Chapter 4. Manure Management and Environmental Quality Challenges

Manure management is the environmental Achilles Heel of animal feeding operations (AFOs), especially large-scale concentrated AFOs, or CAFOs. No issue is more visible or unmistakable, especially for those nearby or downwind. For this reason, manure management is receiving intense attention from government agencies, rural neighbors and communities, and the environmental community.

The USDA's National Resources Conservation Service (NRCS) estimates that 128 billion pounds of manure from confined animal feeding operations (AFOs) are available for land application. This manure contains an estimated 2.6 billion pounds of nitrogen and 1.4 billion pounds of phosphorous. Dairy cattle account for the largest share of the total volume of manure – 45.5 billion pounds – while poultry account for the largest share of nitrogen, 1.153 billion pounds, or almost half the N from all manure.

Economics and scale of operation play a huge role in driving the design and operation of manure management systems. In general, the larger the AFO, the more likely manure is regarded as a waste to dispose of instead of as a resource to recycle for the benefit of soil quality and crop productivity. Recent USDA survey data shows that 48.5 percent of the manure generated on beef feedlots with 8,000 head or more capacity was given away and contractors were paid to remove another 8.4 percent (NAHMS, "Feedlot 99, Part I: Baseline Reference of Feedlot Management Practices, May 2000). On larger lots only a quarter of manure was land applied by the feedlot operator, whereas on feedlots with between 1,000 and 7,999 head, 75 percent of manure was land applied by the operator and only 16 percent was given away.

The larger the AFO, the more investment, effort, and care the managers must invest to avoid significant losses of manure nutrients to the environment. The greater the losses, the more off-site problems with odors and pathogens, and the greater the economic loss to the agricultural production sector because of the inefficient recycling of the nutrients in manure.

First Iowa State and then Purdue University researchers explain why economics can drive inefficient manure recycling on large swine operations or in regions with large numbers of animals relative to cropland, regardless of farm size–

> "...the costs of transporting liquid manure rise with distance, and where livestock are concentrated, there is strong incentive to spread the manure close to its source...It makes clear economic sense that large scale operations should maximize N volatilization through the use of anaerobic lagoons and sprinkler irrigation in order to afford the manure disposal costs. Until the cost of chemical fertilizers is much higher, CAFOs will logically treat manure as a waste disposal problem." (Jackson et al., 2000)

> "As herd size increases, diseconomies in manure management exist when land application at an agronomic rate is required. These diseconomies are primarily the result of transport and application costs and are further compounded when the land base is constrained. Should these diseconomies represent a significant portion of production costs, we would expect to see a movement toward smaller farms rather than larger farms, or at a minimum, a decrease in the acceleration of the movement toward large farms with a high level of animal density." (Martin, et al., *Feedstuffs*, 1998).

The least efficient systems in terms of recycling nutrients -- and most likely in impairment environmental quality -- use anaerobic lagoons and irrigation systems for land application. These systems reduce costs between $0.50 and $1.00 per finished pig compared to a slurry system coupled with field injection, a much more efficient system for recycling nutrients and limiting losses to the environment (Jackson et al., 2000).

The cost difference between the highly inefficient, polluting systems found on most large-scale swine CAFOs, compared to systems that use best available storage and field injection technology to reduce nutrient losses and maximize the efficiency of nutrient recycling, might reach $4.00 per hog capacity, but at least half the difference can be recouped through reduced fertilizer costs on farms efficiently storing and land applying manure.

But recapturing this approximate $2.00 in fertilizer value is not a viable option in areas where animal density is beyond the threshold where manure can be efficiently utilized. In such areas, economics drives farmers toward adoption of the most polluting system and technology that permitting authorities will tolerate. Accordingly, the definition of "best available and affordable technology" is actually just as much a function of animal density and the scale of AFOs as it is a function of system design and technology. In other words, it's a policy-driven definition. (See the references for this chapter, especially the *Feedlot Industry Sector Profile* on swine, for cost estimates by manure management system and animal density).

A. The Impacts and Consequences of Manure Management

Manure storage and land application systems have multiple consequences on the performance and off-farm impacts of an AFO. But by far the most important, these systems determine the efficiency with which nutrients and organic matter in manure are recycled via cropland to a subsequent crop, thereby limiting environmental discharges, reducing cash farm expenses, and building soil quality.

Hence we focus first on the recycling of nutrients as the most important single manure management system performance indicator. **Curiously, the efficiency of nutrient recycling is conspicuous in its absence in both EPA's recently proposed CAFO rule and in USDA-NRCS technical guides governing nutrient and manure management plans. This is a major policy shortcoming that must be confronted in multiple venues.**

The more inefficient a manure system is in recycling nutrients, the greater the volume of nutrients (and pathogens) that are lost to air and water, leading to water quality degradation and odor conflicts with rural neighbors, the focus of the next two sections. Both these problems depress property values and can trigger health problems, the last two impacts reviewed herein. These impacts and associated costs are discussed very briefly in order to introduce the reader to the growing literature documenting various problems in specific regions.

1. Recycling of Nutrients

Under typical management systems, a 1998 USDA analysis found the average nitrogen losses range from 31 to 50 percent for poultry, 60 to 70 percent for cattle, and 75 percent for swine. Typical phosphorous loss is 15 percent (data from proposed EPA CAFO rule, page 42). USDA also found that in 1992 available nitrogen in manure exceeded maximum needs and assimilative capacity in 266 counties, and available phosphorous exceeded needs in 485 counties.

Based on today's distribution of livestock and scale of CAFOs, these numbers surely overstate the efficiency of nutrient recycling and underestimate the number of counties with nutrient supplies in excess of assimilative capacity. Reasons why are clear. For example, a well-respected agricultural engineer working on manure management has written --

- "Many swine manure and wastewater management systems have been designed to maximize nitrogen loss."

- "Where nutrients are not properly accounted for, both water and air quality are at greater risk, along with lessened opportunities for nutrient recovery."(J.M. Sweeten, *Applied Engineering in Agriculture*, Vol. 14(5): 543-549, 1998).

A study of swine CAFOs in Hamilton County, Iowa estimated that 70 percent of manure nitrogen was lost to volatilization alone and that six-times the cropland area was needed by the existing CAFOs to land apply nutrients at agronomic rates (Jackson, et al., 2000).

Enhancing the efficiency of nutrient recycling is a win-win proposition. Done well on moderate scale AFOs, it is self-financing. The larger the CAFO, the higher the cost will be to achieve a given level of efficiency in nutrient recycling. Table 4.1 presents rough estimates of the fertilizer cost savings the agricultural sector can capture by becoming more efficient in N recycling. The average efficiency in recycling nitrogen back into crops of today's manure storage and land application methods is probably between 15 to 30 percent, with the trend moving ever closer to 15 percent. Systems that achieve 60 percent efficiencies in the average year are in fact common in some states. Accordingly, if such systems became the norm, the nation's crop farmers could save about $300 million annually in nitrogen fertilizer costs. Other direct soil quality benefits would likely more than double the gain.

