

Manure Management for Water Quality: Costs to Animal Feeding Operations of Applying Manure Nutrients to Land

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Chapter 1—Introduction

Livestock and poultry manure can provide valuable organic material and nutrients for crop and pasture growth. However, nutrients contained in animal manure can degrade water quality if they are over-applied to land and enter water resources through runoff or leaching. The nutrients of greatest water quality concern are nitrogen and phosphorus. Animal waste is a source of both.

A shift in the livestock and poultry industry over the past several decades toward fewer, larger operations has prompted public concern over the use and disposal of animal manure. Manure lagoon spills in North Carolina and *pfisteria piscicida* outbreaks in North Carolina and Maryland have raised public concerns about the way manure is stored and handled. In response, State and Federal environmental protection authorities now require that manure be handled and applied to land so as to minimize runoff and leaching. However, such restrictions affect livestock and poultry production costs.

Producing feed on the farm, once a mainstay of animal production, is becoming rare. As animal operations grow larger, they increasingly buy feed from outside the farm. This is reflected in the reduced amount of available cropland per animal on livestock and poultry farms (Gollehon et al., 2001). Nevertheless, land application is still the predominant method for disposing of manure and recycling its nutrient and organic content (USDA-EPA, 1999). Concerns have consequently arisen that crops and other vegetation are not fully assimilating nutrients in manure, and that excess nutrients are increasingly likely to degrade nearby water resources. The land application rate—the quantity of manure spread on an acre of land—is believed to be the single most important manure management deci-

sion affecting the potential for contamination of water resources by manure nutrients (Mulla et al., 1999).

Recent policies and programs for increasing the efficient use of nutrients and protecting water quality from nutrient runoff all emphasize the importance of properly handling animal manure. The Unified Strategy for Animal Feeding Operations, jointly developed by the U.S. Department of Agriculture (USDA) and the Environmental Protection Agency (EPA) in 1999, states: “Land application is the most common, and usually most desirable method of utilizing manure because of the value of the nutrients and organic matter. Land application should be planned to ensure that the proper amounts of all nutrients are applied in a way that does not cause harm to the environment or to public health. Land application in accordance with a comprehensive nutrient management plan (CNMP) should minimize water quality and public health risk” (USDA-EPA, 1999, pp. 8-9). A goal of the Unified Strategy is that all animal feeding operations—regardless of size—voluntarily adopt CNMPs for managing their nutrient resources, including both commercial fertilizer and animal manure.

However, rules promulgated in 2003 by EPA are designed to change the way animal operations are handled under the Clean Water Act. Under the new regulations, “concentrated animal feeding operations” (CAFOs) would be **required** to meet nutrient application standards as defined in a nutrient management plan. The plan would become a part of the National Pollutant Discharge Elimination System (NPDES) permits that all CAFOs need in order to operate. Violations of the permit are subject to fines and/or facility closure.

Implementation of nutrient standards for manure application will raise manure management costs for many farms. At the farm level, their implementation will, in many cases, require operators to find additional land on which to spread manure and to absorb the cost of transporting and applying animal manure to this land. If land off the farm is required, animal operations may incur additional rental payments or disposal fees. In most cases, though, the animal operation pays only the cost of hauling and applying manure.

In some areas of the country, large concentrations of confined animals would strain the ability of any individual CAFO to secure adequate land locally for spreading manure. The competition for land would likely elevate waste-handling costs since some operators would be forced to transport manure over longer distances for disposal. The willingness of crop producers to accept animal manure from livestock and poultry operations will also determine land supply and hauling distance. High transportation costs regionally could encourage the development and expansion of alternative uses of manure, such as for commercial fertilizer or energy production. High manure management costs could, under certain circumstances, induce animal operations to spread out geographically, to relocate to areas with more abundant land, or to reduce herd size.

Implementation of new requirements on animal waste management could affect not only producers, but consumers as well. A substantial spike in waste management costs could result in regional shifts in animal production and increased prices for animal products and certain feedgrains and other crops.

