Confined Animal Production and Manure Nutrients

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Abstract: Using data from the Census of Agriculture on animal inventory and sales, we estimate manure nutrient production on farms with confined livestock. Using reported on-farm production of crops on these same farms, we estimate the nutrient uptake for major field crops and pastureland. This enables us to examine the balance between manure nutrient production and nutrient need measured by crop uptake at a farm level.

Examination at alternative spatial scales, shows that 75 percent of counties in the U.S. have farms that produce more manure nutrients than can be assimilated on the farm of production (excess nitrogen). The vast majority of the counties that produce excess nitrogen have adequate land in the county to spread the manure at agronomic rates. Thus, proposed policies that focus on land application have the potential to limit manure nutrient movement to waterways in most areas, if properly managed. However, moving manure to crop farms that formerly had not used manure will increase costs. There were about 5 percent of counties where the manure nitrogen production levels from confined animal production exceeded half the nitrogen assimilative capacity of all the cropland and pastureland in the county. These areas have the greatest need for mechanisms to encourage off-farm solutions to utilize manure as a feedstock for commercial enterprises or central processing.

Confined Animal Production and Manure Nutrients

Livestock and poultry manure can provide a valuable source of organic nutrients to cropland. Careful nutrient management, including the use of manure can reduce or eliminate the use of commercial fertilizers. However, for farms with livestock and limited amounts of cropland, field application of manure may be done for purposes of disposal rather than as part of a nutrient management plan. This may lead to residual nutrients being available for transport to the environment, where they may degrade water quality and impose costs on water users.

There is a trend towards fewer, larger, animal production units. As the size of livestock units has grown and become more specialized, the opportunities to jointly manage animal waste and crop nutrients as part of a single operation have decreased (Govinasamy et al., Trachtenberg and Ogg). Manure from confined livestock operations is a source of water quality degradation through runoff and leaching from manure and wastewater applied to land, open and unpaved feedlots, and runoff and leaching from holding ponds, lagoons, and stockpiles. Reducing the flows of excess nutrients from the application of animal waste to cropland has become a growing challenge[1]. Policymakers are considering ways to encourage the linking of livestock operations with available cropland to maximize the nutrient contributions of the manure to crop yield while reducing damages from residual nutrients.

U.S. animal production provided $98.8 billion in sales in 1997, over half (51 percent) of all farm sales (NASS, 1999a). Sales of confined species (feedlot beef, dairy, swine, and poultry) accounted for over $75.4 billion in 1997 sales. Policy changes that affect industry costs could have significant economic effects on the livestock sector. Federal policies that have a direct impact on manure management are the Clean Water Act (CWA), Coastal Zone Act Reauthorization Amendments (CZARA), and Farm Bill legislation. A growing number of states are implementing laws directed at confined livestock and poultry, in many cases more restrictive than the Federal regulations.

This report describes the amount of manure nutrients that are produced and the cropland and pasture available for nutrient application both on confined livestock operations and on available cropland

[1] Reducing runoff and spills from storage and treatment structures often can be accomplished with engineering technology-based solutions. These structures may be regulated as point-sources under the Clean Water Act.

within the county. To estimate manure production and the land available for application, we use data from individual respondents of the last four Censuses of Agriculture conducted in 1982, 1987, 1992, and 1997. These data provide a consistent information source about animal producers across the United States. We look at those farms potentially regulated under the CWA that require permitting as a point-source discharge site.

The question that we address is: If a livestock operation applied its manure to the available crop and pastureland under its control at a rate that met the nutrient needs of the plants, how much excess nutrient production would require disposal?[2] We recognize that manure nutrients can be applied to land owned by other operators, but high transportation costs often preclude using that disposal option. We want to differentiate those areas for which better on-farm management may be adequate to reduce water quality problems and those areas that would need mechanisms to encourage off-farm solutions such as manure markets or central processing.

Policies Affecting Animal Operations

Current Regulations and Programs

The major federal law affecting animal operations is the Clean Water Act. Specifically, the National Pollutant Discharge Elimination System (NPDES) program permits are required by point sources (facilities that discharge directly to water resources through a discrete ditch or pipe) before they can discharge into navigable waters. The permits specify a level of treatment for each effluent source. Federal NPDES permits cover some animal feeding operations and may be issued by the U.S. Environmental Protection Agency (EPA) or any state authorized to implement the NPDES program.

Under 1974 EPA regulations, certain animal feeding operations (AFOs) can be designated concentrated animal feeding operations (CAFOs) and are considered a point source in the NPDES program. EPA s regulations (contained in 40 C.F.R.⁄122.23 and Part 122, Appendix B) define an AFO as a facility that meets the following criteria:

[2] We assume that manure and commercial fertilizers are optimally managed on the operator s available land.

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and

- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.

A CAFO is defined as an AFO that:

- Confines more than 1,000 slaughter and feeder cattle, 700 mature dairy cows, 2,500 swine each weighing more than 25 kilograms, 30,000 laying hens or broilers (if a facility uses a liquid manure system), and 100,000 laying hens or broilers (if a facility uses continuous overflow watering), 55,000 turkeys, 500 horses, 10,000 sheep, 5,000 ducks, or combinations of animals totaling 1,000 animal units. The CAFO definition of animals per animal unit are specified only for slaughter and feeder cattle, mature dairy cows, swine, sheep, and horses (see 40 CFR Part 122, Appendix B).

