Improving Air and Water Quality Can Be Two Sides of the Same Coin

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Rural areas have long been idealized as the place to go for good, clean air. However, the "fresh" air of the countryside may not be so fresh after all. Since farmers began tilling the soil to grow crops and raise animals, agricultural production practices have generated a variety of substances that enter the atmosphere and have the potential of creating health and environmental problems. The relationship between agriculture and air quality first entered the public psyche in the 1930s with the severe dust storms of the Dust Bowl. Although huge dust storms are long gone, and air emissions in most rural areas are not high enough to cause concern, the air in some farming communities can now be as impaired by pollutants such as ozone and particulates as air in urban areas.

Air quality policies have traditionally focused on urban areas and industrial emissions. Extending these laws to cover agriculture would require an understanding of how farmers respond to different policy incentives. Farmers have many choices in deciding on what to produce and the production practices to use. Their production decisions are based on market prices, the characteristics of the farm's resources, the technologies that are available, and the farmer's particular level of management skill. But incentives to consider wider impacts of their production choices on environmental quality are often lacking. Environmental policy can influence a farmer's decisions by changing the costs of inputs to encourage or discourage input use, or by mandating that particular management practices be used or abandoned. Currently, a lack of knowledge about air emissions from agriculture could hinder the development of cost-effective policies.

Policy formation is also compounded by the fact that possible efforts to reduce agricultural air emissions could diminish the effectiveness of ongoing efforts to address water quality concerns. At a minimum, regulations and incentives designed to address a problem in one medium (air or water) may not be as cost effective at meeting resource quality goals as those that are coordinated across multiple media.

Pollution from agriculture generally has characteristics that make it difficult to control through conventional policy tools.

Putting the Brakes on Agricultural Emissions

Agricultural production releases a wide variety of material into the air—for example, windblown soil, nitrogen gases from fields and livestock, fine particulates from diesel engines and controlled burning of fields, and pesticides. Pesticides can move in air currents in two ways: aerial drift (when applied with crop dusters), and volatilization (a process by which solids or liquids are converted into gases). Other potential pollutants associated with agricultural production include hydrogen sulfide, ammonia, odors, and other volatile organic compounds from animal manure; methane from dairy cows and cattle; and nitrogen oxides from fertilized fields and internal combustion engines. These pollutants can affect people's health, reduce visibility, contribute to global warming, or simply be a nuisance.

