Drainage Water Quality Impacts of Various In-field Nutrient Management Practices:

Southeast Research and Demonstration Farm

Since 2007, research at the Southeast Research and Demonstration Farm (SERF) has examined the effects of tile drainage on crop yield and drainage nutrient loss. The research farm includes eight individually drained plots that range from 3-6 acres in size (Figure 1). The eight plots include two replications of each of the four drainage treatments, including three artificial subsurface drainage systems and one undrained system. Each plot contains both crop phases of a corn-soybean rotation as well as a 24-row section of continuous corn. The center tile line from each plot is monitored continuously with a V-notch weir for drainage volume (Figure 2). Grab samples for nitrate-nitrogen (nitrate-N) and total phosphorus (P) analysis are taken weekly when tiles are flowing. Soils are predominantly Kalona and Taintor, both poorly drained silty clay loams. The 30-year average annual precipitation at SERF is 36.8 inches.

At SERF, drainage water management practices are examined for their impact on N and P loss and crop yield:

Crops: Corn-soybean and continuous corn.

Management Practices: Conventional drainage, controlled drainage, shallow drainage and no artificial drainage (Figures 1 and 3).

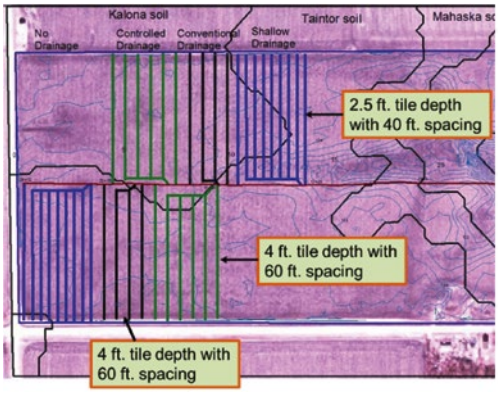

Figure 1. Topographic image of SERF showing layout of drainage treatments.

Figure 2. Image showing the inside of a drainage collection sump with V-notch weir.

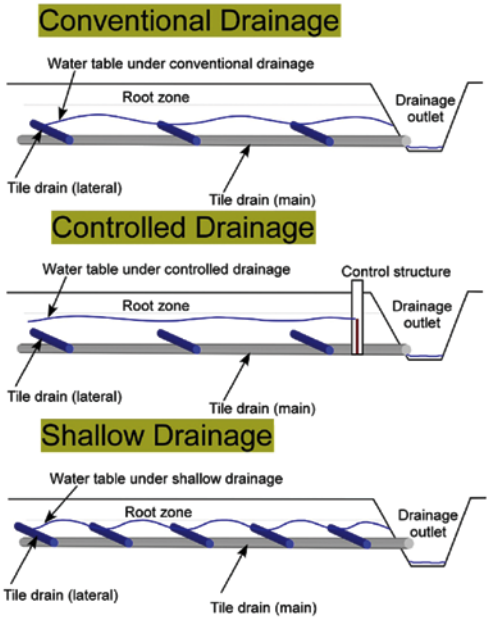

Figure 3. Schematic of subsurface drainage systems, including conventional, controlled and shallow drainage. Control boards are set at 2.5 feet below the ground surface and are removed two weeks before planting.

Key Findings from 10 Years of Research (2007-2016):

- In most years, the majority of the annual tile drainage occurred in April, May and June, due to timing of rainfall.
- Over ten years, the average annual tile drainage volume was 12.1 inches for the conventional drainage system.

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- Tile drainage volume was reduced by 52 percent with controlled drainage and by 53 percent for shallow drainage, when compared to the conventional system. For the controlled drainage system, average annual drainage volume was 5.8 inches and for shallow drainage this was 5.7 inches (Figure 4).

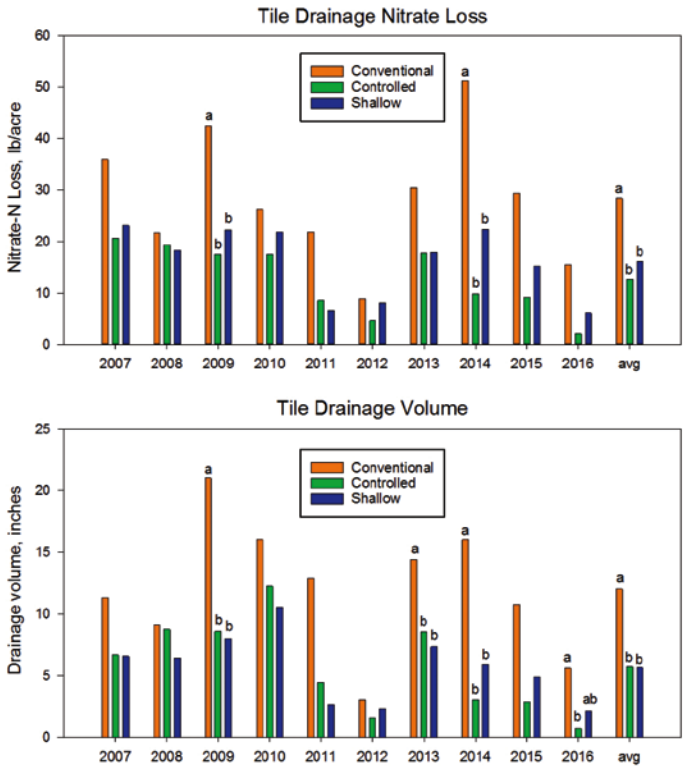

Figure 4. Annual tile drainage nitrate-N loss and volume from three drainage systems. Bars with the same letter (or no letters) for the same year are not significantly different at the P=0.05 level.