- Confines more than 30 percent of the number of animals in the above definition and discharges pollutants into waters through a man-made ditch, flushing system, or similar man-made device, or directly into waters that pass through the facility.

The CAFO regulations contains an exemption for facilities that discharge only in the event of a 25-year, 24-hour storm event[3] (i.e., AFOs of any size that have facilities to contain the runoff associated with a local-area, 24-hour storm of a severity expected only once in 25-years do not need a permit) (40 C.F.R./412).

The Coastal Zone Management Act defines requirements for animal operations in the coastal zone. EPA requires that discharge from confined animal facilities be limited through appropriate storage and waste utilization systems. The requirement applies to all new facilities regardless of size and to all new or existing confined animal facilities with 300 beef, 200 horses, 70 dairy cows, 15,000 layers or broilers, or 200 swine. Exempted are those CAFOs that are required to have an NPDES permit.

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[3] The August 6, 1999, version of proposed revisions to the NPDES permit manual for CAFOs significantly tightens this exception by requiring the facility demonstrate that there has been no discharge to either surface waters or groundwater with a direct hydrologic connection to surface waters.

States may issue their own NPDES permits. Thirty-eight states have some type of permit, license, or authorization program that covers CAFOs. Typically, the program takes the form of a required construction or operating permit, or a setback. The NPDES permits issued by states may be more stringent than federal guidance, but may apply to specific species. Currently, 32 states have a permit requirement that restricts application rates of manure on the land, and 27 states require the development and use of waste management plans.

In addition to the regulatory framework, there are voluntary agricultural programs that are designed to improve water quality by changing farm nutrient management practices. The Environmental Quality Incentive Program (EQIP) was initiated in the 1996 Federal Agriculture Improvement and Reform Act (1996 Farm Act). EQIP provides technical, educational, and financial assistance to farmers and ranchers for adopting structural, vegetative, and management practices that protect or enhance environmental quality. Contracts for financial assistance are for 5 to 10 years, and the annual payment limit is $10,000 per person, with a maximum of $50,000 per contract. By statute, half of the available funding for the program is targeted at practices related to livestock producers of less than 1,000 animal units. Funds allocated by EQIP were near $200 million for 1997 and for 1998, declining to near $175 million in 1999 (Loser, personal communication, 2000).

Future Regulations and Programs

In 1999, the U.S. Department of Agriculture (USDA) and EPA announced the Unified National Strategy for Animal Feeding Operations (USDA - EPA, 1999). The Strategy sets forth a framework of actions that USDA and EPA plan to take to minimize water quality and public health impacts from improperly managed animal wastes, under existing legal and regulatory authority. The development of the Strategy was spurred by changes in the animal feeding industry that are described in the following sections. The geographic concentration of feeding operations can overwhelm the ability of a watershed to assimilate the nutrients contained in the waste and maintain water quality. In addition, the size and number of animal waste storage lagoons increases the chance for a leak or a catastrophic break. Over the past several years, major lagoon spills or leaks have been documented in Illinois, North Carolina, Iowa, Kentucky, Minnesota, Missouri, Montana, South Dakota, Utah, Virginia, Washington, and Wisconsin (NRDC, 1998). Many States have developed and implemented their own programs for controlling the adverse impacts of feeding operations (U.S. EPA, 2000). The Unified Strategy, when implemented, will set minimum standards for all State water quality protection programs.

Under the Unified Strategy, all AFO owners and operators will be expected to develop and implement technically sound, economically feasible, and site-specific comprehensive nutrient management plans (CNMP) for properly managing the animal wastes produced at their facilities, including on-farm application and off-farm disposal. Nutrient management plans will be mandatory for operations that require an NPDES permit, and voluntary for other producers. The nutrient management plans should be tailored to address the individual needs and practices of each individual AFO. Inclusion of a CNMP as part of the NPDES permit, means that for the first time, the application of manure on land will be a part of a required Federal permit (32 states now have alternative versions of this provision —generally for a single species — in state regulations).

The Strategy will redefine the set of operations that will require an NPDES permit. Not only will the largest operations still require a permit, NPDES permits will also be issued to smaller operations with unacceptable conditions or those with significant contributions to water quality impairments (U.S. EPA, 1999). This means that all AFOs in a watershed designated as impaired by nutrients[4] might be considered CAFOs, regardless of their size, if the concentration of animals in the watershed is deemed the reason for the impairment. Knowledge of where animals are highly concentrated could assist resource managers in identifying nutrient-impaired waters and options for remediation.