Table 4.1. Potential Corn Production Cost Savings from More Efficient Nitrogen Management Systems, Based on $0.29 per Pound N Fertilizer Replacement Cost

Total N in Manure = 2.583 billion pounds	Nitrogen Available to Support Corn Crop			
	70% Efficiency	50% Efficiency	30% Efficiency	15% Efficiency
N Available to Support Crops	1,808,100,000	1,291,500,000	774,900,000	387,450,000
Fertilizer Replacement Value	$ 524,349,000	$ 374,535,000	$ 224,721,000	$ 112,360,500
N Loss Compared to 70% Efficient Systems		516,600,000	1,033,200,000	1,420,650,000
Potential Cost Savings		$ 149,814,000	$ 299,628,000	$ 411,988,500
Acres Corn N Needs Met (150 lbs/acre)	12,054,000	8,610,000	5,166,000	2,583,000

It is worth emphasizing that natural gas accounts for about 75 percent of the cost of producing anhydrous ammonia fertilizer. Gas prices are rising sharply and are projected to remain markedly higher than in the recent past.

Between February 2000 and February 2001 nitrogen fertilizer costs more than doubled, according to the USDA "prices paid" index for basic production inputs (NASS, "Agricultural Prices," February 28, 2001). The University of Nebraska's Institute of Agriculture and Natural Resources issued a January 22, 2001 statement to farmers urging them to focus more carefully on nitrogen management in light of the projected $15.00 per acre increase in corn N fertilizer expenses (IANR, 2001). Nationwide across the likely 75 million acres of corn that will be planted in 2001, this increase translates into a $1.125 billion increase in fertilizer costs, and one of the major reasons USDA is forecasting a big drop in net farm income in 2001.

Accordingly, the economic benefits that can be expected from investments in more efficient manure management systems will be substantially greater than just a year ago. Any government or private estimates of the cost-benefit ratios of manure management systems will, accordingly, need to be updated to reflect the recent increases in fertilizer and energy costs.

2. Water Pollution

EPA's most recent data on impairment of streams, rivers, lakes and estuaries continues to identify agriculture as the number one cause of impairment. CAFOs are estimated to account for 16 percent of the total impairment of streams and rivers from agriculture (CAFO rule, page 33).

Animal operations with more than 1,000 animal units account for 42 percent of all confined animals but only 3 percent of the cropland held by livestock and poultry operations, according to USDA analysis of 1997 Census data (CAFO rule, page 37). Excessive manure applied on too narrow a land base creates the potential for significant pollution discharges to surface waters and is the primary reason there is so much attention, locally and nationwide, directed to CAFOs and manure management.

USDA estimates that cropland controlled by operations with confined livestock has the assimilative capacity to absorb only about 40 percent of the manure nitrogen generated by these operations. The rest has to go somewhere and it is either trucked off-site, volatized into the air, leached to groundwater, or it runs off into surface waters.

In 1976, EPA issued regulations under the Clean Water Act that addressed environmental and public health impacts from CAFOs. However, the regulations have never really been adopted nor enforced and animal agriculture industries have changed significantly since 1976. Reams of data confirm that the share of animals on small livestock operations has decreased significantly and the share on large CAFOs has ballooned, along with geographic concentration.

EPA's proposed CAFO rule published in late 2000 cites innumerable documented cases of water pollution from AFOs. Releases of more than 30 million gallons of animal waste have occurred in Missouri, North Carolina, and other states. Twenty percent of drinking water wells in the Delmarva Peninsula were found to contain nitrate levels over 10 mg/L from poultry production, litter and manure. CAFO operators sometimes have to purposely drain overfull lagoons to make room for additional manure. These acute discharges often cause dramatic fish kills. An independent review of the Indiana Department of Environmental Monitoring records in 1997 found that intentional discharges were the most common cause of waste releases, rather than spills due to severe rainfall (CAFO rule, page 48). Two-thirds of 36 lagoons studied in North Carolina in 1995 leaked into groundwater.

A 1999 swine sector study commissioned by the Iowa legislature found that leaking is part of the design standards for earthen lagoons and that all lagoons are expected to leak. It also found that 18 percent of earthen manure storage structures in Iowa were constructed over alluvial aquifers, the most vulnerable in the state. Many of these sites lie in floodplains and are below ground level, 21 percent are within 500 feet of ephemeral streams, and 12 percent were within 500 feet of perennial streams. (Simpkins, et al., 1999). In light of these findings and their research on several CAFOs in north Iowa, a team of Iowa State University scientists ended a recent journal article with this statement –

> "Do current regulations adequately protect against nonpoint source-pollution? Even if loopholes in the [Iowa] law are closed to create more conservative manure

management plans, we conclude that the law will still fail to protect Iowa's waters from nonpoint source-pollution." (Jackson, et al., 2000).

3. Odor

People's willingness to tolerate odor is related to its intensity and duration. People are more likely to tolerate intense odor if it occurs rarely and for short periods. Unfortunately downwind and near many CAFOs odor is both intense and nearly always present.

A variety of gases are produced as animal manure is degraded via microbial activity. Over 150 odorous compounds have been identified in manure. Up to 50 percent of the nitrogen in fresh manure may be in ammonia form or converted quickly to ammonia. Ammonia is volatile and losses can be considerable. In North Carolina, animal agriculture is responsible for 90 percent of all ammonia emissions.

Solving the odor problem is intimately linked to efficient recycling of nutrients via cropland. A valuable paper by a Texas A&M agricultural engineer, Dr. John Sweeten **(1999?),** focused on the relationship between AFO separation distances, manure management and odor control. His research was based on two swine operations, one very large (8,400 sows, a total of 72,000 to 84,000 head, in North central Nebraska on 160 acres) and a second of moderate scale (200 sows, about 2,000 head, in Central Iowa). The large farm used a maximally wasteful lagoon, irrigation management system; the moderate scale farm, a more efficient slurry-injection system.

Scientists use the concept "dilutions to threshold," or DT to measure odor. Near swine buildings and lagoons, odor is most intense, typically falling between 70 and 170 DTs, with the highest values nearby and downwind. Property line measures are typically much lower, in the 10 to 40 DT range. DT values under 2 are associated with barely detectable odors.

The distance required to achieve acceptable odor level – DT 2 – on the 8,400 sow operation in Nebraska was 17,500 feet based on P application (3.3 miles), 6,850 feet for N, and 7,580 feet for odor. For the 200 sow operation in Iowa, odors were acceptable at 2,600 feet, while 2,880 feet was needed to apply P at agronomic rates, and 1,770 for nitrogen. Again, Sweeten's research suggests that a P-based manure management standard will in most instances lead to separation distances also satisfactory to achieve odor control.

