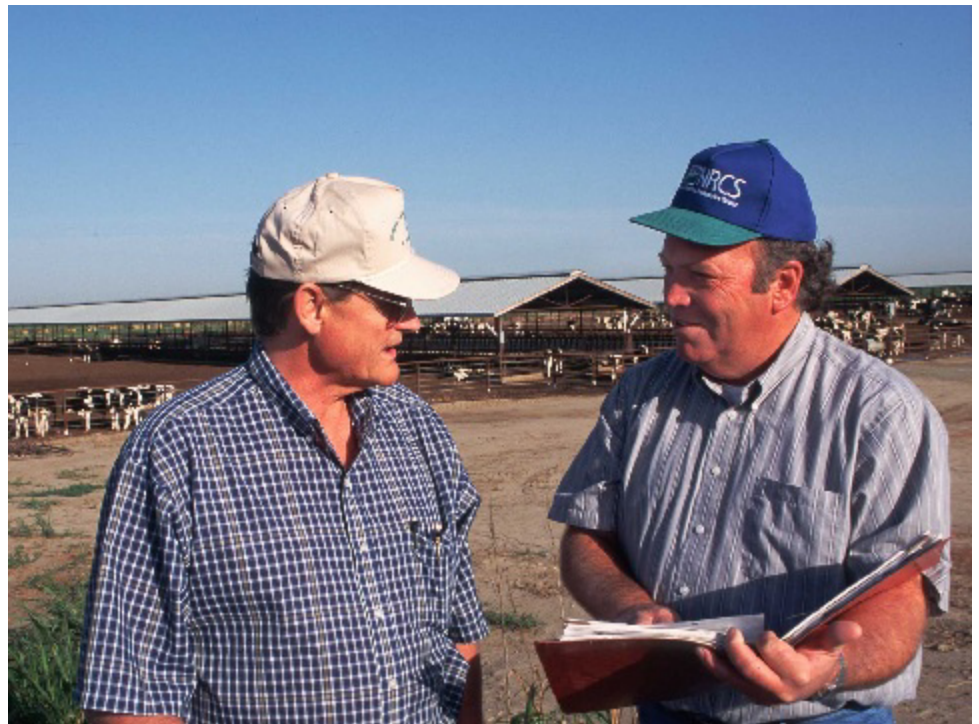


## **Executive Summary**

# **Costs Associated with Development and Implementation of Comprehensive Nutrient Management Plans**

Part I—Nutrient Management, Land Treatment, Manure  
and Wastewater Handling and Storage, and  
Recordkeeping



Issued June 2003

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# Costs Associated with Development and Implementation of Comprehensive Nutrient Management Plans (CNMP)

## Part I—Nutrient Management, Land Treatment, Manure and Wastewater Handling and Storage, and Recordkeeping

### Executive Summary

#### Introduction

The Nation's livestock sector has undergone dramatic change in recent decades. The substantial productivity increases in animal agriculture have fueled consolidation and geographic concentration. Correspondingly, the industry has seen marked declines in the number of livestock operations and an increase in the number of animals produced in confinement. The largest of animal feeding operations—concentrated animal feeding operations (CAFOs)—are defined as point sources and regulated under the authority of the Clean Water Act. However, all animal feeding operations (AFOs) are being scrutinized for their potential to contribute to non-point source pollution of the Nation's water resources.

In 1999, the U.S. Department of Agriculture (USDA) and the U.S. Environmental Protection Agency (EPA) released a joint “Unified National Strategy for Animal Feeding Operations” (Strategy), which presented a plan for addressing the potential water quality and public health impacts associated with AFOs. The Strategy recognized the complementary roles to be played by voluntary and regulatory programs. Importantly, the Strategy articulated a national performance expectation that all AFOs should develop and implement technically sound, economically feasible, and site-specific comprehensive nutrient management plans (CNMPs) to minimize potential adverse impacts on water quality and public health, and to accomplish this within a 10-year implementation period.

#### Comprehensive Nutrient Management Plans

A comprehensive nutrient management plan (CNMP) is a conservation system that is unique to animal feeding operations. It includes conservation practices and management activities which, when implemented as part of a conservation system, will help to ensure that production and natural resource protection goals are achieved. CNMPs may include the following six elements:

**Manure and Wastewater Handling and Storage** – addresses components and activities associated with the production facility, feedlot, manure and wastewater storage and treatment structures and areas, and any areas used to facilitate transfer of manure and wastewater.

**Land Treatment Practices** – addresses components and activities associated with the fields where manure and organic by-products are applied as beneficial nutrients. Generally, this includes identification of sensitive areas and implementation of conservation practices, such as residue management, contouring, and terraces, to retain nutrients on-site and available for plant uptake.

**Nutrient Management** – addresses components and activities associated with land application of all nutrients and organic by-products to meet crop needs and minimize potential adverse impacts to the environment and public health. Generally, this includes planning and applying nutrients with consideration of form, timing, rate, and application method.

**Recordkeeping** – addresses the need for AFO owners/operators to document management and implementation activities associated with their CNMP. Typically, this includes recording soil tests, manure tests, manure and wastewater field application dates and rates, manure transfers, and operations and maintenance activities.

**Feed Management** – addresses activities that improve feed delivery, reduce feed wastage, or improve nutrient uptake efficiency.

**Other Utilization Activities** – addresses AFO alternatives to land application of manure and organic by-products, such as energy production, nutrient stabilization and extraction for commercial fertilizers or other products, composting or pelletizing, mixing or co-composting with other by-products to produce specialized use materials.

The Strategy recognized the importance of understanding the costs of nationwide CNMP implementation and called upon EPA and USDA to evaluate costs and benefits. In September 2000, USDA initiated the first phase of an assessment of:

1. The cost of upgrading facilities and practices on AFOs nationwide to meet CNMP technical guidance.
2. The technical assistance needed to plan, design, implement, and follow up on needed structures and practices.
3. The cost of alternatives to land application of manure, including feed management, alternative uses, and treatment options.

This is a summary of the report addressing the first two components of the USDA assessment. Presented here is an overview of the findings on the number and distribution of operations potentially needing CNMPs, estimated costs for developing and implementing CNMPs on these operations, and overall cost summaries by region, livestock type, and operation size. For detailed information on the assessment the reader is directed to the full report, *Costs Associated with Development and Implementation of Comprehensive Nutrient Management Plans, Part I – Nutrient Management, Land Treatment, Manure and Wastewater Handling and Storage, and Recordkeeping*. A subsequent report will address the cost of alternatives to land application of manure and other strategies to minimize potential nutrient excesses.

