American Farmland Trust

Controlling Nutrient Runoff on Farms

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Reducing nutrients in water is one of the most costly and challenging environmental issues facing our nation. The increased use of commercial and manure fertilizer by farmers has led to a corresponding increase in the occurrence, loads and concentrations of nutrients in our waters. Even when farmers apply fertilizer at the recommended agronomic rates, only 30 percent to 50 percent of the nitrogen added to the soil is taken up by the plant depending on the species and cultivar, with the rest lost to surface runoff, leaching of nitrates, ammonia volatilization or bacteria competition (U.S. EPA 2009b; McAlllister et al. 2012). The amount of nutrient runoff from farm fields depends on the weather, intensity and distribution of fertilizer use, the form and timing of fertilizer used, land management practices, soil and aquifer characteristics and the chemical properties of the nutrient compounds themselves. For the most part, only the most egregious nutrient runoff is penalized. Social, geographic, economic and political factors make the option of directly regulating farms and ranches to reduce nonpoint pollution almost impossible. The following paper explains the challenge.

The loss of phosphorus and nitrogen from fertilizer applications is a problem for farms because all living organisms need nutrients to grow

Since nutrients are needed by all living things to grow and thrive, they are essential to farming (Lory and Cromley 2006). For example, corn roots extract nitrogen, phosphorus, potassium, sulfur, iron and many other minerals from the soil. Because nitrogen (N), phosphorus (P) and potassium (K) are essential nutrients for crops, farmers regularly apply N-P-K fertilizer to crops to increase yields. Similarly, low levels of nutrients are needed in surface waters to assure the growth of aquatic plant species. In lakes and streams, P is the nutrient that typically limits growth. Occasionally, the availability of N is a problem. Since K is not a problem, water quality concerns center around P and N. When the concentrations of P or N are too high, they stimulate increased algae growth which in turn can reduce water clarity, cause water treatment problems (like odor and bad taste), reduce oxygen in the water, lead to fish kills and stimulate the growth of blue-green algae that produce toxins that can affect human and animal health.

Phosphorus can travel up to 50 miles in waterways and lead to algal blooms

P is carried in runoff water from farm fields into streams, wetlands and lakes (Lory 2006). It can attach to particles of soil or manure eroded by water into a stream or dissolve into runoff water as it passes over the surface of the field. Usually it is difficult for P to leach through soil into groundwater because soil particles have a large capacity to fix P in forms that are immobile in soil. However, this filtration process can be overloaded or bypassed under certain conditions, allowing higher concentrations of P into the groundwater (or into drainage tile lines). These include fields with cracking soils or areas with karst topography that allow surface water to travel directly to groundwater and areas with sandy soils or shallow aquifers. Phosphorus losses on farms can result from flash losses of soluble P soon after applications of manure or fertilizer, slow leak losses of soluble P and erosion events. Some of the P entering rivers and streams can move about 50 miles or so before it is deposited in sediment or in biota (Garman et al. 1986). The greatest transport of soluble reactive P occurs during storm events.

Nitrogen can travel long distances in water and lead to eutrophication or be lost to air and act as a potent greenhouse gas

N can be lost from farm fields in water moving as runoff across the surface of the field or can pass through the soils into the groundwater or drainage tile lines. Unlike P, nitrate nitrogen is a highly mobile nutrient because it is not removed from water passing through soils (Lory and Cromley 2006). Also unlike P, N can be lost to air as ammonia or nitrogen gas and eventually return to the soil, streams and lakes through rainfall events. Large ammonia losses are mostly associated with manure storage facilities such as lagoons. Dealing with reactive nitrogen (Nr) is very complex because it changes form and moves between land, air and water in different forms (SAB 2013). Most of the Nr results from energy production (the combustion of both fossil fuels and biofuels) and food production (production and use of N fertilizer and N-fixing legume crops). In addition to being linked to eutrophication and hypoxia in surface waters, excess Nr can cause acid rain, smog, nitrogen saturation of forests, global warming and stratospheric ozone depletion. Recently, EPA's Scientific Advisory Board (SAB) (an independent Congressionally-appointed body) strongly recommended that EPA work to achieve a 25 percent reduction in Nr in the coming 10 to 20 years (SAB 2013). For agriculture, the SAB felt a 25 percent reduction in Nr could be achieved through increased crop uptake efficiencies (through advances in fertilizer technologies), a decrease in livestock-derived NH_3 emissions (through best management practices and engineered solutions) and a decrease in NH_3 emissions from fertilizer application through BMPs related to application rate and timing.

