

## Conclusions

Livestock manure has value for farmers because it contains nutrients that facilitate plant growth and because manure can improve soil quality by increasing organic matter, neutralizing acidity, and expanding the water-holding capabilities of soils. However, manure may not have the precise combination of nutrients needed for optimal crop production in a given field. It is costly to move, and crops in modern agriculture may be produced at some distance from livestock. Manure odors may offend neighbors, and manure may contain a variety of pathogens.

### Extent to which Animal Manure is Used as a Fertilizer

About 15.8 million acres of cropland, equivalent to about 5 percent of all U.S. cropland, are fertilized with livestock manure. This estimate is based on data drawn from several sources and is subject to some uncertainty. Nevertheless, it is clear that manure is used on only a small fraction of U.S. cropland.

Patterns of manure use are driven by the agronomic needs of crops and by transport costs, which limit the distance that manure can be moved and create close links between types of livestock and certain crop commodities. In particular, dairy cow and hog manure tend to be collected in a slurry, and the high moisture content of slurry creates even higher transport costs. But the manure can be applied on-farm to corn; with its high nutrient uptake, particularly for nitrogen, corn is an attractive option for livestock operations seeking to utilize manure, and corn provides a livestock feed. As a result corn, which has accounted for about one-quarter of planted crop acreage in recent years, accounts for over half of the acreage to which manure is applied.

In contrast, drier manure from poultry and cattle feedlot operations has lower transportation costs. Manure from those farms is more likely to be removed and shipped to other operations, and it is spread over a wider range of commodities. Because broiler production is concentrated in the southern United States, crops like peanuts and cotton rely heavily on broiler manure when they use manure fertilizers.

### Potential Impact from Limitations Placed on Use of Animal Manure

Livestock production has shifted to much larger operations, which also consolidate large quantities of manure in limited geographic areas. The quantities of manure nutrients produced on many large livestock operations exceed the capacity of the farm's crops to absorb them, a problem that extends beyond individual farms to some regions where aggregate manure nutrient production exceeds the region's crop nutrient needs. Excess nutrients can lead to water and air pollution.

In response to environmental risks, Federal, State, and local authorities are expanding their regulation of manure storage, transport, and application. Many operations now must prepare, file, and comply with detailed plans for managing manure so as to limit the possibilities for catastrophic spills or for land application in excess of the agronomic needs of crops. Some need to

change manure management practices to comply with the plans. They will need to acquire more land for manure application, arrange with other farmers to accept manure for their cropland, reduce the nutrient content of manure, reduce manure production, or find other uses for manure.

Estimated costs of compliance vary with the degree to which nearby farmers are willing to accept manure for application to their cropland, because a low willingness to accept among nearby farmers means that livestock producers will need to transport manure much farther for crop application. Costs also vary with the size and location of the operation, and with the particular type of nutrient management plan (standards may be set for nitrogen or for phosphorus).

With a limited willingness to accept manure (defined as 20 percent of nearby farmers), production costs, including those for manure management, would likely rise by 2.5-3.5 percent for large operations (Ribaudo et al., 2003). Such costs are unlikely to alter the size structure of livestock production, where large operations have substantial cost advantages over small operations. They are also unlikely to lead to substantial declines in production and consumption; the resulting percentage increases in retail prices would be less than those noted above because farm costs are only a fraction of retail costs, and retail demand for meat and milk is relatively insensitive to price changes. As a result, expanded regulation through nutrient management plans will likely lead to wider use of manure on cropland, at higher production costs, with little impact on farm structure.

## **Effects on Agricultural Production due to Increased Competition for Manure for Energy Production**

There is widespread interest in using manure as a feedstock for energy production. Current examples include combustion power plants and anaerobic digestion systems designed to capture methane gas and burn it as fuel for electricity generation. While each technology is in commercial use in the United States, neither is widespread. Digester systems, either planned, in construction, or in operation, cover less than 3 percent of dairy cows and less than 1 percent of hogs. The single operating combustion plant utilizes litter from 6.6 percent of U.S. turkey production, while an idled plant in California could utilize manure from about 3 percent of fed cattle.

Farmers who produce electricity through digesters can benefit from avoided purchases of electricity, but few can realize enough savings to justify the expense. Similarly, farmers can generate additional revenue from sale of manure to combustion plants, but few potential plant operators have found the economics to be attractive. But because such projects use existing resources, they could provide society with benefits if manure replaces newly mined fossil fuels in energy production, and if methane, a greenhouse gas, can be captured. Those societal benefits have led to proposals to support the use of manure for energy projects through State utility mandates (to purchase electricity from farms and to invest in renewable production sites), subsidies for capital costs, and direct subsidies and credits for energy production. Expanded support could lead to a substantial growth of energy applications for manure. In turn, that leads to a concern that expanded energy uses might compete with fertilizer uses for manure.

Energy projects are unlikely to impose substantive constraints on the use of manure as fertilizer, for two main reasons. First, the technologies do not consume the nutrients in manure that are beneficial for plant growth. In the case of digesters, the nitrogen, phosphorus, and potassium nutrients remain in the effluent of the digester process, to be spread on fields. To the extent that digestion eliminates manure odors and nearly eliminates pathogens in manure, the process may make neighboring farmers more willing to accept manure for cropland application. Combustion plants do burn nitrogen nutrients but leave the phosphorus and potassium in concentrated form in ash residues. Second, manure-to-energy projects function in markets for fertilizer and energy and will be most economical in those areas where the acquisition costs of manure are lowest. In turn, manure acquisition costs will be lowest where manure is in excess supply, with the least value as fertilizer.