

Drainage Water Quality Impacts of Various In-field Nutrient Management Practices: Comparison of Biofuel Systems Site



The Comparison of Biofuel Systems (COBS) site has 24 0.4-acre research plots equipped with a drainage water monitoring system installed in 2008 (Figures 1 and 2). Plots have <1 percent slope with Nicollet and Webster soils. Tile lines are installed at a depth of 3.5 feet spaced 45 feet apart. Management practices are evaluated for their impact on nitrate-N and dissolved phosphorus (P) loss and crop yield. To quantify the impact of these practices, researchers are monitoring subsurface drainage volume and collecting flow-proportional water samples for nitrate-N and dissolved P analysis (Figure 3). The 30-year average annual rainfall at COBS is 35.8 inches. The average tile drainage flow from 2010-2016 is 9.0 inches.

At COBS, multiple management practices have been examined for their impact on N and P loss and crop yield:

Crops: Continuous corn, corn-soybean rotations, perennial prairie

Management Practices: Rye cover crop, no-till, split N application, stover removal, prairie biomass harvest



Figure 1. Comparison of Biofuel Systems (COBS) aerial image.

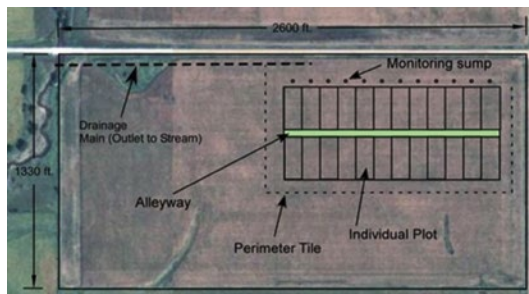


Figure 2. Schematic of the drainage plot setup.

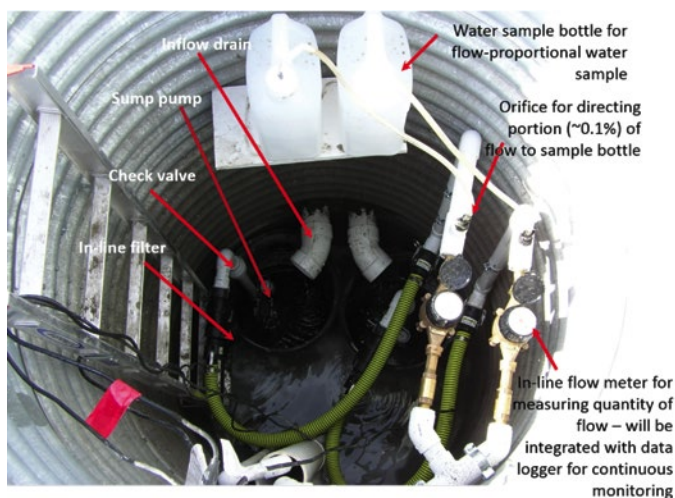


Figure 3. Schematic of the drainage monitoring system.

Key Findings from 7 Years of Research (2010-2016):

- Plots planted to corn received two split applications of injected N in the spring as 32 percent liquid urea ammonium nitrate (UAN), with the second application rate based on the soil nitrate-N values and the late spring soil nitrate-N test. Fertilized prairie plots received broadcast UAN. Average N fertilization rates for the years 2010-2016 were 162, 162, 176, and 77 lb/acre/yr for corn in corn-soybean rotation, continuous corn, continuous corn with cover crop, and fertilized prairie, respectively. Results are shown in Table 1.

