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## CONFINED ANIMAL PRODUCTION AND THE MANURE PROBLEM

by David  
Letson and  
Noel  
Gollehon

**M**anure runoff and leaching from feedlots, holding ponds, lagoons, land applications, and stockpiles can impair water resources. Farming enterprises that integrate crop and animal production can use manures as a nutrient-rich fertilizer, both to reduce expenditure on commercial fertilizers and to lower the risk of contaminating water. As we show below, however, most confined animal production today does not integrate animal and crop enterprises. Specialized animal production separates manure from cropland and presents new challenges for manure management and water quality policy.

### Problems and policy responses

When excess nutrients enter surface waters, they stimulate excessive growth of aquatic vegetation. This growth depletes dissolved oxygen, reduces the diversity of animal and plant life, and causes an odor and appearance that discourage recreation. Nutrients also can impair groundwater. Soluble nitrogen can leach into aquifers, where it may damage drinking water supplies. Pathogens, also in ma-

nure, can impair the use of surface waters for drinking or contact recreation. Cryptosporidium, a pathogen found in bovine manure and other sources, infected 400,000 residents of Milwaukee in 1993. The U.S. Environmental Protection Agency (EPA) believes more than one hundred people with compromised immune systems died as a result. The EPA reports that, nationally, confined animal feedlot runoff contributes to 7 percent of lake and 13 percent of river impairments of designated uses.

Changes in the structure of animal production contribute to water quality problems. Traditional farm enterprises integrate crop and animal production by using manure to fertilize crops. Recent trends toward large-scale, specialized animal production, however, separate manure from cropland. Integration of crop and animal production has always been a crucial element of manure management, but today that integration must occur across multiple farms rather than at the enterprise level.

For proper management, manure may need to leave the animal production site, and nearby crop producers must be willing to accept the manure. Herein lie two policy challenges. First, handling and transport of manure can be costly, and animal producers will likely have to pay. Second, crop producers must be convinced of the resource value of manure. Viewed solely as a source of nutrients, manure is usually not competitive with commercial fertilizers. More generally as a soil amendment, though, continuous and judicious application of manure improves the physical and chemical properties of soil. Manure adds organic matter, improves soil structure and tilth, increases the soil's ability to hold water and nutrients, and boosts the soil's resistance to compaction and crusting.

Since 1990, manure management has received increasing attention from national policy makers. The 1990 Coastal Zone Act Reauthorization Amendments (CZARA) provided the first federal



regulations to address nonpoint source pollution from agriculture. CZARA mandated that animal waste measures include retention ponds, solids separation basins, and vegetative practices, such as filter strips between production facilities and nearby surface waters. While reauthorizing the Clean Water Act (CWA), policy authorities initially proposed to extend the CZARA requirements to inland areas, although that now appears unlikely. Most recently, the Environmental Quality Incentive Program (EQIP), in the Federal Agricultural Improvement and Reform Act of 1996, brings new emphasis to manure management. EQIP dedicates 50 percent of its cost sharing, educational, and technical assistance moneys (a total of \$130 million is authorized for FY96; \$200M/year for 1997–2002) to practices related to animal production, particularly on smaller operations. EQIP cost sharing may not be used for construction of animal waste management facilities on “large” farms as defined by the secretary of agriculture.

Most agricultural programs for nutrient management are voluntary. Cost sharing to promote nutrient management has been successful but requires large expenditures to achieve a large response. Education and technical assistance programs promoting the value of manure as fertilizer are less costly but may be even less successful than cost-sharing approaches (Feather and Cooper). Between 1992 and 1994, USDA conservation programs (Agricultural Conservation, Small Watershed, and Rural Clean Water Programs; and the Water Quality Incentive Projects) provided \$89 million in cost-sharing assistance for manure management.

### Animal production is increasingly specialized

Improper manure management may occur if adequate land is not available near the manure source or under the control of the animal producer. Nationally, farmers planted 435 million acres in crops in 1992. The 511,000 farmers raising confined animals operated 124 million acres.

Table 1 shows distributions of cropland and animal units (AUs) across facility size groups. This breakdown allows us to estimate the number of farms and animals regulated by CWA (that is, AUs greater than 1,000) and the number that might be covered by new policies (between 50 and 1,000 AUs). The animal unit index is a way of adding up animals, across species, based on typical live weights for each species. We use the CWA specifications, for which one AU equals one beef head, 0.7 dairy cows, 2.5 hogs, 55 turkeys, or 100 chickens. For more details on CWA coverage of confined animal productions see Weinberg.