Objectives

Previous studies have suggested that restrictions on manure management similar to the ones promulgated by EPA will increase the costs of manure management. Systematic analyses across the different animal sectors would help to identify critical issues arising from implementation of the new rules. We present a multidimensional framework, based on farm-level, regional, and sectorwide analyses (see box, “Scope of Analysis”). The different scales are important because each addresses a different set of issues or questions. The interactions between the resource base and manure management are best examined at the farm level. However, the impacts of a national policy are felt across regions, and these impacts can be transferred across the economy through the market system. We use the most comprehensive data available to provide a fuller understanding of the costs of the new

Scope of Analysis

As with all research, the strengths and limitations of this analysis are framed by the study objectives and reflected in the study’s scope, methodology, and analytic assumptions. While motivated by Federal policy provisions first proposed in 1999, our study is not intended as a direct examination of either EPA’s new CAFO regulations or USDA’s nutrient management policies. Rather, the study provides an independent analysis of a key provision of these and other Federal and State animal waste initiatives—the land application of manure at agronomic rates. The study examines the costs and feasibility of reliance on land application for manure disposal and the effect of key factors (including policy provisions) on these costs.

The study includes three analytic components—farm-level, regional, and national analysis—to address a range of issues pertinent to the land application question (see table, p. 4). Each of these analyses focuses on issues best evaluated at its respective scale. The farm-level analysis examines onfarm technical choice and costs at the producer level for hauling manure to the minimum amount of land needed to assimilate manure nutrients. The regional analysis focuses on off-farm competition for land to spread surplus manure, using the Chesapeake Bay region as a case study. The sectorwide analysis addresses potential long-term structural adjustments at the national level and ultimate costs to consumers and producers.

While there are many differences in the scale, scope of analysis, economic variables, and assumptions about various facets of the animal industry, there are several unifying elements. Crop producer willingness to accept manure and its influence on producer costs is critical throughout the range of analyses. Our treatment of nutrient application standards, the primary policy tool, adheres to a strict definition of the standards throughout the study. Finally, the cost coefficients used to characterize the nutrient management policies, as well as the physical coefficients used to convert animal numbers to manure nutrients, are consistent among the three analyses.

rules across farm types, regions, and a range of values for key policy variables. We specifically address competition for land on which to spread manure, an issue that has not been addressed in the literature, as well as the willingness of landowners to accept manure.

Chapter 2 reviews some of the structural changes that have occurred in the livestock and poultry sectors, animal agriculture’s impact on water quality, State and

Scope of Analysis

Item	Farm-level model (Chapter 3)	Regional model (Chapter 4)	National model (Chapter 5)
Analytic focus	Land required for manure spreading, and cost of hauling	Land required for manure spreading, and cost of hauling	National price, production, and welfare impacts
Geographic scope	Multistate regions	Chesapeake Bay Watershed	National
Unit of analysis	Farm	County/subcounty	USDA Farm Regions
Species considered	Swine, dairy	Swine, dairy, poultry, feedlot beef	Swine, dairy, poultry, all beef
Manure system types	Lagoon, slurry, dry (dairy)	Lagoon, slurry, dry/litter	Lagoon, slurry, dry/litter
Nutrient management costs included	Manure transport, application, nutrient content testing (soil and manure), management plan development		
Analytic tool	Farm-level manure hauling and application model	Regional manure hauling and application model	U.S. regional agricultural sector model (USMP)
Model structure	Simulation	Optimization, minimize net costs	Optimization, maximize net returns
Manure/Animal production	Fixed	Fixed	Estimated in model
Crop production	Fixed	Fixed	Estimated in model
Output prices	n.a.	n.a.	Estimated in model
Farm size class considered	Yes	No	Yes
Onfarm manure use tracked	Yes	Yes	No
Willingness-to-accept manure considered	Yes	Yes	Yes
Competition for land for spreading	No	Yes	Limited
Manure hauling distance	Estimated in model	Estimated in model	Weighted average
Nonland-based options	Phytase	Phytase, industrial treatment	n.a.
n.a. = not applicable.			

Federal regulations to address those issues, and other research on the impact of environmental regulations on the animal sector. In chapter 3, survey data for hogs and dairy are used to estimate the short-term, farm-level implications of applying manure to land according to a nutrient standard across U.S. regions. This analysis best captures the interactions between a

farm's resource base and manure disposal decisions, including how much land livestock farms would require beyond what they currently control, as well as the cost of hauling manure to this land. Both nitrogen- and phosphorus-based nutrient standards are assessed.

In chapter 4, regional policy implications are assessed for a case-study area of high animal concentrations. The analysis examines how the competition for land influences the costs of spreading manure from the viewpoint of a resource manager or policymaker trying to minimize manure transportation costs. Both nitrogen- and phosphorus-based standards are assessed. In chapter 5, the analysis is extended nationally to assess

the broader impacts of improved manure management on the welfare of U.S. producers and consumers. A model of the U.S. agricultural sector is used to estimate impacts of manure management on prices, total production, and geographic distribution of production. The final chapter summarizes the findings and draws important conclusions for policymakers concerned with manure management and water quality.