Title: Modeling the Source of Gaseous Emissions from Animal Feeding Operations

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Award Amount: $479,958 **Award Duration:** 48 mos

Technical Summary:

This project will collect baseline emission data from broiler chickens, growing pigs, and lactating dairy cows for ammonia, hydrogen sulfide, nitrogen oxides, sulfur oxides, nitrous oxide, methane and volatile organic compounds. The objectives are to: identify the current deficiencies of the conceptual farm-level mass balance that estimates emission concentrations and identify the relative proportion of each form of emission (ie., N2, NOx, N2O, NH3) based on nutrient flows through a whole farm system, with emphasis on the animal component; establish emission data from the animals themselves fed typical diets for emissions that include ammonia, hydrogen sulfide, nitrogen oxides, nitrous oxide, sulfur oxides, methane, and specific volatile organic carbons; identify promising feed strategies and measure emission reductions in ammonia, hydrogen sulfide, nitrogen oxides, nitrous oxide, sulfur oxides, methane, and specific volatile organic carbons that occur following implementation of the dietary regimen; modify the model, as needed, based on the actual animal generated mass balance information such that the accuracy of the model to predict air emissions is improved; quantify the proportion of the total emissions that is accounted for by the different components of the model as well as the measurements that go into the model components such that a few measurements can be identified that account for the greatest proportion of the air emissions; share the emission measurements with regulatory agencies as the best implementation tools at the farm level; impart the information learned and strategies identified to students, producers, and policymakers; and use the information gained to move forward on the long-term goals of the research team that focus on implementation of the modified model to whole farm systems as a component of a holistic program that evaluates the fate of emissions on animal, worker, and citizen health.

Non-Technical Summary:

The current model to estimate emission concentrations and the relative proportion of each form of emission uses vague and ill-suited baseline data. This project will collect baseline data from broilers, growing pigs, and lactating dairy cows for gaseous emissions and will establish the chemical form of elements emitted in the gaseous phase and the relative proportions of each chemical form emitted.

Title: Emission of Nitrous Oxide and Ammonia from New York State Dairy Farms: Measurement, Modeling and Extension

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Award Amount: $400,365 **Award Duration:** 24 mos

Technical Summary:

The goal of this project is to quantify ammonia and nitrous oxide losses from New York dairy farms. Specific project objectives are to: measure ammonia and nitrous oxide emissions from a range of dairy manure management practices; develop a farm model that will assess the impact of emission reductions; develop publications and present training seminars to effect change in farm practices; and develop eco-hydrology and nutrient management course modules on N emissions from dairy farms.

Non-Technical Summary:

Gaseous nitrogen emissions from agriculture have significant environmental impacts: ammonia volatilization from manures contributes to odor and increased N deposition, while nitrous oxide released from agricultural soils is a potent greenhouse gas. The goal of this project is to quantify ammonia and nitrous oxide losses from large dairy farms in New York, which are typical of those in the northeastern United States.

NRI Integrated Air Quality Program 210.1

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Title: Quantification of Gas, Odor, and Dust Emissions from Swine Wean-Finish Facilities

Award Amount: $460,000 **Award Duration:** 24 mos

Technical Summary:

The goal of this project is to determine the effect of diet modification practices and manure storage times on baseline gas, odor, and dust emission rates and determine potential mitigation practices to reduce these air pollutants for the swine industry. The specific objectives of the project are to: establish baseline gas, dust and odor emissions from group-fed pigs housed in environmentally controlled facilities at different stages of growth and at different seasons of the year; conduct nutrition studies to determine the value of new diets formulated with highly available mineral sources (especially sulfur), enzymes, and protein availability and amino acid manipulation, and their effects on excretion of odorous compounds or precursors of odorous compounds in manure, gas emissions and dust in group-fed pig housing facilities; determine the effect of manure storage time within a housing facility on gas, odor and dust emissions from group-fed pigs; and develop prediction models and a preliminary economic analysis of diet manipulation and manure storage times on nutrient excretion, air quality, pig lean growth, and pork production economic stability and profitability.