### Operations Needing Comprehensive Nutrient Management Plans

The 1997 Census of Agriculture reported that there were 1.9 million farms and ranches in the United States. Livestock are produced on nearly 1.3 million of these farms and ranches and in every state across the United States. Operations that were estimated to need a CNMP were identified on the basis of three criteria:

1. Number of animals—operations with too few animals were eliminated from consideration as they were unlikely to need a CNMP.
2. Recoverable manure—operations with sufficient animal numbers to generate at least 200 pounds of recoverable manure nitrogen annually (approximately equivalent to 11 tons of manure).
3. Specialty livestock—operations with specialty livestock types most likely to be raised in confinement settings (primarily operations with fur-bearing animals and poultry other than turkeys and chickens, mostly ducks and geese).

Based on these three criteria, 257,201 operations in the 1997 Census of Agriculture were identified as needing a CNMP. These operations are distributed nationwide, although there are significant pockets of concentration (figure 1). Overall, dairies accounted for the largest share of operations expected to need a CNMP (figure 2).

### Overall Costs of Developing and Implementing CNMPs

The total CNMP development and implementation cost over the 10-year implementation period was estimated to be \$19.5 billion, or about \$76,000 for each of the 257,201 CNMPs. The average annual cost per operation is thus about \$7,600.

CNMP development costs represent about 10 percent of the total cost (\$2.1 billion), equivalent to 38.2 million hours of technical assistance at an average hourly cost of \$55. Technical assistance in developing and implementing CNMPs includes:

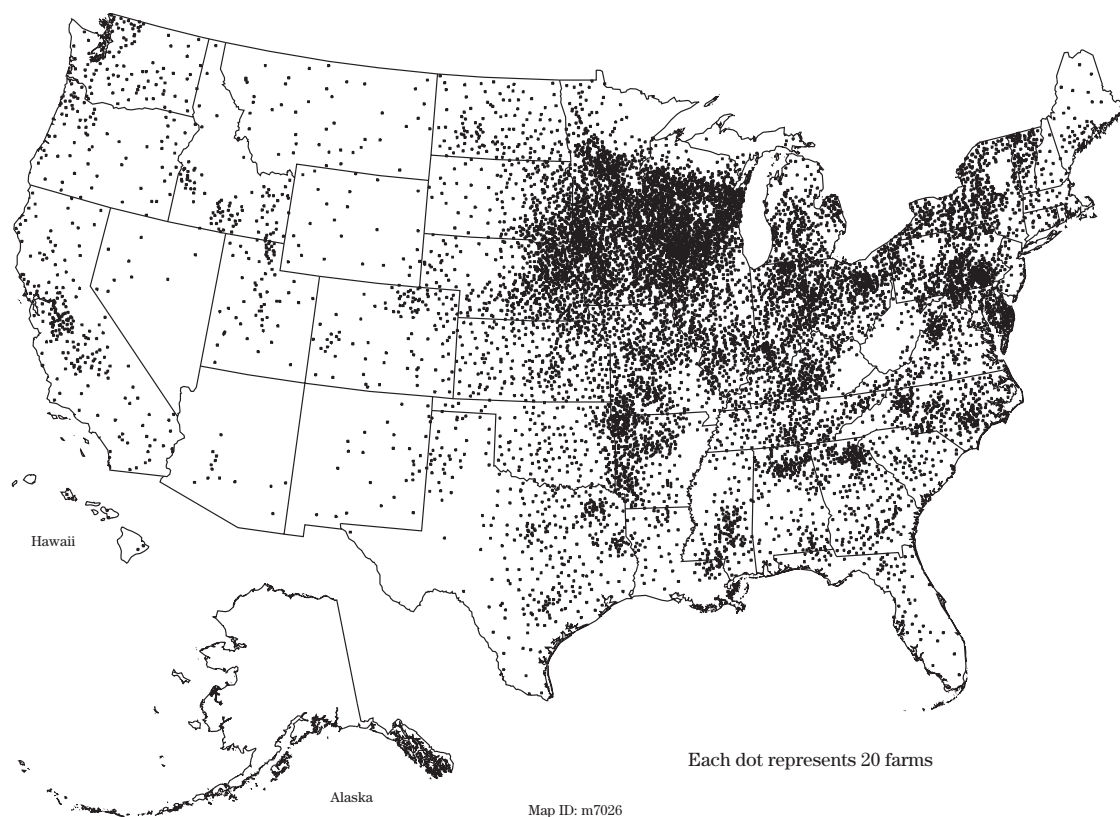
1. *Alternatives development and evaluation*—working with producers to define objectives, develop and evaluate alternatives, and finalize a plan.
2. *Design*—designing needed conservation and management practices.
3. *Implementation*—assisting with and inspecting installation of practices and management activities.
4. *Followup*—working with the producer to ensure the practice is working properly, and to make any needed changes to ensure that the CNMP is meeting the objectives.

The average CNMP development time was 149 hours per operation. The majority of technical assistance time—62 percent—is spent on activities related to manure and wastewater handling and storage because of the time needed for design and installation of structural practices (figure 3).

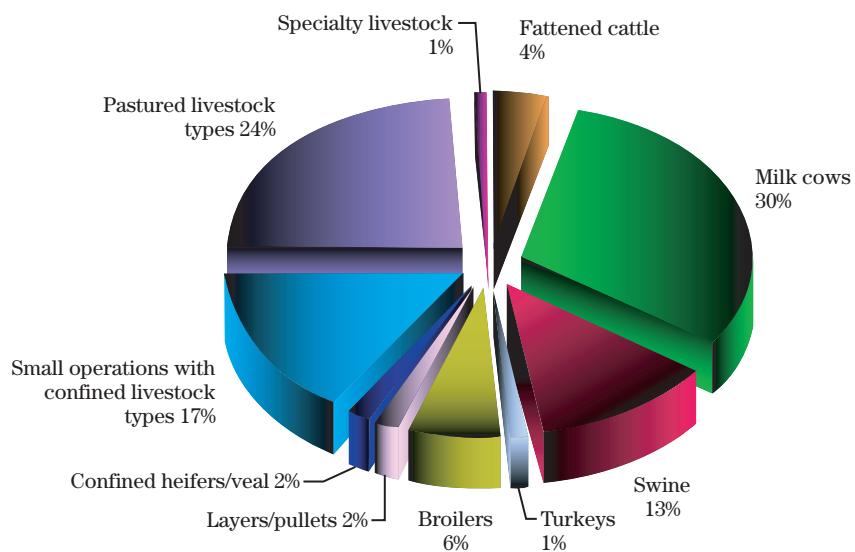
CNMP implementation costs totaled \$17.4 billion over the 10-year period, averaging \$6,748 per operation. This reflects the cost to producers to modify practices and install needed upgrades. Costs varied substantially among operations; the one-percentile cost per operation was about \$195, while the 99th percentile annual cost per operation was about \$67,000.

