Topical Session B: Human Health and Air and Water Quality

Air Quality Around Animal Feeding Operations

Jerry L. Hatfield[1], *Richard L. Pfeiffer*[2], *and John H. Prueger*[3]

Air quality has become one of the primary issues surrounding the development and operation of animal feeding operations. These concerns range from nuisance due to odor complaints to health associated with small-sized particulates (2.5 millimeters). However, there are many unknowns about air quality surrounding animal feeding operations. Some of these unknowns are: type and amount of gases and particulates that are emitted, effect of changing management systems on the emission and dispersion rates, effect of changing atmospheric conditions on the emission and dispersion rates, and effect of seasonal changes on the emission and dispersion characteristics.

We have been evaluating methods to measure air quality around animal feeding operations. These methods include those that trap the gases in a volume of air and those attached to particulates. These different constituents have been captured on organic absorbing materials and on foam plugs. The constituents captured on these media can be extracted and quantified on a gas chromatograph/mass spectrometer to identify the different volatile organic compounds emitted from buildings and manure-storage units. These techniques have been used to measure air quality around swine production units and have revealed that there are five major classes of compounds present in the air volume: acids, indoles, phenols, cresols, and disulfides. These compounds are in addition to ammonia, methane, nitrous oxide, and hydrogen sulfide. Dispersion characteristics of the atmosphere are the major determinants in changing concentrations downwind from the source. These determinants have also proven to be one of the major challenges in placing the sampling equipment in the plume in order to represent the proper conditions. Sampling of air has proven to be a critical part of the development of methods for quantifying air quality.

Air quality that emanates from buildings is different than from manure-storage units. Data were collected around lagoons in Iowa and Oklahoma to evaluate the changes in the microclimate and the emission rates of volatile organic compounds. The microclimate, air temperature, relative humidity, and windspeed were a function of the position around the lagoon and changed throughout the year. Short-term observations of the turbulent fluxes on the side and from the middle of a lagoon have been used to demonstrate how air patterns move across the lagoon and disperse the compounds emitted from the lagoon surface. These changes can have a major impact on the dispersion patterns around the lagoon. These data, coupled with the observations of volatile organic compounds, show that air quality is rapidly changing around livestock-production facilities. Unfortunately, there are no long-term observations of air quality in animal feeding operations that can be used to develop a baseline of emissions.

---

[1]U.S. Department of Agriculture-Agricultural Research Service, National Soil Tilth Laboratory, 2150 Pammel Drive, Ames, IA 50011-3120 (hatfield@nst1.gov)

[2]U.S. Department of Agriculture-Agricultural Research Service, National Soil Tilth Laboratory, 2150 Pammel Drive, Ames, IA 50011-3120 (pfeiffer@nst1.gov)

[3]U.S. Department of Agriculture-Agricultural Research Service, National Soil Tilth Laboratory, 2150 Pammel Drive, Ames, IA 50011-3120 (prueger@nst1.gov)

Environmental and Public-Health Risks Associated with Industrial Swine Production

Amy R. Chapin[1] *and Charlotte M. Boulind*[2]

Currently, the swine industry is moving further away from traditional methods of hog farming, adopting assembly-line methods of large-scale production where hog farms have metamorphosed into swine factories. In Oklahoma alone, the hog population has soared 761% from 1990 to 1998. Meanwhile, the number of hog operations nationwide has steadily declined from 3 million in the 1950s to 138,000 in 1998. Thus, instead of being spread out among family farmers, U.S. pork production is taking place in a concentrated fashion, creating numerous environmental health concerns. Odors, gases, and solid wastes emitted from these factories have drastically altered the quality of life in neighboring communities. In addition, occupational illnesses, such as asthma, bronchitis, toxic organic dust syndrome, hyperactive airway disease, and hydrogen sulfide intoxication have been reported.

This study investigated the environmental and public-health risks associated with industrial swine production. Literature searches and personal interviews were conducted to assess the issue. Findings revealed that the effects of these swine factories are far reaching. Besides the odor and gases, nearby residents have to cope with an increasing number of flies, rats, and other scavenging animals. Improperly managed manure wastes and pre-slaughterhouse carcasses also threaten the water quality in "hog communities." Moreover, the close proximity of humans to these facilities raises concerns that certain infectious diseases may cross over from hogs to humans. In addition, there is new evidence that the necessary use of antibiotics in industrial swine production could be contributing to the increase of antibiotic resistance in human pathogens.

Oftentimes, rural public health issues are overlooked. Meanwhile, the rate at which livestock production is shifting into an industrial process, regardless of the environmental, social, and public health consequences, is alarming. This study sought to shed light on this important rural issue as well as offer solutions regarding the ways in which environmental and public-health problems associated with industrial swine production may be remedied.