The number of AUs per crop acre varies consid-



erably with facility size. Large, specialized farms produce most animals but have little cropland. For example, 1 percent of beef feedlots (the largest ones) produce 71 percent of fed beef but have only 2 percent of the cropland on fed beef farms. Facilities with fewer animals produce a minor share of animals but have a large share of the cropland. Looking again at beef, 92 percent of feedlots (the smallest ones) produce 10 percent of fed beef but have 75 percent of the cropland. Only on medium-sized beef, dairy, and swine operations do the shares of animals and cropland closely match. If it is true that most manure does not leave the farm where it originated (e.g., Bosch and Napit), then confined animal facilities often will not have enough cropland for proper on-site manure treatment.

### Manure, cropland, and fertilizer

Often manure and commercial fertilizers together contribute to impairment of water resources. Applications of manure nutrients to cropland and pasture typically equal about a sixth of that supplied by commercial fertilizer (National Research Council). To be most effective, manure management should be coordinated with nutrient management. The latter considers plant nutrient needs, soil buffering capacity, and the contributions of all nutrient sources such as commercial fertilizer and legumes, as well as manure applications. With sound nutrient management, farmers credit manure nutrients before applying fertilizers to the same field.

Figure 1 classifies each of the nation's 3,056 counties (lower 48 states) by number of AUs, i.e., fed beef, dairy, swine, turkey, broiler, and layer AUs combined. The concentration of confined livestock in the North Central United States, a region known for its animal production, stands out. So do

Table 1. Farms, animal units (AU), and cropland, by confined animal facility size, in 1992

Animal Type	Small (<50 AU)		Medium (50-999 AU)		Large (≥1,000 AU)		Total
	Number	%	Number	%	Number	%	Number
Feedlot beef:							
Fed beef farms	134,847	92	11,411	8	943	1	147,201
Head (1,000)	995	10	1,941	19	7,098	71	10,034
Cropland (1,000 acres)	34,199	75	10,160	22	1,117	2	45,476
Dairy:							
Dairy farms	43,700	28	110,700	71	939	1	155,339
Head (1,000)	238	3	8,002	84	1,252	13	9,492
Cropland (1,000 acres)	6,097	16	32,524	83	515	1	39,137
Swine:							
Swine farms	115,830	56	88,042	43	2,578	1	206,450
Head (1,000)	3,089	5	38,984	68	15,270	27	57,343
Cropland (1,000 acres)	17,029	30	37,121	66	1,795	3	55,945
Turkeys:							
Turkey farms	7,379	70	2,911	28	276	3	10,566
Head (1,000)	892	1	64,019	74	21,703	25	86,614
Cropland (1,000 acres)	848	60	535	38	33	2	1,416
Broilers:							
Broiler farms	17,657	49	16,704	47	1,398	4	35,759
Head (1,000)	2,193	0	684,507	73	246,667	26	933,368
Cropland (1,000 acres)	2,207	58	1,371	36	211	6	3,790
Layers:							
Layer farms	81,903	93	5,733	6	599	1	88,235
Head (1,000)	4,033	1	137,366	39	209,911	60	351,310
Cropland (1,000 acres)	8,848	90	881	9	149	2	9,878
Total over all animal types:							
Farms	312,729	61	191,778	38	6,685	1	511,192
Animal units (1,000)	3,594	6	36,780	61	20,291	33	60,666
Cropland (1,000 acres)	50,764	41	69,445	56	3,796	3	124,004

Notes: The 1,000 AU minimum is a proxy for Clean Water Act coverage, as is the 50 to 1,000 range for CZARA coverage. The latter is also a proxy for the facility size likely to be the target of any new policy. Individual animal types will not sum to the total, because some farms have more than one animal type.

dairy production in Wisconsin and southern California, swine in the Cornbelt and North Carolina, beef feedlots in the Northern and Southern Plains, and broiler production across the Delta, Southeast, and Appalachian regions.

Figure 2 ranks counties by manure nitrogen production and commercial fertilizer expenditures, both on a per acre basis. Farmers producing high amounts of manure while maintaining high fertilizer expenditures may have redundant nutrient applications. The Pacific, Southeast, Delta, and Appalachian regions have both high manure nitrogen production and fertilizer expenditures per acre. Policies which target areas where manure can substitute for commercial fertilizer can lower input costs and create environmental benefits.

