EPA Regional Priority AFO Science Question Synthesis Document

Introduction

Workshop Review Draft:

Supporting Documentation for the EPA Regional Science Workshop on Animal Feeding Operations (AFOs) - Science and Technical Support Needs

December 6-9, 2004, College Park, Maryland

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SECTION 1: INTRODUCTION

1.1 Purpose and Scope

This document is intended to assist EPA Regions in identifying, understanding, assimilating, and utilizing the extensive body of research and scientific/technical tools related to animal feeding operations (AFOs). Only AFO research and tools relevant to regional priority science questions, developed as the initial step in this document's preparation, are addressed. This document will be used as supporting documentation for EPA's Regional Science Workshop on AFO Science and Technical Support Needs, to be held December 6-9, 2004, in College Park, Maryland.

1.2 Statement of the Problem

As defined by EPA's Office of Water (40 CFR 122.23), an AFO is a facility where:

(1) Livestock or poultry are confined and fed for a total of 45 days or more in any 12-month period, and

(2) Vegetative cover of any significance (crops, vegetative forage growth, or post-harvest residues) is lacking.

To be considered an AFO, it is not necessary that the same animals are confined for 45 days, the 45 days do not have to be consecutive, and the 12-month period does not have to correspond to a calendar year. The stipulation of the absence of vegetative cover of any significance intentionally excludes operations where animals are maintained on pasture or rangeland. Sources of emissions from an AFO include the animal confinement facility, manure management systems, and any land to which manure is applied.

Concentrated animal feeding operations (CAFOs) are a subset of the population of AFOs that must obtain a federal water pollution permit (i.e., National Pollutant Discharge Elimination System permit). A CAFO is an AFO that either exceeds a size threshold (number of animals confined), exhibits certain water discharge characteristics, or is designated by a local official as contributing significantly to the pollution of surface waters. While the terms CAFO and AFO often are used interchangeably, AFO is the appropriate term for referring to this industry in general.

Animal feeding operations contribute to pollution in air, water, and soil causing ecological damages and risks to human health. The beef, dairy, pork, and poultry industries when combined generate six to ten times as much waste as is generated by humans. The major stressors associated with the generation and disposal of these wastes include nutrients (nitrogen and phosphorous), sediments from runoff, veterinary pharmaceuticals (e.g., endocrine disrupting chemicals, arsenic, ivermectin, and antibiotics), pathogenic organisms, and atmospheric

emissions of gases and particulates.

Nutrients can create conditions favorable for eutrophication of receiving waters leading to degradation of water quality, including depletion of dissolved oxygen and harmful algae blooms. These conditions have resulted in fish kills and economic losses in the seafood and tourism industries. Excess nitrate in drinking water can cause human health effects, including methemoglobinemia ("blue baby syndrome"), adverse pregnancy outcomes, and gastric cancer. An additional public health concern related to animal manure is the potential for contact directly and through the human food chain with pathogenic organisms, which can cause zoonotic diseases (animal diseases that can cause infection in humans). Of particular concern are zoonotic diseases caused by bacteria that may have developed antibiotic resistance due to the use of antibiotics therapeutically, prophylatically, and as growth stimulants in animal agriculture. Emissions from AFOs can contribute to troposheric ozone, fine particulate matter, nitrogen deposition, odor problems, and airborne pathogenic organisms.

Much research remains to be done on AFO emissions. A review of current literature shows that suitable data to derive emission factors or to support regulatory decisions are lacking. For example, much of the research has focused on issues of limited scope (e.g., local odor problems, animal health, worker safety). As a result, many studies have not collected information to relate measured emissions to a unit of animal production capacity. Another limitation is the absence of long-term studies that can capture the effect of seasonal variability on the microbial processes responsible for emissions. Studies also are needed to characterize emission differences due to animal age, feeding regiment, and animal management practices, which can vary substantially. Research on emission control measures often has focused on a single substance or single emission point (e.g., a barn or open lagoon) and has not considered the effect of controls on overall emissions from the entire operation. Substantial data gaps exist, therefore, in our ability to defensibly characterize emissions at individual sources, assess the impact of these emissions on the environment, assess regional differences in impacts, determine the best management practices to reduce emissions, and assess the performance of emission control technology.

