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The OARDC Research Enhancement Competitive Grants Program

Modeling Nitrogen Nutrient Loss and Ammonia Emissions from Animal Farms

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BACKGROUND

Ohio is the second-largest egg-producing state and the eleventh largest dairy milk producing state in the nation. Ammonia (NH_3) emissions from concentrated livestock feeding operations have become a significant environmental issue by contributing to soil acidification, increased nitrogen deposits in ecosystems, and formation of small aerosol particles. The U.S. Environmental Protection Agency's (EPA) Environmental Planning and Community Right-to-Know Act requires agricultural feeding operations (AFOs) to report NH_3 emissions exceeding 100 lbs in any 24-hour period. Increasing public concerns and the federal air quality regulations make poultry and dairy industries very vulnerable to lawsuits, because they emit about 24 percent and 46 percent, respectively, of total NH_3 emissions to the atmosphere. However, farmers currently lack an ammonia emission estimation tool and thus are unaware of the quantity of ammonia emitted from their operations. This issue is a major constraint to EPA compliance, profitability, and the growth of livestock industries. Therefore, an on-farm NH_3 emission management tool is urgently needed to guide the industry in managing nitrogen loss and ammonia emission.

Field air emission measurement is generally accepted as the most accurate method for quantifying ammonia emissions. However, it is very expensive, time consuming, and limited to specific facilities (e.g., fan-ventilated buildings). The nitrogen mass balance method is fundamental and has been used widely to predict ammonia emissions and validate other ammonia emission estimation methods, but needs precise tracking of mass flows, including waste flow on farms, which is not a typical farming practice and is very difficult.

OBJECTIVES The goal of this project was to provide the Ohio poultry and dairy industries with the necessary tool with which to efficiently estimate and thus manage ammonia emissions, adopt effective mitigation technologies, comply with federal air quality regulations, and maintain viable and sustainable production operations. The project team aimed to develop an innovative mass balance modeling approach to estimate NH_3-N emissions from dairy and poultry layer facilities. The innovative mass balance approach tracks more than two nutrient balances to eliminate the need to precisely measure the waste flow rate at animal farms. It is convenient and low cost and only needs to be proven reliable and accurate.

IMPACTS Through this research, the team developed knowledge base and models to evaluate NH_3 emissions from dairy and poultry layer productions. Baseline nutrient mass balances were verified through studies of small-scale experimental layer and dairy farms. Alternative mass-balance based models reflecting on-farm nutrient balances and the associated spatial and temporal variations in nutrient contents of commercial dairy and layer operations have been established. The models have been converted to a user-friendly tool for producers, governmental agencies, and livestock and poultry professionals to effectively manage ammonia emissions. The tool will facilitate efficient management of NH_3 emissions, adoption of nitrogen conservation practices and ammonia mitigation technologies, reduction of the industry's environmental and health impacts, and viable and sustainable production operations.

To disseminate these research findings, two OSU Extension workshops on understanding ammonia emissions and their mitigation have been developed and offered to producers, governmental agencies, extension educators, and animal industry professionals since 2010. The models were adapted by the U.S. EPA's National Air Emission Monitoring Studies and are expected to contribute to establishment of EPA regulatory ammonia emission estimation tools. The method is promising to be applied to other animal feeding operations to evaluate the carbon and nitrogen footprints of animal industries.

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March 2013 FS64-13

This research is supported in part by state of Ohio funds allocated to the Ohio Agricultural Research and Development Center of The Ohio State University.