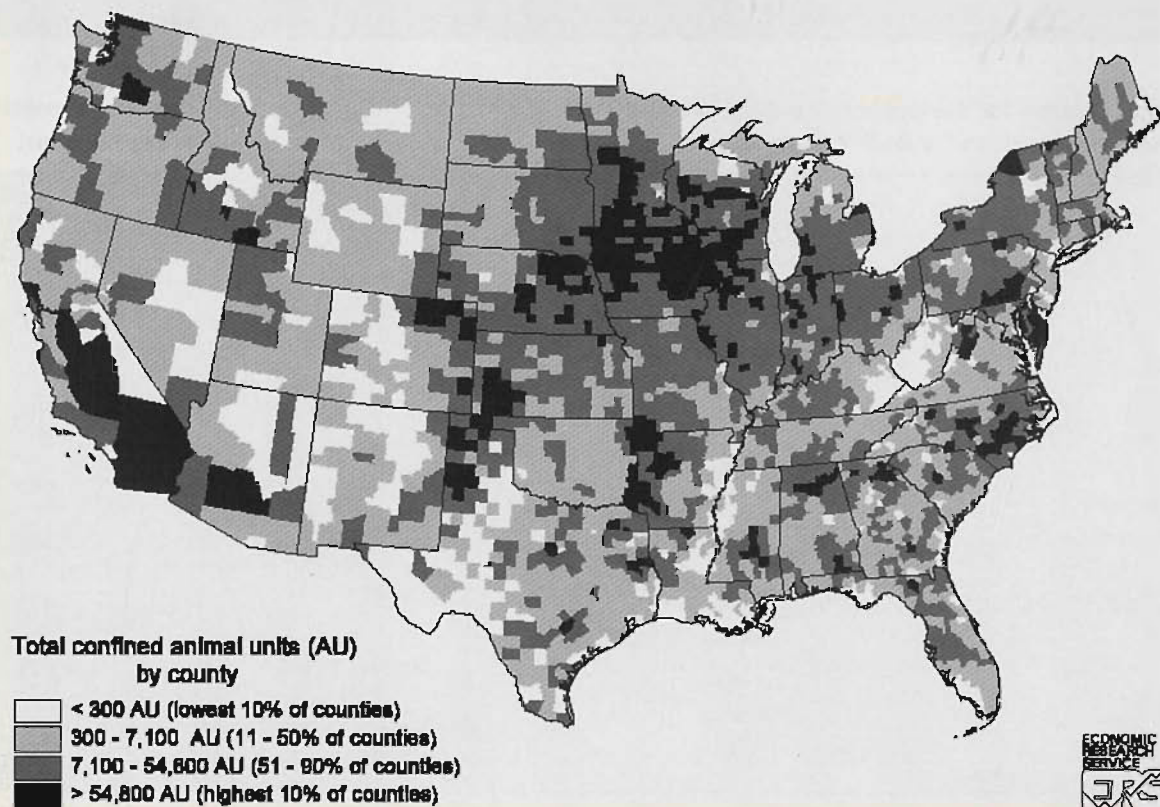
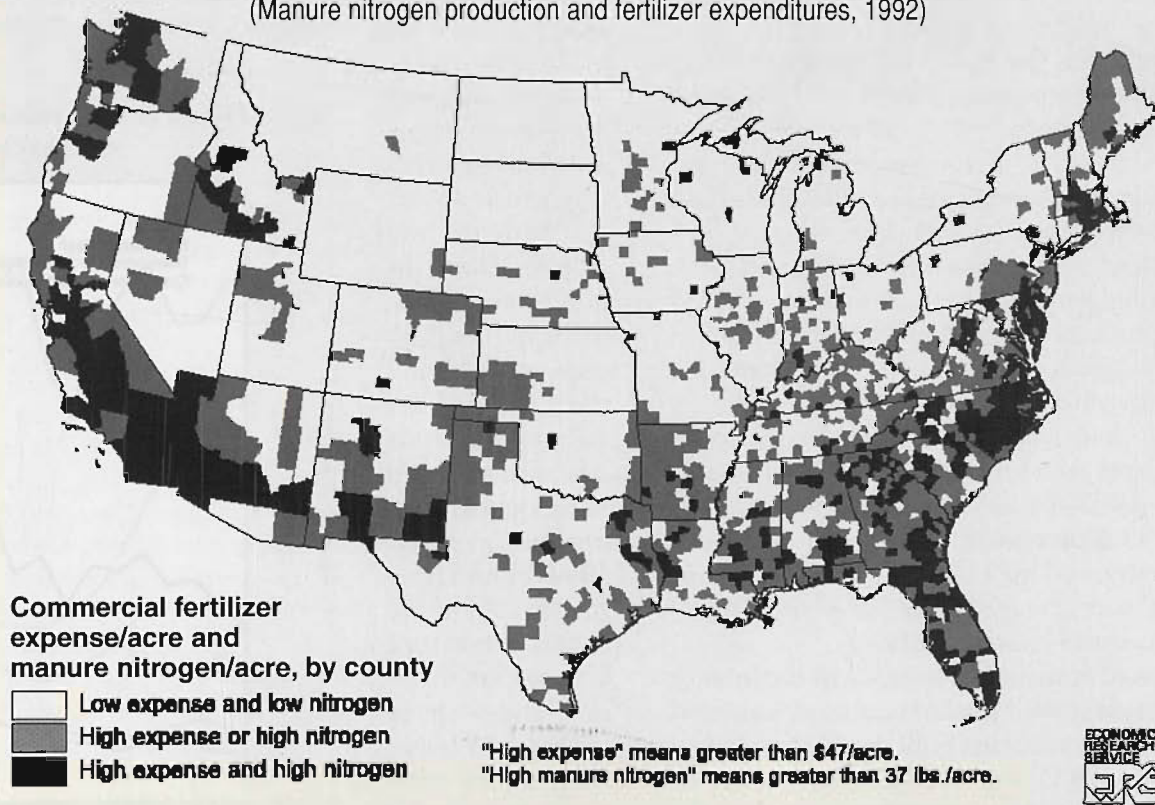
Surprisingly, Cornbelt and Lake states do not stand out in figure 2. The importance of animal production in the Cornbelt and Lake regions is well known (figure 1). What is less appreciated is