Data

Our analysis estimates the on-farm balance of manure nutrient production relative to the farm s current potential to utilize the nutrients for crop production. We use farm-level data collected for the 1982, 1987, 1992, and 1997 Censuses of Agriculture. Our methodology is direct. First, we estimate manure nutrient production on farms with confined livestock. Second, we used the reported on-farm production of major field crops and pastureland crops on these same farms to calculate nutrient

[4] States are required by the Clean Water Act to identify impaired waters, and EPA has recently requested that States accelerate their efforts to identify such waters and to develop remediation programs (Boyd, 2000). EPA is providing the States guidance for identifying nutrient-impaired waters, the lack of which has hindered States from identifying nutrient-related problems in the past (Gibson, et al., 2000). These actions may focus attention to watersheds where animals, and animal operations, are concentrated.

assimilative capacity[5]. Third, we examine the balance between manure nutrient production and nutrient need measured by crop uptake at a farm level. We estimated all parameters at the farm level before aggregating to characterize how individual decisions are made. Then, results were aggregated to geographic units and across species.[6]

Estimates presented here were a joint effort of three USDA Agencies: Economic Research Service (ERS), Natural Resources Conservation Service (NRCS), and National Agricultural Statistics Service (NASS). The details of the computation methods may be found in a companion NRCS report (Kellogg, et al., 2000).

We use a biologically-based definition of an animal unit (AU) as 1,000 pounds of live animal weight to facilitate the calculation of manure production and manure nutrients. We apply this definition to feedlot beef, dairy, swine, and poultry, using average animal weights and constant annual production levels computed from the Census end-of-year inventory and sales data (Table 1). The Clean Water Act s specification of a CAFO is a regulatory definition that is not based on animal biology — hence cannot be used to calculate manure production.

Table 1. Definitions of Animal Units (AU) and specification of minimum size for inclusion in the data

Species	ERS/NRCS Animal Unit Definitions	Minimum number of head before confinement
Feedlot beef	1.14	15
Dairy cows	0.74	20
Swine for breeding	2.67	10
Swine for slaughter	9.09	50
Laying hens & Pullets > 3mo.	250	50
Broilers & Pullets < 3mo.	455	100
Turkeys for breeding	50	50
Turkeys for slaughter	67	50

[5] For crops, assimilative capacity is the amount of nutrients taken up by the plant and removed from the field at harvest, and represents the quantity that can be applied each year without accumulating nutrients. We assume that the nutrients in the nonharvestable portion of the plant are returned to the soil and thus are available in the future for plant growth. Strictly speaking, this quantity is not crop need, nor crop uptake; however, these characterizations are also used in the text for convenience.

[6] Our analysis meets all respondent confidentiality assurances that are required to publish Census of Agriculture values.

We examine operations of different sizes to evaluate impacts of potential regulatory changes and to observe changes in industry structure. We did not want to restrict the analysis to the currently defined designation of CAFOs, so we report results for a distribution of operation sizes and for those potentially subject to regulation. In order to study farms that may be regulated under current CWA rules, we constructed a category (Potential CAFO farms) using the CWA number of head definitions that includes all of our large category and part of our medium category. It is not possible to precisely identify a livestock operation as a CAFO using the information available in the Census of Agriculture. Instead, data on potential CAFOs were constructed based on estimates of the annual average number of livestock on the farm, derived from annual sales data and year-end inventories.[7]

This report examines manure management in the current and the likely future policy context. The data includes farms with confined species[8] with more than $2,000 in livestock sales and at least three AU of all species on the farm. The data were further limited to farms operating above a minimum scale to reflect commercial operations (Table 1). Thus, these estimates are most useful for examining currently regulated CAFO farms, and farms that might be regulated in the future under the CWA, CZRA, or some other authority. This subset of farms does not represent the total production of manure nutrients (see Kellogg et al. (2000) for these estimates), but rather the nutrient production for which policies will be relevant.

Computation of manure nutrients was a three-step process. First, animal numbers were converted to an average annual AU inventory from reported end-of-year inventory and annual sales data. Second,

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[7] The following rules were used to identify potential CAFOs: 1) farms with fattened cattle sales of 1,000 or more, 2) farms with milk cow end-of-year inventory of 750 or more, 3) farms with combined sow inventory and hogs on feed (average annual number based on inventory and sales) of 2,500 or more, 4) farms with an average annual number of pullets and layers (based on inventory and sales) of 100,000 or more, 5) farms with an average annual number of broilers (based on inventory and sales) of 100,000 or more, and 6) farms with an average annual number of turkey hens and turkeys for slaughter (based on inventory and sales) of 55,000 or more. No attempt was made to identify CAFOs based on a mixture of these six livestock types.

[8] Confined species include feedlot beef, dairy, swine, and poultry. These data do not include estimates of the recoverable portion of manure from cattle, other than fattened cattle and milk cows (bulls, beef cows, dairy and beef replacement heifers, calves less than 500 pounds, and calves greater than 500 pounds not in a feedlot). If cattle, other than fattened cattle and milk cows, were included in the analysis farm numbers would double, the number of AU would increase by only six percent, and recoverable manure nitrogen would increase by about five percent.

quantities of manure were computed by applying AU-based coefficients of manure production by species. Third, we compute the recoverable portion of the manure nutrients per ton of manure after storage losses. See Kellogg et al. (2000) for details of the estimation process and manure and nutrient production coefficients.