- Flow-weighted nitrate-N concentrations were 0.1, 0.6, 9.3, 10.4, 13.1, and 13.2 mg/L for prairie, fertilized prairie, continuous corn with cover crop, corn, soybeans, and continuous corn, respectively.
- Annual nitrate-N loads averaged over seven years were 0.6, 0.8, 12.1, 15.7, 18.3, and 22.3 lb/acre for prairie, fertilized prairie, continuous corn with cover crop, continuous corn, soybeans, and corn, respectively (Figure 4).
- Despite higher nitrogen application in the continuous corn with cover crop treatment (176 lb N/acre 7-year average), the nitrate-N loss was less than under the continuous corn with no cover crop (162 lb N/acre 7-year average).
- Continuous corn with residue removal and corn-soybean rotations without residue removal produced similar mean annual flow-weighted nitrate-N concentrations, ranging from 6-18.5 mg/L from 2010-2013. In comparison, continuous corn with residue removal and a cover crop resulted in significantly lower mean annual flow-weighted nitrate-N concentrations of 5.6 mg/L averaged over the four years.
- In bioenergy-based corn systems with 50 percent stover harvest, the subsurface drainage nitrate-N losses were often above the US-EPA drinking water standard of 10 mg/L with exception of when a winter cover crop was used.
- Bioenergy-based mixed prairie systems with annual aboveground biomass harvest after senescence substantially limited nitrate-N losses to subsurface drainage even when synthetic N fertilizer was applied (Figure 4).
- Annual flow-weighted total reactive P concentrations (<0.04 mg/L) and annual loads (<0.13 lb/acre) were not significantly affected by cropping systems or rotational phases over a four year study.

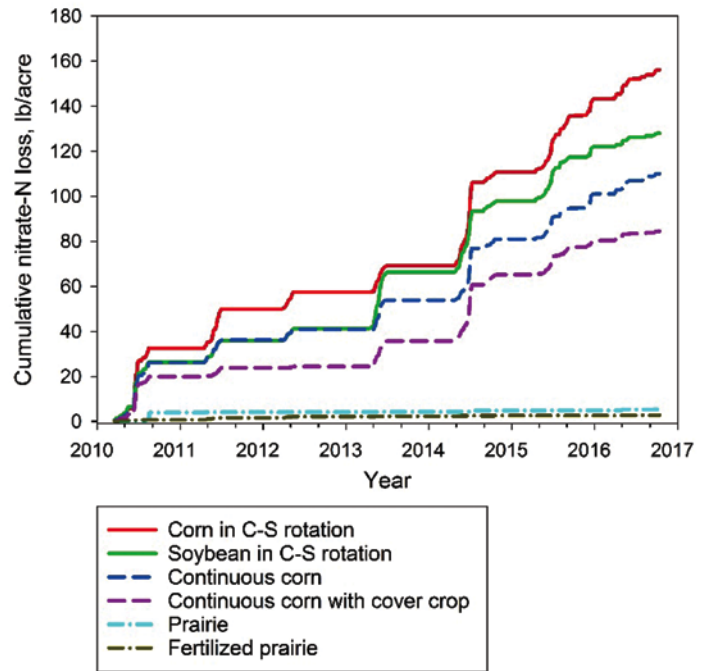


Figure 4. Cumulative nitrate-N losses from 2010 – 2016.

Acknowledgements

We thank Michael Fiscus and the staff of the Iowa State University Agricultural Engineering and Agronomy Research Farm for substantial logistical support, and many students for technical assistance in the field and laboratory. Funding for this research was provided by the ConocoPhillips Company, Iowa State University College of Agriculture and Life Sciences, USDA-National Institute of Food and Agriculture, USDA-National Agriculture Statistics Service Carbon Cycle Science Program, Iowa State University Department of Agronomy, and Leopold Center for Sustainable Agriculture.

For more information contact:

Dr. Matt Helmers
 Dean's Professor and Extension Agricultural Engineer
 Dept. of Agricultural and Biosystems Engineering
 Iowa State University
 Phone: 515-294-6717
 Email: mhelmers@iastate.edu

Table 1. Nitrogen application rates from 2010-2016.

Treatment	Nitrogen Application Rate (lb/acre)							
	2010	2011	2012	2013	2014	2015	2016	Avg.
Corn in Corn-Soybean Rotation	94	113	198	221	180	205	125	162
Continuous Corn	110	128	179	221	160	190	145	162
Continuous Corn with Cover Crop	151	198	198	221	145	205	115	176
Fertilized Prairie	75	75	75	75	75	75	88	77

This institution is an equal opportunity provider. For the full non-discrimination statement or accommodation inquiries, go to www.extension.iastate.edu/diversity/ext.