Implementation costs were estimated for five categories: nutrient management, off-farm export of manure, land treatment to control soil erosion on acres receiving manure, manure and wastewater handling

**Figure 1** Livestock operations potentially needing comprehensive nutrient management plans (257,201 operations)

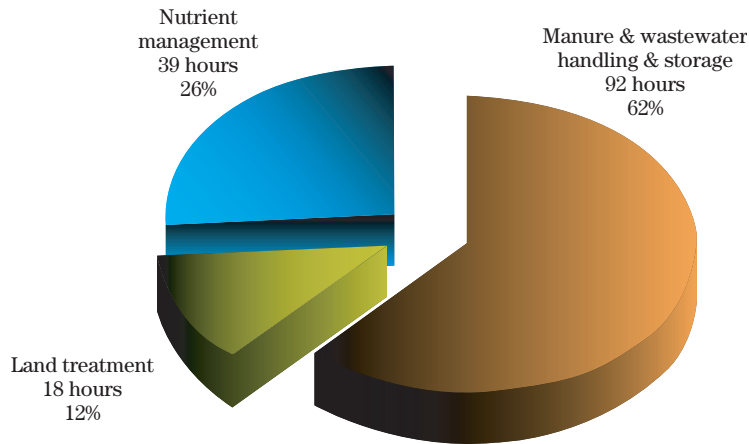


**Figure 2** Distribution of operations needing CNMPs by dominant livestock type





**Figure 3** Average development cost (technical assistance), by CNMP element



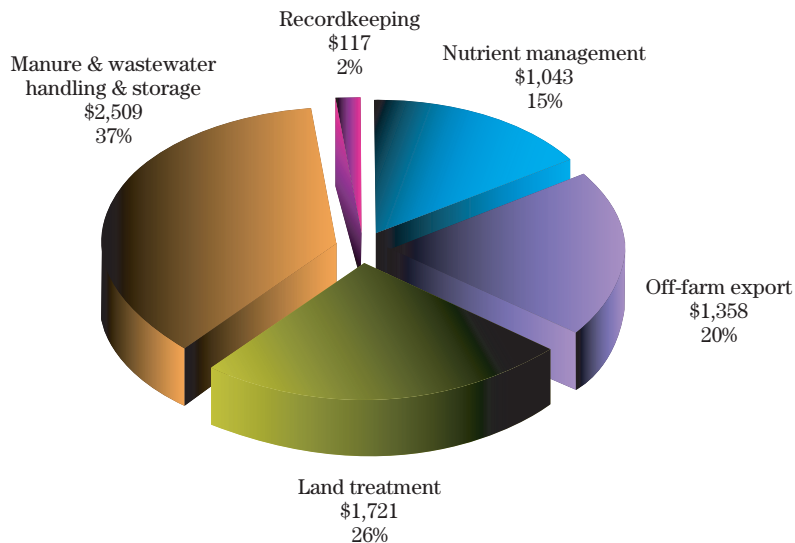
and storage, and recordkeeping. On average, manure and wastewater handling and storage had the highest cost at \$2,509 per operation per year, representing 37 percent of the total cost per operation (figure 4).

Estimated development and implementation costs vary considerably, however, according to livestock type, the size of the operation, and production region.

#### Costs by Livestock Type

The average annual implementation cost per operation was highest for fattened cattle operations and turkey operations (\$18,167 and \$17,820 per operation, respectively), and lowest for specialty livestock, pastured livestock, and small operations with confined livestock types (figure 5).

**Figure 4** Annual average implementation cost, by CNMP element

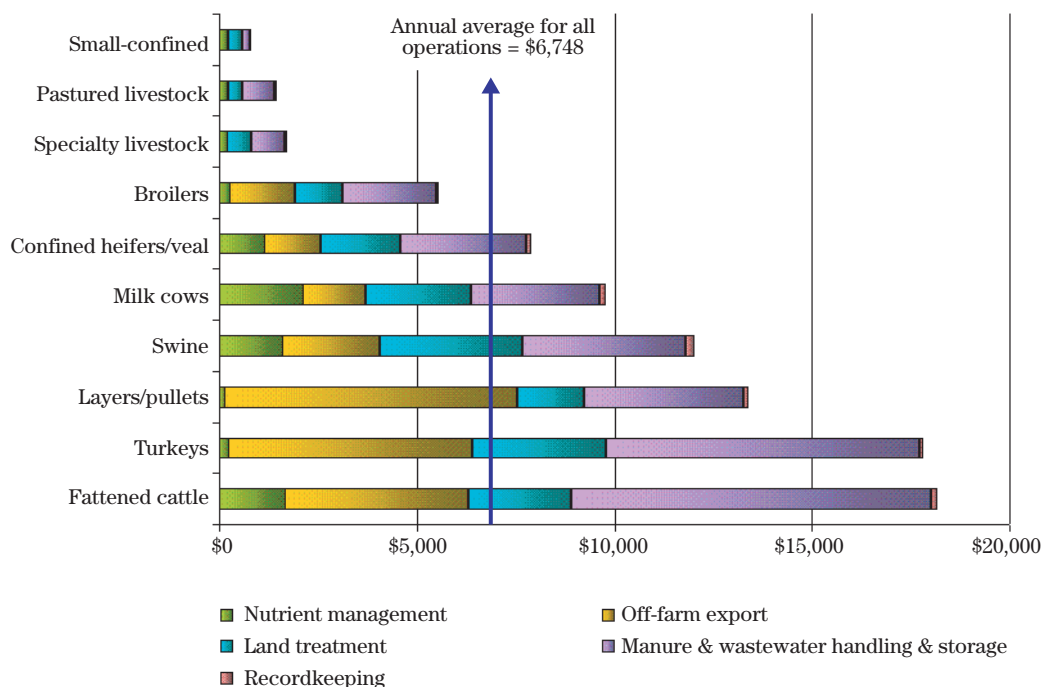


#### Costs Borne by Operations Receiving Manure

One of the results of CNMP implementation is that more manure will be exported off the operation to surrounding cropland and pastureland. Under the assumptions of this assessment, costs associated with off-farm land application of manure would be borne by the operations receiving the manure and not by the livestock operation. These costs include land application costs and soil testing costs for the additional acres with manure applied off the farm.

The total annual cost for off-farm nutrient management of this additional manure was estimated to be \$25.3 million. These costs were not included in the estimate of CNMP implementation costs since they are not costs borne by the livestock operation. Averaged over all livestock operations that may need CNMPs, the average annual off-farm nutrient management cost was \$98 per operation. When averaged over only the 72,000 operations with off-farm export of manure, the average annual off-farm nutrient management cost was \$351 per operation. The highest total costs were for the Corn Belt region—\$4.8 million.