Such benchmarks and standards should obviously be incorporated in new site and permit decisions but unfortunately, many people now live well within the separation distances needed to avoid odor problems from AFOs. Odor is eroding their property values and in some cases, their health, and many are turning to the courts to seek redress.

4. Property Values

An analysis conducted by the University of Missouri's rural sociology and agricultural economics department measured rural property values within about 1.5 miles of hog operations and concluded that proximity to hog farms had a negative impact on property values.

The Missouri legislature has set a setback limit slightly less than the 1.5 miles researchers used, suggesting that the impact of swine odor extended further than the law recognized and implying the need for greater setbacks. Sweeten's research also establishes a clear need for variable setback distances adjusted upward as a function of increasing CAFO scale, coupled with the availability of land for manure application.

A 1990 analysis by Michigan State University economist Larry Conner was one of the first quantifying the reduction in property values because of AFO odor problems. Conner concluded that home values fell .43 cents for each additional hog within a 5-mile radius. A North Carolina State University study in the early 1990s found a 9 percent home price decline near hog CAFOs. A 1999 University of Missouri Policy Analysis Center study estimated property values declined about $112 per acre within 3 miles of a large hog farm (Hog Industry Insider, *Feedstuffs*, 2000).

CAFOs definitely impose an enormous economic penalty on neighbors, property values, and local land tax revenues. Table 4.2 draws upon the studies cited above and estimates the lost property value associated with a single CAFO and the nation's 12,000 CAFOs. We assume that, on average, a two-mile minimum separation distance is required to assure that DT values do not exceed 2 at the property lines. Since many of the nation's 12,000 CAFOs are located nearby, we assume that on average half of the total acres within the 2-mile zones are overlapping. This assumption probably underestimates impacts, since the more animals within the average 2-mile radius, the greater the separation distances needed to meet DT-2 and land apply manure at agronomic rates.

Note the enormous amount of land impacted – over 60 million acres, or about one-fifth of the approximate 300 million acres of harvested cropland. In areas with several CAFOs, the majority of rural land is impacted, concentrating impacts on local property taxes and all public services financed largely through property taxes, like schools.

Table 4.2. Rough Estimates of the Impact of Odor on Property Values for a Single CAFO and 12,000 CAFOs				
	Acres Impacted	Average Land Value	5% Reduction in Value	7% Reduction in Value
Single CAFO	10,240	$ 1,000	$ 512,000	$ 716,800
12,000 CAFOs	61,440,000	$ 1,000	$ 3,072,000,000	$ 4,300,800,000
Assumptions --	A single CAFO needs a minimum 2-mile separation distance to avoid lost property value, or 16 sections of surrounding land.			
	Many CAFO separation distances overlap, and hence total land impacted by 12,000 CAFOs is reduced by 50%.			
	Average land value includes houses and improvements on neighboring properties within the 2-mile radius.			

5. The Health of Farmers and Rural Neighbors

Scientists have documented four main ways that manure odors can impair human health –

1. Volatile organic compounds (VOC's) can produce direct toxicological effects.
2. Odor-producing compounds cause sensory irritation of the eyes, nose, and throat, and can trigger allergic responses and lung diseases like asthma.
3. VOC stimulation of sensory nerves can result in neurological changes that can influence health.
4. Cognitive and emotional factors such as stored mental experience with similar odors or attitudes towards unpleasant odors.

Profound toxic effects of the olfactory system can result from high levels of odor-producing VOC's. These compounds can also be absorbed thru the lungs, gastrointestinal tract, and skin and may affect metabolic and other physiological processes. VOC's with high fat solubility can pass thru the alveolar lining of the lungs into the bloodstream and be distributed to fat stores and organ sites for which they have special affinity. Concentrations of individual VOC's downwind of a hog farm are usually low and most likely not toxic, however, periodic weather conditions can produce spikes in exposures and people are sometimes exposed to mixtures of low level VOC's from multiple sources. In addition to toxicological effects, neurochemical changes can occur in the brain as a result of exposure to unpleasant odors and resultant health effects are largely unknown **(source?).**

A 1995 study of the effect of environmental odors emanating from large-scale hog operations on the moods of nearby residents indicated that persons living near such operations had significantly more tension, depression, anger, less vigor, more fatigue and confusion than control subjects. Conversely, pleasant odors have been reported to improve emotional and physical health. They have been used therapeutically to improve mood, reduce stress and anxiety, increase alertness and performance, and have a beneficial effect on sleep patterns.

A study conducted by University of North Carolina and funded by the Environmental Justice Program of the National Institute of Environmental Health Sciences found that residents near a 6,000 head hog operation experienced diminished quality of life as indicated by the number of times residents could not open their windows or go outdoors. Health complaints included headache, runny nose, sore throat, excessive coughing, diarrhea, and burning eyes. Two-thirds of the respondents were women and 90 percent were black. The average family income was $20,000. The study did not assess long-term physical and mental health impacts.

In North Carolina there are 2,500 intensive hog operations and most are located disproportionately in areas that are poor and nonwhite. According to one of the most complete studies of health impacts --

> "The public health and environmental injustice implications of this geographical pattern extend beyond the physiological impact of airborne emissions to issues of well water contamination and the negative impact of noxious odors on community economic development." **(source)**

The volatile gases and odors from plumes can gain access to the bloodstream through gas exchange where they can then be stored in fat cells (*Hog Watch*, Dr. Susan Schiffman). Dust particles blowing off CAFOs can lead to other problems. About 50 percent of the dust emissions from swine operations are believed to be respirable – small enough to be inhaled deeply into the lungs (CAFO rule, page 50). Inhaled dust particles are one of the primary routes of exposure for pathogens that are commonly found in CAFOs.

Possible health problems that could occur if exposed to odors and dust from hog operations are tearing eyes, sinus headaches, sinus congestion, nasal irritation, other headaches, and throat irritation. Many compounds found in hog odor can cause these and other more serious conditions such as rhinitis and allergic responses, resulting from immune system reaction to irritants in odor and dust from livestock operations. Dr. Dave Peaton, a scientist at the University of Carolina at Chapel Hill believes that the increase in childhood asthma is related to hog farms in the area (**author**, *Environmental Health Perspectives*, 2000)

Furthermore, there are microbial contaminants in hog manure that could cause disease in humans. The concentration of these pathogens in hog waste is much higher than in municipal raw sewage (10 to 100 times more). Municipal wastewater is extensively treated to reduce pathogens and is disinfected before released into the environment. Hog waste, on the other hand, is treated primarily in anaerobic lagoons, which are not effective in reducing disease-causing pathogens. These pathogens can be transmitted to humans through ground water contamination, leaking of lagoons, and growth from land-applied wastewater that has contaminated nearby surface waters. Due to their small size, bacteria and viruses can be aerosolized and transmitted in the air during spraying of liquid wastes, according to Mark Sobsey, professor of environmental microbiology (***HogWatch*, check date and univ. where prof at).**

Present air quality guidelines do not protect people exposed to livestock odors because threshold limit values (TLV) have not been established for most compounds found in livestock odors. Furthermore, concentrations of VOC's used for air quality guidelines that have been established may be too high for people that are susceptible to respiratory illness. Theses guidelines also do not take into account the health consequences of mixtures of VOC's (**author, Journal of Animal Science, date**).

