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March 27, 2014

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Disclaimer: The opinions expressed herein are our own and do not necessarily reflect the views of The Johns Hopkins University.

Re: Manure from intensive livestock operations: health and environmental concerns

To whom it may concern:

We are researchers at The Johns Hopkins Center for a Livable Future, based at the Bloomberg School of Public Health. The Center engages in research, policy analysis, education, advocacy, and other activities guided by an ecologic perspective that diet, food production, the environment, and public health are interwoven elements of a single complex system. We recognize the fundamental importance of food animal production in these issues as they relate to the U.S. food system.

We are writing to present some of the concerns associated with the generation and management of manure from intensive livestock operations, particularly regarding the health of Wisconsin's rural citizens. These health and environmental concerns include:

- The spread of infectious disease, including antibiotic-resistant bacteria, to nearby communities.

- Groundwater and surface water pollution, and associated health and ecological impacts.

- Air pollution, odors, and associated health and social impacts.

These are detailed below, with supporting evidence from the peer-reviewed scientific literature.

Background

According to the 2007 Census of Agriculture, Wisconsin is the second leading dairy-producing state in the country. The state is home to over 1.2 million milk cows, with an inventory of close to 3.4 million cattle and calves—the 9th largest in the nation. Wisconsin is also a significant contributor to U.S. pork, poultry and egg production (1,2).

Over half of Wisconsin's cattle and calves are on farms with reported inventories of over 200 head, and 27 percent are on farms with over 500 head (1). With regards to health and environmental concerns, it is critical to consider inventory size alongside other important factors such as feed inputs, stocking density, and the amount of available cropland for spreading manure.

Producing large numbers of animals over a relatively small land area presents the challenge of managing the quantities of manure they generate. A 1400 pound lactating cow, for example, produces an estimated 148 lbs of waste daily (3). Humans, by comparison, produce 2.5 lbs daily. An intensive dairy operation with several hundred animals, by extension, may produce as much excrement as a small city, concentrated over a tiny fraction of the land area and without the benefit of a wastewater treatment plant to eliminate biological and chemical contaminants. In large part because of these challenges, intensive livestock operations have emerged as a major source of pollution to ground and surface waters (4–9).

Any farmer can attest to the value of manure as a source of nutrients and organic matter for their soil. The quantity of manure generated at intensive operations, however, frequently exceeds the amount that can be utilized by surrounding cropland, and transporting manure further may not be economically feasible (10–12). When manure is over-applied, the excess—along with chemical (13–17) and microbial (4,18,19) contaminants associated with it—may be transported by runoff into surface waters and/or leach into groundwater. Results from a 2005 study, for example, suggest 71 percent of Wisconsin dairy farms generate manure in amounts that exceed the nutrient requirements of the cropland on which manure is applied (20). The potential health and ecological effects associated with these scenarios are detailed below.

Spread of infectious disease to nearby communities

Crowded conditions in intensive livestock operations present frequent opportunities for the transmission of viral and bacterial pathogens among animals, and between animals and humans. Many of these pathogens live in the digestive tracts of animals and may be passed in their waste (4,18,19).

The disease risks stemming from intensive livestock production are heightened by the potential for infection with antibiotic-resistant bacteria. The use of low doses of antibiotic drugs as a means to promote growth (often also called "disease prevention") in animals has become commonplace—an estimated 80 percent of antibiotics sold for human and animal uses in the U.S. are sold for use in food-producing animals (21). Administering antibiotics to animals at doses too low to treat disease fosters the proliferation of antibiotic-resistant pathogens, which can cause infections in humans. When a person is infected with antibiotic-resistant bacteria, these infections can be more difficult and expensive to treat (22).

A growing body of evidence points to the potential pathways by which pathogens (antibiotic-resistant or otherwise) might spread from intensive livestock operations into communities. Studies suggest, for example, that antibiotic-resistant pathogens may be transmitted by workers into their homes and communities (23,24), conveyed by runoff into ground and surface waters (19), blown out of ventilation systems (25–27), and spread to consumers via contaminated meat (28,29). Pathogens may also be transported by flies (30), wild birds (31,32), and animal transport vehicles (33). Further evidence for these pathways is documented in a 2013 study in which living closer to swine operations—and to fields where manure is spread—was significantly associated with elevated rates of infection with methicillin-resistant *Staphylococcus aureus* (MRSA), an antibiotic-resistant pathogen that can be challenging and expensive to treat (34). A similar study found similar associations between proximity to a swine operation and colonization with MRSA (35).

Health and ecological impacts of ground and surface water pollution

Manure from intensive livestock operations may introduce a range of waterborne contaminants into ground and/or surface waters, including nitrates (7,8), microbial pathogens (4,19,34), veterinary pharmaceuticals(14–18,36) and natural and synthetic hormones (37,38). Communities living downstream from these operations may be exposed to these agents via drinking or having skin contact with contaminated ground or surface waters.

