Chapter 8: Ammonia Emissions From Animal Husbandry

LESSON GOAL

Demonstrate, through successful completion of the chapter review exercises, a general understanding of the issues associated with estimating ammonia emissions from animal husbandry operations and some of the efforts that are being undertaken to address these issues.

STUDENT OBJECTIVES

When you have mastered the material in this chapter, you should be able to:

1. Explain the problems that have been identified with the ammonia emission estimates in the NEI.

2. Explain the six-step process for improving the ammonia emissions estimates from animal husbandry operations.

3. Explain the concept of manure management trains.

4. Identify the improvements that are being made to the NEI for the animal husbandry category.

5. Explain the differences between the 1999 NEI and the 2002 NEI with respect to ammonia emissions from animal husbandry operations.

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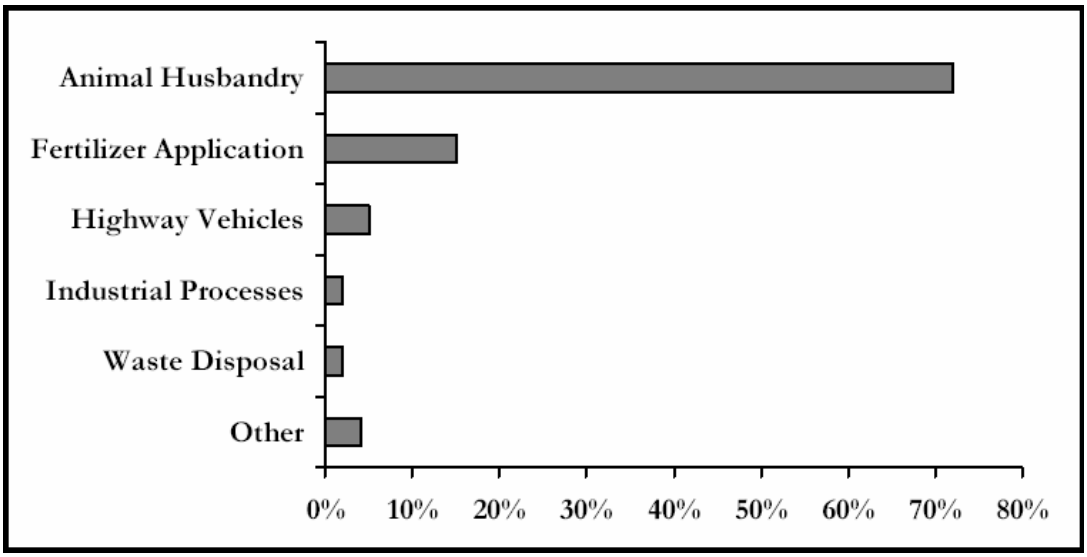
8.1 OVERVIEW

Almost 5 million tons a year of ammonia are emitted nationally and as shown in Figure 8-1 animal husbandry is the largest contributor to ammonia emissions nationally.

Figure 8-1. NH_3 – Precursor to Ammonium Sulfate and Nitrate



In addition to being the largest contributor to ammonia emissions nationally, it is important to address ammonia emissions from animal husbandry because inverse modeling suggests that ammonia emissions may be overestimated. Inverse modeling involves doing a complete chemical transformation and transport modeling of an area and accounting for all of the ammonia through transformation and deposition processes. Comparing these results to the ammonia that has been found in the ambient air indicates that ammonia may be overestimated nationally. The interim improvements described in Section 8.2 below address many of these shortcomings.

Additionally, problems with the old NEI have been identified. For example, there are probable errors in the emission factor selections, especially for beef. Also, the NEI does not use information on variability of emissions due to different manure handling practices within a given animal industry, nor does it make total use of the National Agricultural Statistic Service (NASS) data on different animal populations by weight. The NEI also does not take

temperature into account, which would greatly increase the temporal variation in ammonia emissions.

Moreover, EPA's water emission effluent guidelines project has provided some new information on animal production and waste handling practices. Also, the National Academy of Sciences, at the behest of the agricultural community, has reviewed EPA's inventory work, and recommended a long-term data-gathering effort.

8.2 IMPROVING THE NEI

EPA has recently prepared a report that provides a basis for making interim improvements to the NEI. It provides improved data on populations, practices, and emissions. It is the beginning of a switch-over to a process-based framework that is a consistent and transparent way of estimating emissions that would allow for partial updating as better data becomes available. This technique provides a lot of motivation and a structure for making data-collection improvements. It also provides an opportunity to educate users about the data limitations and the proper use of the data. The goal is for the higher animal production states to begin to adopt and offer improvements to the NEI using this new method.

Table 8-1 lists the six steps that comprise this new methodology for estimating ammonia emissions from animal husbandry operations. Each of these six steps is addressed in detail in the following paragraphs.

