

How much ammonia do dairy farms emit?

by C. Alan Rotz

DAIRY farms, along with other animal feeding operations, are being asked to consider a consent agreement with the U.S. Environmental Protection Agency (EPA) to fund research into whether or not air pollution laws apply to farms. For dairy operations, the major pollutant of concern is ammonia. As described in the March 25 issue of *Hoard's Dairyman* (page 218), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Emergency Planning and Community Right-To-Know Act (EPCRA) require anyone to immediately notify the National Response Center and other emergency planners if more than 100 pounds of ammonia have been released within any 24-hour period. There are large penalties for failure to comply with these laws.

Do dairy farms emit ammonia?

Yes, our dairy farms do emit ammonia. The difficult question to answer though is how much do they emit. Because of the expense and difficulty in making reliable measurements, few actual farm measurements have been made.

Since this is the case, our only other options are process-based models developed from sound science. Real data is being used to calibrate these models for some specific conditions. These general models can then be used to estimate emissions from farms of different sizes and management approaches. As more data becomes available, these estimates will become more accurate.

Although ammonia is also released following manure application to the field and during grazing, EPA's primary concern at this time is ammonia coming from barns, manure storages, and open feedlots. Their current focus is also on maximum daily emissions rather than long-term average emissions.

Ammonia forms from the nitrogen in manure. It becomes a problem when it volatilizes from manure surfaces and moves into the atmosphere where it can be carried for great distances. The ammonia emission rate varies considerably throughout the day and throughout the year. There are several major factors influencing the formation and release of ammonia including temperature, the manure surface area, manure pH, and the manure moisture content.

How much protein your cows are fed and how efficiently they utilize that protein also affects both the amount of nitrogen excreted and the portion of the nitrogen that is urinary. Urinary nitrogen is more readily transformed to ammonia. How manure is handled such as scraping frequency or the use of flushing may have some effect on emission rate, but this effect appears to be small.

Of all these factors, temperature often has the greatest influence. Ammonia emissions are very low when

the air temperature is near freezing. However, emissions increase rapidly as it gets warmer. On a hot summer day, up to half of the nitrogen excreted in manure (primarily that in urine) can be volatilized and lost from the barn as ammonia.

By confining manure to smaller areas such as gutters, and reducing the surface area that is directly exposed to the sun, ammonia emissions can be reduced. Of course, daily hauling and field application can eliminate the loss from manure storage. Technologies such as low emission barn floors and covered manure storages are being developed which may provide future benefits.

How much do our farms emit?

Ammonia emission levels vary considerably among farms due to differences in barn design, manure handling practices, and other feeding and management strategies. The table below lists estimates of typical maximum daily emissions that can be expected from different types of dairies across the northern U.S. In the warmer climate of the southern U.S., average emission levels are greater. However, maximum daily emission rates are not much more than that experienced in the north.

Highest expected daily ammonia emissions*		
Farm type	Emission rate lbs./cow/day	Herd size Cows
Confinement farms		
Tie stall barn with daily hauling	0.40	250
Free stall barn with daily hauling	0.58	170
Free stall barn with bottom-loaded storage tank	0.82	120
Free stall barn with top-loaded manure pit	1.00	100
Open feedlot	0.92	110
Grazing farms		
Tie stall barn with daily haul	0.18	550
Free stall barn with bottom-loaded storage tank	0.45	220

*Maximum number of cows for emitting less than 100 pounds of ammonia per day.

For a free stall barn with a top-loaded manure pit, the emission rate on a hot summer day may be about 1 pound per cow per day. By using a bottom-loaded slurry tank where a crust forms on the surface, this maximum emission can be reduced 20 percent. Eliminating the manure storage through daily hauling can reduce this emission an additional 30 percent. Compared to a free stall barn, a tie stall barn with daily hauling can also reduce this maximum emission rate by about 30 percent.

Use of grazing can also greatly reduce the maximum ammonia emission. Since grazing animals are outside during the warmest part of the year, the maximum emission from the barn occurs under cooler weather. Therefore, the use of grazing reduces the maximum emission by about 50 percent.

Open feedlots are considered to be an ammonia source along with barns and manure storages. Daily ammonia emissions from feedlots can be high, near 1 pound per cow.

What farms might be regulated?

Based upon these emission rates, we can estimate farm sizes that could emit over 100 pounds of ammonia during any day of the year.


The table shows approximate sizes for farms using typical feeding and manure handling practices. These estimated farm sizes can vary by 20 percent or more due to management differences from farm to farm.

For a free stall barn with a top-loaded manure storage, farms with as few as 100 cows could fall under regulation. For farms using either an open feedlot or a free stall barn and bottom-loaded slurry storage, the size limit is just a little greater.

Since most tie stall barns in use today are on relatively small farms, this type of farm would normally not be a concern. Grazing farms would not be either unless herd size is over 200 cows and animals are confined in a barn for a major portion of the year.

All of our estimates include the raising of replacement heifers on the farm. If heifers are purchased or raised on a separate farm, the emission rates listed can be reduced by 35 percent, and the herd size increased by this amount.

We need more actual farm measurements of ammonia emissions to accurately determine ammonia emissions from dairy farms. As we learn more, our models will be refined, and these estimated emission rates and farm sizes may change. Permitted emission levels may also change.

Based upon what we know, the values reported here provide an estimate of farms and show which farms may be affected by CERCLA and EPCRA regulations. As farm sizes continue to grow, major technological changes appear to be needed to reduce ammonia formation and emission from our dairies. 

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