Chapter 6—Summary and Implications for Policy and Research

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 overapplied to land and enter water resources. 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 utilization and disposal of animal manure and the potential degradation of water quality.

EPA recently developed new regulations under the Clean Water Act to address this problem. Under these regulations, operations designated Concentrated Animal Feeding Operations (generally the largest animal feeding operations) are required to meet a nutrient application standard when applying animal manure to land. In addition, all other animal feeding operations are being encouraged by USDA to voluntarily meet these standards by adopting nutrient management plans. Education, technical, and financial assistance are available to all operations through USDA conservation programs. These policies for encouraging or requiring animal feeding operations to meet a nutrient application standard when applying animal manure to land will raise the cost of producing livestock and poultry, and may affect prices throughout the agricultural sector.

Under the EPA regulations, some livestock and poultry producers would have to meet either a nitrogen-based or phosphorus-based application standard, depending on local soil conditions. For most animal operations to meet a nutrient standard, they will have to spread manure on more land than they are currently using. Generally, more land is needed to meet a phosphorus standard because manure contains more phosphorus relative to plant needs than nitrogen. The cost of hauling manure and applying it to a larger land base is the primary source of higher production costs. Some additional costs of meeting a nutrient standard include nutrient testing, soil testing, and plan development. We examine the impacts of these costs on the animal sector and the rest of the economy through analyses conducted at the farm, regional, and national levels.

The new CAFO regulations' impacts on manure disposal costs depend greatly on how willing cropland operators are to use manure as a source of nutrients. The higher the willingness to accept manure, the less distance manure will have to be moved, and the smaller the increase in production costs. Currently, 20 percent or less of cropland is receiving manure. We do not know how much this would increase if animal operations actively seek additional land off their own farms to spread manure. We assume here, for presentation sake, that up to 40 percent of cropland would receive manure after nutrient application standards are implemented. (A wider range is considered in the chapter results). Under this scenario, the overall economic impacts to consumers and producers from CAFOs meeting nutrient standards are a loss of $625.2 million (0.13 percent) in national economic welfare. The added costs of meeting a nutrient standard reduce net returns to the livestock and poultry sectors by $1.04 billion (3.1 percent). This loss is partially offset by gains to the crop sector of $427 million. Consumers see a small reduction in welfare from slightly higher prices for animal products. These estimates do not include the value of improved water quality, nor do they consider lost revenue to the commercial fertilizer industry.

These aggregate results mask the fact that the impacts vary widely between sectors and regions. Costs to the animal sector range from a reduction in net returns of 1.6 percent in the dairy sector ($217 million) to a reduction of 6.7 percent in the beef sector ($495 million). Regional costs range from a reduction in net returns of 7.3 percent in the Northern Plains ($235 million) to a reduction in net returns of less than 1 percent in the Northeast ($33.4 million). These differences are due to availability of land for spreading manure, baseline production costs, and regional animal and crop mix.

Regulations on animal waste spill over into the crop sector for two reasons. Manure nutrients become a cheap source of fertilizer that replaces more expensive commercial forms, reducing production costs. Feedgrains (primarily corn and soybeans) are an import source of animal feed, so changes in the number of animals affect the demand for feed. These sometimes conflicting influences result in increases in net returns in all regions for both corn and soybeans. With a 40-percent substitution between manure nutrients and commercial fertilizer, increases in net returns range from $27 million for corn in the Corn Belt (0.3

percent) to $0.4 million for soybeans in the Southern Plains (16 percent). Most regional changes are less than 5 percent.

While EPA's regulations affect only operations designated as CAFOs, USDA is actively promoting efficient nutrient management for all animal feeding operations. Our analyses show that if all AFOs were to meet a nutrient standard, the magnitude of the impacts to costs, production, and prices would be greatly increased. For example, reductions in net returns in the livestock and poultry sector are about 37 percent greater under an all-AFO requirement than a CAFO-only requirement, with a willingness-to-accept-manure of 40 percent ($1.4 billion vs. $1.0 billion). National economic welfare for producers and consumers declines almost $2 billion (0.43 percent).

