Confined Animal Production Poses Manure Management Problems

Livestock and poultry manure applied to farmland provides a valuable source of organic nutrients. On many operations, careful nutrient management, including use of manure, can reduce or eliminate the use of commercial fertilizers. But nitrogen and phosphorus from manure can cause quality problems when they enter water systems. Reducing flows of excess nutrients from the application of animal waste to cropland has become a growing challenge to confined animal operations.

Nitrogen is easily soluble and is transported in surface runoff, tile drainage, and water leaching through soil (*AO* May 2000). Phosphorus is only moderately soluble, and relative to nitrogen, not very mobile in soil. But sediment-adsorbed phosphorus can transport considerable amounts of phosphorus to surface waters through erosion, and the potential for dissolved phosphorus loss to surface and groundwater increases with buildup of phosphorus in the soil.

The opportunity to jointly manage animal waste and crop nutrients as part of a single operation has decreased with the trend toward fewer, larger, and more specialized animal production operations, which have inadequate land available for utilizing manure.

According to the 1997 Census of Agriculture, sales of confined animal species (feedlot beef cattle, dairy, swine, and poultry) totaled over $75.4 billion, more than 45 percent of total farm sales. Federal policies that affect the industry's manure management costs—e.g., through the Clean Water Act (CWA) and farm legislation—can have significant economic effects on the livestock and poultry sectors. In addition, a growing number of states are implementing regulations directed specifically at confined livestock and poultry operations (see article on page 19).

This article presents national and county-level estimates of numbers of animals and quantity of manure nitrogen produced on confined animal operations (feedlot beef, dairy, swine, and poultry), as well as farmland acreage available for nitrogen application. The estimates are a joint effort of three USDA agencies—the Economic Research Service (ERS), Natural Resources Conservation Service (NRCS), and National Agricultural Statistics Service (NASS).

The study examines national data on farms that could be regulated under the CWA as point-source discharge sites, and on farms that may be eligible for assistance under the Environmental Quality Incentives Program (EQIP) of the 1996 Farm Act. Estimates of manure production and of land available for application are based on data from the four most recent Censuses

Estimating Excess Manure Nitrogen

Farm-level "excess" of manure nitrogen on a confined livestock farm is manure nutrient production less crop assimilative capacity. Manure nitrogen production is estimated using the number of animals by species, standard manure production per animal unit, and nutrient composition of each type of manure. Recoverable manure nitrogen is the amount that can be collected and disposed of by spreading on fields or transporting off the producing farm.

Each farm's nitrogen assimilative capacity (amount of nitrogen taken up by plants that are removed from the field at harvest) is based on onfarm production (acreage multiplied by yield) of 24 major field crops and pasture recorded by the Census of Agriculture. County, regional, and national estimates of excess nitrogen levels are aggregated from farm-level excess estimates (these meet all Census of Agriculture confidentiality requirements for publication).

The calculation process has the potential to overstate excess nitrogen on some farms—because many production farms move manure off the farm instead of utilizing it on land they control—or to understate because it ignores commercial fertilizer applications. Nevertheless, the excess values calculated here represent a consistent, national estimate of manure nitrogen that would need to leave producers' farms in order to be managed in a manner that reduces the potential for undesirable nutrient flows into the environment.

of Agriculture (1982, 1987, 1992, and 1997). The question addressed is: If a livestock or poultry operation applies its manure to the available farmland (cropland and pasture) under its control at an optimal rate to meet the nutrient needs of crops grown, how much excess nitrogen would require disposal?

If the operator controls adequate land for manure application, the focus of manure disposal should be on farm-level solutions. For producers who can gain access to land off their farms, manure disposal involves additional considerations such as timing of transfer and applications, liability for improper application, and transportation costs. Areas that have insufficient cropland for spreading manure at optimal rates will need other manure disposal strategies, with manure management costs depending on the manure management strategy employed and the extent of potential problems—e.g., variable nutrient content in the manure, establishing markets for excess manure nutrients, and manure storage constraints that necessitate coordination of production flows and manure nutrient usage.