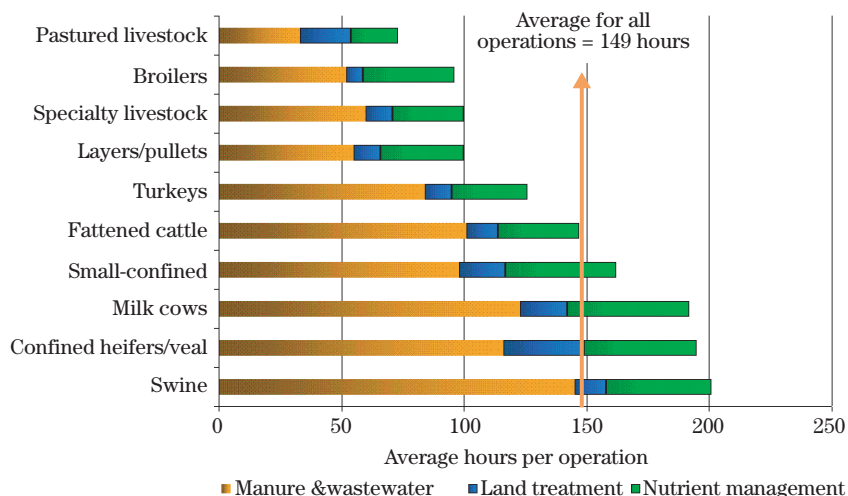
**Figure 5** Annual average implementation cost, by livestock type



These estimates, however, are heavily influenced by the number of livestock on the farm. For example, fattened cattle operations and turkey operations also had the most animal units per farm, on average. On a per-animal unit basis, dairies had the highest annual cost at \$50 per animal unit, followed by layer and pullet farms at \$45 per animal unit and swine farms at \$44 per animal unit. Turkey farms had a moderate annual cost per animal unit of \$26, and fattened cattle farms averaged only \$14 per animal unit, the lowest of all the farm groups except farms with pastured livestock types. CNMP implementation costs for small farms with confined livestock types averaged \$30 per animal unit per year. The average cost per animal unit for all farms was \$32 per year.

Average CNMP development costs were much less variable than CNMP implementation costs. The average development costs were highest for dairies, swine operations, and operations with confined heifers and veal, averaging over 190 hours per operation (figure 6). Broiler operations and operations with pastured livestock types required the fewest technical assistance hours, averaging 95 hours per operation and 73 hours per operation, respectively.

**Figure 6** Technical assistance by livestock type



### Costs by Operation Size

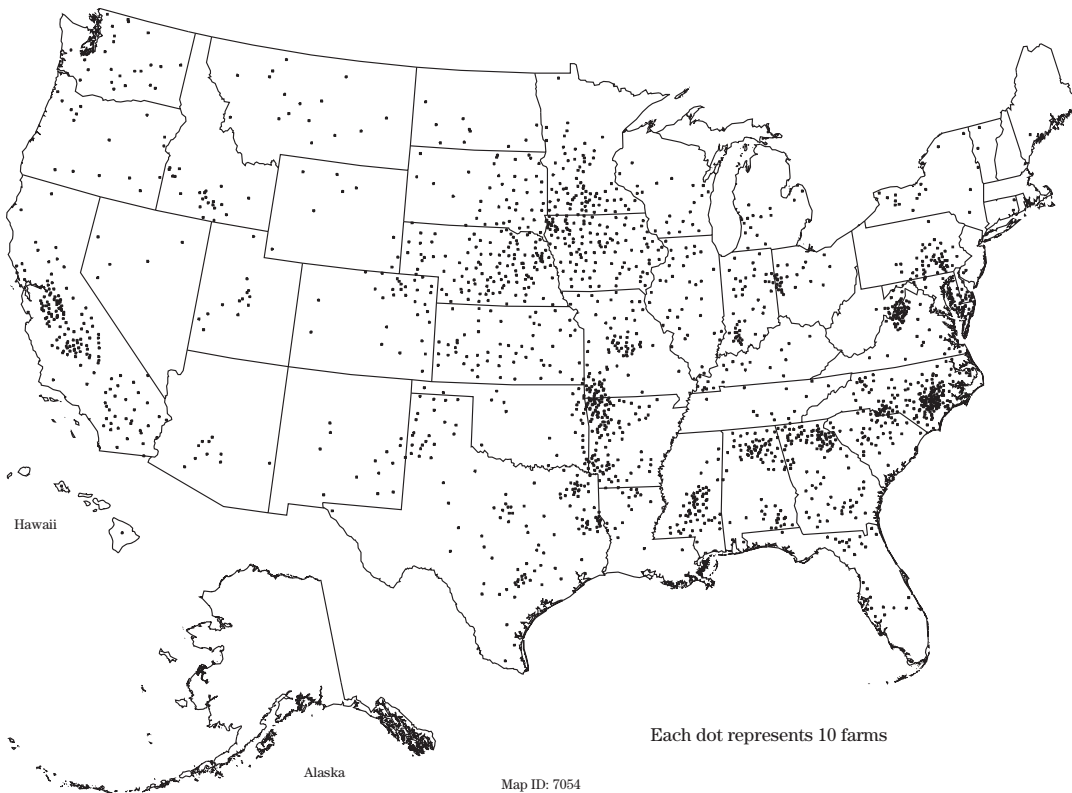
Three size classes of operations were defined on the basis of the amount of manure phosphorus produced annually. Operations producing more than 10 tons (20,000 pounds) of manure phosphorus annually were categorized as large operations, shown in figure 7. Operations producing 4 to 10 tons (8,000-20,000 pounds) of manure phosphorus annually were categorized as medium-size operations, shown in figure 8. Operations with less than 4 tons of manure phosphorus were categorized as small operations. The set of large operations includes most operations in the Large CAFO category as defined by EPA in its CAFO Rule, plus additional operations that produce an equivalent amount of manure nutrients. The 4-ton limit used to define the set of medium-size operations corresponds roughly to the Medium CAFO category defined by EPA. (Ten tons of manure phosphorus would be produced annually by about 600 animal units of beef or dairy cattle, 400 animal units of hogs for slaughter, or 185 animal units of poultry, where an animal unit is 1,000 pounds of live

weight. Four tons of manure phosphorus would be produced annually by about 250 animal units of beef or dairy cattle, 165 animal units of hogs for slaughter, or 75 animal units of poultry.)

Annual average implementation costs per operation are much higher for large operations than for small and medium-size operations (figure 9). The average annual implementation cost for the large operations is about \$30,500 per operation, compared to about \$3,800 for the small operations. Large operations represent only 8 percent of all operations needing CNMPs but account for about 35 percent of the total costs. Small operations potentially needing CNMPs represent 77 percent of the operations, while only accounting for 43 percent of the total costs.

On a per-animal unit basis, however, the costs are lower for the large operations than for the small and medium-size operations, reflecting economies of scale for CNMP implementation (table 1).