Increasing N use efficiency in crops is critical

Increasing N use efficiency in crops is particularly important. Although high yield corn being tested on U.S. experiment stations has achieved use efficiencies as high as 70 percent, the corn grown on most U.S. farms achieves only 40 percent efficiency (Wortmann 2011).

The Clean Water Act is the principal law that deals with water pollution and it focuses mostly on point sources

The Federal Water Pollution Control Act (P.L. 92-500, enacted in 1972), commonly known as the Clean Water Act (CWA) is the principal law that deals with polluting activity in the nation's streams, lakes, estuaries and coastal waters (Copeland 2010). It has two major parts: regulatory provisions that impose progressively more stringent requirements on industries and cities to abate pollution and meet the statutory goal of zero discharge of pollutants (via National Pollutant Discharge Elimination System (NPDES) permits); and provisions that authorize federal financial assistance for municipal wastewater treatment plant construction. Research activities and permit and enforcement provisions support both parts.

The CWA separates water pollution into two categories of sources: point sources (PS) which include wastewater treatment plants, industrial sites and other individual sources with discrete, easy to measure discharges; and, nonpoint sources (NPS) which contribute pollution from multiple smaller sites spread across a landscape, which include farms, ranches, residential lots, urban housing, forested lands, etc. The CWA technically regulates agriculture through various provisions of the act, but only where agricultural operations have been designated as a “point source” (e.g., confined animal feeding operations or CAFOs). The CWA defines a “pollutant” to include “agricultural waste discharged into water.” The primary sections of the CWA that relate to agriculture include §402, §404, §319 §303.

The CWA has many moving parts. The U.S. EPA administers the programs at the federal level but does not directly regulate NPS pollution. State and local governments have the major day-to-day responsibilities to implement CWA programs through standard-setting, permitting and enforcement.

EPA regulates point sources by requiring and enforcing NPDES permits
EPA has the regulatory authority to enforce NPDES permits. These permits authorize a regulated point source to discharge a maximum allowable amount of a pollutant in its wastewater and these limits are revisited every five years. Concentration limits are established in a two-tiered process (Stephenson and Shabman 2011). Initially, EPA assesses the available pollutant control technologies and sets technology-based effluent limitations (TBEL) that the agency deems to be the best performing and affordable technology to control the pollutant. If the TBEL for all point sources discharging to a water body doesn’t achieve ambient water quality standards, a second tier of the effluent standard kicks in, known as water quality-based effluent limits (WQBEL). EPA’s water quality trading policy only allows trading to be used to meet WQBELs.

The States play the key role in assessing waters and dealing with NPS pollution
The CWA basically ensures that the interpretation and implementation of NPS control occurs primarily at the state level (Woman 2009). This has resulted in quite varied responses, reflecting the States' particular resource concerns and organizational capacity. The CWA requires States to meet water quality standards that are comprised of state-assigned designated uses (e.g., swimming) and the measurable criteria used to represent the uses (e.g., clarity of water). First, a State must assess the quality of all of its water bodies (Section 305(b) of the CWA). These assessments include information on monitoring data and trends, illustration of impairment sources and description of state programs implemented to address these water quality issues. The CWA then requires States to identify and list waters that are not meeting water quality standards and therefore, their designated use (Section 303(d)). The resulting list of “impaired” waters is referred to as the “303(d) list.”

For impaired waters, States must design and implement clean-up plans known as TMDLs
Waters on the 303(d) list must have a total maximum daily load (TMDL) assigned to them which stipulates the amount of each pollutant that a water body can assimilate and still meet its designated use. The TMDL is the sum of individual waste load allocations for point sources, load allocations for non-point sources, a margin of safety and natural background levels. Listed waters are prioritized with respect to designated use classifications and the severity of the pollution. Because of the lack of funding and

weak prioritization at both the federal and state level, the TMDL program has been rife with difficulties and challenges: "*TMDLs arrived on the doorstep like a litter of stray cats—with many unpleasant responsibilities and little money to provide for them*" (Houck 2011).

