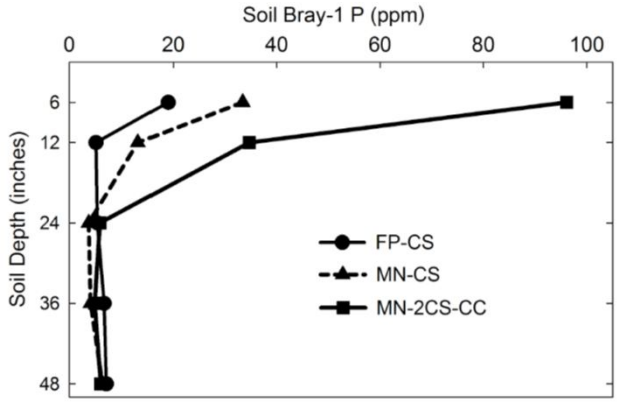


Figure 1. Soil profile P after 11 years of P-based fertilizer (FP-CS) for a corn-soybean rotation, N-based liquid swine manure for corn after soybean average for tillage or no-tillage (MN-CS), or N-based manure every year (MN-2CSCC).

Phosphorus in Drainage Water

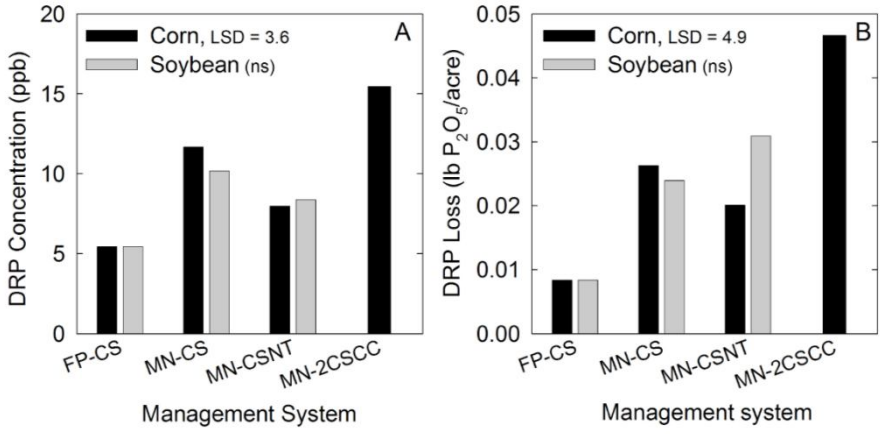


Figure 2. Average annual P concentration in tile drainage (A) and P loss (B) during 11 years of P-based fertilizer for a corn-soybean rotation (FP-CS), N-based liquid swine manure for corn after soybean with tillage (MN-CS) or no-till (MN-CSNT), or N-based manure every year (MN-2CSCC).