Again, this is a hypothetical scenario; operations other than CAFOs are not required to meet a nutrient standard. It is a goal of USDA that these operations adopt nutrient management plans voluntarily. The reduction in net returns when all AFOs meet a nutrient standard is an indication that many will incur costs to do so. If those not designated a CAFO face a cost for meeting a nutrient standard, then they probably would not voluntarily alter their manure management practices without financial assistance, and the estimated economic impacts would not occur.

Potential changes to agricultural sectors in response to manure nutrient standards will not occur in a vacuum. New technologies for treating manure nutrients might develop over time, particularly in areas with high concentrations of animals relative to cropland, such as Delmarva, eastern North Carolina, and southeastern Pennsylvania. In regions where cropland for spreading manure nutrients is scarce, it is likely that other, nonagricultural lands (such as timber plantations) would be used for assimilating manure nutrients. Similarly, other agri-environmental policies may bear on these issues. For example, the 2002 Farm Act provides a large increase in funds intended to help livestock and poultry producers comply with Federal and State water quality regulations, to encourage the adoption of nutrient management practices, and to assist them to move manure off their farms to other landowners. Specifically, the budget for the Environmental Quality Incentives Program (EQIP; NRCS, 2002) is authorized to fund $9 billion in conservation efforts by crop, livestock, and poultry producers over the next 10 years. This amount exceeds agricultural losses under many of the scenarios we evaluated.

How individual farms adjust to nutrient application standards depends on several factors, including the number of animals on the farm, amount of land available on the farm for spreading manure, availability of land off the farm, willingness of cropland operators to accept manure, type of crops grown (providing different nutrient uptake), and type of nutrient standard the farm must meet (nitrogen-based or phosphorus-based). We looked at how these factors affect hog and dairy farms across the country. While many farms (primarily small and medium-sized) control enough land to meet nutrient standards, most are not using all of their cropland, thereby over-applying manure nutrients on the portion that receives manure. Only 18 percent of large hog farms and 23 percent of large dairies are currently applying manure on enough land to meet a nitrogen standard. On average, large hog and dairy farms would have to increase the acreage receiving manure by 114 percent and 99 percent to meet an N-based standard. If a P-based plan is required (which generally requires more land), the increase in acreage would have to be 550 percent for hogs and 529 percent for dairies. Smaller operations also have to increase the amount of land for spreading, but to a lesser degree.

Spreading manure on additional land raises hauling and application costs, which can be partially offset by reduced commercial fertilizer costs. Farms that don't control enough land to meet a nutrient standard (primarily large farms and all farms in some areas) must find land off the farm if applying manure to land is the only option, greatly increasing hauling costs. The impacts on large hog farms for meeting a nitrogen-based standard with a willingness-to-accept-manure of 40 percent would range from a net benefit of $3.20 per animal unit, on average, in the Eastern Corn Belt to a net cost of $4.20 in the South (assuming no changes in prices or number of animals). The availability of cropland both on and off the farm in the Eastern Corn Belt results in the fertilizer benefit from manure outweighing the additional transportation costs. The results in the South reflect a relative scarcity of cropland both on and off the farm.

Impacts to large dairy farms range from a net cost of $8.10 per animal unit in the North to $11.80 in the South. Generally, costs increase the greater the percentage of manure that must be moved off the farm, the smaller the percentage of surrounding land that is in crops that can use manure, and the smaller the nutrient uptake of predominant crops. Consistent with the three analyses, costs are higher with a lower willingness-to-accept-manure.

The relative importance of higher manure management costs to the farm can be indicated by comparing them to production costs. Meeting nitrogen application standards would raise hog production costs on large farms in the South by 1.2 percent with a willingness-to-accept-manure of 40 percent, assuming no other changes are made to the operation. Production costs increase 0.6 percent or less in the other regions. This is an average, and costs to individual farms could be higher (or lower). Manure management costs would be about 75 percent higher if willingness-to-accept-manure does not increase beyond 20 percent.