1.3 Background

There is a broad variety of environmental impacts associated with AFOs, which EPA Regional offices must address on a regular basis, including: excess nutrients, sediments from runoff, aerosols, veterinary pharmaceuticals, metals, hormones, and pathogens. To address a more narrowly defined set of Regional AFO science needs, the Office of Research and Development's Office of Science Policy (OSP), in collaboration with the regions, Office of Research and Development laboratories and centers, and the Offices of Air and Radiation, Water, and Enforcement and Compliance Assistance have developed priority science questions. This document did not utilize an exhaustive search of all related historical research to address these questions. Instead, it focused on synthesizing the more recent (primarily within the last 10 - 15 years) research and scientific/technical tools. Where answers are not available, this document has at a minimum conveyed the state of science surrounding these questions. The

priority science questions are listed below and are addressed in the following sections.

Section 2: Air Emission Characterization and Management

1. What are the air pollutants (e.g., dusts, volatile organic compounds and ammonia), their sources (including housing, storage ponds, lagoons, litter piles, and land application fields), and their emission rates from AFOs, and what metrics, methods, and models should we use in the future to quantify and monitor these emissions to better understand their relationship to atmospheric deposition and the formation of ground-level ozone and $PM_{2.5}$?

2. What are the meteorological (e.g., arid vs. wet conditions) and other variables (e.g., feed management, size of operation, type of operation (finishing), and application rates) that affect the emissions, and volatilization, transport, and deposition of AFO-related pollutants?

3. What are the most effective practices (e.g., covering lagoons, animal housing) and technologies (e.g., employing methane digesters) for reducing emissions of ammonia, criteria pollutants, and dust?

Section 3: Nitrogen Source Tracking

4. What methodologies can be used to distinguish the source(s) of nitrogen in ground or surface waters (e.g., specific animal species, septic tanks, fertilizers)?

Section 4: Pharmaceuticals and Pathogens

5. What specific analytic methods should be used in an environmental setting for the veterinary pharmaceuticals and microorganisms most likely to be found in the environment and most likely to be linked to adverse human health effects, e.g., drugs such as tetracyclines, sulfonamides, and trenbolone and microbes such as *Cryptosporidium parvum, Campylobacter spp., and E. coli* O157:H7?

6. How can we determine the fate, transport, and environmental impacts of pharmaceuticals and pathogens?

7. What is the strength of the evidence that demonstrates linkages between exposures to AFO contaminants and incidents of disease, especially infectious diseases caused by pathogenic organisms originating from AFO wastes (other than acute problems where it is obvious that agricultural runoff has entered drinking water supplies)?

Section 5: Manure Management

8. What are the most effective strategies and practices for minimizing the movement of pollutants from animal confinement areas, manure storage areas, and land applications of manure into surface and ground waters and limiting emissions into the atmosphere?

   Include:

   a. How reducing entry into one media may affect loadings into other media;

   b. For land application of manure, how pollutant movement is affected by (1) the form and amount of manure that is applied, (2) the timing, location, and method of application, and (3) the presence or absence of tile drainage systems in land application fields; and

   c. Consideration of the costs and ease of implementation of the identified technologies and practices.

9. What are the best alternative uses of manure, other than land application? Consider the:

   a. Health and environmental impacts; and

   b. Costs and ease of implementation of the identified uses.

Section 6: Environmental Risk Management Methodologies and Approaches

10. What tools (e.g., models, software) are available to farmers, watershed authorities, consultants and other stakeholders that can help them identify specific conditions (e.g., weather, soil type, hydrogeological characteristics) and geographical locations where animal feeding operations would present a higher risk to water quality?

11. What environmental assessment methodologies/approaches are available to evaluate farming operations and practices in order to determine their contributions toward causing or effectiveness in preventing adverse environmental impacts?