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Managing Agricultural Lands to Minimize Non Point Source Nutrient Losses, With Specific Reference to the Nitrogen Contributions to the Gulf of Mexico from the Upper Mississippi River Basin.

INTRODUCTION

The realization that nonpoint sources of nutrients, specifically nitrogen (N) and phosphorus (P) from agricultural lands represent a significant water quality issue is relatively recent. (Natural Research Council [NRC] 2000; Keeney, 2002). In the 1960-1980 era, federal and state programs were directed largely to controlling point nutrient sources such as sewage treatment plants and industrial outfalls. While largely successful in reducing P and Biological Oxygen Demand loads to waters, these "concrete" projects often did not significantly improve water quality, especially in lakes and streams that receive significant runoff from rural lands. Nonpoint (initially termed diffuse) nutrient sources were soon recognized as a major part of the nutrient budgets of many lakes, streams and reservoirs. Initially, only overland flow was regarded as a major source of nutrients. Hence much of the "water quality" work and policy efforts emphasized controlling runoff and sediment loss. But eutrophication was not checked. Eventually groundwater, tile drainage and interflow were recognized as a key part of the nutrient equation, and now atmospheric transport also is regarded as a potential large source of nutrients.

Excess nitrogen in the estuaries of the oceans enhances growth of aquatic organisms to the point that they affect water quality and lower dissolved oxygen levels (Rabalais et al., 2001). This affects the metabolism and growth of oxygen requiring species, causing a condition referred to as hypoxia (NRC 2000; Rabalais et al., 2001).

Policy and agricultural technology has not kept pace with the science of water quality. Agricultural lands are not managed in general to reduce nonpoint nutrient sources, and there are few if any rewards and incentives for doing so. Farm policy rather has continued to emphasize and reward production, especially of row crops, which are by far the largest contributors of nutrients. The federal and state Departments of Agriculture continue to promote and protect agriculture, often with policies and incentives in opposition to pollution abatement. There have been many attempts to address nonpoint source pollution by legislation, but the issue is not one that is easily addressed. There are many potential sources of nutrients in any given watershed. Transport mechanisms are weather-related, and vary seasonally, yearly and over longer times that may or may not be related to global climate change.

Society has a problem with agricultural nonpoint source nutrient management. It cannot be legislated out of existence (this could be done e.g., for a toxic pesticide); it cannot be controlled with inflows of cash for structures (witness the large expenditure for waterways and terraces that might control soil loss, but do little for nutrient runoff). It is evasive and many feel will require major cropping systems/land management changes before it can be controlled. Incentives might work but so far nothing has really been successful. The low returns to farming give little wiggle room for farmers to do things on their own, and most approaches that might lower nutrient loss require more management and lower net returns through either yield loss or higher input costs. Thus the farming community is understandably reluctant to be part of the solution, especially since they are part of the problem.

The farming community is suspicious of efforts to control nonpoint source pollution. Hence non-point source control has low political weight at state and national levels, and tends to be a "cause" for environmental groups rather than a responsibility of farm operators and landowners. Little if any rewards accrue for control of offsite pollution.

The past two decades have seen a plethora of symposia, studies, extension and private attempts to put better practices into place, many failed attempts at legislation, and lakes, streams and estuaries that are either getting worse or just holding their own. What has been the response to date? Perhaps the most widely attempted has been the establishment of the best management practice (BMP) concept. This essentially is using current technology and information to do things a little better, e.g., less fertilizer, better application, manure added at proper rates and incorporated, etc., etc. There are litanies of these technologies, most of which make much common sense and some of which actually are widely accepted. But they cannot be expected to correct the problem of nonpoint pollution, only to slow its advance. They almost universally promote the very row cropping approaches that lead to the problem. The BMP's that are knowledge intensive usually are not widely accepted, as are those that cost money. And often they involve a risk of crop yield loss, (e.g., using the minimum amount of fertilizer for profitable crop yields). Farm managers are as risk averse as the rest of us and they seldom take chances just for what often is hard to document improvement in water quality downstream.

CROPPING SYSTEMS

Significantly decreasing the export of nutrients from agricultural landscapes will require more than just end of pipe treatment (e.g., wetlands) and lowering inputs. It will require major changes to the landscape in the form of less nitrogen-requiring crops and crops that protect the soil and minimize leaching through out the year. This translates largely to legumes and grasses, a general category of crops that are not known for high agronomic cash returns. Jules Pretty uses the terms "efficiency, substitution, and reinvention" to describe the various phases that agriculture must pass through before it is sustainable (Vorley and Keeney 1998).