Non-Technical Summary:

Public concern over nutrient concentrations in swine manure, air and odor emissions, and their potential impact on the environment has increased in recent years. As a result, producers are trying to minimize nutrient and emission losses from their farms. However, very little data is available on current baseline emission rates from commercial swine facilities. Therefore, a multi-disciplinary swine nutrition and manure management research and extension project will be initiated to determine the effect of diet modification practices and manure storage times on baseline gas, odor, and dust emission. Using specialized facilities and methodologies, nutritionists, and agricultural engineers will team together to determine the baseline emissions of common air pollutants (ammonia, hydrogen sulfide, methane, volatile organic compounds and dust) from confinement swine facilities.

Title: Characterization and Fate of Ammonia and Hydrogen Sulfide from Animal Feeding Operations: Their Emissions, Transport, Transformation, Deposition, and Impact on Fine Particulate Matter

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Award Amount: $479,818 **Award Duration:** 36 mos

Technical Summary:

The goal of this project will be a multidisciplinary approach to study the simultaneous emission and fate of ammonia and hydrogen sulfide from confined animal feeding operations. The specific objectives of the project are to characterize emissions of ammonia and hydrogen sulfide from lagoons, hog barns, soil, and spraying operations, and develop emission factors and inventories for these two gases. The project will also formulate the exchange of ammonia and hydrogen sulfide flux in terms of external properties, including physical, chemical, and biological status, and atmospheric process. Validation and utilization of a coupled mass-transfer model for a waste treatment lagoon and for local soil conditions will be performed, as well as estimating the deposition velocity and the deposition potential for ammonia and hydrogen sulfide. Estimates of the wet deposition potential for ammonium and sulfate at a regional scale and the characterization of source/receptor relationships between agricultural emissions, and regional deposition of N and S using isotopic studies and back-trajectory analysis will be performed. Knowledge gained from measurements of emissions and dry deposition will be synthesized into a detailed air quality model to diagnose and reduce uncertainty and to improve the current understanding of the cycling of reduced N and S compounds in the atmosphere. Characterization and assessment of air quality in a regional area surrounding North Carolina will also be performed.

Non-Technical Summary:

Emissions of ammonia and gaseous sulfur compounds from confined animal feeding operations (CAFOs) and their impact on fine particulate matter have become a significant national problem. This has influenced air and water quality, human health, and the economy of agricultural regions. This project will lead to a detailed understanding of the extent of such problems and make scientific recommendations on potential solutions.

Title: Inherent PM10 and PM 2.5 Stack Sampling Errors Due to the Interaction of Particle Size and Sampler Performance Characteristics

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Award Amount: $196,646 **Award Duration:** 24 mos

Technical Summary:
This project will focus on theoretically and experimentally defining the errors associated with PM10 and PM2.5 stack samplers. The specific objectives of the project are to: conduct theoretical simulations to estimate the errors due to the interaction of particle size and sampler performance characteristics of EPA approved PM10 and PM2.5 stack samplers; conduct theoretical simulations to estimate the errors due to PM10 and PM2.5 stack sampler performance characteristics that vary beyond EPA's defined performance criteria; experimentally determine sampling errors of stack samplers; and compare the experimental data with the results of the theoretical simulations and explore theoretical methods of predicting the variations in the stack sampler performance characteristics due to particle size and loading.