The results are similar for large dairies. Meeting a nitrogen application standard would raise production costs between 0.6 and 0.7 percent with a willingness-to-accept-manure of 40 percent. Manure management costs double if willingness-to-accept-manure does not increase beyond 20 percent.

If a farm must meet a P-based standard, costs would generally be greater because more land would be required for spreading manure. In the Mid-Atlantic, for example, hog production costs would rise 1.5 percent under a P-standard, compared with an increase of 0.5 percent under an N-based standard. Dairies would see similar increases in production costs if a P-standard is to be met.

Expanding nutrient management requirements to all AFOs would affect numerous small and medium-sized farms. Nearly 90 percent of small hog and dairy farms control adequate cropland to meet the needs of a nitrogen standard, so they would generally not incur the cost of moving manure off the farm. In contrast, less than half of large hog farms and only 25 percent of large dairy farms can make this claim. Nutrient plan development and testing costs tend to be more important to these operations than to larger farms because the costs are spread over fewer animals. The additional manure management costs generally increase production costs 1 percent or less for small and medium hog and dairy farms. Again, costs are higher if willingness-to-accept-manure is lower.

While the costs to small and medium-size AFOs for meeting a nutrient standard are relatively low, the benefits from reducing manure runoff are also low. Raising production costs on the 94 percent of AFOs that are small and medium-sized to reduce the 35 percent of all excess nutrients they produce may not be a cost-effective means of improving water quality. This is a major reason why EPA focused its regulations on large AFOs.

While we did not analyze other sectors at the farm level, it is likely that the results would be similar. Poultry in particular is produced on large operations that have relatively little land for spreading manure. However, poultry manure is drier than other types, so it can be economically transported longer distances.

A factor that can greatly increase the cost an individual farm may face in meeting a nutrient standard is the regional concentration of animals. As noted in chapter 2, in some regions the amount of manure nutrients generated exceeds all that region's crop nutrient needs. In this setting, finding adequate land for spreading may be more costly than elsewhere because of competition for land. The Chesapeake Bay watershed (CBW) is one example; it contains counties with concentrations of surplus manure nutrients that rank among the highest in the Nation.

Using a model of the CBW that accounts for competition for land on which to apply manure, we estimate that net land application costs for meeting an N-based standard increase by $66.6 million per year under a 40-percent willingness-to-accept-manure assumption (21 percent of total net revenues from animal production). The average distance manure would have to hauled is greater than that estimated in the farm-level analysis, where competition for land was not considered. The farm-level analysis for hog farms in the Mid-Atlantic region, which includes most of the CBW, found that the average distance manure would have to be hauled is 1.4 miles, with a maximum for any one farm of 14 miles. In contrast, the average distance manure would have to be hauled in the CBW is 2.3 miles (on farm and off). Some manure would have to be hauled more than 50 miles to other counties.

If a phosphorus-based plan is required in the CBW (with a willingness-to-accept-manure of 40 percent), about 20 percent of manure would be in excess of what the accessible land in the watershed could assimilate. This manure would have to be hauled more than 90 miles, or a nonland-based solution would have to be found. Willingness-to-accept-manure would have to be greater than 60 percent for the watershed's manure to be spread agronomically within 90 miles of manure producing areas within the watershed.

One way of coping with a regional excess of manure is to find alternatives to land application. The cost of building an industrial facility that uses manure to produce a fertilizer product compares favorably to the cost savings from shifting manure from land application to industrial uses. For example, shifting manure to an industrial plant rather than hauling it to a distant

site for land application would save $2-$7 million in land application costs per year under a P-standard, depending on the region's willingness-to-accept-manure.

Another way to reduce the amount of land required for spreading manure is to reduce the nutrient content of manure. Advances in feed and nutrition management are starting to offer some options to farmers for doing just this. Phytase is an enzyme currently being used in some swine and poultry feed. Adding phytase to the diet of swine and poultry in the Chesapeake Bay watershed could reduce land application costs by $6-$10 million.