In almost all cases, proposals to reduce the upper Mississippi River Basin N load stop at the efficiency phase. (Keeney, 2002). Improved N management, including soil and plant testing, more timely applications, elimination of the practice of applying fertilizer in the fall, and precision agriculture, are efficiency measures (best management practices) that echo the management that caused ecosystem degradation in the first place. A student of the history of soil fertility would see little new in the efficiency proposals from those of the past. Incorporation of improved management practices will help minimize nitrogen output but I feel that nitrogen outputs cannot be reduced sufficiently with even improved management practices to meet the 30% reduced nitrogen load target. The concept of substitution, a concept that works at least in theory for pest control, is not easily carried out for nitrogen. The only substitution is using nitrogen-fixing legumes in place of fertilizers, an age-old practice that was finely honed in the first half of the last century, but abandoned quickly when nitrogen fertilizers became readily available.

Reinvention of corn-soybean based agriculture will have its strong critics. Most naysayers would first bring up the issue that a lower productive agriculture would not feed the world nor save land for wildlife, but rather would impoverish the farm sector. These are issues beyond the scope of this paper, but they can be addressed with policy changes that support smaller farms and rely less on expanded grain trade.

Alfalfa is a source of high quality protein, but it has the disadvantage of high processing costs. These can be overcome by the use of improved plant varieties and new technologies. This concept is now being considered in Europe as a substitute for soy protein. Marketing of alfalfa in regions where it is deficient is also likely. Transferring some of the intellectual input and marketing currently going into corn to alfalfa would lead to breakthroughs that would cause us to regard alfalfa as the miracle plant of the future.

THE WORKING LANDSCAPE

A new concept, the working landscape, is emerging in Europe and the United States. This is the precept that our private lands need to do more than just produce food and fiber, but can provide biodiversity protection, improved soil and water quality, wildlife habitat, carbon sequestration, viable rural economies, and a host of other benefits. Working Landscapes looks at ways to couple voluntary, incentive-based policies with landowner innovation and private enterprise. It is a goal rather than a set of practices. It involves developing profitable uses of the land while maintaining and improving social and environmental services.

Working landscapes is a win-win concept. It always involves forming urban-rural partnerships, and looks to find ways to diversify rural communities and develop profitable, environmentally and socially responsible enterprises. Examples include new products such as wind and biomass energy, organic agriculture, green agriculture and forestry and tourism and hunting. It would also involve use of government programs in ways that enhance environment and social structure of rural landscapes rather than contribute to the current overproduction problems.

To successfully develop working landscapes requires a strong partnership of farmers, landowners, policy makers, industrialists, input manufactures and suppliers, financiers, and the public. To get the many groups on one page is going to be very difficult, especially given that agriculture currently does not perceive itself to be at a crisis stage.

THE 2002 FARM BILL

The Conservation Security Program of the 2002 Farm Bill offers many stewardship options that if properly used and adequately funded can be a positive step toward a new agriculture include:

- Nutrient management
- Integrated pest management
- Water conservation and quality management, including irrigation
- Grazing, pasture, and rangeland management
- Air quality management
- Energy conservation measures
- Biological resource conservation and regeneration
- Contour farming
- Soil conservation, quality, and residue management
- Invasive species management
- Fish and wildlife habitat conservation, restoration, and management
- Strip cropping
- Cover cropping
- Controlled rotational grazing
- Resource-conserving crop rotation
- Conversion of portions of cropland from soil depleting to soil conserving use
- Partial field conservation practices
- Native grassland and prairie protection and restoration
- Other practices approved by USDA

Payments are made based on the resource of concern addressed in a conservation security plan and can be a maximum of $20,000, $35,000 or $50,000 per farm per year (referred to as tier 1, 2 or 3 contracts). Base payments involve rental rate, and cost share for land management, vegetative or structural practices.

Rules for this program are being developed. They are complicated, and often the Natural Resources Conservation Service will not have sufficient personnel to develop and oversee these practices. Partnerships will need to be developed, offering many opportunities for coalition building and watershed planning.