Non-Technical Summary:
Agricultural operations are encountering difficulties complying with current air pollution regulations for particulate matter (PM). These regulations are based on the National Ambient Air Quality Standards (NAAQS), which set maximum concentration limits for ambient air PM. Source sampling for compliance purposes require the use of EPA approved samplers. Ideally, these samplers would produce accurate measures of the pollutant; for instance, PM10 samplers would produce accurate measures of PM less than or equal to 10 Ym (true PM10). However, samplers are not perfect and errors are introduced due to established tolerances for sampler performance characteristics and the interaction of particle size and sampler performance characteristics. These errors result in unequal regulation between industries. To achieve equal regulation among differing industries, PM10 and PM2.5 measurements MUST be based on true measurements. Holding rural sources to a substantially higher standard than urban sources, federal and state regulatory agencies are essentially placing unjust economic burdens on rural sources, which include agricultural industries. This project will focus on theoretically and experimentally defining the errors associated with PM10 and PM2.5 stack samplers. These types of samplers are currently being used to monitor and/or evaluate emissions emitted by agricultural point source exhausts. Project results could be used by agricultural industries and State Air Pollution Regulatory Agencies in assuring that agricultural operations and other industries are equally regulated.

Title: Ammonia Loses from a Commercial Cattle Feedlot: Towards a Realistic NH3 Emissions Inventory for the Great Plains

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Award Amount: $477,775 **Award Duration:** 36 mos

Technical Summary:

This project aims to improve the ability to measure and predict ammonia emissions from cattle feedlots in the Great Plains. The specific objectives of the project are to: advance science that will lead towards improved measurement, understanding, and prediction of ammonia losses (gaseous and aerosol) from cattle feedlots in the Great Plains; measure the fluxes of ammonia from a large block of pens at a commercial cattle feedlot for approximately two years; measure fluxes of ammonia and aerosol ammonium with novel techniques that integrate over a very large sample area to quantify vertical and horizontal transport in the boundary layer; constrain the atmospheric measurements by estimating the mass of feed nitrogen inputs into the study area and determine the fraction of the pen-surface nitrogen loading that is lost to the atmosphere as NHx; and analyze the relationship between feed-nitrogen and NHx emissions in response to weather conditions, boundary layer physics, soil moisture, and soil chemical conditions at the pen surface.

Non-Technical Summary:

Ammonia losses from a commercial cattle feedlot will be measured continuously for two years. Results will improve estimates of ammonia emissions from cattle production in the Great Plains and improve the U.S. ammonia inventory. The research will help quantify agriculture's impact on air quality and lead to improved strategies for reducing ammonia losses from cattle feedlots.

Title: Verification of Odor Dispersion Modeling for Siting of Livestock and Poultry Production Systems

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Award Amount: $479,808 **Award Duration:** 24 mos

Technical Summary:

This project will validate and improve an odor dispersion model for siting poultry and livestock production facilities. The specific objectives of the project are to: compare and standardize ambient level odor measurement methods from livestock and poultry production systems for evaluation of atmospheric dispersion models (ADM) for odor; incorporate existing odor dispersion modeling techniques into one consistent tool capable of handling multiple sources in a community of multiple receptors, and incorporating localized weather patterns, terrain, production size, and manure management techniques; and disseminate the knowledge and use of a standardized ambient level odor footprint tool and odor dispersion characteristics to stakeholders.

Non-Technical Summary:

Nuisance problems related to livestock and poultry odors have become an issue limiting the growth and viability of the animal producing industries. Some agricultural practices contribute to nuisance odors in the surrounding community. The purpose of this study is to learn more about odor dispersion as affected by atmospheric stability, and how this knowledge can be used to develop siting tools for state and local planners.

Title: Effect of Cropping Systems and Water on N2O Emissions from Soil as Influenced by Fertilization and Crop Residues in the Northern Great Plains

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Award Amount: $421,184 **Award Duration:** 48 mos

Technical Summary:

The overall goal of this project is to address the current paucity of data on nitrous oxide (N2O) emissions from the Northern Great Plains by conducting emission studies at two locations in Montana. The first study will integrate measurement of N2O emissions with a project on best management practices for soil carbon sequestration. The second study will examine the levels of N2O generated from fertilizer N and crop residues under a water gradient. The specific objectives of this proposal are: to measure seasonal patterns and accumulative N2O emissions for four cropping systems and a perennial grass system applicable to the Northern Great Plains; to determine if, and how, best management practices for carbon sequestration in the Northern Great Plains affect N2O emissions; to quantify and contrast N2O emissions derived from N fertilizer and crop residues (wheat and legumes) under varying water regimes; and to contrast field-measured losses of N2O under the first two objectives against predicted N2O losses using IPCC methodology.