Concentration in Animal Production & Manure Output

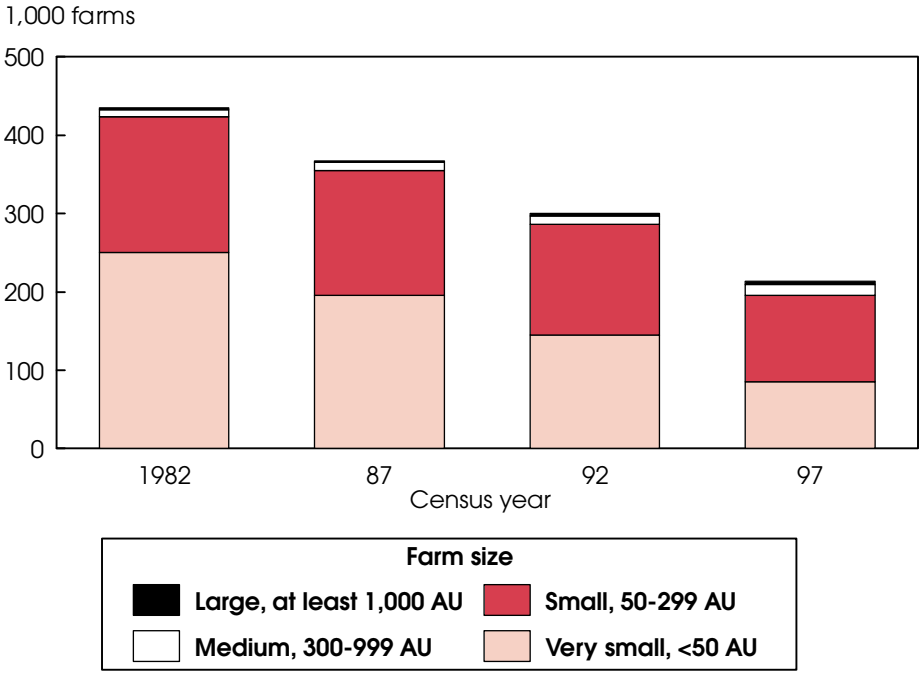
The number of farms with confined animals has declined dramatically and steadily from 435,000 farms in 1982 to 213,000 in 1997. The number of animals on these farms is measured based on an *animal unit* (AU), which allows multi-species comparisons relative to some specific standard—e.g., 1,000 pounds of live animal weight. Using the 1000-pound definition in this analysis means an AU is equivalent to 1.14 head of feedlot beef, 0.74 dairy cow, 2.67 swine for breeding, 9.09 swine for slaughter, 250 laying hens and pullets greater than 3 months old, 455 broiler chickens or pullets less than 3 months old, 50 turkeys for breeding, or 67 turkeys for slaughter.

All the decline in numbers of confined animal farms occurred in the smallest size groups—i.e., very small operations with fewer than 50 animal units (AU), and small operations with 50 to 300 AU. In contrast, the number of medium-size operations (300-999 AU) grew by 4,400 farms, and large farms (at least 1,000 AU) more than doubled to almost 4,000 farms. However, in 1997, medium-size farms accounted for only about 6 percent of all confined animal farms and large farms almost 2 percent, so that very small and small farms still dominate the number of confined animal farms by a wide margin.

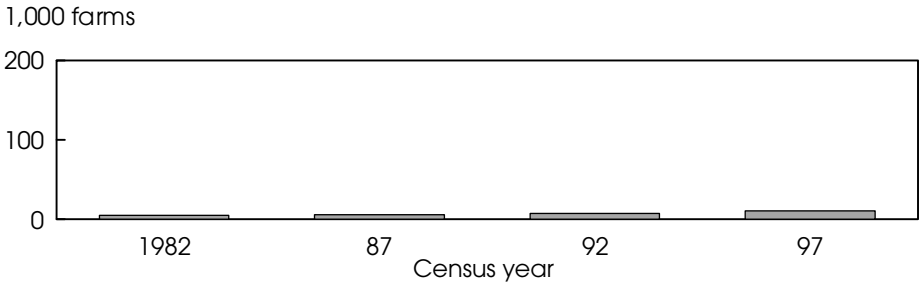
At the same time that the number of confined animal farms was falling, the number of confined animal units rose 10 percent. On very small farms, AU's dropped 64 percent overall to 1.6 million, while on small farms, AU's fell 74 percent to 11.1 million. Meanwhile, AU's on medium-size farms grew by more than half—from 4 million to 6.4—and almost doubled on large farms to reach 14.5 million.