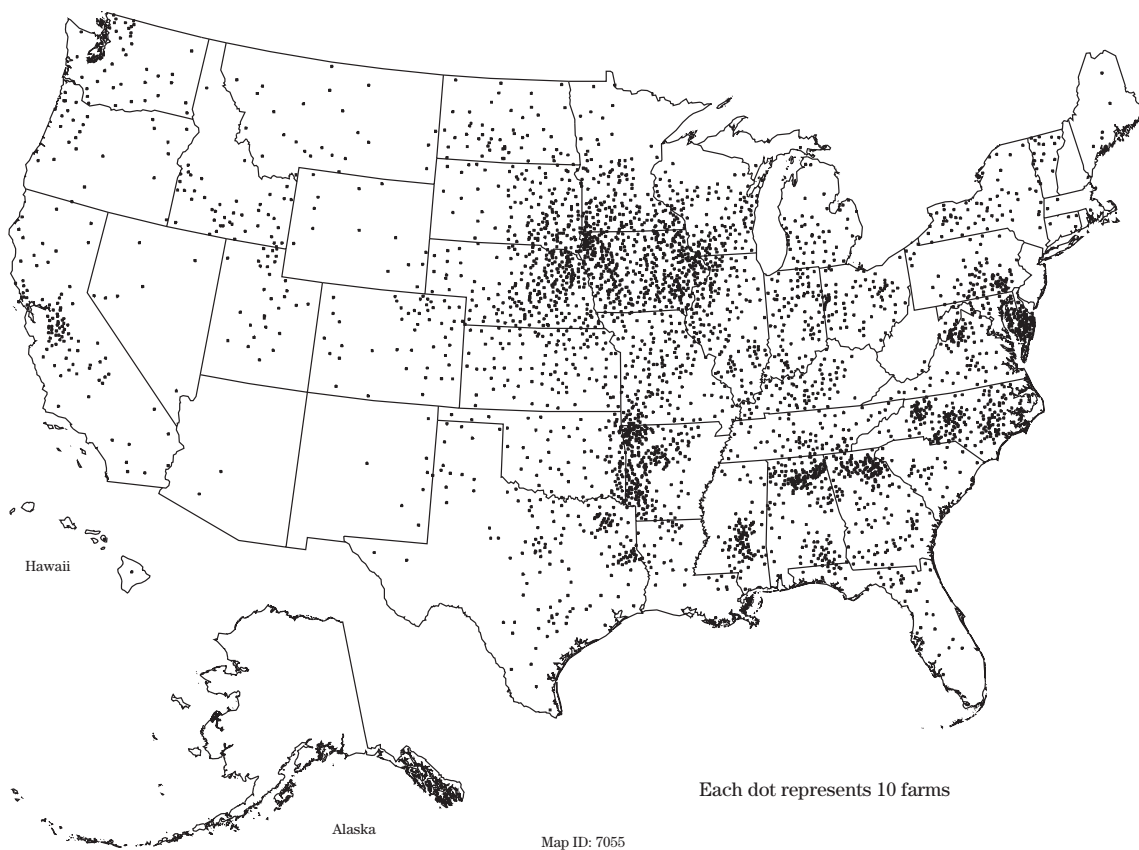
**Figure 7** Large operations (producing more than 10 tons of phosphorus per year—19,746 operations)





**Table 1**—CNMP Implementation Costs by Size of Operation

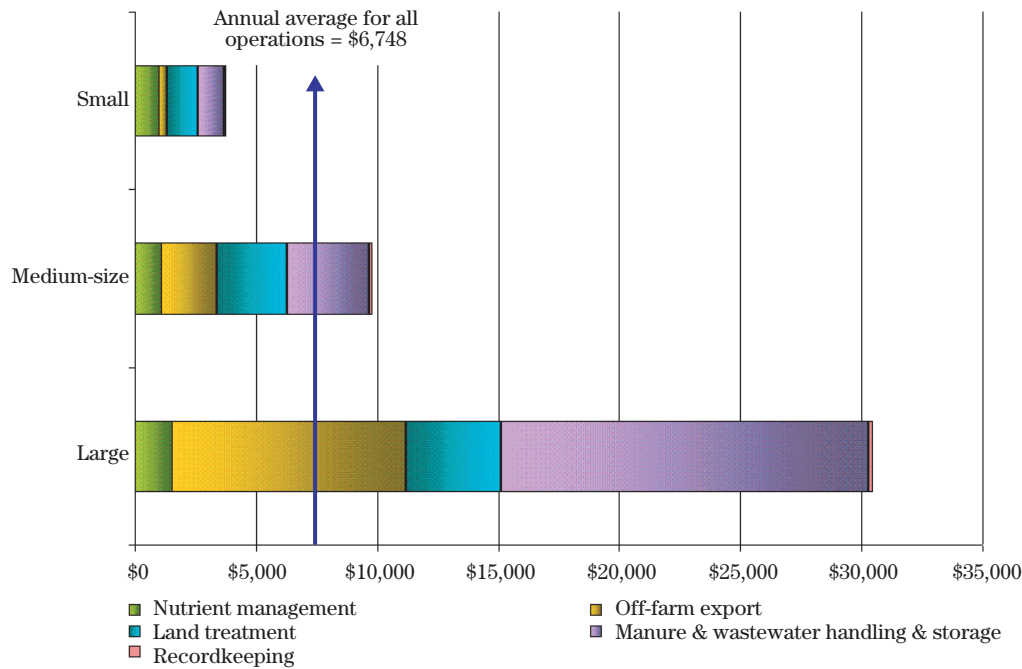
Operation size	Number of operations	Percent of operations needing CNMPs	Average annual cost per operation	Average annual per animal unit cost	Total cost for all operations size class (millions)	Percent CNMP implementation costs
Small	198,018	77	\$3,775	\$47	\$748	43
Medium	39,437	15	\$9,810	\$39	\$387	22
Large	19,746	8	\$30,465	\$21	\$602	35
Total	257,201	100	\$6,748	\$32	\$1,736	100

**Figure 8** Medium-size operations (producing 4 to 10 tons of phosphorus per year—39,437 operations)

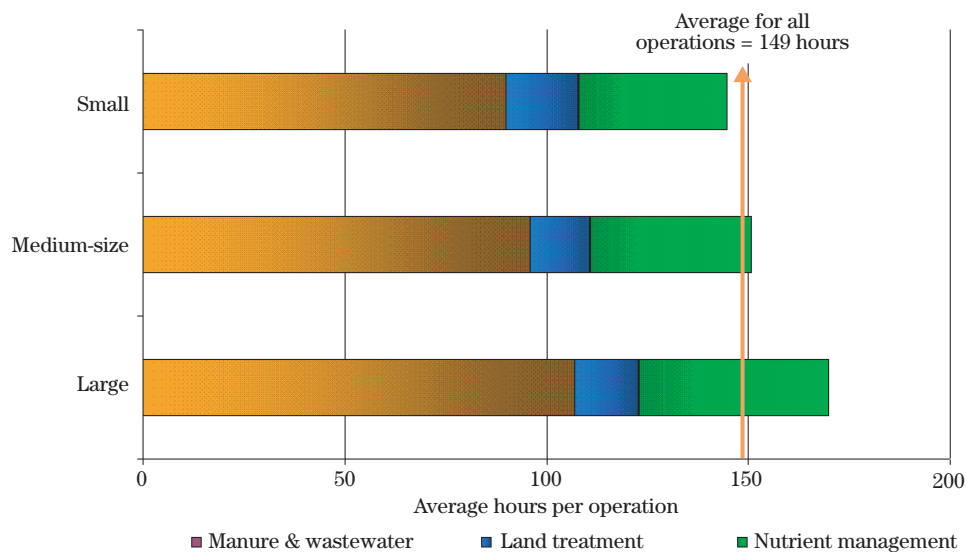
Variation in CNMP development costs according to the size of operation was not pronounced, which is expected as there is a practical minimum cost for developing a CNMP. Large operations averaged 170 hours of technical assistance per operation and small

operations averaged 146 hours per operation (figure 10). Larger farms generally have more complex situations, but the technical assistance required is not proportional to the size of the operation.