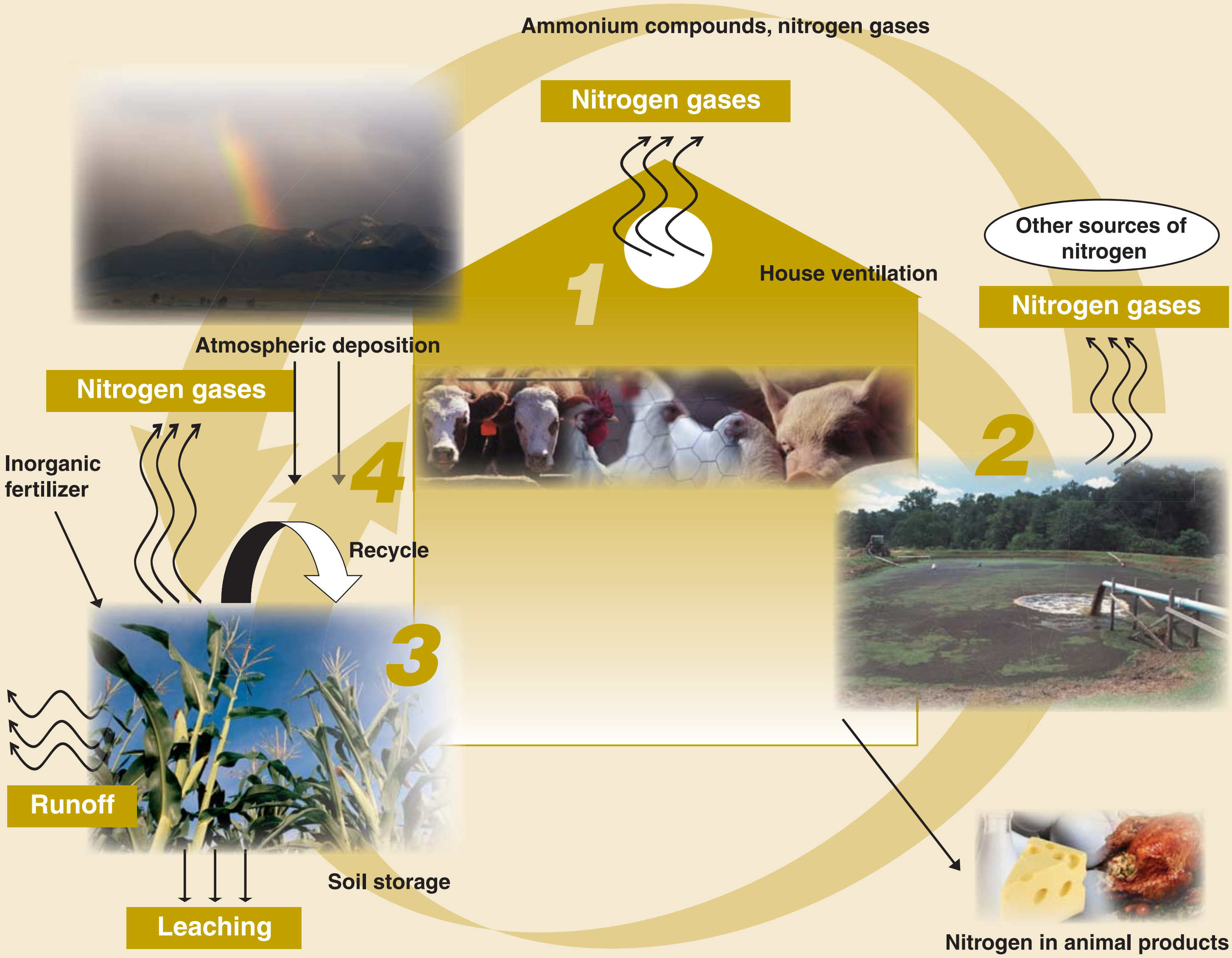
Air quality is protected primarily through the Clean Air Act and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The Clean Air Act sets limits on how much of a pollutant can be in the air anywhere in the United States. When the air quality standard for any of six air pollutants is exceeded, States must inform the U.S. Environmental Protection Agency (EPA) how they plan to respond. Any farm in a nonattainment region (regions where air quality standards are exceeded) found to be a "major source" of regulated emissions could be required to apply for and comply with an operating permit. CERCLA requires facilities to report to EPA when more than a "reportable quantity" (100 pounds in a 24-hour period, for example) of a hazardous substance is released.

Regulation of air emissions under the Clean Air Act and CERCLA has focused on such sources as factories and cars but not on emissions from agriculture. Part of the reason is a lack of information about the sources and effects of agricultural air emissions that would be necessary to develop regulations. Pollution from agriculture generally has characteristics that make it difficult to control through

Lynn Betts, USDA/NRCS

A California dairy farmer discusses manure management with an official from USDA's Natural Resources Conservation Service.

Nitrogen Follows Many Pathways in a Livestock Operation



The nitrogen cycle is a complex one, without a beginning, middle, or end. The principle of mass-balance ensures that the amount of nitrogen in a closed system is constant. Thus, any action to divert it from one pathway must necessarily transfer it into another. In this stylized figure:

1 animals in the "house" release nitrogen in three ways: they produce manure (which then enters a storage system); they store nitrogen internally, which is bound in animal products distributed to markets; and they produce gases (directly and indirectly in manure production), which are released as air emissions;

2 manure is stored in lagoons, tanks, pits, or other structures before being transported to fields for use as fertilizer;

3 manure nitrogen applied to fields may be stored in the soil, leached into groundwater, run off into surface water, volatilized into air emissions, and be bound in crops; or

4 nitrogen bound in crops may be used for feed for the animals, and the cycle begins again.

Nitrogen also enters and exits the system through intermediate pathways, for example, some of the nitrogen released into the air will settle back on the fields (deposition) and some new nitrogen will be added in the form of commercial fertilizer.

conventional policy tools that are applied to industrial sources. Agricultural emissions tend to be generated diffusely over a broad land area, rather than from a single pipe or smokestack, so it has not been cost effective to accurately monitor emissions from individual agricultural sources using current technology. For example, ammonia emissions from an animal operation can come from a barn, manure storage structure, and field. The difficulty and cost of monitoring agricultural pollution sources is one reason that agriculture is largely exempt from environmental regulations that were primarily designed to address urban and industrial air pollution problems.