Potential manure nutrient use by the farms on which it was produced was also estimated. In these calculations the land area and the per-acre nutrient uptake for the production of 24 major field crops and permanent pasture was computed for each farm in the Census. Manure nutrient production on confined livestock farms was compared with crop assimilative capacity to compute a farm-level excess of manure nutrients. We recognize this calculation process may overstate potential excess nutrients because some manure is moved off many production farms. However, excess nutrients may be understated because commercial fertilizer applications are not considered. Most crop farms without livestock, and many farms with livestock, use chemical fertilizers because they are less bulky, easier to apply, and have a more predictable nutrient content than manure. The convenience of commercial fertilizers often outweighs the value of manure as a soil amendment that can improve physical and chemical properties of cropland.

Our analysis shows which areas have sufficient cropland associated with the livestock operation to use all the manure nutrients at an agronomic rate. Manure-nutrient production from confined livestock was also compared to total county nutrient needs to help identify areas where manure nutrients could provide a portion of the county s nutrient needs for all farms. The excess values calculated here represent a consistent, national estimate of the manure nutrients that would need to leave the farm of production in order to be managed in a manner that reduces the potential for nutrient flows into the environment. Also, by using data from several Censuses of Agriculture years, we are able to show how the potential excess-nutrient problem has changed over time

National Confined Animal Production and Nutrients

Farm Numbers and Animal Units

The number of farms with confined animals has declined dramatically and steadily over the period from 1982 to 1997 from 435,000 to 213,000 farms, (Figure N-1). The decline occurred in the very small (less than 50 AU) and small (from 50 to 300 AU) size groupings. There was an increase in the number of medium and large operations. Medium sized operations (300-1000 AU) have grown by 4,400 farms to account for about 6 percent of all confined livestock farms in 1997. Large farms (more than 1000 AU) have more than doubled in the period to almost 4,000 farms, almost 2 percent of all confined livestock operations. The decrease in the number of farms occurred at the same time as a 10 percent increase in the number of confined AU, which means that the average AU per farm has increased significantly. However, the number of AU on very small farms declined from 4.4 to 1.6 million and on small farms the decline was from 14.9 to 11.1 million. The number of AU on medium sized farms grew from 4 to 6.4 million. On large farms the AU almost doubled from 7.4 to 14.5 million. Martinez discusses many of the reasons behind the industrialization of poultry and swine production, which leads directly to the growth in large operations.

Livestock Operation Size Categories	
Very Small	< 50 AU
Small	50 to 300 AU
Medium	300 to 1,000 AU
Large	>1,000 AU
Potential CAFO	CWA specification

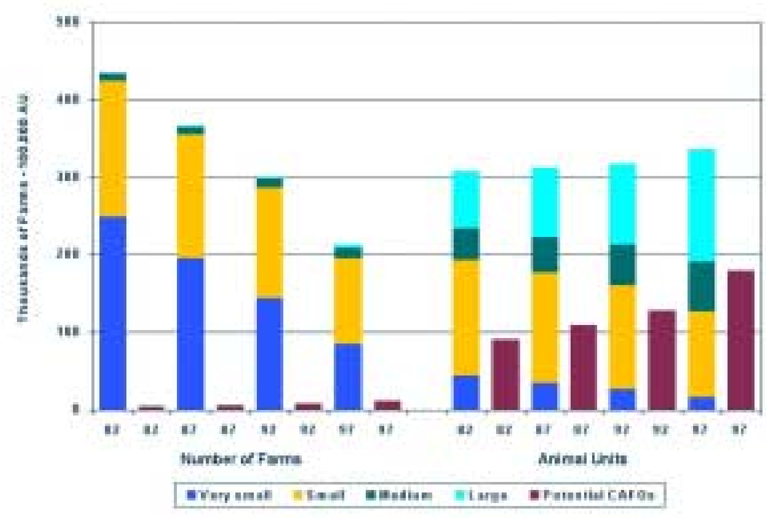

Figure N-1. Numbers of confined livestock farms and animal units, by size class and year

Figure N-1 also presents the number of potential CAFO farms and the AU on those farms. The number of potential CAFO operations, which include all the large and most of the medium categories, more than doubled from 1982 to 1997 increasing from about 5,000 to 11,200 (126 percent) or from 1 to 5 percent of all operations. During the same period the number of AU on these farms increased from 9.1 (30 percent of total confined AU) to 18.0 million (54 percent of total confined AU), an increase of 98 percent. Nationally, the average number of AU on each potential CAFO did not increase over the period; the gain in AU on potential CAFO farms was due to the increase in the number of potential CAFO operations.

The distribution of potential CAFO farms by species experienced significant change over the 1982-1997 period, (Figure N-2). There were declines in the share of feedlot beef operations from 47 to 17 percent of farms, and growth in swine (21 to 39 percent of potential CAFO farms) and poultry (24 to 33 percent of potential CAFO farms). In 1997, the 4,370 potential CAFO swine operations and 3,760 potential CAFO poultry operations accounted for 72 percent of all potential CAFO operations. There were about 1,300 potential CAFO dairy farms and 1,900 beef feedlots that were potential CAFOs in 1997.