Tillage, Cover Crops, and P Placement Impacts on Runoff - Mallarino

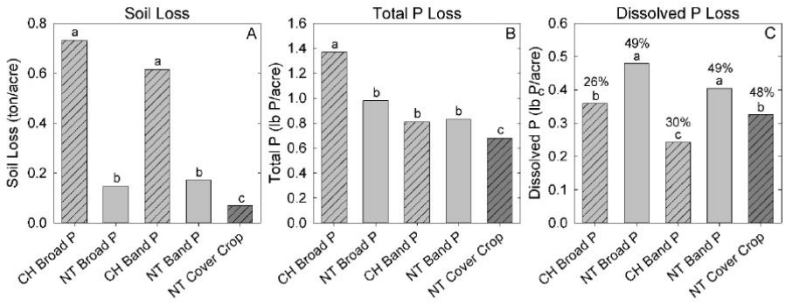


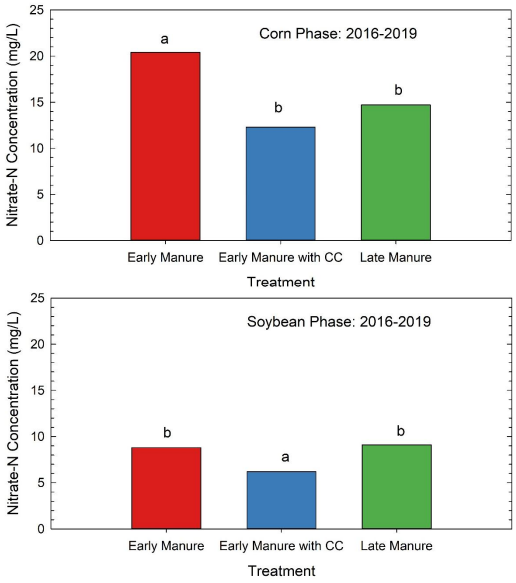
Figure 2. Annual average soil (A), total P (B), and dissolved P (C) losses with runoff across six years. Numbers on top of the dissolved P bars indicate percent dissolved P of the total P loss. Different letters on top of the bars of each graph indicate statistically significant differences. Caution must be used when interpreting differences between results for the NT cover crop system and the other systems because the plots had different initial soil-test P levels and previous management history.
CH = chisel tillage, NT = no-till, Broad = broadcast P, Band = planter-band P.

Management systems for 2016 - 2018 study

System	Application timing and N source	Crop	Tillage	N rate (lb/ac)
1	Spring UAN -	Corn Soybean	Chisel plow Field cultivate	150 -
2	Early fall manure -	Corn Soybean	No-till No-till	150 -
3a	Late fall manure + Instinct	Continuous corn	Chisel plow	200
3b	Spring manure	Continuous corn	Chisel plow	200
4a	Late fall manure	Continuous corn	Chisel plow	200
4b	Late fall manure + 1 ton/ac gypsum	Continuous corn	Chisel plow	200
5	Early fall manure -	Corn + Rye cover Soybean + Rye cover	No-till No-till	150 -
6	Late fall manure -	Corn Soybean	No-till No-till	150 -

Research funded by Iowa Pork Producers Association and Calcium Products Inc

Nitrate-N Concentration



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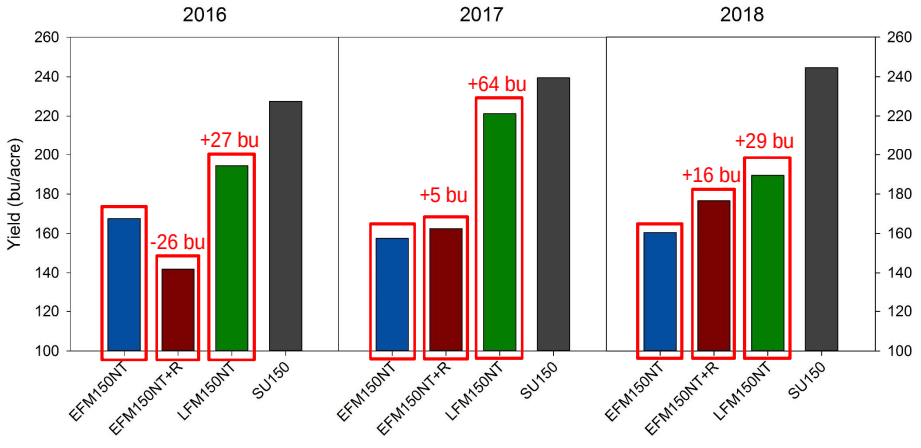
Corn phase yields



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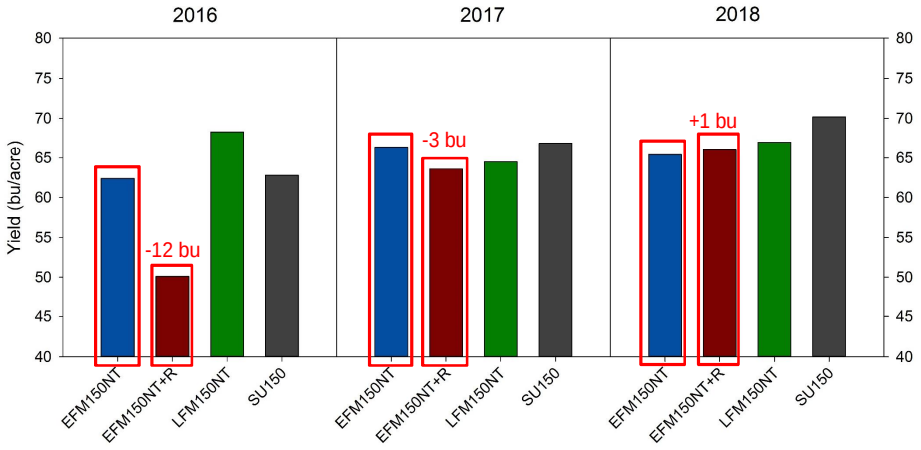
Soybean phase yields



Research funded by Iowa Pork Producers Association and Calcium Products Inc.