However, new State regulations may seek to reduce air emissions from agriculture, particularly from animal feeding operations. Under the Federal Clean Air Act (and its amendments), States are responsible for achieving the air quality standards established by EPA. Recent lawsuits, court decisions, and consent agreements have induced States to start regulating emissions. California is the first State where air quality regulations are significantly affecting agriculture. Ozone and particulate levels in the San Joaquin Valley of California, which has some of the most polluted air in the country, with nonattainment areas for both Federal ozone and particulate matter standards, have led to new requirements for agricultural producers. Farmers must develop management plans showing how they will reduce dust, the burning of crop residue (e.g., rice straw, orchard trimmings) is restricted, and large dairies must manage their manure to reduce ammonia emissions.

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However, farmers do not bear the cost alone. USDA helps farmers in California's nonattainment areas with a cost-share program funded through the Environmental Quality Incentives Program to help finance farming practices that reduce airborne dust and ozone precursors. USDA also funds research to understand the processes of air pollution emissions from agricultural operations, to develop and test control measures, and to provide decision aids that can be used to reduce agricultural air pollution emissions.

Protect Air Quality, Compromise Water Quality?

An important issue in addressing pollution from agriculture is that emissions to the atmosphere do not necessarily occur in isolation, but can be linked by biological and chemical processes to emissions to water. Nitrogen emissions from animal feeding operations are the best example. Nitrogen excreted from an animal can follow any of a number of pathways between collection and disposal, and enter water or the atmosphere in the form of any of a number of compounds. These interactions have important consequences for policies to protect environmental quality. Reducing nitrogen movement along one pathway by changing its form will increase nitrogen movement along a different path. For example, reducing ammonia losses from a field by injecting animal waste directly into the soil increases the amount of nitrogen that can be made available for crop production, but, because more nitrogen is now available in the soil profile, the risk that nitrates will enter water resources is increased. The fact that these processes are linked requires that efficient management of manure consider

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An uncoordinated approach between air and water policies could reduce water quality.

Animal feeding operations are a major source of ammonia emissions.

Bob Nichols & Jeff Vanuga, USDA/NRCS

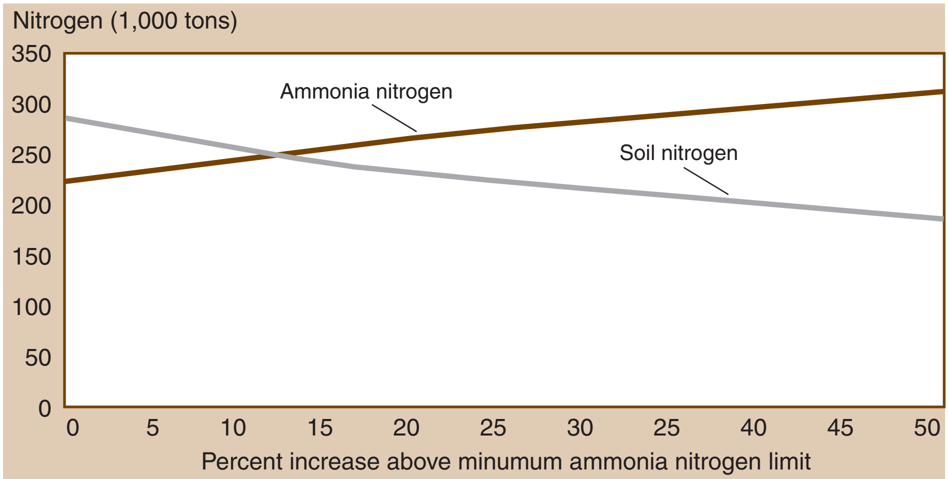
how different environmental media (that is, land, water, and air) are affected. (See box, "Nitrogen Follows Many Pathways in a Livestock Operation.")

Potential cross-media links in the emission process suggest possible advantages to a multimedia perspective in developing regulations. A multimedia perspective is neither new nor unique to agriculture. Many industries generate multiple pollutants that affect several environmental media. Yet, environmental regulations, by and large, take a single-medium perspective. The Clean Water Act addresses surface water quality (not ground water). The Clean Air Act addresses air quality. The Resource Conservation and Recovery Act (RCRA) addresses hazardous waste disposed on land.