Although States use the best available science to develop TMDLs, their rigor is often challenged

Although the science behind many TMDLs is the best available, it is limited by available data and accuracy of models. Approaches for TMDL development typically vary, depending on available resources and data, types of sources, type of waterbody, type of parameters evaluated and the focus or priority of the TMDL (e.g., identification of sources, evaluation of management scenarios, evaluation of seasonal differences) (Tetra Tech 2004). Since few states have numeric nutrient criteria formally established, most nutrient TMDLs rely on establishing site-specific targets based on literature sources. Some nutrient-related targets are based on modeling or statistical data and reliable data may be limited. For example, many TMDLs are developed without stormwater data and have to use various methods and models to predict stormwater contributions that are based on generic impervious cover estimates and pollutant concentration values that may not be very accurate (Washington State Department of Transportation 2010). Other TMDLs apply a reference watershed approach that uses an "unimpaired" watershed to establish acceptable loading rates that are then applied to the impaired watershed to calculate the TMDLs. Approaches to developing stream TMDLs vary, although many use a simple direct calculation of the target concentration and the appropriate flow.

A group Load Allocation assigned to farmers in an impaired watershed can make it difficult to figure out what an individual farm needs to do

A further uncertainty in most TMDLs results from assigning load allocations for groups of farmers since states have few tools to determine what these load reductions are at an individual property scale (Willamette Partnership et al. 2012). Wisconsin has started experimenting with TMDLs that break out the load allocation by sector and source area. The loads are then linked to edge-of-field loads that better match the implementation tools used by local conservation districts, NRCS and others (Tetra Tech 2011). In any case, however, load allocations and load reduction targets represent best estimates.

Direct regulation of agricultural water pollution is difficult, if not impossible

The possibility of directly regulating farms and ranches to reduce NPS has been proposed numerous times, but social, geographic, economic and political factors make that difficult, if not impossible. Perhaps the most famous example of the failure of regulations to control agricultural NPS at a national level was the 1987 attempt in The Netherlands to regulate and set standards for agricultural nutrient usage (Haskell 2007). They mandated that all farms maintain government-approved nutrient management plans and included recordkeeping requirements, taxes on excess manure production and manure banks. It failed for a number of reasons. They focused on livestock operations but left cropland virtually unaffected. The restrictions on manure were unenforceable because transactions would often go unreported. Informal black-markets facilitated the purchase of manure from nearby farms. And it was too expensive to observe manure application and measuring nutrient loss on a farm-by-farm basis was too imprecise to legally justify penalties. On the other hand, Denmark also enacted nutrient management legislation in the 1980s and apparently got the mix right. By coupling regulatory requirements with incentives, from 1980 to 2006, they decreased their national surpluses of N and P by 41 percent and 62 percent respectively. Total N concentrations in 48 streams draining agricultural watersheds decreased significantly but total P concentrations did not (attributed to legacy P and its resilience in water bodies) (Maguire et al. 2009).

Geography, economics and politics make direct regulation of agricultural nutrient runoff unlikely

Direct regulation of nutrient runoff from farms is highly unlikely in the United States (Williams 2002). The geographic dimensions make “federally designed, nationally uniform technology based performance and emissions standards” difficult to implement without a marked increase in budgeting for individual farm permitting, monitoring and enforcement. Local variations in weather, soil salinity, and soil erosion potential, leaching potential, and freshwater availability present further challenges to an effective national regulatory regime. Variations in crop type, production practices, livestock type and concentration, use of irrigation, tillage practices, sediment runoff and fertilizer runoff all contribute to the difficulty of “one size fits all” regulation. Social factors like proximity to metropolitan area, and surrounding land use also influence farm practices. EPA has noted that a program of this breadth would make it very difficult to implement and enforce regulations.