Table 8-1. Overview of New Estimation Methodology

Step 1	Estimate Animal Populations
Step 2	Identify Manure Management Trains (MMT)
Step 3	Estimate Amount of Nitrogen Excreted
Step 4	Identify Emission Factors
Step 5	Estimate Ammonia Emissions
Step 6	Estimate Future Ammonia Emissions

Step 1

The first step in this process is estimating average animal populations by animal group, state, and county. This step uses the 2002 NASS data for state-level populations, and the 1997 census of agricultural to apportion the state-level NASS data to the county level. However, there are some privacy issues with regard to animal populations. For example, a county with only one large

facility would create an industrial privacy issue since that facility will not want their competition to know how many animals they are raising.

Step 2

The second step is using Manure Management Trains (MMT) for each animal group to estimate the distribution of the animal population. Fifteen manure management trains have been identified. Figure 8-2 shows an advanced manure management train, one of several such trains for the dairy industry. This manure management train begins with the amount of nitrogen excreted by dairy cows. The train traces the manure through the different handling options and shows how much is handled in different ways. The train also shows the nitrogen and ammonia emissions at the various handling points. For example, there is nitrogen loss in the flush barn and the lagoon, and ammonia loss in the dry lot. There are other trains that provide similar information for other farm industries. These trains characterize a type of industry, and the general way that manure would be handled in a facility.