Over the past decade, EPA has experimented with coordinated implementation of the Clean Air Act, Clean Water Act, and RCRA to reduce implementation costs and to help regulated industries organize pollution control activities more efficiently. The pulp and paper industry was the first to benefit from this multimedia approach. EPA developed integrated air and water rules that set emission levels based on the performance of a combination of source reduction technologies and management practices, air pollution control devices, and upgrades on existing wastewater treatment systems.

Why might a multimedia approach be important for agriculture? The increasing size and geographic concentration of animal feeding operations, driven by the economics of domestic and export markets for animal products, have resulted in large quantities of manure accumulating in relatively small areas. In 2003, EPA introduced revised Clean Water Act regulations to protect surface waters from nutrients from concentrated animal feeding operations (CAFOs). The regulations require CAFOs to follow a nutrient management plan to minimize nitrogen and phosphorus runoff to surface water. Those plans will specify the application rate for nutrients that must be followed when applying manure to land (the primary disposal method). The cost to farmers of complying with the plans can be relatively high because compliance often will entail moving manure to a larger land base. To meet the requirements as cheaply as possible, and without any incentives to protect air quality, farmers could continue to use (or adopt) uncovered lagoons and apply ani-

Steps farmers take to meet increasingly stringent ammonia emission reductions increase the amount of excess nutrients applied to fields



Farmers reduce ammonia emissions by putting a cover on lagoons that trap gaseous emissions or by injecting wet waste (slurry) into soil rather than spreading it on top. The right edge of the graph shows the situation when farmers emit 50 percent more ammonia than the best possible situations (all farmers cover their lagoons or inject slurry). At this point, farmers emit about 300,000 tons of ammonia-nitrogen, and apply about 200,000 tons of nitrogen to fields. As the amount of ammonia is reduced (moving from right to left), the amount of nitrogen applied to fields increases.

Source: USDA, Economic Research Service.

mal waste to the surface of fields without incorporating it into the soil. Those practices reduce the nitrogen content of manure spread on fields by volatilizing nitrogen to the atmosphere. In so doing, however, nitrogen that otherwise would be available for runoff to water bodies is transformed into atmospheric ammonia emissions to the possible detriment of air quality.

According to a 2003 National Academy of Sciences study, animal feeding operations are the primary source of ammonia emissions in the U.S., and ammonia emissions are already a cause for concern in some rural communities. Ammonia emissions are regulated in parts of California. Current Federal air quality rules (e.g., Clean Air Act's PM 2.5 standards and CERCLA) might force more States to consider regulating ammonia emissions from animal operations.

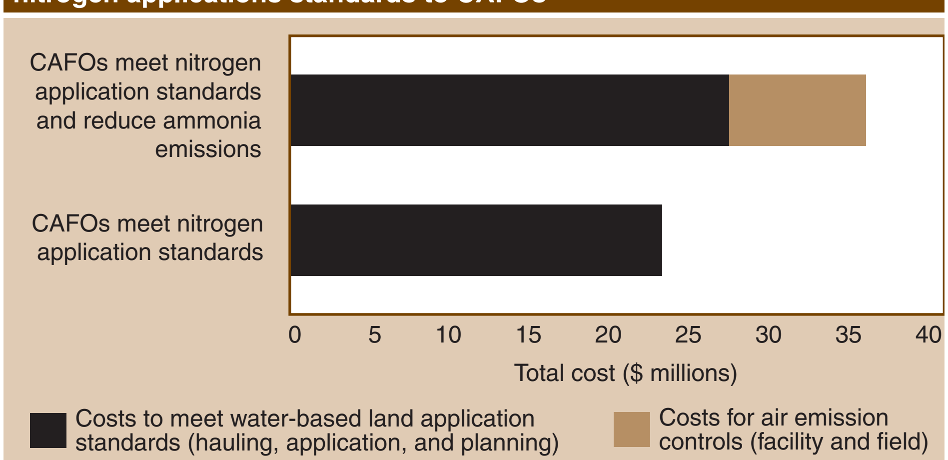
An ERS study estimates that farmers would respond to hypothetical ammonia emission standards by adopting manure management practices that reduce nitrogen emissions to the air but increase the nutrient content of animal waste spread on fields. Depending on how the air quality regulations were applied, this could have two impacts on CAFOs and water quality. First, CAFOs might need to further increase the amount of land on which they spread manure in order to continue to meet nutrient application standards. This increase could be particularly costly in a region where animal concentrations are high and cropland available for spreading manure is relatively scarce. For example, in the Chesapeake Bay watershed, ERS found that requiring CAFOs to adopt practices that reduce ammonia emissions would increase the nitrogen content of manure and thus the CAFOs' cost of applying manure to land to meet water quality requirements.