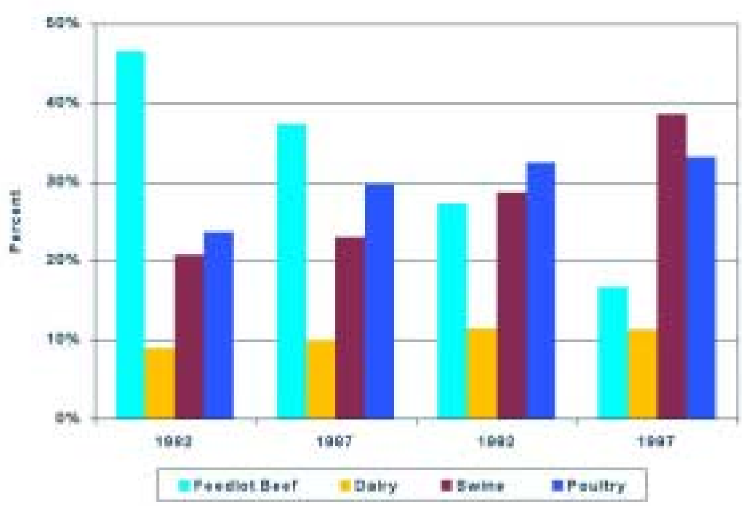

Figure N-2. Species distribution of potential CAFO farms by year

Manure Nutrients

Confined livestock produced 1.23 million tons of calculated recoverable nitrogen and 0.66 million tons of calculated recoverable phosphorous in 1997. The 73 million acres of cropland and permanent pasture controlled by operators of confined animal operations was estimated to have the capacity to assimilate only 38 percent of the nitrogen and 27 percent of the phosphorous. Growth in the number of confined AU from 1982 to 1997 has increased the quantities of nutrients produced by about 20 percent. There has been a decline in the amount of land on livestock and poultry farms relative to the nutrients produced, which has resulted in an increase in potential excess manure nutrients by 20 percent over the period**.** The growth in excess nutrients is one indication of a potentially growing problem.

The inability to assimilate all the manure nutrients produced on the farm affects operations of all sizes. In 1997, about 15 percent of the very small farms did not have the capacity to utilize all the nitrogen produced on the farm (20 percent for phosphorous). The share of large farms that produce more nutrients than can be utilized on-farm increases to 72 percent of farms when considering nitrogen and over 90 percent of farms when evaluating phosphorous.

In terms of nutrient production, small farms produce more recoverable nitrogen than any other size class, almost 500,000 tons, down from the 534,000 tons in 1982 (Figure N-3). Farms in the 50-299 AU size class (small) produce about 30 percent of the excess nitrogen, almost all on poultry farms. Poultry farms in the small size class are currently not under NPDES permit requirements, except in unusual circumstances. Proposed revisions to regulations may designate these farms as CAFOs if the concentration of farms contributes to water quality impairments. Very small farms produce only about 2 percent of the excess nutrients, even though 15-20 percent of the farms has excess nutrients.

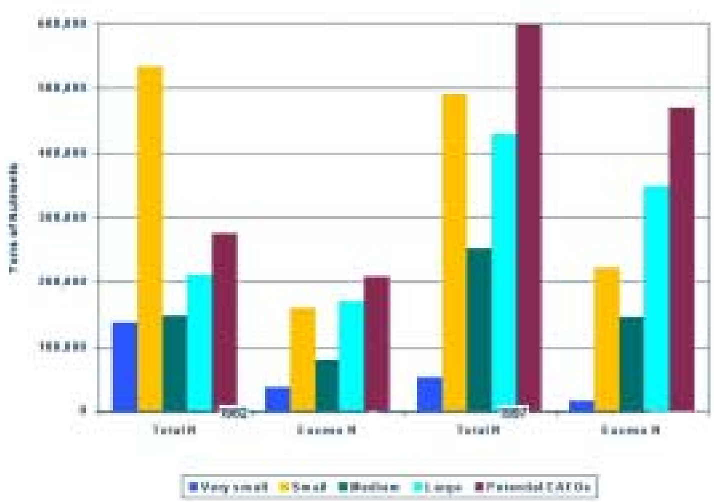

Figure N-3. Available and excess manure nitrogen by size class, 1982 & 1997

There has been a significant increase in nutrient production from confined animal operations in the 1982 to 1997 period in the medium and large size classes, including the potential CAFO operations. Recoverable nitrogen production on medium sized operations increased by 68 percent to 250,000 tons in 1997 and on large farms by over 100 percent to 430,000 tons. Excess nitrogen increased by 83 percent to 146,000 tons on medium farms and 104 percent to 350,000 tons on large farms in 1997. The 6 percent of farms in the medium size class accounted for 20 percent of the excess nitrogen and large farms (2 percent of total) almost half of the excess nitrogen in 1997 (Figure N-3).

In 1997, the potential CAFO farms were the source of over half of the calculated excess nitrogen from all confined livestock operations (Figure N-3). The increase in recoverable nitrogen was almost 120 percent over 1982 and increases in excess nitrogen exceeded 120 percent over the period. Excess nutrients on potential CAFO farms increased at a faster rate than either component category (large and part of medium), because most of the medium group farms with excess nutrients were also classified as potential CAFOs and were added to the large category.