The economic dimensions of agriculture also pose barriers to regulation. Agriculture in the United States has vast economic value, yet is dispersed widely across the country and by landowner. Faced with the rising costs of inputs and equipment, the farm industry is quickly consolidating. Increased environmental regulation of farms may reduce their economic viability due to compliance costs. And the political dimensions, mentioned earlier, that make regulation of agriculture difficult include a consolidated voting block, strong lobbying and political pressure.

Government agencies at different levels indirectly regulate nutrient runoff from farms

U.S. agriculture has received so many exemptions within the current regulatory structure that now, a mishmash of government entities, operating independently at the local, state and federal levels, indirectly regulate nutrient runoff from farms and ranches (AFT 2009; Ruhl 2001; Woman 2009). As stated above, for a farmer in a watershed under a TMDL, EPA states that the farmer must meet his/her load allocation but this is not legally enforceable at the federal level. Thirty-three States have laws with provisions that regulate agriculture <u>under certain conditions</u>, such as when voluntary approaches fail to achieve water quality goals. States commonly use technology standards that require farmers to implement conservation plans that contain recommended management practices, such as conservation tillage, nutrient management, pesticide management and irrigation water management. These plans can be required statewide, or in areas particularly vulnerable to agricultural pollution. Enforcement in these states remains a widespread challenge. For example, one of the most restrictive water quality laws was passed in Maryland in 1998 (the Water Quality Improvement Act (WQIA)) as a policy response to an outbreak of *Pfiesteria piscidica* during 1997. The WQIA mandated nutrient management plans for all agricultural operations that grossed more than $2,500/year and provided technical and financial assistance to help transition to N and P based nutrient management by 2005. However, over one-third of the farmers who are required to have a nutrient management plan report they don't have one (Lichtenberg et al. 2010).

Five different enforcement mechanisms are currently in play at the State level to make BMPs enforceable

States have generally controlled agriculture and grazing through five different mechanisms to make BMPs enforceable or at least something more than voluntary by linking them to other enforcement mechanisms (Environmental Law Institute 1997; 1998). First, some laws make BMPs directly enforceable in connection with required plans and permits. A second approach makes BMPs enforceable, but only after the fact when a "bad actor" is causing pollution. A third approach makes BMPs the basis for an exemption from a regulatory program. Fourth, compliance with BMPs may be an allowable defense to a regulatory violation (for example, a state could be prohibited from taking action under a water pollution control statute against a farm that is implementing BMPs, whether or not the operation is causing pollution). Finally, many states make compliance with BMPs a defense to nuisance actions (for example, a neighboring landowner could not sue under state nuisance laws if BMPs are implemented) (Dexter 2010).

Current strategies to address NPS pollution are being re-evaluated

EPA announced a revised strategy to address nonpoint source pollution in March 2011 after convening key stakeholders (US EPA 2011a). Key EPA actions to reverse the nutrient contaminations trends include: "*1) Determine needed nutrient load reduction targets to restore and maintain water quality in key areas using the best available peer-reviewed science and support the development of numeric nutrient water quality standards; 2) Work with states to carry out more strategic and effective implementation of watershed nutrient reduction plans to protect their local waterways as well as those downstream; 3) Maintain and advance an open dialogue between USDA, states and local stakeholders/landowners regarding how all parties can best cooperate to reduce nitrogen and phosphorus pollution from agricultural nonpoint sources; 4) Leverage federal funding to assist communities in implementing targeted nutrient reduction strategies; 5) Use trading and other market-based tools where appropriate, to improve cost effective clean up of impaired watersheds; and, 6) Improve public understanding of the seriousness of nutrient pollution including impacts on drinking water sources and other public health, environmental and economic benefits*."

In addition, EPA has also urged states to consider "certainty agreements" to manage N and P (i.e., provide regulatory relief in exchange for implementing an approved suite of conservation practices). Virginia recently passed a proposed regulation for this concept. It provides a level of “safe harbor” for farmers who implement and maintain a Resource Management Plan. Minnesota is working on a similar approach. EPA is now meeting with agricultural groups about certainty agreements (providing regulatory assurance for farmers if they do what they can to implement appropriate BMPs).

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is the only national conservation organization dedicated to protecting farmland, promoting sound farming practices, and keeping farmers on the land.

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