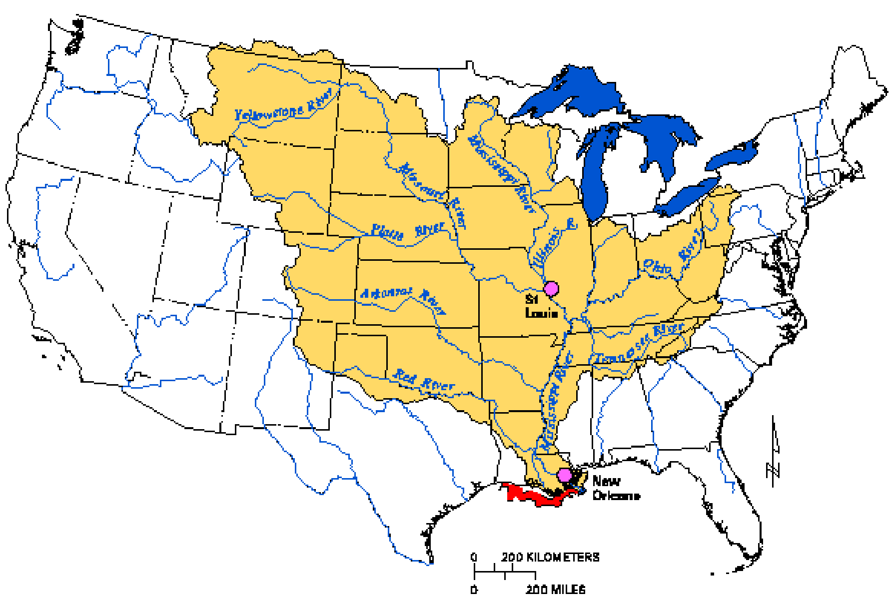
SUMMARIZING

In summary, reducing nonpoint output of nitrogen to the Gulf of Mexico from the Upper Mississippi River Basin will be a difficult task. It will require new partners, new approaches to develop true working landscapes and use of all available resources including appropriate technologies, education, demonstration, and farm policy provisions.

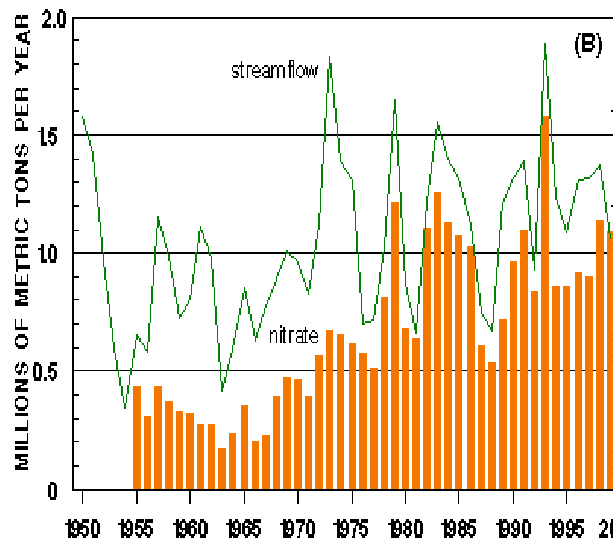
I recommend that the conservation provisions of the 2002 farm bill be adequately funded and that the federal government, specifically the NRCS, be urged to apply these programs in targeted areas of the upper Midwest that would be most likely to reduce nitrogen output. These programs, and allied state federal and university rural development efforts should use the working landscapes concept as they are developed and initiated.

SOME STATISTICS

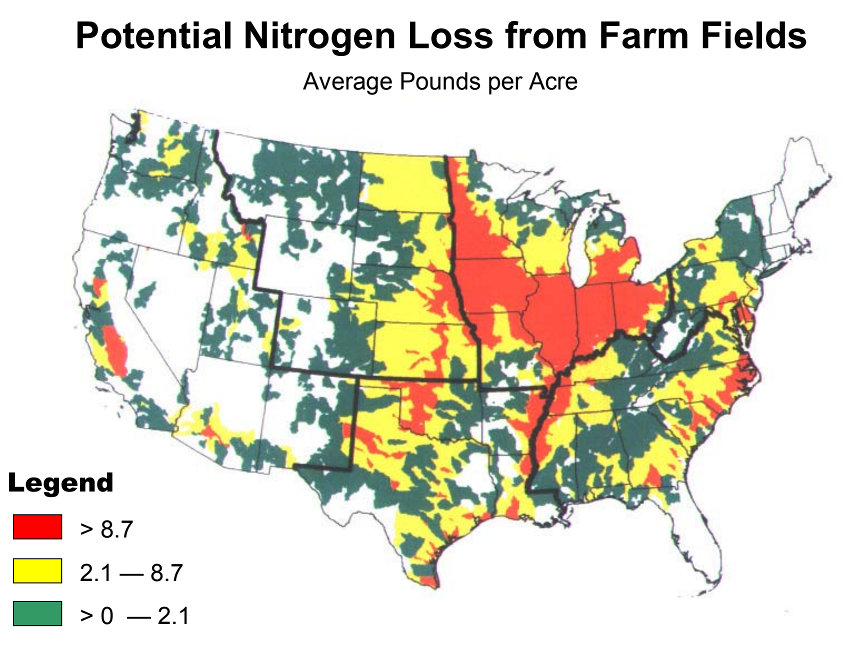
I. The Mississippi River Basin drains about 41% of the conterminous U. S. (Fig 1).