The production of more excess nutrients in larger size classes has resulted from the shift to more concentrated production units, more specialized management, and the separation of land from livestock. This continuing change in the structure of the confined animal production industry is reflected in the 39 percent decline in cropland and pastureland available to spread manure from each confined AU, from an average of 3.6 acres per AU in 1982 to 2.2 acres per AU in 1997. In 1997, very small confined operations had an average of about 15 acres of land to spread the manure from each animal unit of livestock on the farm. The available area to spread manure drops to about 3.5 acres per AU for small farms, 1.2 acres per AU for medium farms, and about 0.2 acres per AU for large operations.[9] There is little change in these relationships by size group from 1982 to 1997, which implies that nutrient management problems on the average large farm were no worse in 1997 than in 1982. The aggregate problem is much greater, however, because there are many more large farms in 1997 that have excess nutrient production.

[9] Pennsylvania specifies that 0.5 acres per animal unit is a threshhold land to livestock ratio. Farms with a smaller ratio are classified as a CAFO (Beegle, et.al., 1997).

In 1997, total recoverable manure nitrogen exceeded 1.2 million tons and 62 percent of that nitrogen exceeded the amount that could be assimilated on the farms on which it was produced. In other words, crop uptake on confined livestock farms, with no transfer to other farms, could utilize only 38 percent of the recoverable manure nitrogen (identified by species in Figure N-4). Poultry produced 47 percent of the total recoverable nitrogen and farm use could absorb only 8 percent of that amount. The 39 percent of recoverable poultry nitrogen above farm assimilative capacity accounts for 484,000 tons, or 64 percent, of the total excess nitrogen. (Excess nitrogen by species is also shown in Figure N-4.) Dairy produces 26 percent of recoverable nitrogen, but 20 percent could be used on the farm. Dairy operations had only 6 percent of nitrogen produced in excess of farm needs, which translates to 9 percent of total excess nitrogen. Feedlot beef farms produced 18 percent and swine 9 percent of the excess nitrogen (Figure N-4). The share of total recoverable nitrogen in excess of farm needs increased by 16 percentage points from 1982 to 1997. This increase in excess nutrients implies a growing need to move nutrients off the farm where they are produced. We found that in a species-by-species comparison, 10 of the 16-percentage point increase in excess nutrients occurred in poultry production. A slightly larger share of the dairy and swine nitrogen and a slightly smaller beef share was in excess in 1997 when compared to 1982.

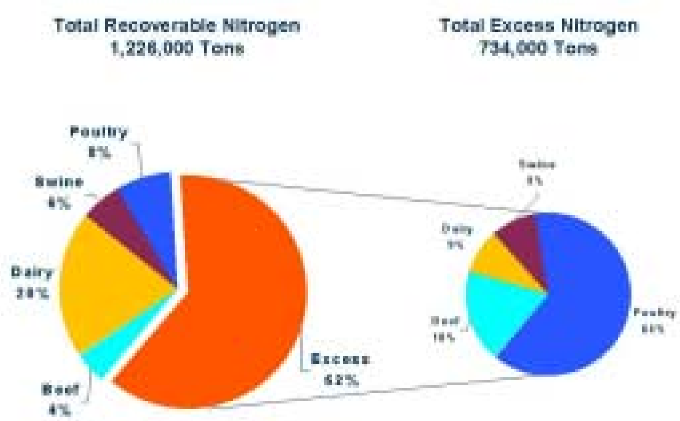

Figure N-4. Species distribution of potential on-farm utilization and excess manure nitrogen, 1997

County Confined Animal Production and Nutrients

Figure C-1 presents the number of confined animals by county in 1997. Confined animals are concentrated in a band in the central part of the Nation from southeastern New Mexico stretching northeastward through the Plains states to eastern Nebraska and then eastward through Iowa to the Great Lakes. There are other regions of confined animal concentration in the Northeast, mid-Atlantic, California s southern Central Valley, western Arkansas, and far northwest areas. Almost every state has at least one county with more than 10,000 animal units. Figure C-2 shows the recoverable manure nitrogen per county. The pattern is similar to the one that shows the location of animal units, however, there is not a direct match because recoverable nitrogen varies by species and species tend to concentrate. One area that receives relatively greater attention on the recoverable manure nitrogen map (Figure C-2) than on the AU map occurs is Georgia, Alabama and Mississippi. This region has significant broiler poultry production, and broilers have greater recoverable nutrients per animal unit than other animals.[10]