The need to transport manure over longer distances has structural implications for the agricultural sector. Moving manure many miles from its source presumes that a marketing structure is in place and that a consistent, standardized product is shipped to the destination. It is likely that a more formal marketing system will develop over time to satisfy this need. The recently adopted USDA policy and EPA regulations could well spur a growth in these markets. The fertilizer industry could recoup some its losses in fertilizer sales by using manure as a source of raw materials (e.g. the Harmony Farms Shenandoah Valley fertilizer plant), organizing and operating regional manure markets, and providing manure nutrient management services to farmers.

Another structural issue is what happens to the economic advantages of vertical integration seen in the poultry and swine sectors. There are significant economic benefits to this structure, but one of its consequences is regional concentration. Our results indicate that the large production units typical of this structure would generally have the largest costs per animal unit for applying manure to meet a nutrient standard. Thus, the benefits of integration might be reduced because of manure management regulations.

Manure nutrient standards have been shown to affect regions differently, largely because of the availability of cropland for spreading manure. Animal feeding operations in regions with abundant cropland would generally have lower costs than other regions, giving them a competitive advantage. These regional differences can spur shifts in production between regions, as demonstrated in the national-level analysis. Large animal feeding operations looking to expand would likely consider the availability of spreadable land when making a decision.

Implications for Policy and Research

The analysis presented here is only a first step in fully evaluating the implications of environmental policies on animal feeding operations. Several issues deserve further research.

Advances in feed management may soon increase the options available to farmers for reducing nutrients in manure (CAST, 2002). While we study how phytase use reduces phosphorus in manure and affects manure spreading costs under a P-based plan, other feed management options include optimizing the amino acid content of feed, thereby reducing manure nitrogen. Optimizing feed for nitrogen excretion is more difficult to manage than for phosphorus, but it may play a future role in reducing excess nitrogen on animal farms. Further economic analyses could indicate the potential for such advances to reduce overall manure management costs.

The willingness of cropland owners to accept manure was found to be an important variable in all three analyses. Impediments to using manure are well known. However, the willingness to accept manure has not been directly studied. Survey data indicate that less than 20 percent of cropland in major crops currently receives manure. Whether this reflects willingness-to-accept-manure is unknown. It might be that agricultural land currently receiving manure is on operations that have animals. A study of the willingness of cropland operators who don't have livestock to use manure in place of commercial fertilizer would indicate the potential of using land application of manure as the principal manure disposal method, and it could identify areas for education and extension that might reduce cropland operators' reluctance. Financial assistance through programs such as the EQIP could be used to encourage crop operators to use manure as a fertilizer and soil amendment. Animal producers might be able to increase willingness-to-accept-manure by paying crop farmers to take manure. Savings in manure hauling costs by increasing willingness-to-accept-manure could make this worthwhile.

The farm and regional analyses took a short-term view, not considering farm-level changes in animal numbers and manure handling that might be made if a nutrient standard is met. The national analysis also took a short-term view in that it did not take into account structural changes on the farm or induced technological change. Analyses using optimization models that allow for all inputs on the farm to adjust would help indicate the longer run impacts on the

industry. The impacts of manure management costs on the nature of production contracts and on the structure of the industry are of significant interest.

The results of the national analysis reflect in part the responsiveness of consumers, domestic producers, and foreign suppliers of livestock and poultry to U.S. price changes. The greater the responsiveness of supply and demand to price changes (also known as elasticities of supply and demand), the smaller the price shocks from increased production costs. Smaller price shocks are beneficial to consumers, but reduce the ability of market prices to compensate animal operators for higher manure management costs. Research on how changes in international trade patterns and consumer preferences affect price elasticities for livestock and poultry products— and the eventual costs to consumers and the agriculture sector from enhanced manure management—would provide additional depth to the analysis.

Our analysis only provides a first look at how alternative uses for manure might alleviate some of the costs of land application. Further assessment of the potential for manure products such as compost, fertilizer, and energy would be helpful. Such markets, if they develop, can be expected to have impacts on the cost of meeting regulations, and thus on location and structure of animal operations.