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

**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.

<table>
<thead>
<tr>
<th>Table 1. Nitrogen application rates from 2010-2016.</th>
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<tr>
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<tr>
<td>Corn in Corn-Soybean Rotation</td>
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<tr>
<td>Continuous Corn</td>
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<td>Continuous Corn with Cover Crop</td>
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<td>Fertilized Prairie</td>
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