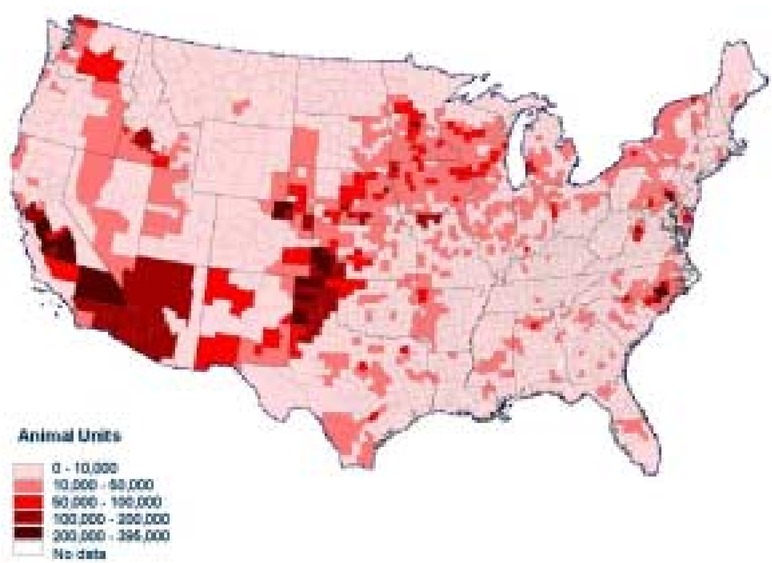

Figure C-1. Location of confined animals, 1997

[10] Ranked the number 1, 3 and 5 states, respectively, in broiler production in the 1997 Census of Agriculture (NASS, 1999b).

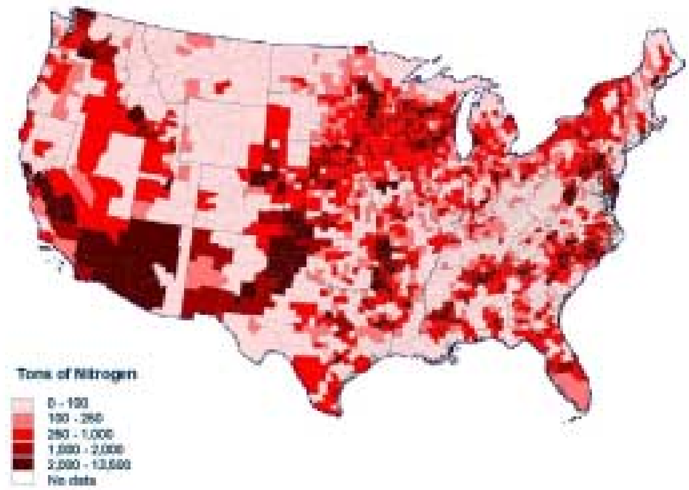

Figure C-2. Recoverable manure nitrogen, 1997

Figure C-3 shows the share of recoverable nitrogen in excess of on-farm crop and pastureland needs in 1997. Counties with color in this map are those in which there is at least one ton of excess manure nitrogen produced on confined livestock and poultry farms somewhere in the county. The existence of calculated excess does not imply that manure nitrogen is necessarily contributing to water quality and other environmental problems. Figure C-3 does indicate that manure movement off confined livestock farms is necessary to avoid excess nitrogen accumulation in 75 percent of the Nation s Counties.

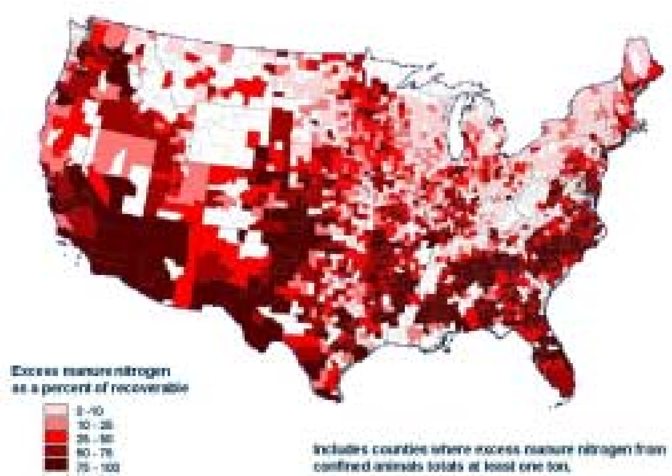

Figure C3. Excess manure nitrogen as a percent of recoverable nitrogen, 1997

The darker the shading in Figure C-3, the greater the share of manure nitrogen in excess of on-farm needs. Generally, excess manure nitrogen is the greatest in counties with the largest concentration of confined animals (Figure C-1). However, there was not a perfect correlation between AU and excess manure nitrogen. Northern Alabama and Georgia do not have the greatest number of animals, but do have high excess nitrogen because poultry has a high nitrogen content per animal unit and poultry is the dominate species in this area. Conversely, northeastern Iowa and southern Wisconsin had among the highest concentration of animals, but have less excess nitrogen that might be expected because of more available land and lower nitrogen production per AU. Once again, a large quantity of calculated excess nitrogen does not indicate an environmental problem; it does indicate where manure may need to be moved off-farm to avoid an over-application of nutrients.

Figure C-3 indicates where manure needs to move off the confined livestock farm for utilization and as long as other land in the county or adjacent counties are available for application the manure nitrogen may be effectively used. Not all crop or pastureland in the county will be available for manure application for many reasons, including transportation costs, timing of applications relative to cultural operations, and producer preference.

Figure C-4 identifies 154 counties where manure nitrogen produced on confined livestock and poultry farms is at least half the county s total nitrogen need. With such a large share of nitrogen available from confined animal manure it will be increasing difficult for find land available for spreading in the center of the areas identified in Figure C-4. Viewed in a different way, these areas have the greatest need for off-farm alternatives for manure treatment to reduce the volume (composting) or for industrial processes that use manure as a feedstock.