---

[1]Kerr Center for Sustainable Agriculture, 110 W. 39th Street, # 1216, Baltimore, MD 21210 (amy.chapin@hotmail.com)

[2]Yale University, New Haven, CT 06520 (Charlotte.boulind@yale.edu)

Reduction of Odor Gases from Cattle Manure with Chemical Additives

V. H. Varel[1] and D.N. Miller[2]

In order to reduce odor emitted from livestock manure, the microbial populations responsible for producing the odorous fermentation end products must be controlled. Odorous compounds are produced from an incomplete fermentation of the organic substrates in manure. Even under optimum conditions, complete fermentation of manure produces the greenhouse gases--methane and carbon dioxide. The environmental conditions that livestock manures are exposed to are unpredictable, and manure-handling systems vary greatly. Thus, microbial manure fermentation is difficult to predict and usually results in a variety of odorous and greenhouse-gas emissions. Therefore, the fermentation should be inhibited before the odorous gases are produced. The objectives of our studies were to evaluate a variety of naturally produced chemicals, which inhibit the microbial fermentation of stored manure. Duplicate one-liter stoppered flasks with a 500-milliliter working volume were used in a series of experiments with beef cattle manure (urine and feces) to evaluate chemicals that reduced total gas and volatile fatty-acid production. Over 20 antimicrobial chemicals were evaluated separately and in combination. A combination of a cationic agent, halogenic carboxylic acid, and a plant essential oil reduced the volatile fatty acids and gas volume after 27 days, 50% and 80%, respectively, when compared with controls. Further studies are needed to determine which volatile organic compounds are reduced. We conclude that various naturally produced additives can be added to manure, which will reduce odorous and greenhouse gases, conserve nutrients in manure that are valuable as plant fertilizer, and potentially reduce pathogenic microorganisms.

---

[1]U.S. Department of Agriculture, Agricultural Research Service, U.S. Meat Animal Research Center, P.O. Box 166, Clay Center, NE 68933-0166 (varel@email.marc.usda.gov)

[2]U.S. Department of Agriculture, Agricultural Research Service, U.S. Meat Animal Research Center, P.O. Box 166, Clay Center, NE 68933-0166 (miller@email.marc.usda.gov)

Determination of the Potential Toxicity of Contaminants in the Water Requires Improving the Understanding of Low-Concentration Effects

Gary A. Boorman[1], *Samuel H. Wilson*[2], *and Robert C. Sills*[3]

The identification of contaminants, often at very low concentrations, in ground, surface, and drinking water raises concern. Toxicology studies and risk assessment on water contaminants are done at unusually high levels of exposures. Usually, rodent studies use a maximum level of tolerated exposure with several lower concentrations at one-half to one-fourth of the maximum concentration. The results must then be extrapolated from the toxic levels tested to the potential health effects of environmental concentrations. The linear extrapolation used to extrapolate from high to low concentrations has some serious defects. First, it assumes the mechanism of toxicity at high concentrations is similar to the mechanisms of toxicity at lower concentrations. However, for several chemicals, including chloroform, this is simply not the case. The carcinogenicity found at high concentrations is a reflection of repeated cellular toxicity. Second, linear extrapolation assumes that the response to toxicants at low-dose concentrations is similar to the response to high concentrations where adverse health effects are known. Linear extrapolations ignore the fact that cells can repair damage and can respond to minimally toxic exposures. These repair and response systems are necessary because normal cellular processes create endogenous toxicants such as free radicals. Thus, the body has evolved many ways in which to protect itself from many otherwise potent toxicants. These low-dose protection systems potentially provide for a threshold below which exposure has little consequence and above which there could be health problems. It is only when an exposure level is high enough to overwhelm the body's innate protection system that adverse health effects occur.

The National Institute of Environmental Health Sciences (NIEHS) and the National Toxicology Program (NTP) are investigating the molecular pathways of toxicant action and the mechanisms by which the body repairs damage from toxicants. Such knowledge is crucial to the interpretation of the rodent studies at high concentrations. This new research opportunity stems from the dramatic increase in our understanding of biological mechanisms at the cellular and molecular levels and the corresponding increase in our capabilities in the area of analytical chemistry. For example, it is possible to measure DNA damage by quantification of adducts with great precision examining the response to chemicals at low concentrations. Further, quantification of various cellular DNA repair systems has now become standard. Incorporation of relevant mechanistic research from all exposures into the risk-assessment enterprise will reduce uncertainties and produce more accurate and realistic estimates of human risk. While toxicologists are more comfortable working at toxic levels, a paradigm shift will be required to focus on the lower more relevant concentrations. The NIEHS/NTP currently is working on a targeted low-dose/threshold research initiative because the state of the science now allows for such an undertaking. The ultimate goal is to ensure that exposure standards truly protect the health of the public and are based on sound science.

---

[1]National Institute of Environmental Health Sciences, Environmental Toxicology Program, P.O. Box 12233, 101 S. Campus, Rm B-350, Mail Drop B3-08, Research Triangle Park, NC 27709 (boorman@niehs.nih.gov)

[2]National Institute of Environmental Health Sciences, Environmental Toxicology Program, P.O. Box 12233, 101 S. Campus, Rm B-350, Mail Drop B3-08, Research Triangle Park, NC 27709 (wilson5@niehs.nih.gov)

[3]National Institute of Environmental Health Sciences, Environmental Toxicology Program, P.O. Box 12233, 101 S. Campus, Rm B-350, Mail Drop B3-08, Research Triangle Park, NC 27709 (sills@niehs.nih.gov)