Average AU per farm increased 6-17 percent for the lower three size classes between 1982 and 1997, but dropped 10 percent—from 4,019 AU, on average, to 3,643 AU—for large confined animal

Numbers of Small and Very Small Confined Animal Farms Are Declining. . .



. . .While the Number of Potential CAFO's Is Small but Growing

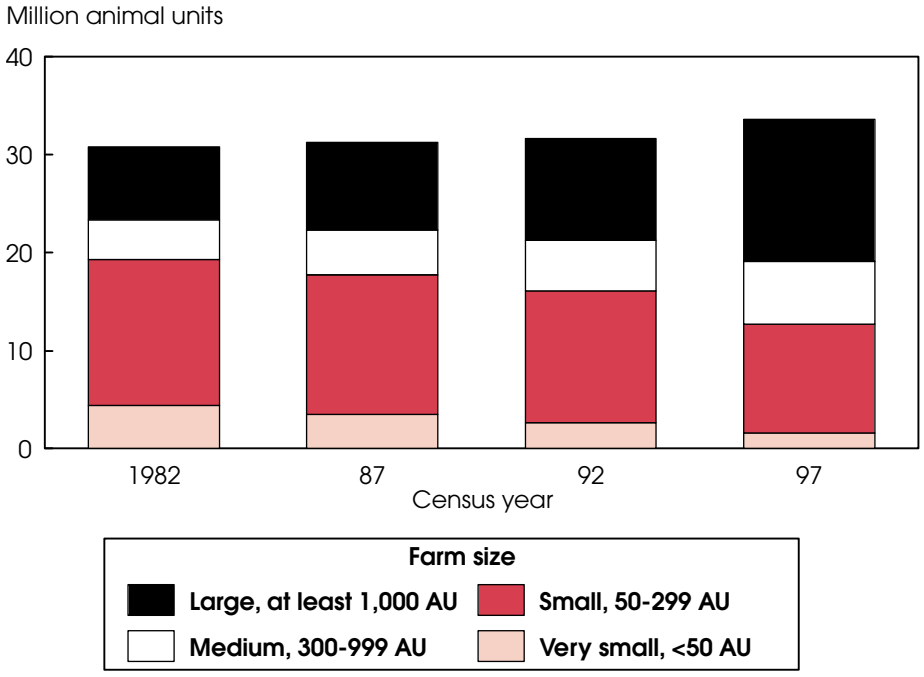


An animal unit (AU) in this analysis is the equivalent of 1,000 pounds of live animal weight—e.g., 2.67 swine for breeding or 67 turkeys for slaughter. Potential concentrated animal feeding operations (CAFO's) are confined animal farms with large enough numbers of animals to likely make them subject to regulation under the Clean Water Act. All large-size and most medium-size confined animal farms are potential CAFO's.

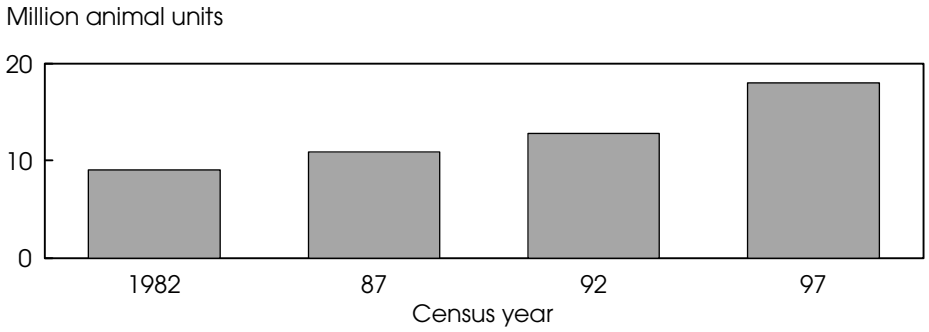
Source: Based on data from the Census of Agriculture.