B. Scope and Efficacy of Current Programs and Policies Addressing Manure Management

Given the diversity and scope of public policies and programs addressing manure storage and management, and the public funds spent in the name of manure management, it is remarkable how ineffective the overall effort has been. EPA's proposed CAFO rule acknowledges candidly in several places the minimal consequences of its past and current efforts to deal with manure management.

For the most part farmers install the cheapest system possible and acceptable to their rural neighbors and permitting authorities. In general the swine systems in the East are less efficient than those in the Midwest. Certain states have stricter laws and make a point of at least occasional enforcement, and hence fewer operations cut corners and facilities are built better and located more intelligently. It is also important to note that in some regions, rural communities have been remarkably successful in imposing reasonably strict standards on most AFOs, plus they have managed to deny permits for very large-scale operations.

Both the USDA and EPA, though, are determined to make more headway in addressing manure management needs. Here we assess the major programs and policies through which they will do so.

1. EQIP

USDA's technical and financial assistance for manure storage and land application "Best Management Practices" (BMPs) is primarily provided through the Environmental Quality Incentive Program, or EQIP. There is a statutory requirement that at least 50 percent of EQIP funds be directed to livestock related production practices; 58 percent has been invested in livestock-oriented practices in recent years (ERS, *Agri-Environmental Policy at the Crossroads*, January 2001). For CAFOs with over 1,000 animal units, EQIP funding is restricted to system design and other technical assistance.

From FY 1996 through 1998, the USDA provided $326.4 million in financial and technical assistance for animal waste management through its cost-share programs. About $209 million of the assistance was provided through EQIP, of which 20 percent is to be spent on livestock waste management. This is about twice the level from the mid-1990s. Such a sizable increase in a time period when overall program resources were declining is clear evidence that Congress views animal waste management as a top priority.

Undoubtedly more federal money will be appropriated through EQIP to address animal waste management but the question remains, what will it accomplish? **The next farm bill is likely to establish the basic requirements and expectations for the next decade's investment in animal agriculture's environmental problems, especially manure management.** The policy slate is not completely clean, but there should be more degrees of freedom in crafting innovative and hopefully more effective policy approaches in this area than in erosion control and commodity programs, where payments are now seen more as entitlements than incentives for changes in behavior.

There are six capital spending and two management based components in EQIP with direct relevance to animal agriculture. Other aspects of the EQIP program are considered neutral in their impacts on animal agriculture. The eight program components of relevance account for approximately 75 percent of the $100 million in FY 2000 funding for livestock oriented practices and installations.

- Capital Expenditures – composting facility, filter strip (buffers), manure transfer system (pipelines, concrete-lined ditches), waste management system, waste storage facility, and waste treatment lagoon.

- Management-Based Expenditures – nutrient management and waste utilization.

2. CRP and CREP

Initially, the Conservation Reserve Program (CRP) focused on protecting highly erodible cropland and controlling, to some degree, overproduction. Congress directed USDA to enroll as many acres as possible within appropriated funds, and so low-value cropland was enrolled most heavily at an average cost around $40.00 per acre per year. As a result, CRP enrollments came to be concentrated in the Great and High Plains and other states with extensive acreage suited to small grain production, where average land rental rates were relatively low.

As the CRP grew, politicians from other states argued that their producers also had unmet erosion control needs and fragile land that belonged in the CRP. But average rental rates in these other states were often over $100.00, so a CRP contract paying $50.00 per acre was not seen by many landowners as a viable option. A new mechanism was introduced in the program to select eligible land, coupled with much higher ceilings for higher-value land.

For each parcel of land offered for enrollment, landowners were required to set the minimum annual payment rate per acre they would accept over either a 10-year or 15-

year contract period. USDA computed an "Environmental Benefits Index" (EBI) score for each parcel of land. The components of the EBI were heavily weighted to wildlife management and water quality goals. The EBI was then used to produce a ranking of all parcels in a given state, from the greatest EBI return per dollar spent per acre, to the least. Contracts were awarded to the top parcels, until available funds in each area were fully committed.

These policy innovations have proven very successful in improving the environmental benefits of the CRP. By taking advantage of market forces through a competitive bidding process to set payment rates, the USDA was able to maximum the number of acres enrolled into the program within a given spending cap.

To further enhance the ability to enroll environmentally sensitive lands into the CRP in critical watersheds like those around the Chesapeake Bay, Congress established the Conservation Reserve Enhancement Program (CREP) in the 1996 farm bill. This program offers additional financial incentives and is administered through federal-state partnerships. Several CREP programs are now in place, most with a water quality focus. The installation of riparian area buffer strips is a major component of the programs. These key practices will definitely help reduce the run-off of sediment, nutrients, pesticides, and other pollutants from livestock farms and AFOs.

The shift to protection of the environment, as opposed to just erosion control, will make the CRP and CREP more relevant to the needs of livestock producers. Another program provision is also of some importance to cattle and sheep producers, especially in arid regions. When drought significantly impairs range condition and forage supplies, the Secretary of Agriculture is authorized to open up land enrolled in the CRP or CREP for haying or grazing. Landowners that exercise these options typically have to pay back part of the their annual contract payment. Still, this option has kept the price of forage from rising dramatically in many areas and as a result, has helped maintain the viability of many cow-calf and other grazing-based livestock operations. The benefits from this policy have been distributed widely and do not in any way favor large-scale operations.

3. CAFO Rule

EPA's proposed CAFO rule estimates that there are some 376,000 animal feeding operations (AFOs) in the country, of which some 12,000 are likely to meet the current definition of a CAFO (proposed rule, page 23). Implementation of CAFO permit programs differs greatly state by state, some relying exclusively on federal rules and authority, others mixing federal regulations and state laws. (See the reference section for more on the proposed CAFO rule).

Despite years of effort and multiple lawsuits, federal permits now cover relatively few CAFOs. Seventeen of 43 states authorized to issue National Pollution Discharge Elimination System (NPDES) permits to CAFOs have never issued a single one. EPA estimates that states have issued permits to about 45,000 AFOs under non-

NPDES permit programs. Minnesota alone has issued more than 25,000 state permits for AFOs.