Exposure to these waterborne contaminants can result in adverse health effects. Ingesting high levels of nitrate (naturally occurring in manure), for example, has been associated with increased risks for thyroid conditions (39,40), birth defects and other reproductive problems (39,41), diabetes (39), various cancers (39,42), and methemoglobinemia (blue baby syndrome), a potentially fatal condition among infants (43).

The risks of exposure to waterborne contaminants are particularly salient for the 70 percent of Wisconsin's population who depend on groundwater for their drinking water supply—the state ranks fourth in the nation for the percentage of households on private wells (44). Adding to these concerns, much of southern and eastern Wisconsin has karst geology—a feature that can readily channel surface contaminants into groundwater sources (45). Private wells are not subject to federal drinking water regulations, and while some states have minimal requirements for private wells, state-level action is usually only triggered during property transfer and rarely requires periodic monitoring of water quality (46). Further, most water treatment systems for private wells are designed to deal with heavy metals and other more common drinking water contaminants, and are not suited for removal of drug residues and hormonally-active compounds.

Nutrient runoff into surface waters may also have consequences for marine ecosystems and the people who depend on them for recreation and economic activity. Intensive livestock operations are a major source of nutrient runoff (6,7,47), contributing to algal blooms and subsequent hypoxic "dead zones" that may result from algal decomposition. Aquatic regions exposed to long periods of hypoxia often see dramatic reductions in fisheries, among other health, ecological, and economic harms (48). Nutrient runoff has also been implicated in the growth of harmful algal blooms (49), which may pose health risks for people who swim or fish in recreational waters, or who consume contaminated seafood. Exposure to algal toxins has been linked to neurological impairments, liver damage, stomach illness, skin lesions, and other adverse health effects (50).

In more severe cases, manure storage facilities may rupture, leak, or overflow during extreme weather events, releasing their contents into surrounding waterways. For example, in 1995 a large swine waste holding lagoon in North Carolina ruptured due to faulty management. Close to 26 million gallons of manure emptied onto fields and lawns of adjacent homes before draining into a nearby river. The pollution load led to the proliferation of toxic algal blooms and widespread fish kills, and fecal bacteria were detected in river sediment at levels over 15,000 times higher than state standards (51).

Air pollution, odors, and associated health and social impacts

Intensive livestock operations release a range of airborne pollutants, including ammonia, hydrogen sulfide, and other gases emitted from animal waste; and airborne particulates, which may be comprised of dried feces, animal dander, fungal spores, and bacterial toxins (52). Results from a two-year air monitoring study, jointly sponsored by the U.S. Environmental Protection Agency and representatives of the pork, poultry, dairy and egg industries, suggest intensive livestock operations produce several of these pollutants at levels well above federal standards.(53)

Much of the research on the health effects associated with exposure to airborne pollutants from confinement operations has focused on workers. At least one in four workers in these operations are estimated to suffer from respiratory illness (54).

A growing body of evidence suggests residents living near intensive livestock operations may also be at greater risks of respiratory illness. Results from a study of industrial-scale dairy operations in Washington State, for example, suggest intensive dairy operations are a significant source of particulate matter among nearby rural communities (55). Another study detected high concentrations of particulate matter downwind from swine confinement operations, which was linked to wheezing, breathing difficulties, and eye, skin, and nasal irritation among residents of downwind communities (56). Indicators of air pollution from swine confinement operations have also been linked to asthma symptoms among students at nearby schools (57). Additional studies have illustrated relationships between proximity to intensive livestock operations and respiratory effects (58–61) among other adverse health outcomes.

Odors associated with air pollutants from intensive livestock operations have been known to interfere with daily activities, quality of life, social gatherings, and community cohesion (62,63). In addition to the stigma and social disruption they often generate, odors from swine confinement operations have been associated with physiological and psychological effects, including high blood pressure, depression, anxiety, and sleep disturbances (64–66).

Despite the above concerns, all but the largest livestock operations—those designated as "Large CAFOs" (concentrated animal feeding operations)—are required by federal law to report hazardous airborne emissions, and then only if the levels are above certain thresholds. Even in cases when operations report emissions, such information may not be available to the public. For these reasons, the relationships between intensive livestock operations, air quality, and the health of rural residents are poorly understood. These data gaps speak to the need for better methods of estimating emissions, including more stringent reporting requirements and air monitoring stations at intensive livestock operations and communities (67).

Conclusion

For thousands of years, manure has been valued by farmers for its roles in building soil quality and increasing crop yields. Producing livestock such that they generate more manure than can be utilized by nearby cropland is not only a waste of this important resource, it is also a public health and environmental problem. A growing body of evidence has implicated the generation and management of manure from intensive livestock operations in the spread of infectious disease (including antibiotic-resistant strains), the introduction of microbial and chemical contaminants into ground and surface waters, impacts to air quality, and the wide range of adverse health, social, ecological and economic outcomes that result from these events.

We hope our letter is helpful in describing some of the public health and environmental concerns associated with the generation and management of manure from intensive livestock operations. Please do not hesitate to contact us if you have any questions.

Sincerely,

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