Economic Research Service, USDA

Production Has Shifted to Medium- and Large-Size Confined Animal Farms. . .



. . .and Doubled on Potential CAFO's



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Source: Based on data from the Census of Agriculture.

Economic Research Service, USDA

operations. Large swine feeding operations proliferated during the period, and large swine operations generally have fewer AU than other types of confined animal operations.

Quantities of nutrients produced by confined AU's rose about 20 percent in 1982-97, while acreage on livestock and poultry farms declined. The result is a 20-percent increase in estimated excess manure nutrients during a 15-year period, because of inadequate cropland for utilizing manure on the producing farms. For example, confined animals produced an estimated 1.23 million tons of recoverable manure nitrogen (collectible for spreading) in 1997, but 73 million acres of cropland and permanent pasture controlled by operators of confined livestock and poultry operations is estimated to have assimilative capacity for only 38 percent of the calculated nitrogen available. This is one reason for increased policy attention focused on confined livestock operations.

Inability to assimilate all manure nutrients produced on the farm occurs on operations of all sizes, but not equally. In 1997, about 15 percent of very small farms and 72 percent of large operations had inadequate capacity to utilize all the nitrogen produced onfarm. Very small farms produce only about 2 percent of the national total of excess nutrients, while small farms (50-299 AU) produced more recoverable manure nitrogen than any other size class—almost 500,000 tons—and about 30 percent of total excess nitrogen, primarily accounted for by poultry production.

Nutrient production from medium- and large-size confined animal operations increased significantly during 1982-97, and quantities of total recoverable manure nitrogen and excess nitrogen almost doubled. Recoverable manure nitrogen production on medium-size operations increased 68 percent, and excess nitrogen by 83 percent; on large farms the corresponding increases were 102 percent and 104 percent. Medium-size farms accounted for 6 percent of confined animal operations but for 20 percent of 1997 excess nitrogen from confined animal production, while large farms accounted for 2 percent of confined animal farms and almost half of excess nitrogen.

Farms subject to regulation under current CWA rules are designated concentrated animal feeding operations (CAFO's) based on number of animal units and amount of point-source discharge from the operation. CAFO's are not directly identified in Census of Agriculture data. Because the regulatory impact of the CWA on CAFO's is of interest to policymakers, ERS has constructed a category of farms—"potential" CAFO's—that would likely be considered CAFO's under EPA rules. Farms are designated as potential CAFO's from estimates of annual average numbers of animals on the farms, derived from data on annual number of animals sold and year-end inventories. Potential CAFO's—5 percent of all confined animal farms—include all farms in

the large-size category and most in the medium-size.

Potential CAFO's more than doubled from 1982 to 1997, increasing from about 5,000 farms to 11,200, while the number of AU's on these farms increased from 9.1 million (30 percent of total confined AU's) to 18 million (54 percent of total confined AU's). Nationally, the average number of AU's on each potential CAFO has remained stable, so the gain in AU's on potential CAFO farms was due simply to the increase in number of potential CAFO's. Potential CAFO's could be the source of over half of estimated excess itrogen from all confined animal operations.