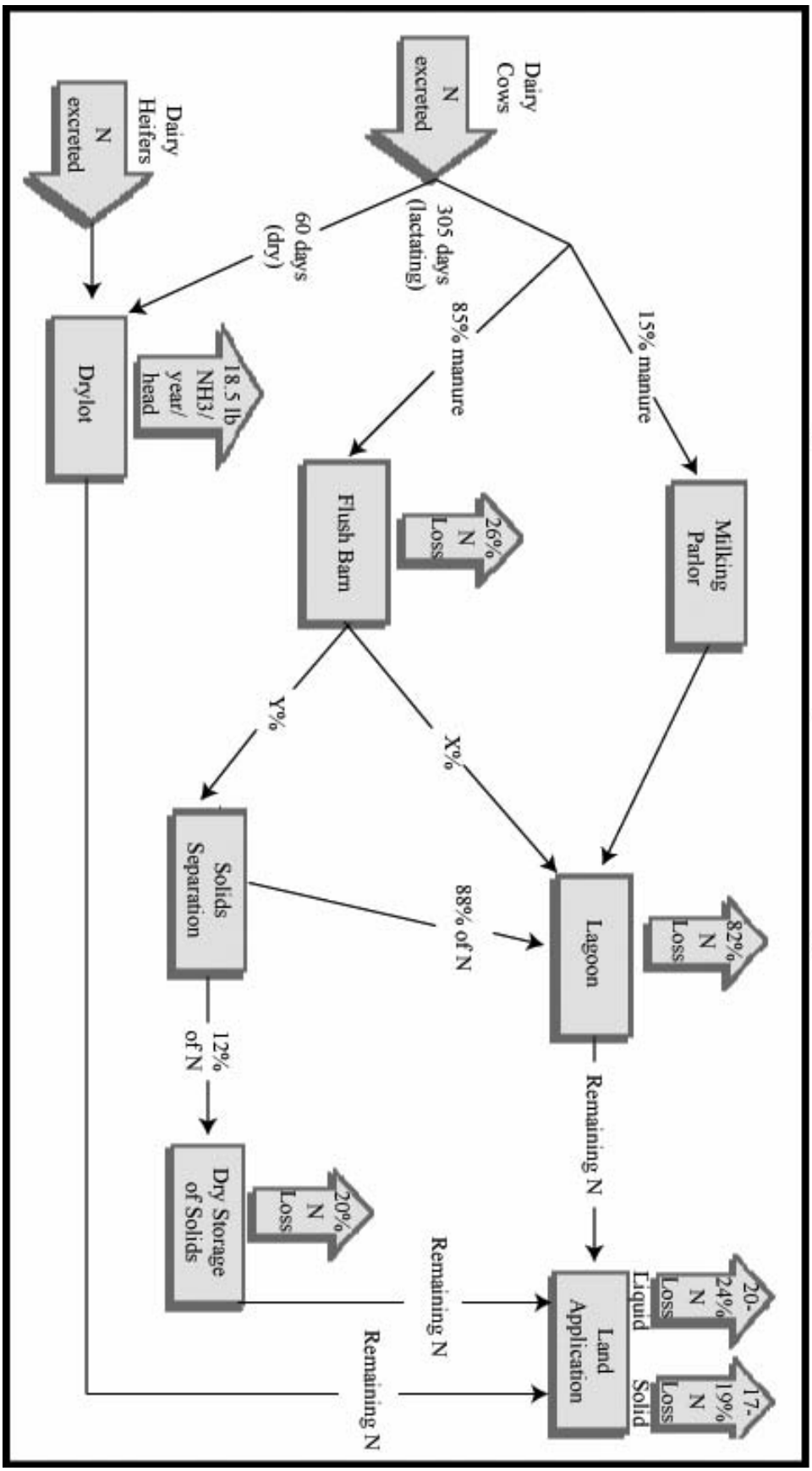


Figure 8-2. NH3 - Example Manure Management Train

Some of the variables that affect the different trains include the way the animals are housed, the waste storage methods, and the land application methods that are used. For example, the non-feedlot outdoor confinement (e.g., pasture) is one of the trains for swine, dairy, and beef. The MMTs represent different pathways for the escape of ammonia into the air. In applying the MMT approach to estimate the 2002 ammonia inventory, the mix of MMTs is assumed to vary by state, but not within a state. Animal population is allocated among the applicable trains. For example, in a given state 20% of the hogs may be handled using manure management train 3, another 60% may be using manure management train 7, and the rest of them may be using manure management train 14. Finally, it should be noted that the final stage on every train is land application.

Step 3

The third step is estimating the amount of nitrogen excreted from the animals using each type of MMT. This step involves looking at typical animal weights and data on the amount of nitrogen per thousand kilos of live weight. The data on the nitrogen amounts can be obtained from NRCS *Agricultural Waste Management Field Handbook*. Another useful source of information is land grant university researchers and local agricultural extension agents. It is important to include experts in the agricultural industry in the inventory development efforts.

Step 4

Step four involves identifying or developing the emission factors for each component of each manure management train. Some of these factors are in pounds per animal, and some are percent air release of the input ammonia. These factors are used to determine the amount of ammonia that goes to the next stage of the manure train process. Under this approach, the air emissions could never be higher than the original manure content. Also, using this approach sets the stage for applying temporal profiles and process-related variables such as moisture and rainfall.

Step 5

The next step involves applying this methodology to estimate annual ammonia emissions from each animal group by MMT. This includes tracking the ammonia release through each manure management train for each animal type for each county and calculating ammonia releases to the air and transfers to the next stage. This whole process assumes no air emission controls at this time, but control assumptions could be added later. Emissions are summed up to animal type and county, but the database is preserved with full detail for transparency so that changes and improvements can be made.

Step 6

The last step involves estimating ammonia emissions for future years.

Other improvements that are being made to the NEI for animal husbandry operations are to incorporate emission estimates for sheep, ducks, goats, and horses. Additional data sources are being examined to provide recently available data on manure production and excretion rates by animal type and weight. Finally, EPA is examining ways to better address special, seasonal, and regional differences in emissions.

Carnegie Mellon University has prepared a model for estimating ammonia emissions from agricultural activities, humans, wastewater treatment, wildfires, domestic and wild animals, transportation sources, industrial activities, and soils. The Carnegie Mellon model includes an improved methodology for fertilizer application when compared to the methodology used in previous versions of the NEI. EPA is evaluating the methodologies used for other source categories in the Carnegie Mellon model.

8.3 COMPARISON OF THE 1999 AND 2002 AMMONIA NEIs

A comparison of the 1999 NEI version 3 with the 2002 NEI version 1 shows that there are some significant differences in the ammonia emissions (See Table 8-2). As shown on this chart, about half of the emissions from all animals come from calves and cattle. Also, total ammonia emissions from animal husbandry operations decreased significantly from 3.4 million in 1999 to 2.3 million in 2002.

Table 8-2. NH_3 – Comparison of '99 and '02 NEIs

Animal Group	1999 NEI			2002 NEI		
	Population	**Emission Factor lb/head/yr**	**Emissions Tons/year**	**Population**	**Emission Factor lb/head/yr**	**Emissions Tons/year**
Cattle and Calves Composite	100,126,106	50.5	2,476,333	100,939,728	23.90	1,205,493
Hogs and Pigs Composite	63,095,955	20.3	640,100	59,987,850	14.32	429,468
Poultry and Chickens Composite	1,754,482,225	0.394	345,325	2,201,945,253	0.60	664,238
TOTAL	1,917,704,286	N/A	**3,461,758**	2,362,863,831	N/A	**2,299,199**

Review Exercises

1. Which of the following statements about ammonia emissions from animal husbandry operations is false?
   a. Animal husbandry operations are the largest emitter of ammonia nationally.
   b. Inverse modeling suggests that ammonia emissions may be underestimated.
   c. There are probable errors in some of the ammonia emission factors in the NEI.
   d. The NEI does not take temperature into account in estimating ammonia emissions.

2. The _____ characterize(s) the general way manure is handled by a specific facility.
   a. NASS data
   b. NEI
   c. MMT
   d. All of the above3. Improvements are being made to the NEI to account for ammonia emissions from _____.
   a. sheep
   b. ducks
   c. goats
   d. All of the above

4. Which type of livestock emits the most ammonia on a per animal basis?
   a. cattle
   b. pigs
   c. poultry
   d. horses

5. Which type of livestock emits the most ammonia on a yearly basis?
   a. cattle
   b. pigs
   c. poultry
   d. horses

Review Answers

1. b. Inverse modeling suggests that ammonia emissions may be underestimated.

2. c. MMT

3 d. All of the above

4 a. cattle

5 a. cattle

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