**Figure 9** Annual average implementation costs, by operation size



**Figure 10** Technical assistance by operation size



### Costs by Production Region

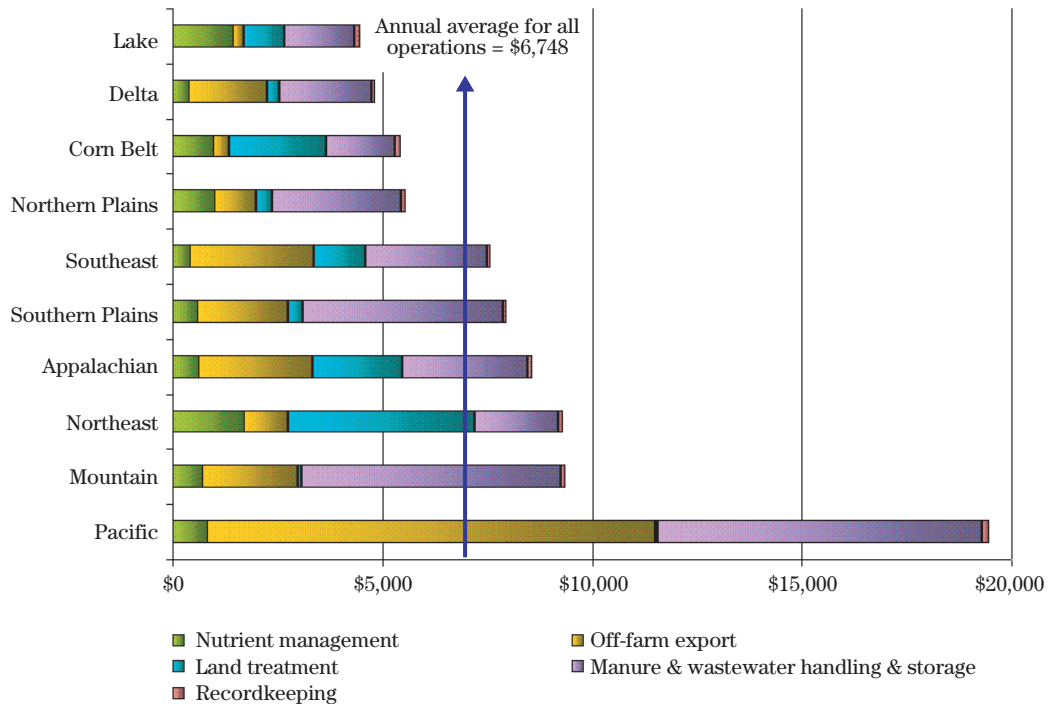
The 10 USDA farm production regions are used to represent geographic variability in CNMP development and implementation costs (table 2). Average costs generally reflect the regional distribution of large, medium-size, and small farms, whereas total costs are also influenced by the number of farms in each region. Over one half of all operations that potentially need CNMPs are in the Corn Belt, Lake, and Northeast regions. However, these regions also account for almost 70 percent of all small operations. A disproportionate number of large operations are in the Pacific, Southeast, Delta, and Mountain regions; the percentages of large operations in these regions are 2 to 3 times the national average.

Regionally, the highest annual average CNMP implementation cost is \$19,464 per operation in the Pacific Region, while the Lake States region has the lowest at \$4,469 per operation, reflecting the differences in the mix of operation sizes among the regions (figure 11). Off-farm export costs also had a significant effect on cost variability among regions, reflecting regional differences in land availability relative to operation size. CNMP development costs were higher in the Northeast and Pacific regions (figure 12). Over half of the total CNMP implementation costs and two-thirds of the total CNMP development costs were accounted for in three regions—the Corn Belt region, the Lake States region, and the Northeast region.

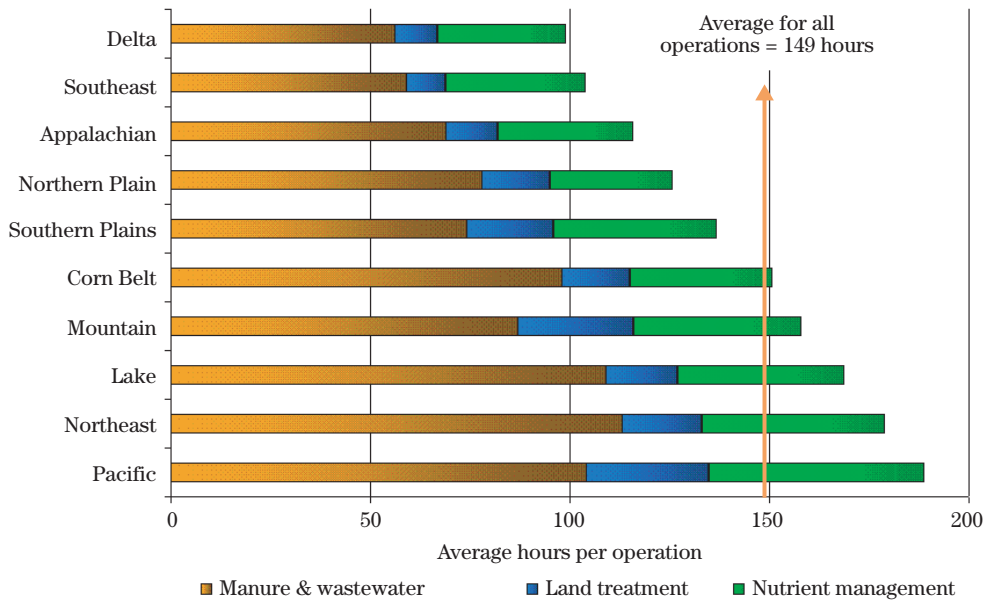
**Table 2**—Distribution of operations that potentially need CNMPs according to production region.