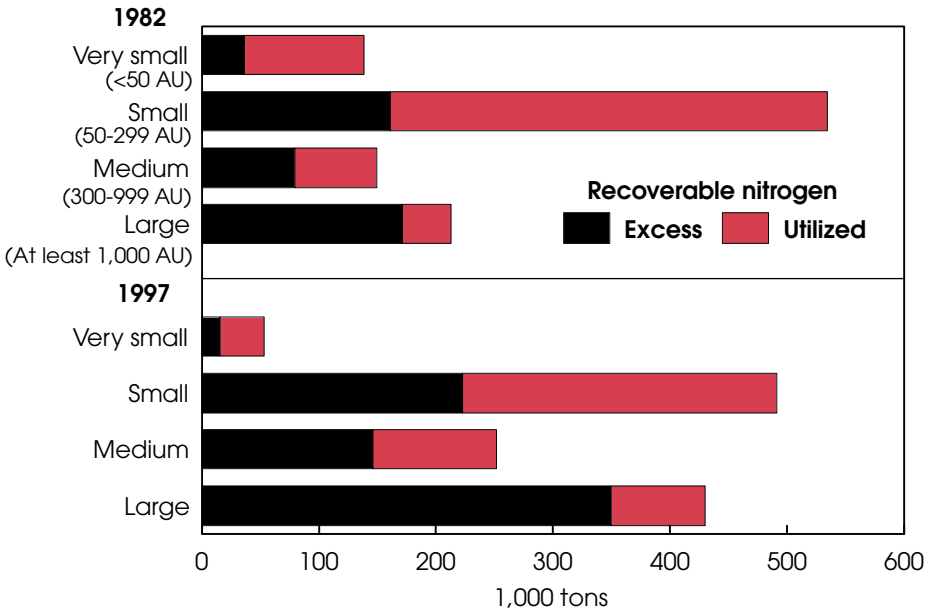
High Excess Nitrogen From Poultry

Confined animal operations and resulting manure nitrogen are not evenly distributed across the nation. In 1997, the Southern Seaboard region—a major poultry- and swine-producing area—generated the largest quantity of recoverable manure nitrogen (256,000 tons, or over 20 percent of the nation's confined animal total). The region also has farms with among the fewest acres per AU on which to apply manure, so it accounts for the largest quantity of excess nitrogen (200,000 tons, or over 27 percent of the national confined animal total).

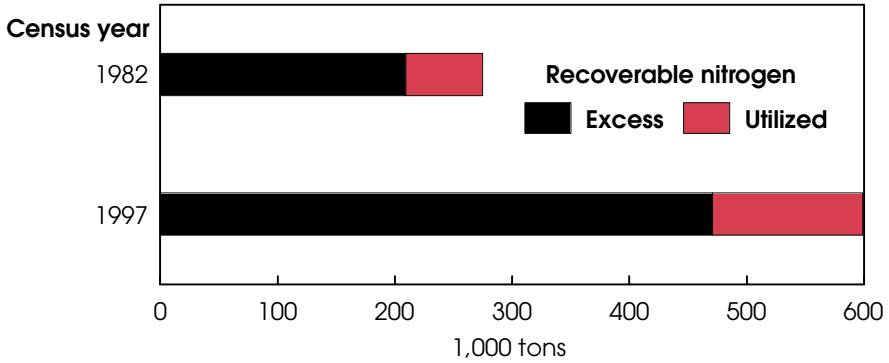
The Southern Seaboard leads in production of recoverable manure nitrogen despite having about half the AU of the Heartland region. Nutrient production differs by species, with some types of poultry producing up to 5 times as much nitrogen per AU as feedlot beef cattle. While both the Heartland and Southern Seaboard regions produce significant numbers of swine, the Southern Seaboard region has more poultry and fewer cattle, resulting in greater recoverable manure nutrients from fewer AU.

Total recoverable manure nitrogen declined from 1982 to 1997 in both the Northern Crescent and Basin and Range regions, but increased in all other regions. The Southern Seaboard showed the greatest increase in both absolute and relative terms—95,000 tons, an increase of almost 60 percent.

Medium- and Large-Size Farms Accounted for More Recoverable Manure Nitrogen in 1997 than in 1982. . .



. . .and Estimated Recoverable Nitrogen from Potential CAFO's Has More Than Doubled