Most of these 45,000 state permits authorize construction of an animal feeding yard or installation of a manure storage facility, and do not extend to other facets of AFO operation or management. Most do not specify environmental performance goals.

EPA's Compliance Assurance Plan provides the framework for ensuring compliance with NPDES permits and enforcement of point source pollution regulations as they relate to concentrated animal feeding operations (CAFO's). EPA's Office of Enforcement and Compliance Assurance (OECA) has placed a priority on implementation of existing CAFO regulations in order to prevent major spills and reduce pollution. While still in the developmental stages, OECA hopes to achieve this goal through several mechanisms –

- A risk-based monitoring program to assure CAFO compliance with the NPDES requirements.
- Periodic inspections.
- Coordination with other state and federal agencies as well as stakeholders.
- Information to CAFO's provided by the Agriculture Compliance Assistance Center.
- Tailoring compliance strategies to accommodate existing state programs and priorities that use risk-based targeting.

But in fact, several states are openly antagonistic to any role for EPA in addressing manure management and environmental problems associated with AFOs. Officials in these states typically argue that state programs and agencies have already gone well-beyond EPA requirements and are pushing farmers as fast as they can go in modernizing manure management systems. The state-federal roles in implementing stricter CAFO rules remain in play and are not likely to settle out for many years. Litigation is bound to play a major role in sorting out the roles for different agencies and levels of government. The level of government, and the agencies and programs with significant budgets to work with will invariably play a more direct role in setting the rules and expectations for system performance.

4. Other Initiatives and Efforts

Excess flow of nutrients – especially nitrogen and phosphorus – is the major cause of the Gulf of Mexico "dead zone". Nitrogenous pollutants from fertilizer and animal waste enter streams, stimulating the growth of algae. As the algae die and decompose, dissolved oxygen levels plummet causing "hypoxia". This has resulted in a large area devoid of marine life in the Gulf. High nutrient levels are causing similar problems in rivers throughout the Midwest, resulting in impaired water quality and fish and wildlife habitat.

The out-going Clinton administration developed a long-term plan for reducing the size of the "dead zone" in the Gulf of Mexico. The Environmental Protection Agency released the final version of the plan in January 2001. It provides incentives for farmers and a series of voluntary measures to improve water quality and reduce nutrient loading of streams.

Existing conservation programs, such as the CRP, CREP, and the Environmental Quality Incentives Program, provide farmers with the resources needed to install buffer strips and protect highly erodible land, protecting water quality locally and wherever it flows. Demand for these programs is high, but two out of five farmers are turned away because Congress has not provided adequate funds to enroll all eligible lands. According to Jeff Stein, Mississippi River Regional Representative of American Rivers --

> "Steps taken in Minnesota, Iowa and Illinois to reduce the dead zone will have benefits close to home," The dead zone plan "identifies clear steps needed to reduce polluted run-off of excess nutrients and sediment into the Mississippi River Basin. These nutrient reductions will benefit the Gulf of Mexico and reduce hypoxia, but they will also help improve water quality here at home". **(Source)**

However, President Bush's moratorium on new rules has left this plan up in the air. The future of this plan, or the extent to which conservation program expenditures are targeted to address this special problem, is unknown.

Air Quality

Most states are unable to enforce federal air quality standards for odor violations because typically CAFO's are classified as agricultural farms and as such are exempt from the Clean Air Act standards, as well as occupational health and safety standards. The same is true of most state laws. For example, in Arkansas, odors from agricultural operations are exempt from state regulation under a 1949 Water and Air Pollution Act.

C. Policy Reforms to Accomplish Manure Management Goals and Minimize Off-farm Impacts within a Generation

In the comprehensive review of agriculture's impact on the environment just released by the ERS, *Agri-Environmental Policy at the Crossroads* (AER-794, January 2001), a succinct box offer many examples of adverse impacts of agriculture on the environment. Nine of 13 problems discussed are directly related to animal production and CAFOs. Another box highlights nine major agri-environmental policy successes. None involve problems stemming largely from livestock production.

Tremendous strides have been made in reducing soil erosion, both on the policy and technology-tillage system front, since passage of the 1985 farm bill. In that farm bill cycle, the leaders of the Congressional agriculture committees were personally committed to conservation and convinced that the explosion in commodity program spending in the early 1980s had made matters worse. They worked hard to craft a truly historic set of reforms in conservation policy, with erosion control as the major focus. The new policies and programs have stood the test of time and are now firmly a part of the nation's resource conservation policy tool-kit.

Erosion control will remain one of agriculture's most important and unending challenges, and it is surely one where all the evidence points to steady progress in improving the cost-effectiveness of public policies and government spending.

In the case of the environmental impacts of animal agriculture, the exact opposite is the case. All evidence suggests that problems are growing rapidly worse and that the current policy response is feckless at best and a waste of public funds at worse.

New technologies are aggravating already serious problems, often in an attempt to accommodate ever-larger operations or make the adverse impacts of a CAFO seem more palatable. And policy has done virtually nothing to help change the economic forces driving animal agriculture toward systems and animal densities that are fundamentally and perhaps irrevocably incompatible with environmental quality.

There will be much discussion in the next farm bill debate about the need to spread more evenly the subsidies and incentive payments flowing from USDA to farmers. Crop farmers not now enjoying support like producers growing core commodity program crops are seeking a fairer slice of the pie. Conservation proponents are pressing the case that current levels of direct payments to farmers can only be defended in the context of multilateral agricultural policy reform if redirected to focus largely on resource conservation and environmental goals. Livestock producers, who have traditionally remained outside most USDA benefit streams, are now asking for help in deferring some of the costs of increasingly threatening infectious diseases and more and more complicated biosecurity strategies. They also want help dealing with the stricter environmental regulations that are emerging at the state, local, and belatedly, from federal EPA.

Policy lessons learned in recent years in soil erosion control and land preservation programs like the CRP, CREP and the Wetlands Reserve Program are not likely to be terribly relevant in confronting the policy challenges inherent in dealing with large-scale CAFOs. Indeed, the USDA has few tools, limited legislative authority, and next to no inclination to deal with the manure management challenges arising from today's livestock and poultry sectors.

By virtue of the Clean Water Act, EPA has the regulatory mandate and authority to address pollutant discharges from CAFOs. The EPA has followed a tortuous course in developing and releasing the newly proposed CAFO rule. Along the way it has been pushed by the courts and environmentalists and repelled by farm groups, their friends in Congress, and many state political and agricultural leaders.

Still, the EPA's proposed CAFO rule is a major evolutionary step in the policy process, and will remain so even if it goes no further. Eventually, some combination of state and federal authority will surely give birth to a CAFO permitting program that addresses the issues and confronts the complexities that EPA has tried to deal with in its current proposal.