Non-Technical Summary:

Nitrous oxide (N2O) is an important atmospheric gas because it contributes to global warming and destruction of the ozone layer. Although, agricultural soils have been identified by the Intergovernmental Panel on Climate Change (IPCC) as a major source of global N2O emissions into the atmosphere, there is great uncertainty in these estimates. Little information exists on N2O emissions from agroecosystems in the Northern Great Plains (Montana, North Dakota, and South Dakota) of the United States (NGP), and it is not known whether the current IPCC methodology accurately predicts emissions. The goal of this project is: i) to learn more about seasonal patterns and accumulative N2O emissions from agricultural soils in the Northern Great Plains under different cropping systems, water regimes, crop residue levels, and nitrogen fertility rates; and ii)to determine if field-measured losses of N2O are consistent with estimates made using IPCC methodology.

Title: Air Quality Impacts Planning Tool (AQUIPT) for Improved Air Quality Management

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Award Amount: $475,059 **Award Duration:** 36 mos

Technical Summary:

The project will create a web-based planning tool for assessing the impact of air quality from a variety of agriculture, forest, and range emissions source characteristics, particularly the use of controlled burning. The specific project objectives are to: model controlled burning; provide information on the fate and transport of emitted particles and gases from controlled burning; and predict movement and dispersion of air pollutants from production practices and management operations.

Non-Technical Summary:

Newly revised clean air standards and new regional haze rules are prompting emitters and regulators (states, tribes, and county or local air agencies) to develop more accurate accounting of emissions and impacts. At the same time, there is an increasing use of fire in forested landscapes to help reduce hazardous fuel buildup and maintain and restore healthy ecosystems. The result is that in many parts of the country, agriculture and forest activities are directly competing for the same air space. This project will aid in the assessment of air quality impacts from a variety of forest and agriculture emissions sources, with a particular focus on the use of controlled burning. By providing rapid assessments of alternative strategies, this project will help land managers plan activities, and help state, tribe, and regional to local air agencies plan monitoring or regulatory needs.

Title: Measurement and Total Accounting for Particulate Emissions from Agricultural Field operations

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Award Amount: $466,130 **Award Duration:** 36 mos

Technical Summary:

The goal of this project is to measure and account for the particle emissions from agricultural field operations. The specific project objectives are to: develop and test a novel measurement system for quantifying agricultural particulate matter emissions; produce the initial sets of data detailing the mass accounting of particulate emissions from two different types of field operations: irrigated cotton production at the New Mexico State University research farm and corn silage production at the University of Connecticut research farm; and relate measurable characteristics of the wind and turbulence flow field to the amounts, movements and dispositions of particle emissions.

Non-Technical Summary:

The goal of this project is to measure pollution particles emitted to the air during agricultural in-field operations. Final products from the research will include recommendations for techniques to measure and monitor particle emissions from a wide array of agricultural operations. The project will provide the first total accounting for the particle material emitted during two "typical" crop operations, southwestern irrigated cotton and northeastern silage corn. The operations to be studied will include plowing, planting and harvesting. The air pollutants most likely to be emitted are nutrient enriched dust, machinery exhaust, and tiny particles of crop residues. Accurate measurements will be made of these emissions and the pollution plume in the air will be tracked by laser radar until it disperses into the atmosphere or deposits on the ground. The ground-based remote measurements with laser radar, called LIDAR, will be especially developed for monitoring air pollution emissions from individual operations such as a tractor plowing in a field. This project has a significant potential to develop relatively simple ground-based remote sensing methods to measure air pollution from individual agriculture sources. In regions where agriculture is mixed with other land uses and local air emissions are likely to receive significant attention, such as Connecticut and the lower Rio Grande river valley of NM, this ability will be singularly useful. Use of the tools developed in this project can make a major difference in helping farmers identify and reduce particle emissions.