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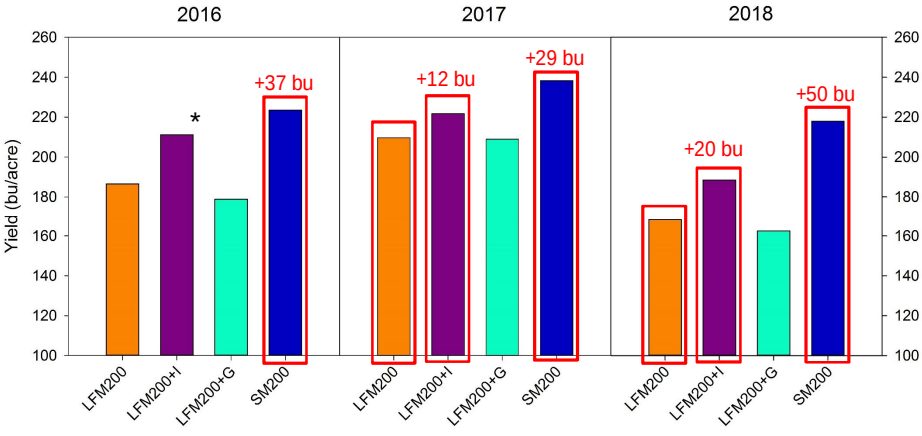
Continuous corn yields



*LFM200+I was planted to soybeans in 2015

Research funded by Iowa Pork Producers Association and Calcium Products Inc.

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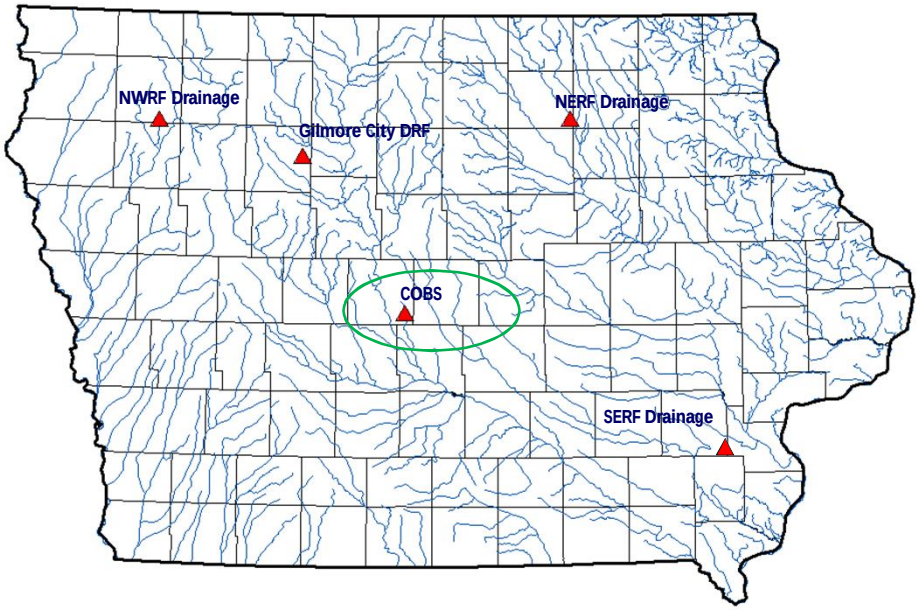
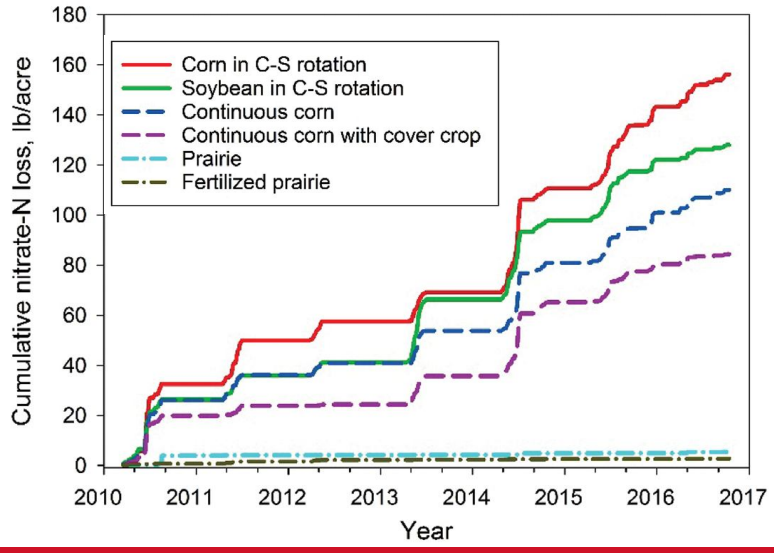
Replicated subsurface drainage plots to evaluate performance of various in-field management practices



