National Research Project to Identify Sources of Agricultural Phosphorus Loss

By Andrew Sharpley, Tommy Daniel, Bob Wright, Peter Kleinman, Terry Sobecki, Roberta Parry, and Brad Joern

Why the Concern?

Reductions in point sources of water pollution over the last 20 years have drawn attention to the role of agricultural nonpoint sources in water quality impairment. According to a recent EPA survey, most of this impairment is caused by eutrophication. Eutrophication is the process of increased aquatic productivity due to excessive nutrient inputs. While both nitrogen (N) and P contribute, P is the primary agent in freshwater eutrophication, since many algae are able to obtain N from the atmosphere. Consequently, controlling eutrophication mainly requires reducing P inputs to surface waters.

The U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS) is coordinating a National Phosphorus Research Project in cooperation with universities, the Environmental Protection Agency (EPA), and the Natural Resources Conservation Service (NRCS) to establish soil-specific threshold phosphorus (P) levels in watersheds sensitive to P losses. The results of this research will provide defensible recommendations for protecting water quality in nutrient management plans utilizing animal wastes.

What Is the Research Need?

In many areas of intensive livestock production, manures are normally applied at rates designed to meet crop N requirements. This often results in P being applied in excess of crop needs, which can increase the amount of P in the surface soil and enrich surface runoff with enough P to accelerate eutrophication.

In response, several states have used agronomic soil tests to identify threshold soil P levels perceived to limit eutrophic runoff. However, agronomic soil tests were designed to estimate plant-available P, not to predict soil P release to surface runoff. Also, soil P must be used in conjunction with an estimate of the potential P transport from a site in surface runoff and erosion. The P Index is a tool that integrates these source and transport factors.

The P Index was developed by ARS, NRCS, and university scientists as a screening tool to rank the vulnerability of fields as sources of P loss in surface runoff. To increase its accuracy and reliability, research is needed on the soil-specific relationships between soil P and P in runoff water.

What Are the Project Objectives?

The goals of the National Phosphorus Research Project are to:

- provide a sound scientific basis for establishing threshold soil P levels in areas where P enrichment of waters (surface and subsurface) may impair water quality,
- develop a reliable indexing tool to assess and rank site vulnerability to P loss from watersheds throughout the U.S., and
- incorporate this information into an integrated nutrient management decision-making process at a watershed scale.

The time frame for these objectives ranges from two to five years. We plan to quantify the relationship between surface runoff P and soil P for several key areas and soils with-

in the next two years. Over the following three years, we will increase the number of soils and sites investigated. With NRCS, we will develop a framework to extrapolate National Phosphorus Research Project results to the national soils data base. Working with EPA at all stages of this project will ensure that policy regarding nutrient management strategies and criteria is based on sound scientific information.

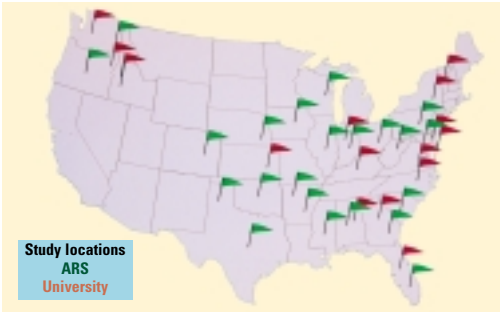

Figure 1. Flags indicate ARS and university locations currently cooperating on the National Phosphorus Research Project.

Where and How Will This Be Done?

This work will be done by ARS in cooperation with the following agencies and institutions at national, regional, state, and local levels: land grant universities, EPA, NRCS, state soil and water conservation agencies, Cooperative Extension Service, and agricultural experiment stations. Currently, there are over 20 cooperators (**Figure 1**).

Initially, eight to 10 locations will be selected throughout the U.S. Each location will have four or five soil types that are characteristic of the region. These sites will be located in areas of elevated soil test P and which have potential for water quality impacts. A total of 45 to 50 different soil types will be studied.

We will use plots (6 feet long and 3 feet wide) to determine the relationship between soil P and surface runoff P. For each soil type, sites ranging in soil P content (low to very high soil test P) will be selected. Sites will not have had manure or fertilizer P additions in the last six months, so that we will be investigating the effect of soil P on runoff P rather than recent land management. On additional plots, manure will be applied to evaluate the effect of manure rate, application timing, and manure type on P transport in surface runoff.

