Conclusions

In this report, we describe how the size and location of confined livestock farms, and how the manure nutrients produced on those farms, have changed over time. Changes are measured in a variety of ways, including the relationship between manure production and the physical capacity of crop and pastureland to utilize manure nutrients. The physical feasibility of using manure nutrients at an agronomic rate on land controlled by livestock operators or on other crop and pastureland within the same county will determine potential policy options for reducing manure-related environmental problems. The physical capacity defines the universe for economic assessment of any policy options that make use of manure application on crop and pastureland as a waste management approach.

The number of confined animal farms decreased consistently from 1982 to 1997, particularly among smaller farms with fewer than 300 animal units. On the other hand, the total number of animal units increased, with most of the growth occurring in large farms (more than 1,000 animal units). Increasing average size means that more livestock production units will be subject to potential regulation under the Clean Water Act.

Data from the 1997 Census of Agriculture show that 78 percent of animal operations have sufficient crop and pastureland to use all manure nitrogen on the farm (69 percent of farms for phosphorus) at agronomic rates. This finding does not mean that manure is being managed in this manner on all farms with adequate capacity. Nor should it suggest that manure application is necessarily an economically feasible option on these operations. It does, however, indicate the number of livestock operations on which land application can be considered as a sole option. Whether that management option is prohibitively costly or actually profitable has yet to be assessed, and is likely to vary across the operations where land application of manure is physically feasible.

Although most animal operations have adequate land to at least consider manure application as a waste management strategy, the majority of manure nutrients are from the relatively few larger operations that do not control enough land to apply the generated manure at agronomic rates. Manure from these operations accounts for 60 percent of the Nation's manure nitrogen and 70 percent of the manure phosphorus. Thus, even if it is economically feasible to supply crop nutrient needs with manure on all farms where that is physically feasible, a majority of manure nutrients could not be managed so. This excess manure, which is concentrated on larger livestock operations, must be moved off the farm to land not controlled by the producing operation or to an alternative use.

We calculated the potential for manure to be applied at agronomic rates to crop and pastureland that is within the same county, without considering if the land is associated with livestock production. This estimate of the county's potential to use all the manure nutrients produced finds that most counties have sufficient land to apply all the manure produced in that county. However, further research is necessary to assess barriers to the general acceptance of manure as a source of crop nutrients. Transportation costs, application problems (e.g., ease, timing, and odors), and potential liability for nutrient flows to the environment may discourage other farmers from using manure generated by local animal operations. In addition, the costs of including manure as a nutrient source on farms where manure is not currently in use will need to be examined.

We also identified areas in which spreading of all the manure on available land is not viable. About 20 percent of the Nation's **onfarm excess** manure nitrogen is produced in counties that have insufficient cropland for its application (23 percent for phosphorus). Research is necessary to ascertain the costs of alternative uses for manure or spreading manure on lands other than agricultural lands (e.g., public land or recreation areas). In some locations, technologies may be available and cost effective for processing manure into soil supplements or organic fertilizer that can be transported to other areas for application. It may be possible to use manure as a raw material in industrial processes producing energy or other products. The economies of scale associated with these alternative technologies may determine the level of industry concentration (and quantity of manure produced) necessary to solve the problem within an area. The costs of long-haul manure transport relative to technology-based manure processing also need to be assessed.

This analysis of nutrients from confined animal production in 1997 has shown that livestock operations have the potential to use about 40 percent of the manure nitrogen and 30 percent of the manure phosphorus produced if applied at agronomic rates. Successful

incentives to encourage more land application off the livestock farm (within the county) might account for another 46 percent of nitrogen and 51 percent of phosphorus. However, in a few counties with high animal concentrations relative to available land, long-distance hauling or further processing will be needed to address the remaining 14 percent of manure nitrogen and 19 percent of manure phosphorus produced.

If the trends in livestock industry concentration that we found between 1982 and 1997 continue, more manure will be produced in areas without the physical capacity to agronomically use all the nutrients. Structural change in animal production may make the land application of manure less feasible as a means of managing livestock waste. Regulations and policies that affect the costs of manure management could affect the economies of scale and regional comparative advantage in animal production, although there is little evidence of environmental regulations affecting the location of livestock production to date. Further research needs to examine the forces driving industry change and how that change could be influenced by policy development.