Impact of Land Management



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Summary

- N management does impact nitrate-N loss
- Cover Crops can aid in reducing nitrate-N loss, sediment loss, and total P in runoff
- No-till has limited impact on nitrate-N loss
- No-till reducing total P loss with runoff but less impact on dissolved P in runoff

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Discussion

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www.extension.iastate.edu/diversity/ext

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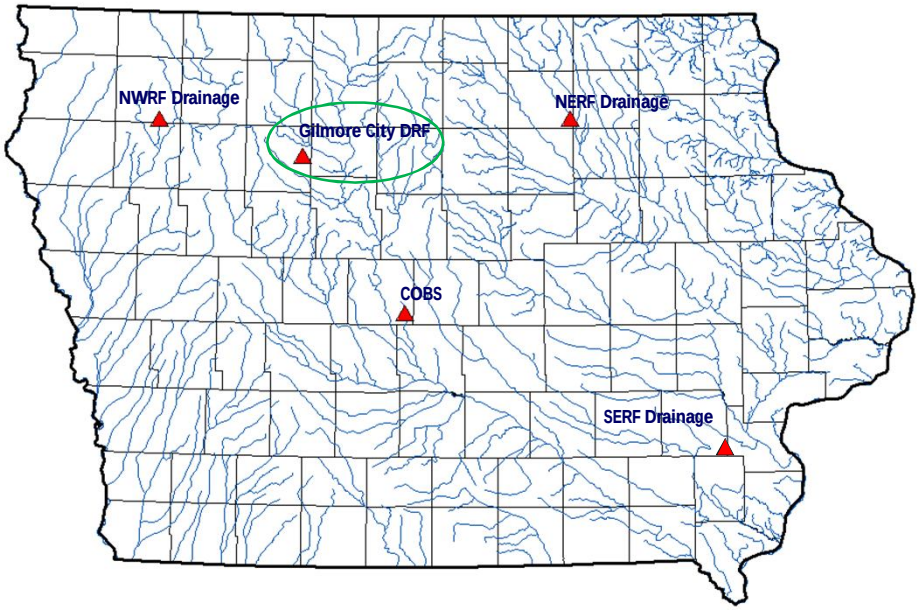
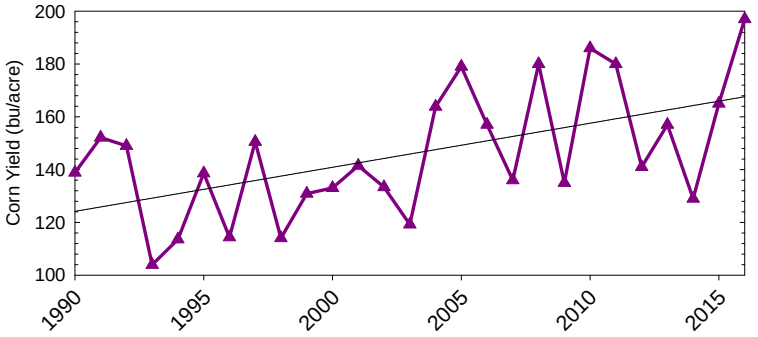
Extension and Outreach