Soil P will be determined by agronomic soil tests and by new environmental methods [water extractable, iron (Fe) oxide strip, and P sorption saturation]. Surface runoff from simulated rainfall-runoff events will be collected and analyzed. Rainfall will be applied using simulators designed for this project (**Figure 2**). Lysimeters will be installed at sites where P movement through the soil profile has been shown to predominate or where it is a potential pathway of concern.

The various soil specific relationships between soil P and surface runoff P will be incorporated into the P indexing tool. The index will be modified and tested at the watershed scale throughout the U.S.

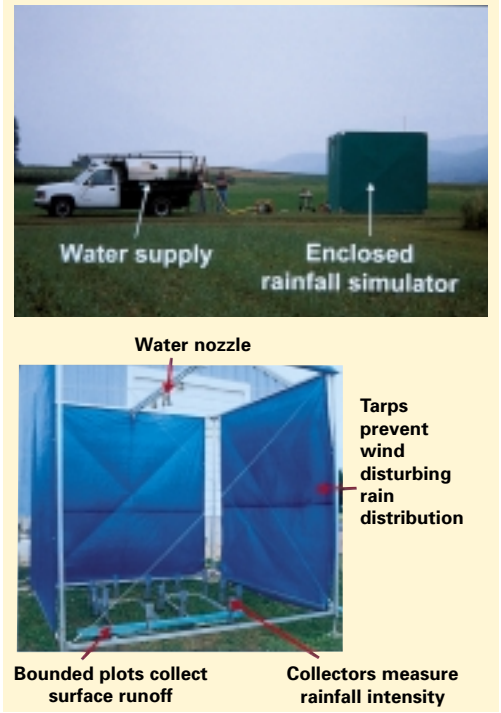

Figure 2. Prototype rainfall simulator being used in the National Phosphorus Research Project.

What Can We Expect from the Study?

This research will support a scientifically defensible environmental P index for nutrient management. This indexing tool will allow greater flexibility in managing manures, because it will allow more manure use on soils capable of retaining P while avoiding such use on soils with high risk of P loss. Manure applications will be better targeted to benefit productivity in high yield cropping systems. This will meet critical needs of NRCS and EPA as they develop guidelines for nutrient management planning to utilize manure and protect water quality. BC

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TABLE 1. Institutions participating in the National Phosphorus Research Project.

Northeast
ARS, Beaver, WV
ARS, Beltsville, MD
ARS, University Park, PA
Cornell University, Ithaca, NY
University of Delaware, Newark, DE
University of Maryland, College Park, MD
University of Vermont, Burlington, VT
Virginia Polytechnic Inst. and State University, Blacksburg, VA

Southeast
ARS, Auburn, AL
ARS, Booneville, AR
ARS, Florence, SC
ARS, Miami, FL
ARS, Mississippi State, MS
ARS, Oxford, MS
ARS, Tifton, GA
Auburn University, Auburn, AL
North Carolina State University, Raleigh, NC
University of Florida, Gainesville, FL
University of Florida, Ona, FL
University of Georgia, Athens, GA
University of Arkansas, Fayetteville, AR

Midwest
ARS, Coshocton, OH
ARS, Madison, WI
ARS, West Lafayette, IN
Purdue University, West Lafayette, IN
University of Wisconsin, Madison, WI

Great Plains/Rockies
ARS, Akron, CO
ARS, Bushland, TX
ARS, Fayetteville, AR
ARS, Lincoln, NE
ARS, Temple, TX
Brigham Young University, Provo, UT
Iowa State University, Ames, IA
Kansas State University, Manhattan, KS
NRCS, Fort Worth, TX
NRCS, Lincoln, NE
Oklahoma State University, Stillwater, OK
Texas A&M University, College Station, TX
University of Missouri, Columbia, MO

Northwest
ARS, Kimberly, ID
Oregon Graduste School, Beaverton, OR
Oregon State University, Corvallis, OR
University of Washington, Prosser, WA

Administration
ARS, Beltsville, MD
EPA, Washington, D.C.
NRCS, Lincoln, NE
NRCS, Washington, D.C.