Region	States	Number of operations	Percent in large size class	Percent in medium size class	Percent in small size class
Appalachian	Tennessee, Kentucky, West Virginia, North Carolina, Virginia	22,899	13.1	19.9	67.1
Corn Belt	Iowa, Illinois, Missouri, Indiana, Ohio	71,540	4.3	12.8	82.8
Delta	Arkansas, Louisiana, Mississippi	12,352	16.5	31.6	52.0
Lake	Minnesota, Wisconsin, Michigan	52,817	2.2	6.4	91.5
Mountain	Montana, Idaho, Wyoming, Nevada, Utah, Colorado, Arizona, New Mexico	7,964	15.4	21.9	62.7
Northeast	Maine Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, Pennsylvania, New Jersey, Delaware, Maryland	31,598	3.2	9.1	87.7
Northern Plains	North Dakota, South Dakota, Nebraska, Kansas	26,309	8.5	19.9	71.7
Pacific	Washington, Oregon, California, Hawaii, Alaska	7,974	24.9	21.1	54.1
Southeast	Alabama, Georgia, South Carolina, Florida	12,807	19.8	34.3	45.9
Southern Plains	Oklahoma, Texas	10,941	13.6	23.1	63.3
All Regions		257,201	7.7	15.3	77.0

**Figure 11** Annual average implementation costs, by region



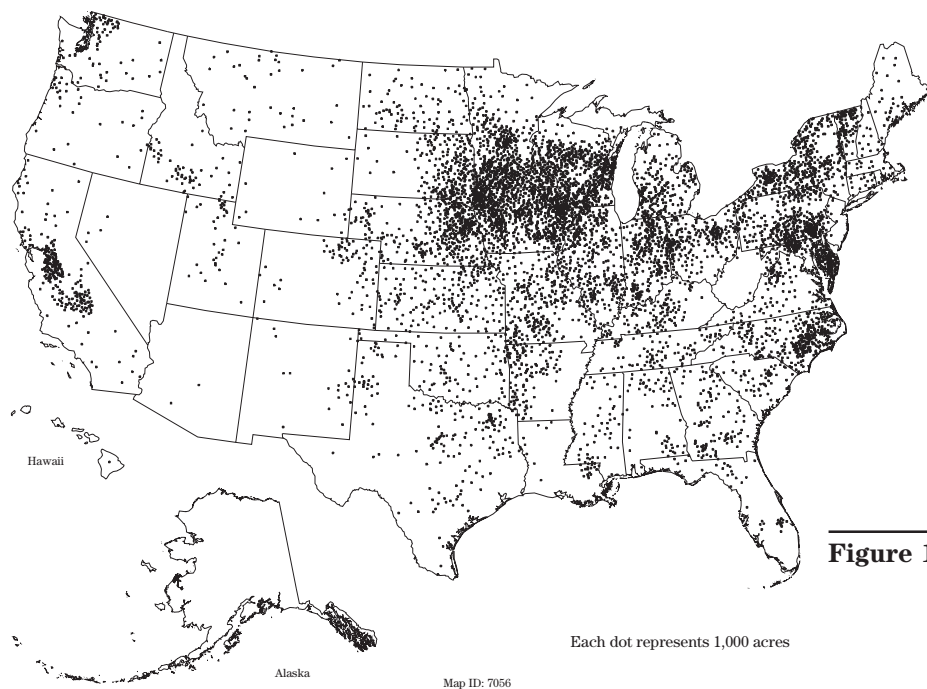
**Figure 12** Technical assistance by region



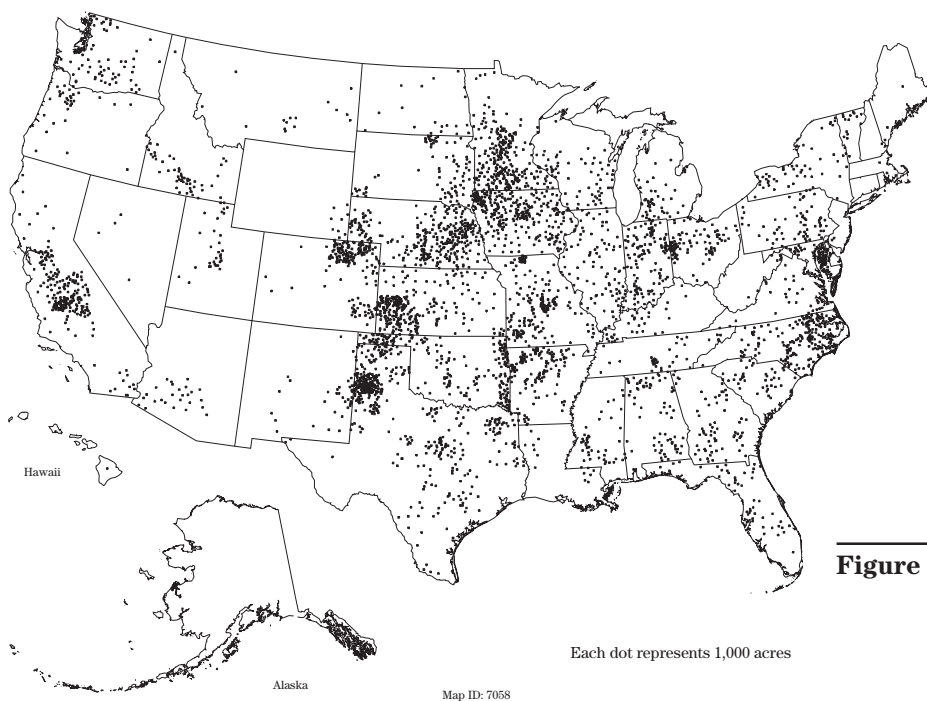
## Additional Acres Needed for Land Application of Manure

An essential element of CNMPs is managing the land application of manure nutrients based on a site-specific evaluation of potential risk of nutrient transport to surface waters. Through nutrient management planning, it is determined if manure nutrients may be applied at a nitrogen rate (provides phosphorus in excess of crop needs), a phosphorus rate (provides phosphorus at or below crop needs depending on the amount of phosphorus in the soil), or if manure application should be avoided.

CNMP implementation will result in the need for additional acres to land apply manure nutrients. An additional 7.6 million acres on livestock operations are expected to have manure applied after CNMPs are fully implemented (figure 13) and an additional 4.0 million acres will be needed on non-livestock operations receiving manure (figure 14). The total number of additional acres expected to have manure applied as a result of implementing CNMPs on 257,201 livestock operations is therefore about 11.6 million acres.