Replicated subsurface drainage plots to evaluate performance of various in-field management practices



Temporal Changes

Corn Yield



Rsquared = 0.30
Slope = 1.67, p-value=0.0033

Combined Corn-Soybean System – Same N management – Early Spring Sidedress at 150-160 lb-N/acre

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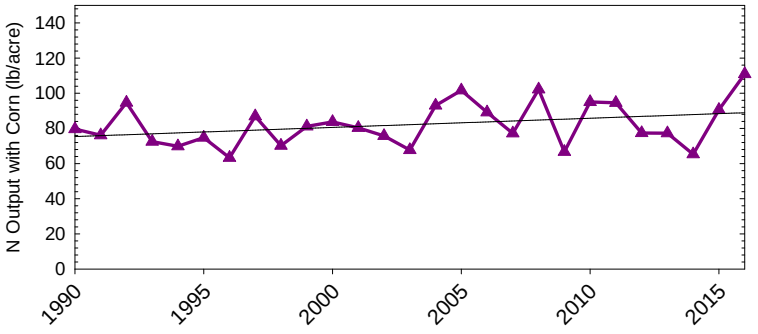
N Output with Corn Grain



Rsquared = 0.11
Slope = 0.52, p-value=0.09

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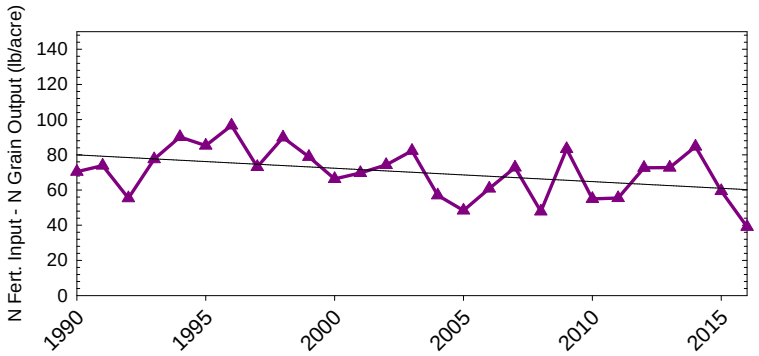
N Fertilizer Input – N Corn Output in Grain



Rsquared = 0.17
Slope = -0.76, p-value=0.0306

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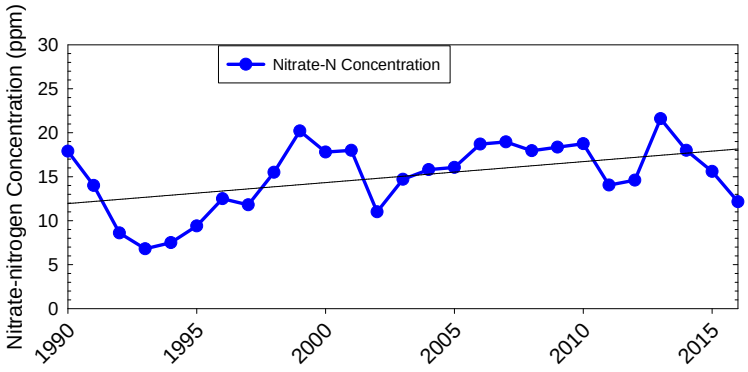
N Concentration



Rsquared = 0.23
Slope = 0.24, p-value=0.12

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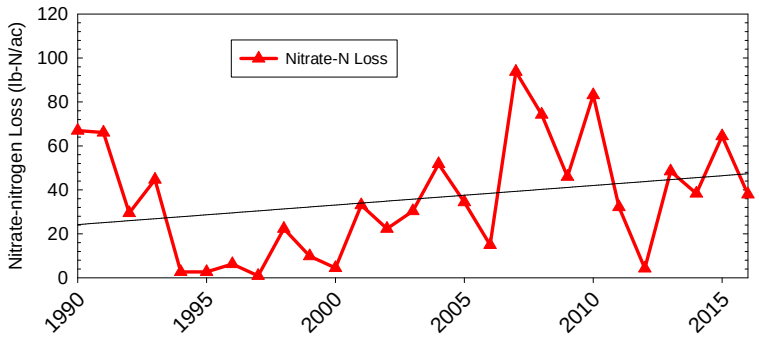
N Loss