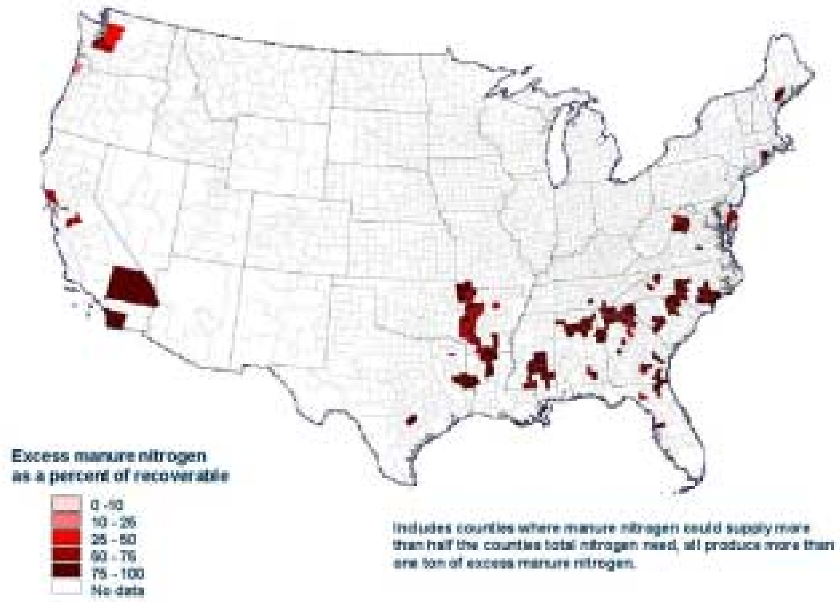

Figure C4. Excess manure nitrogen as a percent of recoverable nitrogen for selected counties, 1997

Summary of Findings

The number of confined livestock farms has declined by half from 1982-1997 while the number of animal units has increased by 10 percent, resulting in greater average number of animals per farm. The increase in aggregate average farm size has occurred through the replication of large farm units rather than large farms becoming even larger. This represents a change in the structure of the industry that partially is driven by the efficiencies of producing at a large scale.

- The number of confined animal farms and the number of AU on those farms **declined** in size classes with less than 300 AU from 1982 to 1997.

- The number of confined animal farms and the number of AU on those farms **increased** in size classes with more than 300 AU from 1982 to 1997.

Over 60 percent of manure nitrogen produced is above the assimilative capacity of farms on which the nutrients are produced. Over 60 percent of the excess manure nitrogen and was attributable to poultry operations in 1997. By farm size class, a significant share of farms in all size classes produced more manure nutrients than the farm could assimilate. The share of farms and the quantity of excess nutrients were greater on large farms, due to less land area per AU.

- Farms in the very small size class (less than 50 AU) produced only 2 percent of the total excess nitrogen, even though 15 percent of farms in this size were in excess of farm assimilative capability in 1997.

- Farms in the small size class (50 to 300 AU) produced more recoverable nitrogen than any other class and more on-farm excess than any size class, except the large class. This was found to be attributable to poultry operations.

- Farms in the large size class (more than 1000 AU) produced about 40 percent of the excess manure nitrogen. Within the size group, over 75 percent of the manure nitrogen was in excess of farm assimilative capability, and over 66 percent of farms had excess nitrogen in 1997.

The concentration of excess manure nutrients in poultry on small farms, and on larger sized operations, implies there is significant need for economic, effective off-farm technologies to deal with excess poultry manure nutrients.

Most counties (about 75 percent) in the Nation produce excess manure nutrients on at least a few farms. To avoid excess nutrient accumulation in soils, the manure needs to be moved off the confined operation to other land for application or to an industrial process using manure as a feedstock. Without considering commercial fertilizer, relatively few areas (about 5 percent of counties) have farms producing significant quantities of excess manure nitrogen relative to the nitrogen need in the county. A corresponding examination of on-farm excess manure phosphorous finds more and larger areas (about 10 percent of counties) where manure phosphorous could meet half the counties phosphorous requirements. These are areas where off-farm technologies are most needed.

Current EPA proposals for future NPDES permits for Concentrated Animal Feeding Operations require the development of Comprehensive Manure Management Plans (CNMP) as part of the permit (U.S. EPA, 1999). These permits will include management strategies for manure collection, storage, and disposal — including the use of manure nutrients in crop production. The CNMP requirement brings, for the first time, land application of manure into the NPDES permitting process. Examining the 5 percent of confined livestock farms that are potential CAFOs, we find that over half of the excess nitrogen and two-thirds of the excess phosphorous will need to be addressed in a CNMP before a NPDES permit can be issued.

States are required by the Clean Water Act to identify impaired waters, and EPA has recently encouraged States to accelerate their efforts to identify such waters and to develop remediation programs (Boyd, 2000). These actions could very well focus attention to watersheds where animals, and animal operations, are concentrated. Knowledge of where animals are highly concentrated could assist resource managers in identifying nutrient-impaired waters and options for remediation.

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