WATER RESOURCES RESEARCH GRANT PROPOSAL

Geochemistry, Geostatistics, and Hydrology of Phosphorus Losses in Agricultural Drainage Developing Improved Phosphorus Management Practices for Surface Water Protection

Duration: September 1, 1996 to August 31, 1999

Federal Funds Requested: $208,160

Non-federal Matching Fund: $484,422

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Congressional District: At-large

Statement of Critical/Regional Water Problems:

Phosphorus (P) originating from agricultural crop production has been identified as a key factor in nonpoint source pollution of surface waters in many areas of the United States and western Europe, particularly in regions dominated by animal-based agriculture (Breeuswma, 1995; Daniel et al., 1994; Mozaffari and Sims, 1994; Sharpley, et al., 1994; Sims and Ritter 1993; Sims, 1995; Sims, 1993; Sims and Wolf, 1994). Nutrient management measures that will effectively reduce the impacts of P on surface water quality must address an array of interrelated issues, but ultimately must focus on the factors that control the *supply and transport* of P from agricultural soils to waters sensitive to eutrophication. The nature of animal-based agriculture often results in an oversupply of P to agricultural soils. On the Delmarva peninsula, as in many northeastern and Atlantic coastal plain states, the presence of a large and highly concentrated poultry industry exacerbates the problem of nutrient management. Sims and Wolf (1994) estimated that between the poultry industry and fertilizer sales, there is an

coastal plain states. Recent soil test summaries in Delaware showed that 82 % of manured soils are now high or excessive in P, where no further application of manure or fertilizer P would be recommended (Sims and Schilke-Gartley, 1993). Previous research has also shown that it can take from 10 to 20 years to deplete soil P from excessive to optimum levels (McCollum, 1991). Therefore, even if manure applications were stopped completely, unlikely given the fact that the poultry industry is expanding at about 5 % per year on the Delmarva peninsula, the potential environmental impact of soil P on surface water quality will remain an issue for years to come.

It can certainly be argued that soils with extremely high P levels will only be of environmental concern if a means exists to transport P to surface waters sensitive to eutrophication. Many fields in Delaware's coastal plain, and in other northeastern states with similar topographic and hydrologic conditions, are relatively flat and reasonably well-drained, hence erosion and surface runoff will be rather low, except from soils with extremely high P levels. However there are large areas of agricultural cropland that are farmed only because an extensive ditch drainage system was constructed beginning in the 1940's. In some northeastern states tile drainage is used rather than open ditches. The water table in these fields can be at or near the soil surface during the spring or even following heavy rainfall events in the summer. These ditches are extensions of the natural drainage system in a watershed and serve to drain the fields by capturing surface runoff and by airing the water table. Little is known about the possible transport of P from agricultural fields via these drainage systems (ditches and/or tiles) to downstream surface waters or to shallow ground waters. Moreover, since the mid 1980's water control structures (WCS) have often been installed in these ditches to artificially slow drainage, raising the water table beneath fields during the growing season in an effort to "sub-irrigate" crops. Some research in other states has shown that WCS enhance water quality by reducing water flow and thus creating anoxic conditions that may promote denitrification in soils, removing nitrate from shallow ground waters (Evans et al., 1989; Gilliam et al., 1979; Deal et al., 1986). However, previous studies in other regions have shown that P release from soils and sediments can be greater under anoxic conditions, resulting in increased concentrations of soluble P in drainage waters (Gale et al., 1992; Logan, 1982; Moore et ai., 1992; Sallade and Sims, 1994; Vadas and Sims, 1995, 1996). Hence, a management practice installed to mitigate one environmental problem (nitrate transport of P). Information on the role of agricultural drainage, controlled or otherwise, on nonpoint source pollution of surface waters by P is badly needed to help develop management practices that improve water quality. Quantification of the potential for surface runoff of soluble P from the relatively flat, high P soils in this watershed to these drainage ditches is also needed.

Statement of Results and/or benefits

We believe that three important benefits will result from this research. First, we will improve our fundamental understanding of the soil and geochemical processes that control the release of P to drainage waters and surface runoff. Second, the geostatistical analyses and hydrologic modeling will identify the areas where improved management contamination) may be creating another (solubilization and practices for P should be focused in Delaware's Inland Bays Watershed, site of a national estuary and many small, locally important ponds and lakes. Finally, we believe that the integrated nature of this study should allow its application to many other northeastern states faced with similar water quality problems. Specifically we believe that innovative, mechanistically-based soil management practices for high P soils can be developed to minimize the transport of P from agricultural cropland to surface waters via drainage and surface runoff.