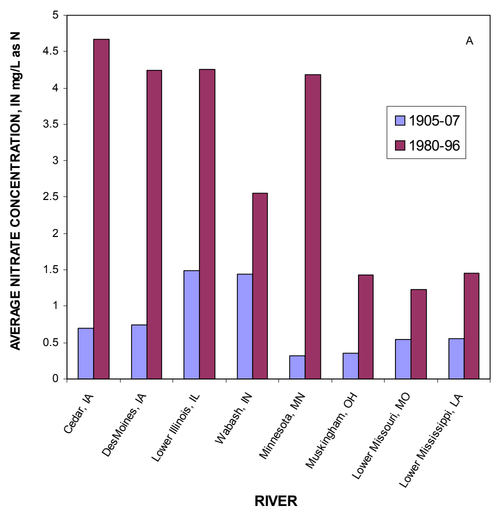
II. The nitrogen loading to the Gulf of Mexico has increased steadily through the years, with large yearly fluctuations affected largely by streamflow Goolsby, 2002. Fig 2.



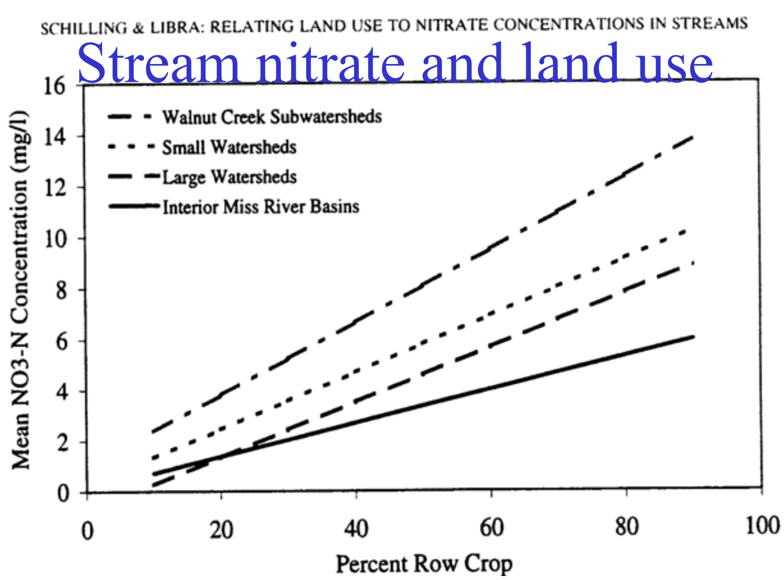
III. The intensive tile drained agriculture of the upper Midwest is the major source of nitrogen to the Mississippi River



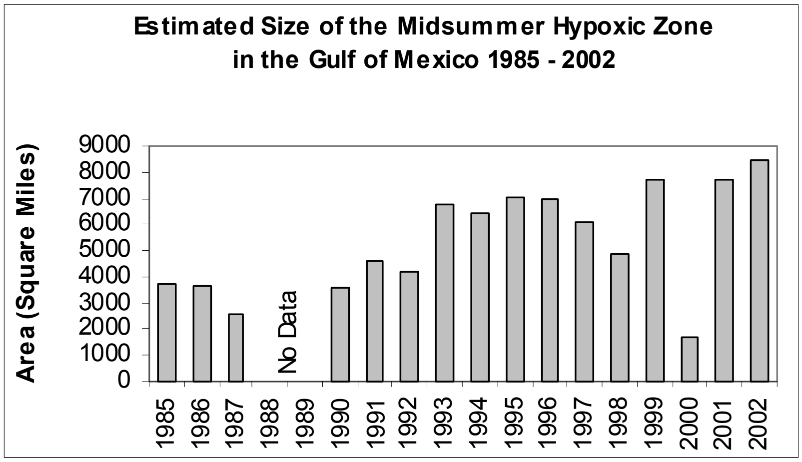
IV. Nitrate concentration of Midwest U.S. rivers has increased markedly in the past 90 years (Fig 3, Goolsby, 2002)



V. In Iowa, nitrate loading to streams is a direct function of % of land in row cropping Schilling and Libra, 2001)



VI. The area of the hypoxia zone in the Gulf of Mexico fluctuates widely, but is generally on the increase over time (Rabalais, Pers. Comm., 2002)



VII. Agriculture sources of nitrogen comprise over 90% of the N load to the Gulf of Mexico (Goolsby, 2002)

Estimated nitrogen contribution to the Gulf of Mexico from specific activities in the Mississippi Basin. [Nitrate flux = 0.95 million t/yr; Total nitrogen flux = 1.57 million t/yr] Goolsby, 2002

Source of nitrogen transported to the Gulf	Percent of nitrate flux from source	Percent of total nitrogen flux from source
Fertilizer and mineralized soil nitrogen	58	50
Animal manure	16	15
Atmospheric deposition, ground water discharge, soil erosion	16	24
Municipal and industrial point sources	9	11

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