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Impact of Liquid Swine Manure Application and Cover Crops on Nitrate in Subsurface Drainage Water

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Abstract
The primary objective of this project was to determine the impact of appropriate rates of swine manure applications to corn and soybeans based on nitrogen requirements of crops and the potential of nitrate leaching to groundwater. Another purpose of this longterm experimental study was to develop and recommend appropriate manure and nutrient management practices to producers to minimize the water contamination potential and enhance the use of swine manure as an organic fertilizer. A third component of this study was to determine the potential effects of rye as a cover crop to reduce nitrate loss to shallow ground water.

Keywords
Agronomy, Agricultural and Biosystems Engineering

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Introduction

The primary objective of this project was to determine the impact of appropriate rates of swine manure applications to corn and soybeans based on nitrogen requirements of crops and the potential of nitrate leaching to groundwater. Another purpose of this long-term experimental study was to develop and recommend appropriate manure and nutrient management practices to producers to minimize the water contamination potential and enhance the use of swine manure as an organic fertilizer. A third component of this study was to determine the potential effects of rye as a cover crop to reduce nitrate loss to shallow ground water.

Materials and Methods

Table 1 identifies the treatments established in 2007 on 36, one-acre plots. Comparisons begin in 2008 to eliminate previous treatment effects. Five treatments compare the effect of timing and source of N on subsurface drain water quality and crop yields in a corn-soybean rotation, and two treatments compare the effect of manure use on water quality under continuous corn rotation with and without stover removal. The spring-applied UAN (urea-ammonium nitrate) with cover crop and fall-applied manure are the only treatments using no-till while the rest of the treatments use fall chisel plow as method of tillage.

Results and Discussion

The effects of nutrient management treatments on NO_3-N concentrations in subsurface drain (tile) water are summarized in Table 2. Seven-year average NO_3-N concentrations in tile water from plots under continuous corn and receiving swine manure every year (System 4) were the highest in comparison with other treatments/systems. Systems 2, 3, and 6, which received fall swine manure for corn, gave the highest NO_3-N concentrations in tile water in comparison with other systems under corn-soybean rotation (Systems 1 and 5). The fall-applied manure to soybean rotation in Treatment 3 had consistently higher NO_3-N concentrations in tile water when compared with all other soybean rotations. Two systems (Systems 1 and 5) receiving UAN resulted in the lowest NO_3-N concentrations in tile water. Overall, the five-year experimental data from this study show that average NO_3-N concentrations in tile water from Treatment 5, with a cover crop, was the lowest in the corn and soybean phases of the production system.

The effects of source and timing of nitrogen application on corn and soybean yields for 2008 through 2014 are shown in Figure 1. The spring UAN application at 150 lb N/acre resulted in the highest average corn yield of 196 bushels/acre compared with other systems. Treatments 2 and 3 had the next highest corn yields. Treatments 5 and 6 had the lower corn yield for the rotation treatments. Although receiving higher nitrogen rates, the continuous corn treatments showed slightly lower corn yields than the rotation treatments. Soybean yields from Systems 2 and 3 receiving swine manure resulted in the highest average soybean yield of 63.7 and 65.2 bushels/acre, respectively.

Table 1. Experimental treatments for water quality study at the ISU Northeast Research Farm, Nashua, IA.

System	Timings and source of N	Crop	Tillage	Application method	Rate, lb/ac N-based	Rate, lb/ac P-based
1	Spring (UAN)	Corn	Chisel plow	Spoke inject	150	If needed
	-	Soybean	Field cultivate	-	-	If needed
2	Fall (manure)	Corn	Chisel plow	Inject	150	-
	-	Soybean	Field cultivate	-	-	If needed
3	Fall (manure)	Corn	Chisel plow	Inject	150	-
	Fall (manure)	Soybean	Field cultivate	Inject	100	-
4	Fall (manure)	Cont. corn	Chisel plow	Inject	200	-
4	Fall (manure)	Cont. corn Stover removal	Chisel plow	Inject	200	-
5	Spring (UAN)	Corn/rye cover	NT	Spoke inject	150	-
	-	Soybean/rye cover	NT	-	-	If needed
6	Fall (manure)	Corn	NT	Inject	150	-
		Soybean	NT	-	-	If needed

Table 2. Effects of experimental treatments on flow weighted average NO_3-N concentrations in drainage water (in mg/l).

	2008		2009		2010		2011		2012		2013		2014		08-14	
Experimental Treatments	**CS**	**SC**	**CS**	**SC**	**CS**	**SC**	**CS**	**SC**	**CS**	**SC**	**CS**	**SC**	**CS**	**SC**	**CS**	**SC**
1. Spring UAN 150 lb N/ac	15.1	8.0	12.1	9.5	12.3	8.0	17.8	13.8	14.0	19.5	14.6	23.3	17.7	11.5	14.8	13.4
2. Fall manure 150 lb N/ac	17.7	8.3	19.9	10.3	12.8	8.4	29.4	12.4	22.3	15.7	36.2	12.2	30.6	8.6	24.1	10.9
3. Fall manure 150 lbN corn & 100lbN soybean	20.3	14.2	20.3	11.1	16.1	14.0	27.7	18.2	32.1	20.1	38.3	34.3	39.9	17.7	27.8	18.5
4.1 Fall manure 200 lb N/ac	23.1		20.1		15.1		22.3		21.9		36.6		23.9		23.4	
4.2. Fall manure 200 lb N/ac + Stover removal	23.0		17.6		16.0		24.2		19.4		40.2		25.9		23.8	
5. Spring UAN 150 lb N/ac + Rye removal	12.3	8.6	8.9	8.3	10.4	4.4	9.2	8.9	8.4	7.4	7.7	12.4	15.3	10.1	10.3	8.6
6. Fall manure 150 lb N/ac	15.3	8.9	15.8	8.3	12.8	8.0	20.9	9.5	23.4	13.4	31.2	8.3	26.2	8.7	20.8	9.3

Figure 1: **Corn and soybean crop yields for years 2008-2014 at the ISU Northeast Research Farm, Nashua, IA.**