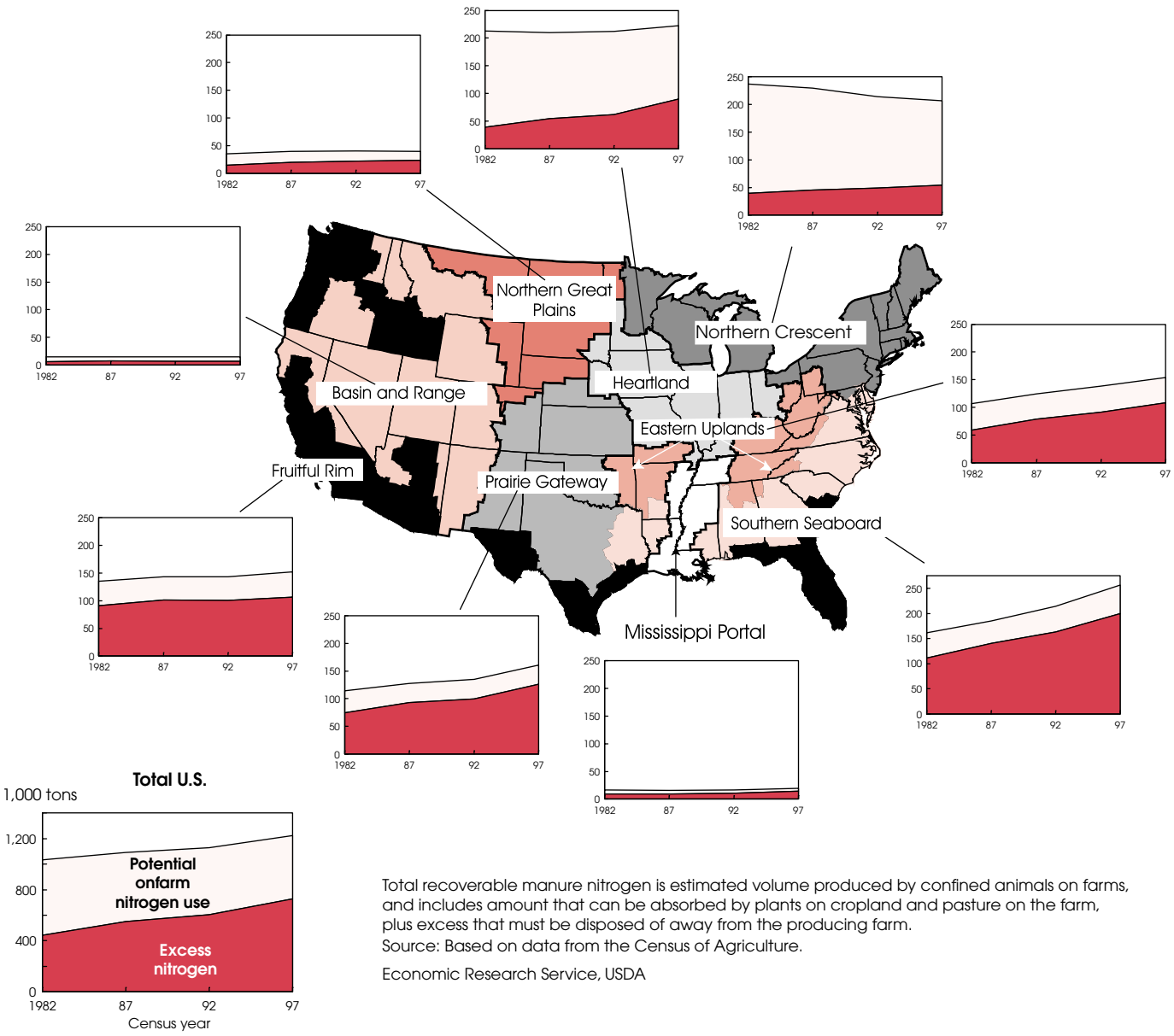


An animal unit (AU) in this analysis is the equivalent of 1,000 pounds of live animal weight--e.g., 2.67 swine for breeding or 67 turkeys for slaughter. Recoverable manure nitrogen is estimated collectible volume produced by confined animals on farms. Assumes utilized manure nitrogen is spread on producing farms' cropland and pasture at optimum rates; excess must be disposed of by applying to land on other farms or by other means. Potential concentrated animal feeding operations (CAFO's) are confined animal farms with large enough numbers of animals to likely make them subject to regulation under the Clean Water Act.
Source: Based on data from the Census of Agriculture.

Economic Research Service, USDA

About three-fourths of U.S. counties contain farms that have to dispose of recoverable manure nitrogen in excess of onfarm crop and pastureland needs. While production of excess manure nitrogen does not always contribute to water quality and other environmental problems, manure movement off confined livestock farms is necessary to avoid excess nitrogen accumulation. Areas with excess manure may need mechanisms to encourage land application on other farms, or to provide incentives for alternative manure treatment strategies.

