Impacts on Michigan Communities of Air Emissions from Livestock and Poultry Farms

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Potential health impacts of livestock and poultry farms on nearby residents is an issue that livestock and poultry industries have faced nationally, though the topic is dealt with primarily at the local level.

University of Iowa and Iowa State University joint report

The topic prompted the formation of a study group in Iowa to answer questions related to air emissions from animal feeding operations (AFOs) and health impacts on nearby residents. In February 2002, the University of Iowa and Iowa State University (UI/ISU) released a report that addressed concerns of Iowans by responding to the following four pertinent questions (Merchant and Ross, 2002).

1) *Do peer-reviewed, duplicated, legitimate, published scientific research show any direct evidence of harm to humans by emissions, byproducts, toxic waste or infectious agents produced by confined feeding operations?*

Studies conducted with AFO workers document declines in lung function, likely the result of exposures to complex mixtures of dust and gases within the AFO. Similar studies with residents near AFOs do not exist where physiological and air quality measures are available within the same study to demonstrate a relationship between the two factors.

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2) *What human research is there to confirm the existence of disease, and exactly what are the specific chemical, bacteria or aromatic causes of such diseases?*

No specific diseases were identified. However, the UI/ISU committee reported that a limited number of self-reported survey studies (i.e., participants completed a questionnaire) reported impacts that were consistent with health effects that result from exposure to gases and compounds known to be present in AFOs.

3) *On the basis of an analysis of peer-reviewed, duplicated, legitimate, published scientific research, what specific substances, including aromatic compounds, do you believe require regulatory action to protect the public?*

The study committee recommended that hydrogen sulfide and ammonia standards be established because of the association of these gases with livestock production and established health impacts resulting from exposure to these gases. Under specific exposure conditions, both ammonia and hydrogen sulfide do have respiratory health impacts. The Agency for Toxic Substances Disease Registry (ATSDR), a non-regulatory federal agency, had conducted previous studies and determined that deleterious health impacts occurred in humans exposed to these gases under certain conditions. The exposure conditions are a combination of exposure duration and exposure concentration clearly defined by the ATSDR.

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4) *On the basis of an analysis of peer-reviewed, duplicated, legitimate, published scientific research, what would you recommend as Iowa or national consensus standards for any proposed substances to be regulated as emissions from confined feeding operations?*

The ATSDR reports health effect values (HEV) with respect to long-term exposures (more than 365 consecutive days with continuous exposure), intermediate (15 to 365 days) or acute exposures (1 to 14 days). The UI/ISU committee proposed that a standard reflect both acute and chronic exposure conditions outlined by the ATSDR by proposing standards with measurement at the property line for acute exposures and at the residence for chronic exposures. Property line standards of 70 parts per billion (ppb) hydrogen sulfide and 500 ppb ammonia were proposed; standards of 15 ppb and 150 ppb at the residence were proposed (chronic exposures). The assumption was made that both compounds would be present at the residence, so the proposed value for each was half the value established by the ATSDR. The committee recommended that operators be allowed to exceed the concentrations seven times per year and that each measure represent the average reading over a one-hour period with observations made at least 24 hours apart.

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The committee made recommendations for hydrogen sulfide and ammonia but was divided on making a recommendation for odor. Some of the committee members felt that a recommendation could be made based on what other states had in place. The balance of the members felt that no data were available linking odor concentration to health impacts on which to base a recommendation.

As a result of this report, Iowa has implemented a hydrogen sulfide standard of 30 ppb, measured at the separated distance. An operation is out of compliance with the standard if the one-hour time-weighted average exceeds 300 ppb more than seven times in 365 days. In addition, the Iowa Department of Natural Resources conducted a monitoring study to look at setback distance hydrogen sulfide concentrations. Their findings suggest that few, if any, of the monitored sites would have exceeded the state standard.

The answers to the four questions represent the best information available at present. A more recent series of reports concur with the findings reported in the UI/ISU study (Gilchrist et al., 2007; Heederik et al., 2007).

Survey studies

Concern over the impact of AFO emissions on nearby residents is increasing, but little information exists to support the idea that risks exist. Much of the data available from residents came from surveys in which the residents self-report their status. This makes it difficult to consider the data completely objective. Furthermore, though survey studies can lead one to believe that there may be cause for concern, the surveys have not simultaneously included quantitative air quality measurements (odor or specific gases) in those communities, so it is impossible to relate any health impacts to specific exposure conditions. For this reason, much of the premise that people living near AFOs experience health impacts is based on studies conducted with workers in AFO facilities.

Endotoxin

Endotoxin is the pollutant most likely to have health impacts in communities. Endotoxin is a component of some bacteria that can lead to inflammation of the respiratory tract even at very low concentrations. Endotoxin concentrations are high in livestock facilities but also are high in homes with pets (Heederik et al., 2007). Ammonia concentrations inside homes may be high, also, because of cigarette smoke, cleaning agents and cat litter boxes. Data are lacking to quantify downwind movement of endotoxin from livestock facilities. However, what research is available suggests that this pollutant, rather than specific gases or odor, may be the most significant in respect to community health. The UI/ISU committee acknowledged this in its response but did not make a standard recommendation for endotoxin because of the lack of exposure studies.

Worker exposure studies

Studies conducted with employees of AFOs suggest increased risk for asthma, believed to be due to dust and endotoxin exposures. Endotoxin is a component of bacteria present in air (bioaerosol). Some studies suggest that agricultural workers take more sick days than those in other industries, suggesting health impacts as a result of exposure to agricultural workplaces. More studies have been conducted with workers than with neighbors, and making the connection between the two groups remains problematic. Workers in AFOs are viewed as a "less susceptible population" because they would self-select themselves out of an environment where they could not function normally. The general public, on the contrary, includes higher risk populations such as children and the elderly. These groups are less tolerant than the worker group, necessitating more stringent standards to protect their health. For this reason, eight-hour worker exposure standards are often higher than standards for long-term exposure conditions (constant exposure; under constant exposure one can tolerate a lower concentration than can be tolerated for a short-term exposure).

Odor composition and impacts

More than 200 compounds make up odor from AFOs. These compounds include gases that have the potential to move downwind. Nuisance odor is the primary driver behind complaints from neighbors. In general, very little is known about which compounds are the largest contributors to odor and therefore are the most important to control. There is no established relationship between odor and health impacts. Hydrogen sulfide and ammonia are certainly components of odor (odorants), but studies demonstrate that these two compounds correlate poorly with odor itself.

Self-reporting studies conducted with AFO neighbors suggest that odor contributes to depression, headache and nausea, but in these survey studies odor measurements were not made when the symptoms occurred, and the objectivity of the surveys has been questioned. Symptoms may be related to the stress of being upset by the fact that a nearby AFO exists as much as by physical effects of proximity.

Exposure models

At present, a national study is underway, joint between the EPA and industry, to establish baseline emissions from AFOs (EPA Air Consent Agreement). In addition, efforts are under way in various places around the country to establish community exposures to gases, dust and bioaerosols. Ideally, studies would include measured gas concentrations at the AFO and in the community, coupled with wind, weather and topographical data, and detailed management practice information. From these data, models can be developed to better understand how far pollutants travel under certain weather conditions and how best to protect both communities and workers.

Conclusions

- Specific exposure condition recommendations are available for many compounds, including some that result from AFOs.
- Limited studies that have monitored concentrations of gases in areas near AFOs suggest that these gases may not occur long enough or often enough to exceed recommended exposures.
- No data exist that document health effects as a result of quantified odor exposure.
- Exposures that have received little attention to date may have a greater impact on human health than odor or specific gases.

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