In all likelihood, EPA's current CAFO proposal will be whittled down and made less encompassing and less consequential. As this process unfolds, it will be made increasingly moot by stricter state laws and regulations, as well as by judgments flowing from the growing number of lawsuits targeting CAFOs. Litigation as a lever for change is likely on a step upswing, given that 10 of the nation's top class action law firms, who collectively won billions in tobacco litigation in the 1990s, are gearing up now for a major, coordinated assault in the next decade on the environmental and public health impacts of CAFOs (**source**).

1. Critical Role of Science-Based Performance Standards and Cross-Compliance in Permits and Cost-Share Agreements

Manure management is a classic example of a win-win opportunity. Done well, it helps achieve two universally accepted goals and is largely, if not fully self-financing.

The first goal is the recycling of nutrients in manure. Manure storage systems and land application are supposed to efficiently recycle valuable plant nutrients. This lowers the cost of food production and sustains, indeed often builds, soil quality. Farmers incurring the costs of manure management stand first in line to achieve its most direct benefit – lower fertilizer bills and healthier crops.

The second goal is protecting public health. Manure management reduces nutrient and pathogen losses to the environment via surface water run-off, leaching to groundwater, and in the air, thereby reducing public exposure and health risks.

Any manure management plan, system permit, or regulation should be judged relative to the extent to which the performance standards embedded in the plan, system, or regulation achieve these two goals.

Plans, permits or regulations without quantifiable performance standards are much less likely to change significantly the environmental outcomes of "manure management."

There are three key, operational performance standards that all manure management plans, permits, and regulations should incorporate in one-way or another –

- Efficiency in nutrient cycling and recovery.
- Soil quality and health.
- Off farm movement of nutrients and pathogens.

Efficiency in Recycling Nutrients

The greater the percentage of nitrogen in fresh manure that is recycled in a subsequent crop, the lower the percentage of total manure nitrogen that will be lost to the environment where it might cause harm. Accordingly, all plans and permits should require farmers to achieve a minimal level of efficiency in the recycling of manure N. Currently none do.

There are, of course, practical limits in the efficiency of manure management systems in recycling nitrogen. Above a certain level of efficiency, each additional incremental gain in efficiency can be accomplished only at higher and higher costs. Across the country, in different climates and in areas with different soils and cropping patterns, practical and affordable efficiency goals for recycling manure nitrogen will vary within a range from about 60 percent to 80 percent on average over several years. This is not an area where "one size fits all" and policy-makers must build a role into the standard setting and reviews processes for experts in manure management at the regional and local.

The efficiency of recycling manure N in subsequent crops is the best and most universal performance standard because adherence to it, as a function of system design and management practices, is readily verifiable using current manure management planning tools and information, at least for most common systems and practices. In addition, the field monitoring needed to resolve uncertainties or disputes over a plan's efficiency can be resolved without great expense or lengthy research projects. The information flowing from such monitoring will, moreover, have value, since it will provide the foundation to further sharpen nutrient management plans in the future.

As evident in the data presented in the first part of this chapter, many of today's manure management systems fall far short of a minimum performance standard set, for example, at 60 percent efficiency in recycling nitrogen into a subsequent crop. Others already meet or exceed it.

Soil Quality and Health

The second basic performance standard should assure that land application of manure does not impair soil quality or health. Plans must avoid two major hazards: compaction and excessive buildup of soil phosphorous (P) levels. In some regions, other hazards can arise from the buildup of salt or minerals in soils, from weed seeds or pathogens, or other minor nutrients in soils. But most plans will only have to address soil compaction and P levels.

Soil compaction will result from the land application of liquid manure using heavy ground equipment whenever the ground is wet. Plans should allow ground application only when the soil is sufficiently dry, and to enforce this provision, plans should call for periodic tests of compaction. The plans and permits should also include a clear threshold for soil bulk density above which remedial measures will become essential. (The bulk density of a soil is a basic measure of compaction; the denser soil particles are packed together, the slower water infiltrates soil. Roots have a harder time seeking out moisture and nutrients in compacted soils, and compacted soils increase the loss of sediment and nutrients to surface water run-off).

Phosphorous is an essential plant nutrient that tends to bind tightly to soil particles. For this reason, soil P tends to not flow off cropland in surface water run-off, except to the extent it catches a ride on eroding sediment. But there are some soils naturally high in P. Other soils have been over-fertilized or over-manured to the point where the P binding sites on soil particles are largely taken up by other forms of phosphorous. Then, any additional P added to the system becomes soluble and mobile, greatly accelerating P losses to surface waters and problems with eutrophication. This is now occurring in many intensive farming regions with high animal densities per acre of cropland.

This is a problem easily solved. Routine soil samples will show whether a field is near or exceeds its capacity to bind further added phosphorous. In such cases, manure management plans must treat phosphorous just like nitrogen – by assuring that no more is added in a given year than removed by the crop. As a practical matter, applying manure so that soil phosphorous levels do not rise will limit the pounds of manure applied per acre well below what would be acceptable in meeting a given nitrogen efficiency goal. Accordingly, in areas where soil P levels are already at or beyond soil binding thresholds, manure management plans based on meaningful P thresholds will bring about substantial change in where and how much manure is applied to a given acre.

Off farm Movement of Pollutants

A third performance standard should define the acceptable levels of nutrients and pathogens from manure that can flow off farms and into water bodies. Farms with cropland along streams, rivers, and lakes will, in particular, need to pay close attention to run-off water quality. Typically, such farms will need to invest in some edge-of-the-field practices, like riparian area filter strips, to reduce the volume of nutrients and pathogens entering water.

The cleaner the water flowing off a field near surface waters, the less the need for additional practices designed to trap sediment and nutrients at the field's edge. Some farmers may find it more cost-effective or pleasing to establish and maintain relatively wide buffer strips, which can serve as pasture and a source of shade, as opposed to investing in more efficient systems to hold nutrients on farm fields. The EPA's proposed CAFO rule seeks comments on whether farmers should be given the option to balance and trade-off buffer strip design features with cropland BMPs.

There is also clear need to avoid the placement of CAFOs, especially manure storage facilities, above vulnerable groundwater resources, in areas with Karst geography, or near surface waters. Doing so is just asking for trouble. Existing facilities near vulnerable water resources must be held to a higher standard since any accidents or lapses in management will trigger more serious adverse consequences.

2. Leveraging Cost-Share Dollars

Most state or federal cost-share programs offer to pay a portion of the expenses associated with a list of eligible facilities, installations, or management-based practices. Technical guides set forth design specifications and other requirements. Most will need to be revised to more explicitly state verifiable performance standards and how compliance will be monitored.

Establishing clear, practical and verifiable performance standards to embed in cost-share contracts is the critical first step to maximize return to public expenditures. Now is the time to accomplish this in the context of the EQIP.