Rsquared = 0.07
Slope = 0.89, p-value=0.18

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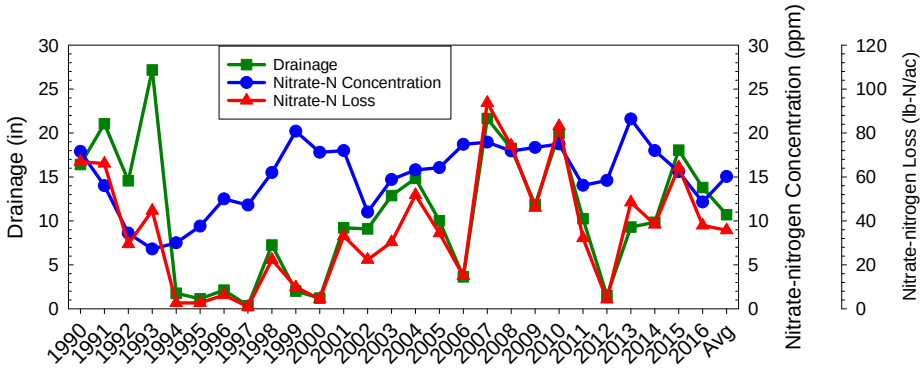
Twenty-Seven Year Summary



Combined Corn-Soybean System – Same N management – Early Spring Sidedress at 150-160 lb-N/acre

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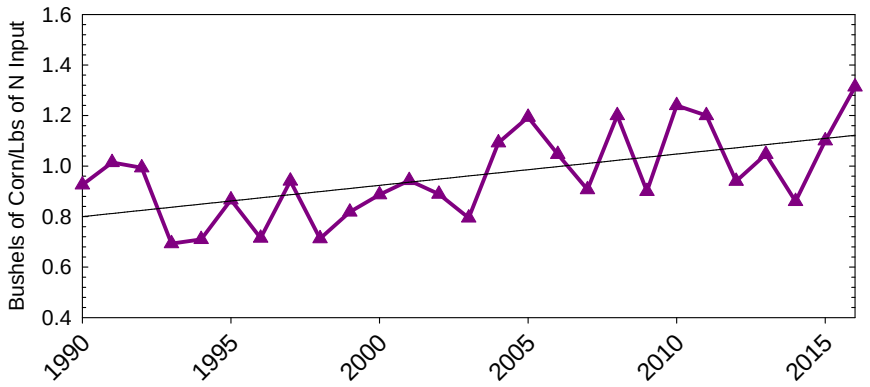
Bushels of Corn per Unit of N Input



Rsquared = 0.33
Slope = 0.012, p-value=0.0018

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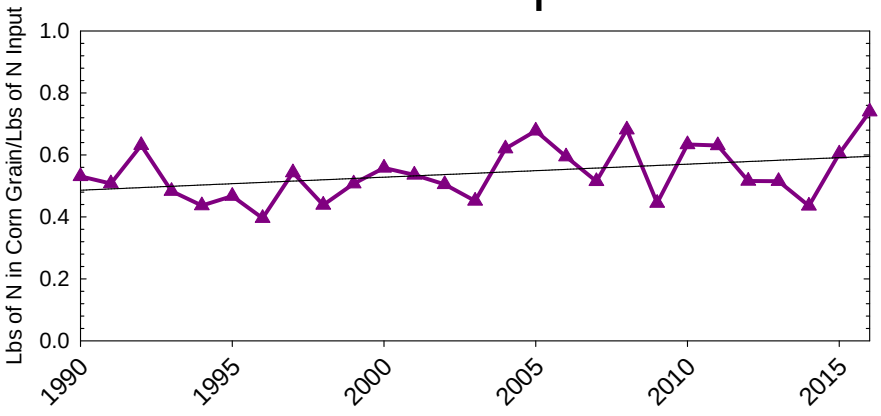
Pounds of N in Corn Grain per Unit of N Input