An uncoordinated approach between air and water policies could also reduce water quality. The Clean Water Act's manure regulations apply only to CAFOs. If ammonia reductions are required on farms other than CAFOs, the water quality benefits of the CAFO regulations are potentially reduced by increased nutrient applications on these other farms. In the Chesapeake Bay watershed, for example, ERS research estimates that the nutrient content of manure produced on farms not covered by current regulations would more than double if ammonia restrictions were applied to all animal feeding operations. This would increase the risk of nitrogen runoff that eventually reaches the Chesapeake Bay.

USDA has long recognized the impacts of conservation practices on multiple environmental resources (soil, water, and air). Yet, when a set of conservation practices is recommended to improve water quality, full consideration is not always given for accompanying air quality benefits. In the Conservation Reserve Program, for example, the Environmental Benefits Index used to rank applications for enrollment includes wind erosion benefits but not benefits for reduced ammonia, odor, fine particulates, oxides of nitrogen, or pesticide volatilization. A fuller accounting of the multimedia benefits in the implementation of conservation programs could result in a redirection of resources to producers who could provide a higher level of overall environmental quality for a given cost.

Information on environmental emissions from production practices would improve coordination of environmental policies.

Reducing ammonia emissions would increase costs of meeting nitrogen applications standards to CAFOs*



*CAFOs are concentrated animal feeding operations, or those operations regulated by EPA under the Clean Water Act.

Source: USDA, Economic Research Service.

Jeff Vanuga, USDA/NRCS

Better Data for Better Coordination

Information on environmental emissions from production practices would improve coordination of environmental policies. The National Academy of Sciences review of air emissions from animal feeding operations found that, while pressure to regulate air emissions from animal operations has mounted, the basic scientific information needed for effective regulation and management of emissions is lacking. The study was requested jointly by EPA and USDA to assess the state of knowledge and to recommend steps for bridging the information gap that is hindering the development of effective regulations and management measures. Existing data are insufficient to establish thresholds for emissions from livestock operations that would trigger compliance with air quality requirements.

This need for better data about air emissions from animal feeding operations has led to an innovative agreement between EPA and some sectors of the animal industry to monitor air quality on farms. The Air Emissions Consent agreement and National Monitoring Study between pork and egg producers and EPA calls for a 2-year national air monitoring study on animal feeding operations that agree to participate in the study. The study will use state-of-the-art technologies and standardized procedures to monitor emissions from barns and lagoons. These data will help State and Federal regulators and farmers identify farm sizes and manure handling systems that exceed thresholds for regulated pollutants. For farms that participate, EPA has agreed to provide certain legal protections for past and current emissions violations. EPA has invited other sectors of the animal industry (broilers, dairy, and fed beef) to participate.

The information gathered during the study will be valuable for both farmers and regulators. Many producers are not aware of their operation's contribution to emissions or whether they are subject to existing air quality regulations. Knowing the legal and financial risks for different types of operations would help farmers make decisions about reducing emissions to protect them from possible lawsuits or enforcement actions and still remain profitable.

Information on atmospheric emissions from agriculture can help regulators identify the emission thresholds that meet air quality goals at minimum cost to the sector and develop coordinated incentives to help farmers simultaneously protect air and water quality. This would reduce unintentional harm to the environment because of unconsidered cross-media effects and minimize the cost to producers who change their production practices to comply with emerging environmental regulations. AW

This article is drawn from . . .

Managing Manure To Improve Air and Water: Coordination Works Better, by Marcel Aillery, Noel Gollehon, Robert Johansson, Jonathan Kaplan, Nigel Key, and Marc Ribaudo, ERR-9, USDA, Economic Research Service, September 2005, available at: www.ers.usda.gov/publications/err9/