Title: Direct, Fast-Response Measurements of Gas-Phase Ammonia at a Swine Production Facility

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Award Amount: $223,052 **Award Duration:** 24 mos

Technical Summary:

This project will further develop a spectroscopic field technique to measure ammonia directly. The specific project objectives are to: improve and automate the spectroscopic instrument for field deployment; measure ammonia emissions from an operating farm using a novel photothermal interferometric method; provide accurate information about the diurnal cycle of ammonia emissions, the variation of ammonia emissions with variable meteorological conditions, and with estimates of the ammonia flux within and at the edge of the working farm; and compare measurements simultaneously with citric acid filter disks.

Non-Technical Summary:

Animal husbandry produces large amounts of ammonium-containing animal waste products. Ammonia emissions from farms are an environmental health, climate and air quality concern at global, national and regional scales. The purpose of this project is to better quantify agricultural ammonia emissions by improving instrumentation needed to make accurate measurements, and by obtaining data from a working animal feeding operation that will be provided to agricultural scientists.

Title: Vegetative Environmental Buffers to Mitigate Odor and Aerosol Pollutants Emitted from Poultry Productions Sites

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Award Amount: $440,205 **Award Duration:** 36 mos

Technical Summary:

This project will use vegetative environmental buffers to provide cost effective best management practices to facilitate the mitigation of odor, particulates, and ammonia associated with animal production farms. The specific project objectives are to: quantify the efficacy of the vegetative buffers for ammonia mitigation and species hardiness; model poultry emissions from the buffers; evaluate biochemical and physical tree interactions with ammonia and particulate matter in the greenhouse; analyze costs of the buffer system with and without government assistance, and provide outreach to growers with visualization planning software to aid in implementing the buffer system.

Non-Technical Summary:

The US poultry industry is facing unprecedented environmental challenges. Scientific evidence strongly suggests that shelterbelts of trees and shrubs when arranged in specific designs near and within poultry facilities can provide effective and cost-effective mitigation of odor, particulates, and ammonia. The purpose of this study is to provide measurements of how good shelterbelts are in terms of trapping and reducing air pollutants coming from poultry farms. We will evaluate several tree species in shelterbelts for their abilities to reduce odor, particulates, and ammonia. Field and greenhouse studies will provide data to be used in modeling how odor and particulates flow and move in the air from poultry operations. Also, we will determine the shelterbelt costs and impacts of governmental assistance programs on costs.

Title: Detecting Forest Fire Emitted PM 2.5 Using a Novel Thermo Elemental Analysis Method

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Award Amount: $100,000 **Award Duration:** 12 mos

Technical Summary:

This project begins development of a sensitive and convenient method for the study of forest fire emitted PM2.5 based on a novel scanning thermal elemental analyzer (STEA) technology through a bridge grant. The specific objectives of this revised project are to: develop a sensitive and convenient method for the identification and monitoring of prescribed burning emitted PM2.5 based on STEA technology and test the developed technology on at least one field scale prescribed forest burning experiment.

Non-Technical Summary:

Prescribed burning has become a common practice in forest management. The impact of forest fire on air quality is a major concern in affected areas. Fire emitted particulate matter (PM), especially those very fine sized (PM2.5), are of particular concern because they can remain suspended in the air for a long period and may cause health problems such as asthma, upper respiratory infections and bronchitis. This project will develop a sensitive and convenient method for the identification and monitoring of prescribed burning emitted PM2.5 based on a scanning thermo-elemental analysis (STEA) technology.