**Figure 13** Additional onfarm acres required to meet CNMP application criteria (7.6 million acres)



**Figure 14** Additional off-farm acres required to meet CNMP application criteria (4.0 million acres)



### Limits to Land Application of Manure

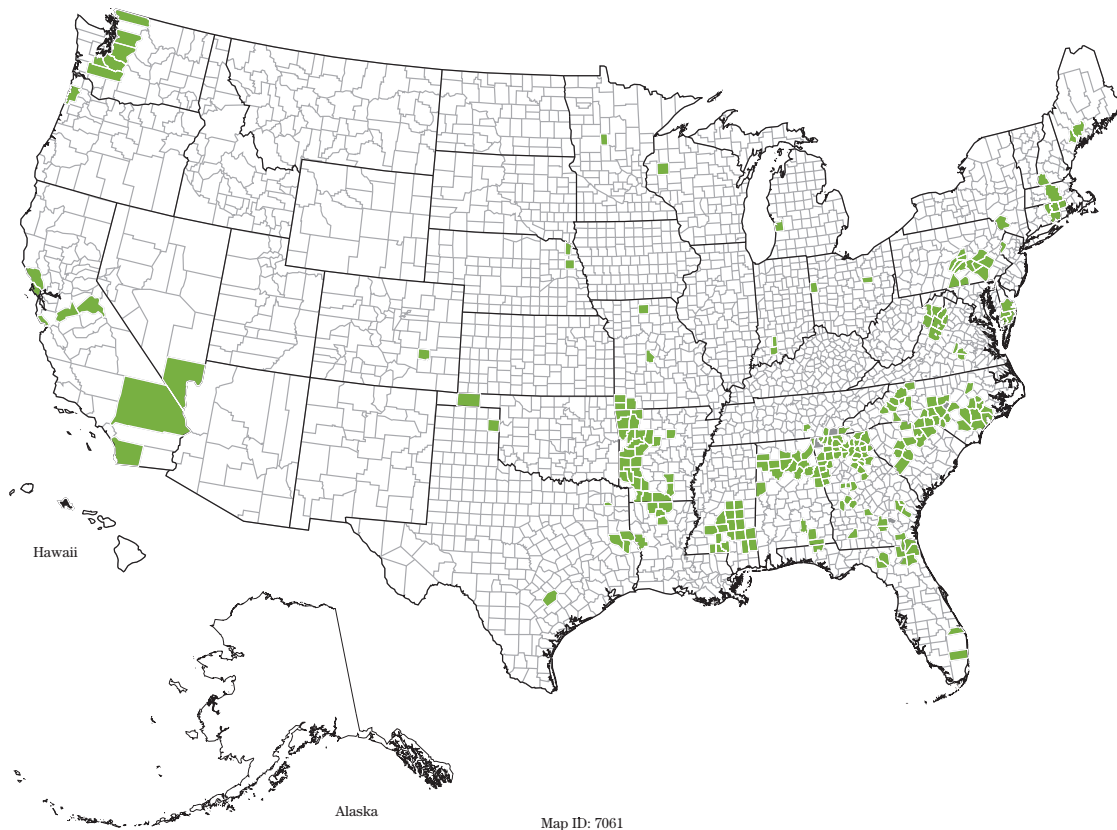
The model simulation shows that not all of the manure produced can be land applied after CNMPs are fully implemented. About 3 billion pounds of recoverable manure nitrogen and about 1.4 billion pounds of recoverable manure phosphorus will be produced by the 257,201 livestock operations that are expected to need a CNMP. Of this, approximately 35 percent will be applied onfarm on livestock operations and 49 percent will be exported for land application on non-livestock operations, leaving about 16 percent that cannot be land applied. One of the assumptions of land availability used in the model simulation is that manure would not be transported out of the county in which it was produced. This excess manure is thus called “county-level excess manure.”

Most counties have sufficient acreage for off-farm land application of the manure produced in those counties, and therefore do not have any county-level excess manure after CNMPs are fully implemented.

However, there are 248 counties where the production of manure nutrients will exceed the capacity of the cropland and pastureland in those counties to assimilate the manure nutrients when applied at rates that meet nutrient management criteria (figure 15). Complicating the management of these nutrient excesses is that most of these counties are co-located, reducing the opportunity to transport the manure to surrounding counties for land application.

The costs of exporting county-level excess manure off the farm are included in the cost assessment, but other costs associated with disposal and use of county-level excess manure were not addressed. These costs will be addressed in Part II, which will assess the costs associated with alternatives to land application and implementation of other strategies, such as feed management, that can reduce the amount of excess manure nutrients.

**Figure 15** Counties with excess manure after CNMPs are implemented (248 counties)



## Concluding Remarks

The costs presented in this assessment reflect the upgrades needed to bring existing operations up to a level of environmental performance characterized by a CNMP. Presently, CNMPs primarily address water quality concerns. Thus, cost could be affected as practices and treatments to address emerging environmental concerns—such as air quality, pathogens, and use of growth hormones and pharmaceuticals—are woven into CNMPs.

There are aspects of the simulation that limit the accuracy of the estimates presented or affect how these estimates can be used appropriately, including:

- **Uncertainty regarding input data and assumptions.** The simulation model is a mix of census, survey, and statistical data with further benefit of expert judgment and modeling assumptions. The resulting cost estimates for specific operations are therefore inexact. The expectation is that underestimates of CNMP costs for specific operations will balance against over-estimates for other operations, and that the final result will be a reasonable cost estimate at the national and regional level.
- **Changes in the livestock sector.** These cost estimates represent costs associated with the assemblage of farms and ranches as of December 31, 1997. No adjustment was made for continuing trends of concentration and consolidation; thus actual costs are expected to differ somewhat from the estimated costs presented here.
- **State and local regulations.** States continue to move forward in addressing their specific AFO concerns. Many have already implemented legislation calling for AFOs to adopt nutrient management. It was not possible to factor the ongoing adoption rate into this assessment; hence, some CNMP costs may have already been borne by some livestock operations.
- **Inflation and potential cost offsets.** Costs represented do not reflect inflation over the 10-year implementation period or any potential cost offsets that producers might receive. Cost offsets could include reductions in commercial fertilizer purchases, benefits from improved efficiencies attained by CNMP implementation, improved yields resulting from enhanced soil quality and better management of nutrients, and government cost-share or incentive payments.

### **CNMP development and implementation costs are not estimates of the costs to producers of complying with EPA regulations**

The largest livestock operations and operations that may pose a risk to the environment because of location are regulated by the U.S. Environmental Protection Agency. Under the National Pollutant Discharge Elimination System (NPDES), Concentrated Animal Feeding Operations (CAFOs) are required to have permits to ensure that the operation of the facility does not threaten water quality. In December 2002, EPA announced revisions to the CAFO rule. Under the new rule all large CAFOs will be required to apply for a permit, submit an annual report, and develop and follow a plan for handling manure and wastewater. EPA estimates that the CAFO rule will affect about 15,500 operations nationwide.

It was **not** the purpose of this publication to estimate the costs to livestock operations of complying with EPA regulations, but rather to estimate the costs for the development and implementation of CNMPs on all operations expected to need CNMPs (257,201 operations). The costs associated with regulation may be more or less than the costs of developing and implementing a CNMP, depending on the specific location and characteristics of the facility.