Southern Seaboard Has Greatest Total Recoverable Manure Nitrogen, and Most Cannot Be Used on the Producing Farms



Total recoverable manure nitrogen is estimated volume produced by confined animals on farms, and includes amount that can be absorbed by plants on cropland and pasture on the farm, plus excess that must be disposed of away from the producing farm.
Source: Based on data from the Census of Agriculture.

Economic Research Service, USDA

Generally, excess manure nitrogen is greatest in counties with the largest concentration of confined animals, although AU numbers and excess manure nitrogen are not perfectly correlated. For example, northern Alabama and Georgia, where poultry is dominant, have high calculated levels of excess nitrogen because poultry manure has a high nitrogen content per AU and land available for spreading is limited. Northeastern Iowa and southern Wisconsin have a relatively high concentration of animals but lower excess nitrogen than might be expected, because there is more available land per farm and lower nitrogen production per AU.

Concentration of excess manure nutrients on small poultry farms and on all larger sized operations may provide opportunities to effectively target policies to reduce excess manure nutrients. The potential exists to develop and utilize econonomical, effective off-farm technologies, since operations are geographically concentrated (minimizing manure transport costs) and species-dominant (producing relatively homogeneous manure for processing).

Future of National Policies Affecting Animal Operations

Federal policies related to regulation of manure produced on confined animal operations are still evolving. The *Clean Water Act* (CWA)—passed in 1972 and

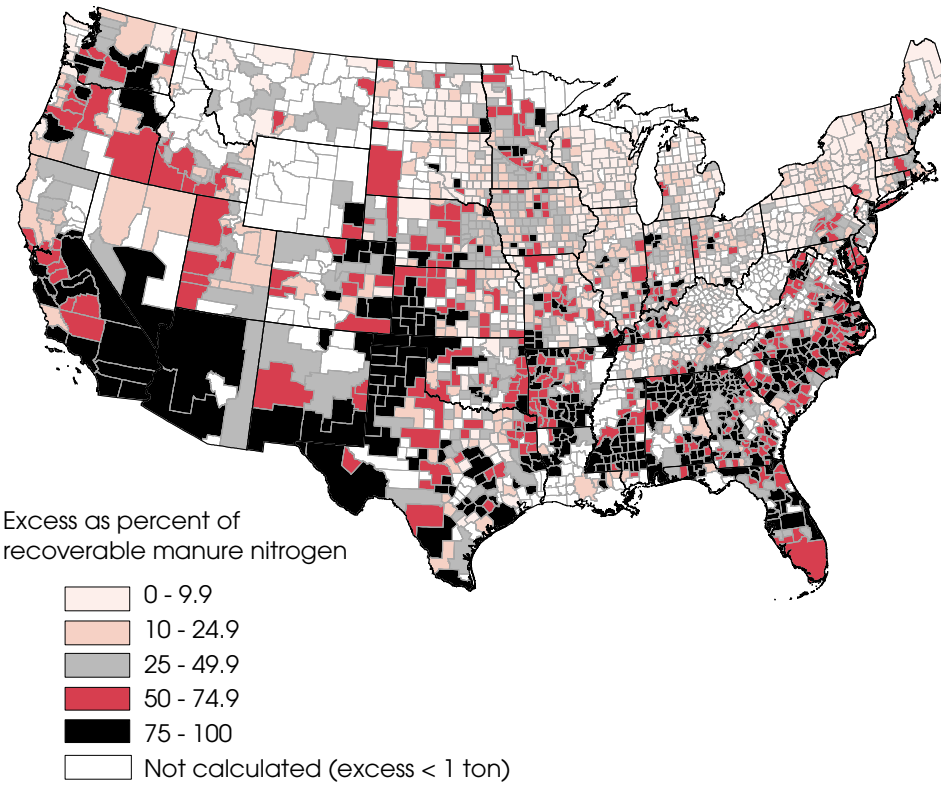
administered by the Environmental Protection Agency (EPA)—is the major piece of Federal legislation affecting animal operations. The CWA defines water quality in terms of designated beneficial uses (e.g., drinking water, recreational use, and aquatic life support) and establishes criteria to support each use. USDA's *Environmental Quality Incentive Program* (EQIP)—authorized by the 1996 Farm Act—replaces most previous financial assistance programs and better targets assistance to areas most needing actions to improve or preserve environmental quality.