- The annual flow-weighted mean nitrate-N concentration of the drainage (total annual nitrate-N loss normalized to total annual drainage volume) was significantly greater in the shallow drainage system than the other two drainage systems (Figure 5).

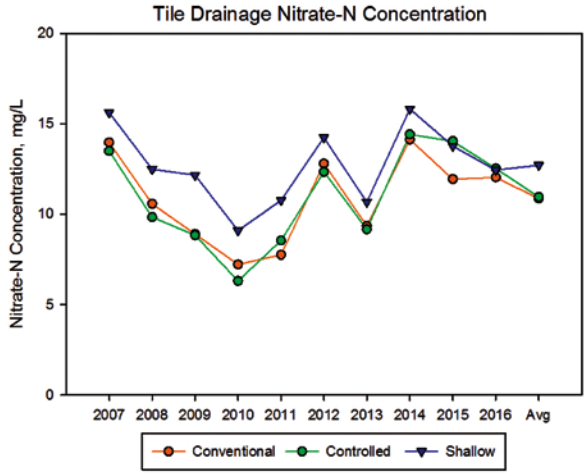

Figure 5. Annual flow-weighted nitrate-N concentrations for three drainage systems.

- The conventional drainage system exported 28.4 lb/ac of nitrate-N within tile drainage, on average over the ten years (Figure 4). The controlled drainage system significantly reduced this ten-year average nitrate-N loss by 55 percent with 12.7 lb/ac of nitrate-N loss and the shallow drainage system significantly reduced this by 43 percent with 16.2 lb/ac of nitrate-N loss.

- Reduction in drainage volume and nitrate-N loss for the controlled and shallow systems varied annually and depended on timing and quantity of annual precipitation. The reductions were generally greatest in years with below-average rainfall, rather than years with above-average rainfall.

- Average drainage nitrate-N concentrations were either greater than the conventional system (shallow drainage) or the same as the conventional system (controlled drainage). This means that reductions in mass of nitrate lost from shallow and controlled drainage systems was mostly attributed to reduced tile drainage volume.

- On average, drainage improved corn yields by 12.4 bu/acre and soybean yields by 4.8 bu/acre (Figure 6). Controlled drainage reduced corn yield by 8.0 bu/ac and shallow drainage reduced corn yield by 4.4 bu/ac, on average over ten years, and the greatest yield reductions occurred in years with high rainfall.

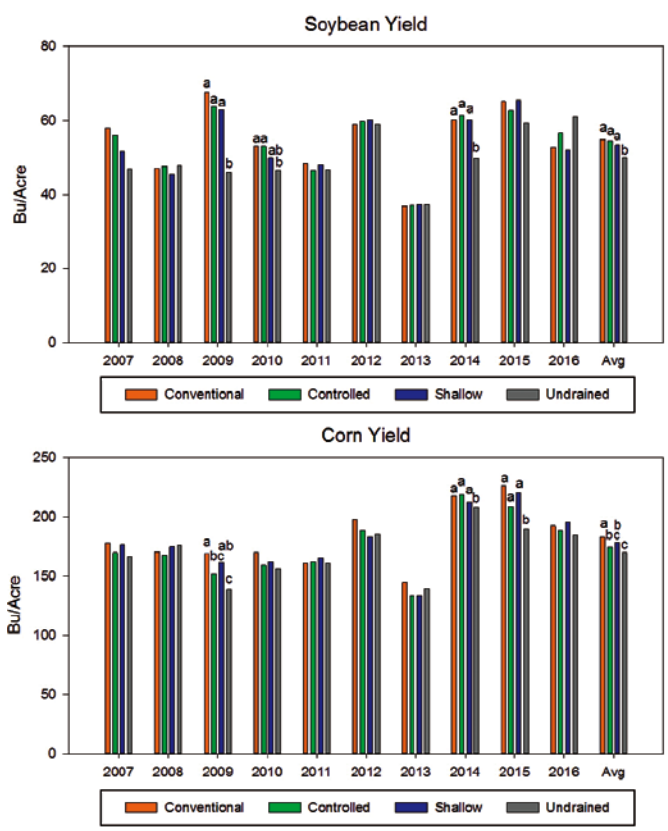

Figure 6. Annual soybean and corn yield from three drainage systems and undrained system. Bars with the same letter (or no letters) for the same year are not significantly different at the P=0.05 level.

- The depth to the water table was significantly shallower in the undrained plots and there were more occurrences of the water table reaching within one foot of the ground surface, compared to the drained plots. When the water table reaches within one foot of the ground surface, there is an increased risk of excess water stress and crop yield reduction.

- Water tables were generally the deepest in the conventional system, followed by the controlled and then the shallow system. There were no significant differences, however, in the time that the water table was within one foot of the ground surface between the conventional, controlled and shallow treatments. This means that even with shallower drains in the shallow drainage system, both the shallow and controlled drainage systems did not increase the risk of crop excess water stress as much as an undrained system.

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