Rsquared = 0.14
Slope = 0.042, p-value=0.05

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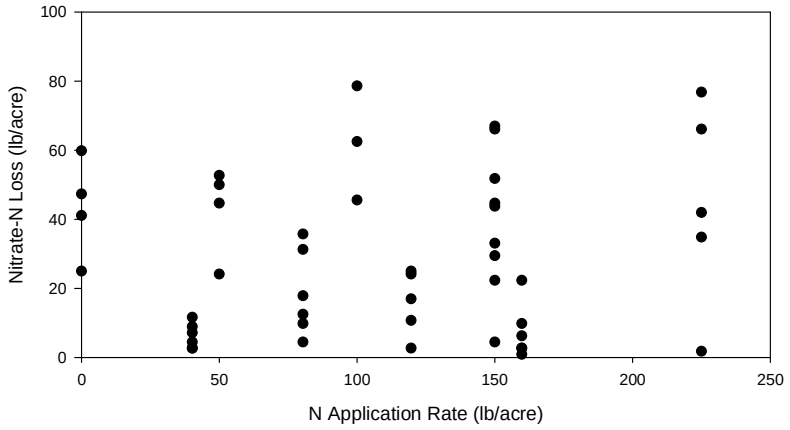
N Rate versus Load



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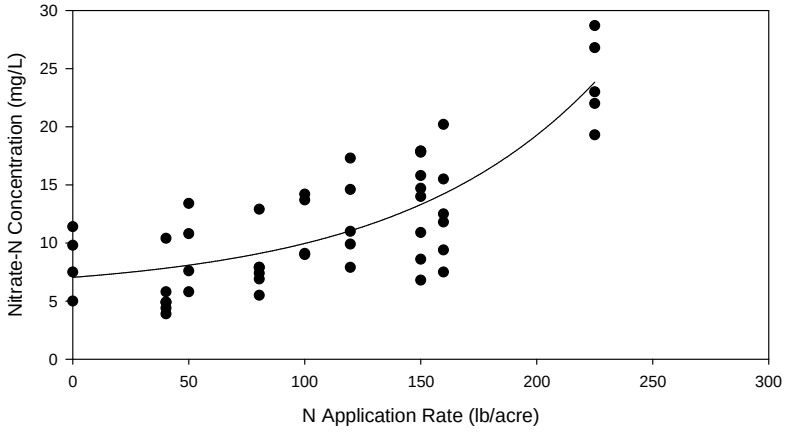
N-Rate versus Concentration



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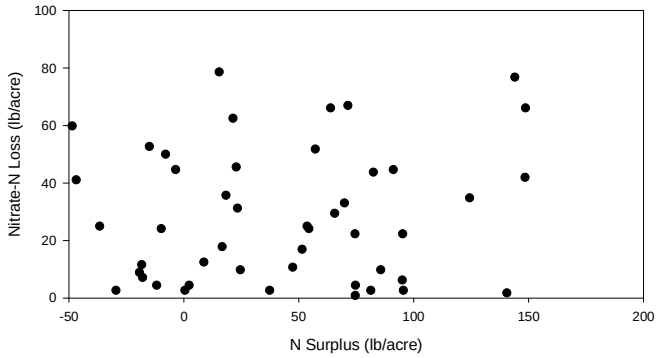
N Surplus = N input with fertilizer – N output with corn grain



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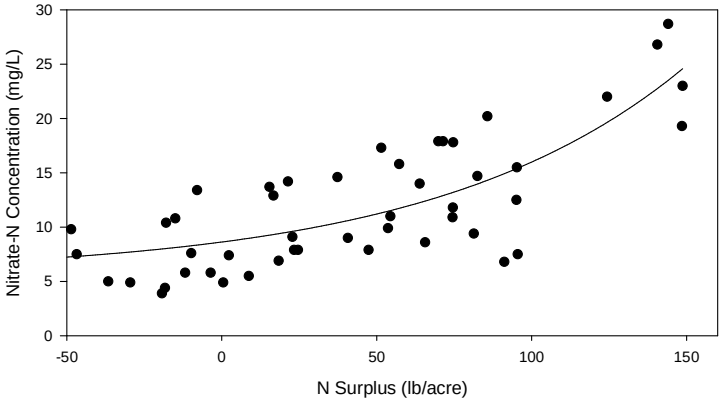
N Surplus = N input with fertilizer – N output with corn grain



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