Approval of an application for cost-share funds should be based on a determination that the system or practice, as designed and proposed by the farmer, will reliably achieve a given minimal level of performance in recycling nutrients or promoting water quality, for example. Building performance standards into agreements and contracts, and consequences for noncompliance, is an example of cross-compliance, a common policy tool used by Congress to link changes in management behavior and system performance to receipt of public subsidies or other economic incentives.

Cross-compliance is essential in order to assure program accountability. In all likelihood, Congress will appropriate several hundred million dollars through EQIP in the next decade to help farmers install manure storage and management systems required by the state-federal CAFO regulations or court orders. These systems will often be costly and will require large, up-front payments to individual operators. The public will support such expenditures only as long as compliance and field performance monitoring data show that the systems are delivering tangible benefits well in excess of their costs.

For example, the economic benefits to society of a manure management storage system, installed with cost-share dollars, will depend on how and when the manure is land applied. Just effectively storing manure on the farm does not remove the risk of significant losses to surface waters or the risk of soil compaction. **Accordingly, the contract covering the installation must go beyond the storage system and encompass cross-compliance provisions covering land application.**

Cost-share contracts covering the installation of facilities or structures should specify the time period during which the farmer is required to maintain the facility or structure in good working order. Agreements and contracts also need to state how compliance will be monitored. To the full extent possible, the farmer, a crop consultant or extension specialist working with the farmer, should be able to monitor compliance with accessible analytical tools and routine soil and water quality tests.

Contracts should also explain the steps that will be triggered when evidence suggests a farmer has not attained the performance standards in the plan. The initial focus should be on helping farmers understand how compliance should be monitored and the linkages between compliance tests, specific practices and management decisions, and the environmental or resource conservation goals applicable to a given field.

Flexibility in how goals are to be achieved is key because the real world is never as orderly or predictable as envisioned by those writing program rules. It also makes it possible for farmers to achieve higher levels of performance within a given level of investment of time and money, as documented in the recent ERS report, A*gri-Environmental Policy at the Crossroads* (ERS, 2001). When necessary, plans can be revised to add additional practices, or alter other aspects of management or system design that allow the farmer to achieve the performance goal in a way that is more cost-effective.

Punitive provisions should be invoked only in cases where recommended remedial actions are not taken. Any cost-share program that rests largely on punitive measures to achieve its goals is simply not going to be adopted nor would it work.

Payment Rates

The Bush Administration has stated its preference for market-based incentives in achieving environmental program performance goals. Such incentives can be incorporated into cost-share programs by offering variable payment rates as a function of the performance standards embedded in contracts and agreements.

As stated above, meeting a minimum efficiency in nutrient management, for example, should be the responsibility of all farmers. The bulk of cost-share assistance should be offered to farmers willing to take the next steps, thereby further reducing the off farm impacts of their operation. Such an approach and policy is essential to avoid penalizing those farmers who have already made the needed investments to improve the performance of their systems. It will also allow market forces to be tapped in two ways.

Some farmers may be able and willing to achieve a markedly higher performance standard than others in a given watershed. When a plan is submitted that includes higher standards, county committees, conservation districts, or whoever is administering the program should be able to offer higher cost-share rates or other performance-based bonuses. For example, a nutrient management plan just meeting a minimum 60 percent efficiency goal in an area might qualify for the current $17.50 payment per acre, while $25.00 per acre would be paid for a plan that reaches 80 percent efficiency. The added payment would reward the farmer for additional steps. In many cases, it would also constitute a bargain for the government in terms of the marginal cost of added nutrients kept out of water.

Market forces can also be brought to bear through a competitive bidding process used to allocate limited funds to a pool of eligible farmers and landowners. All applicants for assistance would be screened and those meeting eligibility requirements would then be asked to specify the lowest cost share rate they would accept to go forward with a given practice or installation. Applicants offering the lowest bids would be the first to receive available program dollars. This simple approach has worked well in improving the cost-effectiveness of the Conservation Reserve Program and CREP.

Budget Realities

Some 12,000 concentrated animal feeding operations will be required to obtain permits under the EPA's current National Pollutant Discharge Elimination System. EPA estimates that about 2,500 of these currently have permits. Under the proposed CAFO regulations, the number of operations needing permits and upgraded manure management plans will surely rise, perhaps doubling. Currently, CAFOs are not eligible for EQIP cost-share payments for facilities. What if Congress removed this prohibition?

Currently, the maximum assistance allowed per EQIP contract is $50,000.00 and no more than $120 million has been available for all livestock oriented payments in a fiscal year. If 12,000 CAFOs obtained this maximum allowable assistance, in most cases just a down payment on total system costs, EQIP would require $600 million just for CAFOs. Congress had good reasons for not opening EQIP funding to CAFO structures. It should not change this policy; a CAFO is a large company and should be held responsible for meeting environmental standards, just like all other businesses and municipalities.

EQIP funding will be stretched thin enough meeting the needs of the over 350,000 small to moderate-scale livestock feeding operations, many of which will also need help in more efficiently recycling manure nutrients.

The USDA and other agencies need to also take into account animal density per acre of cultivated cropland in a given watershed in designing and administering cost-share programs. Many small to moderate-size livestock farms, side-by-side in an area, can lead to excessive animal numbers, just as a few large CAFOs can. Where animal density and the supply of manure exceeds the assimilative capacity of accessible cropland, there may be little point in investing public cost-share dollars in water quality programs. In such cases, novel strategies must be incorporated into cost-share programs and area-wide management solutions. These might include cooperative biogas facilities and composting, so that manure nutrients can be stabilized and economically shipped longer distances.

But USDA and State agencies must not run away from a simple reality and commonsense solution -- some farms will need to reduce animal numbers and mechanisms to reduce animal densities in defined areas are gong to be needed.

3. Negotiated Settlements and Public-Private Sector Agreements

The EPA's long-awaited CAFO rule released in December 2000 was developed in response to a series of court orders. Manure management and odor control are the core issues in dispute in thousands of legal proceedings unfolding at any given time around the country.

The prospect of more draconian penalties imposed by a court played a major role in bringing Smithfield Foods to the table in negotiations with North Carolina Attorney General Mike Easley. In July 2000 this process led to an agreement calling for the State to spend $65 million, most of it from Smithfield Foods, to develop and implement environmentally friendly waste treatment technology. Some $15 million will be spent on technology development and $2 million annually for 25 years for water quality restoration and enhancement measures.

In addition, Smithfield is required to eliminate open-air lagoons on its 276 company-owned farms within 5 years. It must supply financial and technical assistance to any of its 1,257 contract growers who choose to replace their lagoons. Smithfield also agreed to take immediate actions to –

- Reduce environmental impacts caused by farms in 100-year floodplains.
- Identify and properly decommission abandoned lagoons.
- Protect wetlands located on company farms thru conservation easements or other barriers.

