# Report for 2004IA62B: Identification of Relationships Between Soil Phosphorus and Phosphorus Loss Through Tile Drainage to Improve the Subsurface Drainage Component of the Iowa Phosphorus Index

There are no reported publications resulting from this project.

Report Follows

# Identification of Relationships Between Soil Phosphorus and Phosphorus Loss through Tile Drainage to Improve the Subsurface Drainage Component of the Iowa Phosphorus Index

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## Problem and Research Objectives

The problem addressed by this project and the objectives were explained in the original proposal and have not changed. Therefore, only a brief summary is included.

Many questions related to the impact of current P management practices on P-related water quality are being asked by the public, government agencies in charge of nutrient regulations, producers, and researchers. Because of inappropriate fertilizer or manure management or the need to dispose of manure, excess P often is delivered from agricultural fields to water resources. Management guidelines and regulations are being established based on a P risk assessment tool often referred to as the P index. Although a P index has been developed for Iowa and many other states, gaps and insufficient information about some processes have created a great deal of uncertainty for some P index components. This project focuses on excess dissolved P loss through subsurface drainage that can occur when soil P concentration increases. Although many studies have monitored P concentration in tile drainage, few (and none in Iowa) have studied relationships between soil-test P and P loss through tiles. Soil-test P is affected by P fertilization, manure application, crop production, and several management practices. Although results of agronomic soil P tests are currently used in P indices, environmental P tests have been proposed as an alternative to these to measure P in soil and runoff water. There is little information concerning correlations of P extracted by either agronomic or routine tests and P loss through subsurface drainage. Limited information led the team that developed the Iowa P index to include approximate estimates of relationships between soil-test P and P loss in its subsurface drainage component.

The overall goal of the project is to establish relationships between soil P measured by various tests, fertilizer and manure P management, and P loss through subsurface drainage. The work is an interdisciplinary effort that uses existing facilities and inter-departmental cooperation to achieve objectives at a low cost. Specific objectives include:

1. Study the impact of fertilizer and manure applications on soil P measured with routine agronomic soil tests and environmental soil test methods that emphasize an assessment of potential P losses to water supplies;
2. Establish relationships between soil-test values and P concentrations in subsurface tile drainage for selected manure/fertilizer management systems; and
3. Develop equations that can be included in future revisions of the soil P factor of the subsurface drainage component of the Iowa P index.

## Methodology

The methods used during the first year of the project followed those explained in the original proposal and only a brief summary is included here. Soil and tile drainage samples were collected during 2004 from three long-term field experiments. The experiments included replicated manure treatments or a combination of nutrient and cropping systems treatments. All plots have a tile collection system with automatic water sampling devices. One experiment at the Northeast Research Center evaluates cropping (tilled or no-till) and manure/fertilizer management systems for corn-soybean rotations. The systems include only N and P fertilizer according to crop needs, only manure according to the N needs of the corn, manure according to the P needs of the corn (and N fertilizer supplementation), and manure according to the estimated N removal by both the corn and soybean crops. Two other experiments are established at the Agronomy and Agricultural Engineering Research center near Ames. One experiment includes various rates of poultry manure compared with equivalent N fertilizer rates for the corn-soybean rotation. The other experiment evaluates swine manure placement (broadcast, injected) and time of application (fall, spring) for the corn-soybean rotation. Soils were sampled to a depth of 3 feet.

## Principal Findings and Significance

No detailed results for the first year can be reported at this time because many samples are still being analyzed in the laboratory or results are being summarized into computer files. For example, all water samples collected along the season at the three sites were analyzed for orthophosphate P, but data are still being studied for possible outliers before calculating average concentrations for the year and P loads. Approximately 400 soil samples (considering all plots and various sampling depths) were processed; many analyses were completed, but others are still in progress and a database generation needs all results completed. Soil is analyzed for P by routine soil P tests (Bray-P1, Mehlich-3 P, and Olsen), pH, two environmental P tests (Fe-oxide impregnated paper strips and water extraction), and total P.

The preliminary results indicate that the treatments applied to these experiments resulted in large differences in soil-test P values for the 6-inch top layer of soil. This is a good result because it guarantees meaningful relationships between soil-test P levels and P in tile drainage. For example, the results of agronomic soil tests indicate that soil-test P ranged from values near optimum for corn and soybean production (for which maintenance P fertilization is recommended) to values as high as six times the optimum values (higher than 120 ppm by the Bray-1 or Mehlich-3 tests and higher than 70 ppm by the Olsen test). The largest soil P values were observed for plots in which manure was applied every year at estimated N-removal rates or when manure was applied only for corn but at rates higher than needed according to current recommendations for N fertilizer application.

Observation of P concentrations in tile water also showed large variation, although raw data have not been summarized at this time for all sites or treatments. For example, data available for the Northeast Research Center indicate that average orthophosphate P in tile

water ranged from values less than 20 ppb (parts per billion) to almost 210 ppb. The highest value corresponded to a treatment in which swine manure is applied to both corn and soybean crops in the rotation at rates based on N needs of corn and expected N removal with soybean harvest. The lowest values corresponded to treatments in which either fertilizer or manure P was applied according to current Iowa recommendations for both crops. Interestingly, however, P in tile water was also low for plots of a treatment involving application of swine manure at N-based rates only for corn. This result, together with results of soil P tests, suggests that manure application only for corn at amounts that supply the N needs of corn and at the same time approximately the P needs for the two crops of the rotation does not result in elevated P concentrations in tile drainage. The tile water flow data are also available for these sites, but calculations of P loads have not been completed at this time.