Under the *CWA*, National Pollutant Discharge Elimination System (NPDES) permits are required for point sources (facilities that discharge directly into a discrete ditch or pipe) that will empty into navigable waters. NPDES permits for animal feeding operations currently focus solely on developing engineering (technology-based) solutions to reduce runoff and spills from manure storage and treatment structures.

Under 1974 NPDES regulations, several criteria may be used to designate an animal feeding operation (AFO) as a concentrated animal feeding operation (CAFO), thereby labeling it a point source. The criteria may include number of animals, days in confinement, lack of vegetation in the confinement area, and potential for waste runoff into waterways. For example, an AFO could be designated a CAFO if the farm confines 1,000 or more slaughter or feeder cattle for a total of 45 days annually, or if the farm confines 300 head of slaughter or feeder cattle for 45 days annually *and* discharges directly into a waterway. Threshold animal numbers are specified for slaughter and feeder cattle, dairy cows, swine, laying hens, broilers, chickens, turkeys, horses, sheep, ducks, or may be a combination of animals.

EQIP is a voluntary agricultural program that can improve water quality through changes in farm nutrient management practices. EQIP provides technical, educational, and financial assistance to farmers and ranchers for adopting structural, vegetative, and management practices that protect or enhance environmental quality. By statute, half the program's available funding is targeted to conservation problems of livestock and poultry producers.

Most Counties Have Confined Animal Farms with Excess Manure Nitrogen to Move Off-Farm



Excess manure nitrogen as share of total recoverable (collectible) nitrogen from confined animals. Excess manure nitrogen is amount beyond a farm's absorptive capacity on cropland and pasture—i.e., it must be moved off the producing farm.

Economic Research Service, USDA

All 213,000 confined livestock and poultry farms are eligible for nutrient management technical assistance under EQIP. Operations with fewer than 1,000 AU are also eligible for financial assistance with manure storage or treatment facilities. Operations with more than 1,000 AU—the 2 percent that produce 35 percent of excess nitrogen—are not eligible for government financial assistance to design and build manure management facilities.

Limited funds may lessen the effectiveness of EQIP. Funds allocated by EQIP were near $200 million for 1997 and 1998, but declined to around $175 million in 1999 and 2000. Even if total annual EQIP funding were devoted solely to manure management planning, average spending would be only $820 per confined livestock or poultry farm.

USDA and EPA announced a new initiative in 1999—the *Unified National Strategy for Animal Feeding Operations*—that will set minimum standards for all state water quality protection programs. Regulations to implement the Unified Strategy are currently under review.

Under the Unified Strategy, all animal feeding operation (AFO) owners and operators would be expected to develop and implement site-specific comprehensive nutrient management plans (CNMP), including onfarm application and off-farm disposal. The strategy will revise the criteria that identify operations requiring an NPDES permit. The largest operations will still require a permit, but NPDES permits will also be required of operations with

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unacceptable conditions, regardless of size, that pose a significant risk of water pollution or public health problems, or that are concentrated in a watershed designated as impaired because of nutrient discharge from AFO's. For example, many poultry farms in the small-size category that are not currently required to obtain NPDES permits might be required to have them in the future, if their concentration in the watershed makes a significant contribution to water quality problems.

Under current EPA proposals for future NPDES permits, development of a CNMP will be a required part of the permit process. Permit applications will include management strategies for manure collection, storage, and disposal—including use of manure nutrients in crop production.

The CNMP requirement brings land application of manure into the Federal NPDES permitting process for the first time. The costs of implementing off-farm manure management strategies are still to be determined. But more stringent application of the CNMP requirement on potential CAFO's could significantly reduce the possibility of excess nutrients entering water sources. AO

Noel Gollehon (202) 694-5539 and Margriet Caswell (202) 694-5540
gollehon@ers.usda.gov
mcaswell@ers.usda.gov

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