North Carolina State University has two years to come up with environmentally superior and economically feasible waste management technologies that meet "strict" environmental standards (including the elimination of atmospheric ammonia-nitrogen emissions). Full implementation also depends on the commitment of the next Attorney General to enforce the agreement. Smithfield was not required to post a performance bond to ensure compliance. The Attorney General did not waive any rights to pursue enforcement actions against Smithfield farms or its subsidiaries for any past, present, or future violations of federal or state laws.

This agreement could bring about long-overdo, major changes in manure management in the North Carolina hog industry. The odds of success, however, would be greater if the agreement was more explicit in setting forth the performance standards for nutrient management that each contract farm will be required to meet.

The agreement allows manure to be applied to cropland at "agronomic rates" but does not require overall manure storage and management systems to attain a given minimum efficiency in nutrient recycling. For this reason, manure storage systems and application technologies that result in the most loss of nitrogen through volatilization and leaching will be the most attractive to farmers. The more nitrogen that can be lost before land application, the fewer the acres needed to support a hog operation of a given size. Managing phosphorous will require even more creative accounting.

The North Carolina agreement did not include a minimum nitrogen recycling performance goal for a practical reason. To keep soil P levels from rising above thresholds and recycle 60 percent of the nitrogen from all hog operations in North Carolina, USDA scientists have estimated that manure would have to be trucked to somewhere in eastern Indiana to access enough cultivated cropland. Such a requirement would, of course, lead to reductions in the total number of hogs fed in the state.

The only way to avoid this outcome, while still achieving minimum nutrient recycling performance standards, will be for the state and integrators to invest in new manure-biogas and/or composting technology. Such on-farm systems are among the options under active investigation by scientists at NC State.

4. Meaningful Permitting Requirements for CAFOs

Some sort of permitting process, whether run by EPA or the States, is the best hope for imposing stricter standards for manure management comprehensively, and fairly, across all CAFOs. Permits should set forth minimum performance goals and how compliance will be measured and verified, and by whom.

Permits should grant a producer the right to operate for a discrete time period, not to exceed five years. The consequences of noncompliance should be clearly spelled out. The permits should state that failure to achieve performance standards will be grounds for fines, and if corrective actions are not taken within realistic timeframes, permits will be rescinded or not renewed. **Unlike cost-share programs, consequential punitive measures are the only way to make a permit-based system work.**

Permits should make it clear that responsibility for manure management is shared by the CAFO and its owners, as well as by the entity that owns or has a contract on the animals moving through the CAFO. In addition, permit conditions must encompass land application of the manure, whether the CAFO sells, gives away, or applies the manure to its own land.

In general, the bigger the CAFO, the stricter the rules and reporting requirements should be, and the higher the penalties for noncompliance.

It must be left up to CAFOs to figure out how to comply with permit requirements addressing the ultimate efficiency of nutrient recycling, even when the CAFO disposes of its manure by giving it away or by paying someone to haul it off. Farmers or contractors taking manure from a CAFO will have to understand and accept the permit's land application manure management requirements and standards, and must work with the CAFO to document compliance with the requirements as called for in the permit and plan.

Much discussion will focus on the definition of CAFOs and what size of operation should trigger permit requirements. Given the degree of concentration in the industry, the largest operations account for by far the most animals and efforts must be focused first on them. Accordingly, environmental gains matter less where EPA or states draw the line in defining CAFOs, and more on what the rules require the largest operations to do. If EPA or States cannot tackle the problem on the largest operations, there is little hope for progress across the nations 376,000 smaller AFOs.

Progress made in reducing run-off from the largest operations will generate much valuable data and experience. It will also add confidence that the problem can be tackled on moderate scale operations.

There are dozens of specific provisions in the proposed CAFO rule on which EPA seeks comments on options that should never have arisen. For example, EPA may prohibit land application on frozen soils or on land that is saturated, but has asked for comments to convince it otherwise. Obviously, applications under either circumstance are going to lead to surface water run-off and significant impacts, especially when carried out by high-volume CAFOs. EPA should have ruled them out and moved on to more complicated issues, like the tradeoffs between riparian area management and cropland run-off BMPs.

EPA is considering two options governing land application near streams or lakes: farmers would either have to restrict applications within 100 feet of surface water, or install a 35 foot buffer strip. Here it is best to give farmers options to meet defined performance goals.

In general, permissive decisions will make it easier for CAFOs to comply and over time will assure that some progress is made on many CAFOs, but such decisions will also reduce the likelihood of significant water quality improvements in areas with many animal units.

Cost of CAFO Compliance

EPA estimates the cost to CAFOs of compliance at $831 billion under the two-tier structure and “Best Available Technology” option, encompassing 25,540 operations. CAFOs with more than 1,000 AU will account for an estimated $605 million of total costs, or 73 percent. Assuming no government assistance in meeting manure storage and management requirements, EPA estimates, with USDA assistance, that 1,890 operations would experience some financial stress under this option, about 7 percent of all affected CAFOs. Some 18,580 out of 28,970 operations would not experience financial stress in complying with the proposed rules, 64 percent of the total.

Offsite costs to those receiving CAFO manure are estimated at between $9.6 million and $11.3 million, less than one percent of production expenses.

While the total costs of improving the efficiency of nutrient recycling in the U.S. will be in the billions, so too will the benefits. In all likelihood, the total costs of a universal retooling of manure storage and land application would cost no more than $4 billion over about five years. It is conceivable that government programs will cover perhaps one-quarter of these costs, leaving the private sector to cover about $3 billion.

Once improvements are in place on a given farm, or across a watershed, the investments will deliver sizable dividends. We estimate that close to $1 billion in soil fertility benefits will be realized, including a reduction in farm fertilizer expenditures on the order of $500 million annually.

These net costs are modest compared to the costs of today's inefficient management of manure "wastes". Land values from odor and other CAFO problems now cost landowners and communities billions of dollars. Millions of cases of illness would be prevented and millions more would be less severe. Water quality would greatly improve, fish populations would recover, and the dead zone in the Gulf of Mexico would begin to recede. Recreational amenities would emerge and further reward communities for the investment made in improved systems.

Over time knowledge and new technology will lower the cost of systems designed to achieve a given level of efficiency in nutrient recycling, opening the possibility to push the envelope of manure management a bit further.

In the end, policy will be successful to the extent it focuses the expenditure of public and private resources, and the innovative skills of farmers, on pushing that envelope rather than on fighting about its shape or who is responsible for its contents and consequences. In a valuable article on swine CAFOs in Iowa, a team of university experts said basically the same thing --

> "Rather than rely ever more heavily on regulations and monitoring, we should research and demonstrate the economic viability of integrated livestock-crop production systems whose intrinsic features encourage nutrient use and protect our groundwater and surface water." (Jackson et al., 2000)