the large cropland base that their animal producers control. Nutrient applications and the cropland base are better balanced because farms continue to integrate animal and crop production. Policy makers concerned about manure as a source of water quality impairment could target specialized animal production, which figures 1 and 2 show is different from the regions having the most animals.

## Conclusions

Animal waste is an important contributor to water quality impairment in the United States. Across animal types, the trend is toward concentrated and specialized animal production. The structural changes sever traditional links between manure and cropland for manure disposal and present new challenges for manure management. Policy makers should reconsider the manure-land linkage, because animal producers increasingly do not control enough land to manage their manures. Manure

Figure 1. Where were the animals in 1992?

Figure 2. Manure: a possible substitute for nitrogen fertilizer  
(Manure nitrogen production and fertilizer expenditures, 1992)

(continued on p. 24)

## Data and Estimating Procedures

The availability of extensive, detailed data aided our estimation. The 1992 Census of Agriculture micro-data provide a consistent, national information source for all animal producers. Matching confined animal production with land on the farm, rather than at the county level, gives this analysis an advantage over previous research by avoiding aggregation problems (USDA/SCS). Data aggregated to the county level often do not reveal site-specific manure/water quality problems.

We estimated the nitrogen and phosphorus content of manure, using assumptions from Van Dyne and Gilbertson, the most recognized source for this information. Manure production closely follows the geographic pattern of animals in figure 1.

To get manure applications, we assumed that producers of confined animals apply manure only to their own land. We know of no detailed, national information about manure applications to cropland. Other research has made an assumption different than ours, allocating estimates of manure nutrients to all cropland by county. Not surprisingly, their results are quite different from ours (USDA/SCS). Some manure does leave the farm, but only about 10 percent nationally (Bosch and Napit). Farmers often haul manure up to 10 miles (Bosch and Napit). In areas with soils lacking organic content, hauling distances may be greater. In Arkansas, for example, rice farmers haul poultry litter as far as 100 miles for their sandy soils. Across the country, some large operations can sell manure to crop farmers and lawn caretakers. We believe our assumption of on-site application is approximately correct, but where most manure does leave site, our estimates overstate actual applications.

(continued from p. 21)

management is often costly, and policy to protect water from contamination should be well targeted (Westenbarger and Letson).

On-farm use of animal manure may be problematic where animal production is highly specialized, as in the Pacific, Delta, Southeast, and Appalachian regions. Large, specialized farms produce most animals but have little cropland. The most highly specialized animal production includes dairies in southern California, swine in North Carolina, and broiler production in Arkansas, Georgia, and Alabama. In contrast, on-farm treatment appears less problematic in the Cornbelt and Lake regions, where crop and animal production remain more integrated at the farm level. Policy makers could target specialized animal production if the goal is to protect water quality from manure-related impairment.

We also considered commercial fertilizer expenditures by confined animal producers. Areas appear to exist where there is the opportunity for "win-win" nutrient management. Locations such as the southeastern region have both high manure nutrient production per acre and high fertilizer spend-

ing per acre, a redundancy that may be an avoidable expense and a threat to water resources. ■

## ■ For more information

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*The views expressed are those of the authors and are not necessarily shared by the University of Miami, USDA, or Bureau of the Census.*

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The authors are, respectively, assistant professor, University of Miami, RSMAS Division of Marine Affairs and Policy; and agricultural economist, Natural Resources and the Environment Division, Economic Research Service, U.S. Department of Agriculture.