Air Quality

Odor, Dust and Gaseous Emissions

An agricultural research partnership of TAES, WTAMU, TCE, KSU and USDA-ARS funded by USDA-CSREES

A federal agricultural air quality initiative involving more than 20 scientists and engineers representing five agencies or universities in two states (TX & KS).

PM_{10} and

TSP Samplers

Texas Agricultural Experiment Station
a member of The Texas A&M University System

2004
FEDERAL INITIATIVE ACCOMPLISHMENTS

"Air Quality: Odor Dust And Gaseous Emissions from Concentrated Animal Feedyard Operations in the Southern Great Plains"

PURPOSE AND OBJECTIVES:

This multi-agency project is designed to:

1. Characterize air quality emissions from open-feedyards and dairies in the Southern Great Plains using the best available scientific procedures.
2. Develop and evaluate cost-effective abatement measures.
3. Develop a scientific basis for applicable air quality protection policies.
4. Determine the impact of feedyard air contaminants on animal health and productivity.
5. Deliver education and technology transfer programs to CAFO operators, livestock associations and agencies.

ACCOMPLISHMENTS/IMPACTS:

- Multi-agency field sampling continued at a cooperative feedlot. Diurnal patterns were observed for both hydrogen sulfide (H_2S) and ammonia (NH_3) concentrations, which varied exponentially with temperature. Both flux gradient/micrometeorology and surface isolation flux chamber approaches were used with acceptable agreement.

- TAES-Amarillo project personnel developed a wireless, Internet-based system for continuous measurement of fugitive particulate matter (PM_{10} and total suspended particulate, or TSP) from a commercial feedyard. Co-locating the PM_{10} and TSP monitors allows real-time estimation of the particle-size distribution of feedyard particulate-matter emissions.

- By redesigning the size-selective inlets, filter holders and flow-control systems, TAMU-CAAQES (Center for Agricultural Air Quality Engineering and Science) project personnel significantly improved the accuracy of measured time-averaged TSP and PM_{10} concentrations at dairies and cattle feedyards.

- TAES-Amarillo, under a three-year subcontract with the Texas Commission on Environmental Quality (TCEQ), has moved the federal fine-particle compliance monitoring site for the Amarillo airshed from downtown Amarillo to the Texas A&M University System Agricultural Research and Extension Center in northwest Amarillo.

- Ammonia and hydrogen sulfide concentrations were quantified in ambient air along the edges of the project feedyard and were correlated with wind direction, wind speed, time of day, relative humidity and air temperature. Concentrations of the two gases at breathing height appear to be well below human-health thresholds, according to TAES research.

- Volatile organic compound (VOC) emissions were quantified by TAES personnel from feedyard surfaces using a flux chamber. The primary focus was on volatile fatty acids (VFAs), major contributors to feedyard odor. Early experiments show the most offensive odorants in feedyard air are semi-volatile organic compounds (semi-VOCs), which are often overlooked in such monitoring studies. In particular, *p*-cresol was found to be a highly persistent component of feedyard odor.

Evening feedlot dust cloud forming

NH_3, H_2S & VOC measurements

Micromet-based measuring

LEAD AGENCY:
Texas Agricultural Experiment Station

PARTNERS:
Texas Cooperative Extension
West Texas A&M University
U.S. Department of Agriculture-Agricultural Research Service
Kansas State University

- Using Bowen ratio and energy-balance data collected during an intense field-sampling campaign, USDA-ARS personnel showed ammonia emissions decrease immediately after a rain and then increase as the pen surface dries and the Bowen ratio increases. Preliminary results from an *in vitro* study and a small pen-surface study suggest ammonia emissions are low from a dry pen surface and most of the ammonia released from the feedyard surface is released rapidly over a short period of time from urine spots.
- West Texas A&M University is conducting a literature review to evaluate the potential benefits of dust control on the health and feed-to-gain performance of beef cattle. The literature review will facilitate an ongoing economic analysis to estimate the capital and operating costs associated with sprinkling feedyard pens with water to control dust. The results will include an assessment of the break-even thresholds required to recover capital and operating costs of sprinkler systems in terms of per-animal and per-pound gains.
- Kansas State University researchers are evaluating surface applications of wheat straw, sawdust, water, magnesium chloride and organic-based materials to reduce PM_{10} emissions from feedyard surfaces. The evaluations use pilot-scale weight-drop test chambers (WDTC) to simulate kinetic energy imparted by motion of cattle hooves on feedyard surfaces.
- Evaporation rate from a feedlot surface was 30-70 percent or less of overall grass-reference evapotranspiration, depending on ground-level temperature, relative humidity, wind speed and solar radiation. Hygroscopic uptake of moisture from the air decreased the net diurnal evaporation of water from manure surfaces.
- The EPA-approved Gaussian dispersion model, ISCST3, provided accurate calculated emission fluxes. The CAAQES team found errors associated with inputting fluxes obtained using ISCST3 into other models. For instance, a Backward La Grangian Stochastic model was determined to have a 10-fold error in predicting downwind concentrations with fluxes derived using ISCST3 as input.
- Peak, instantaneous PM_{10} and TSP concentrations measured at dusk and a short period thereafter during spring and summer field sampling trips displayed step function increases of eight to 10 times higher than the average concentrations for the remainder of the 24-hour period. The increasing stability of the atmosphere immediately above the ground surface, typical for early evening, can contribute significantly to the evening peak in PM_{10} concentrations associated with feedyards as well as the kinetic energy of cattle hooves.
- TAMU-CAAQES researchers are finding traffic on alleys and unpaved roads in the feedyard contributes significantly more PM than originally thought.
- Project faculty played a key role in technical design, prioritization criteria and implementation of the USDA-NRCS Environmental Quality Incentive Program (EQIP) in Texas for air-emissions abatement from feedyards. EQIP expenditures under this program have exceeded $10 million and have been directed to two main management techniques: installation of solid-set sprinkler systems and incentive payments to increase manure-harvesting frequency.
- TAMU research engineers conducted the first-ever study of ammonia emissions from free-stall and dry-lot dairies. Each dairy had about 2,000 lactating cows, but different animal housing systems, waste management practices and animal population densities. During summer months, lagoons emitted more ammonia relative to the other sources, and the free-stall dairy emitted more ammonia than the open-lot dairy. Compared to lagoons and corrals of the dry-lot dairy, higher ammonia emission rates for the free-stall dairy were attributed to greater manure loading of lagoons and barns.
- A research peer review with industry participation was conducted with positive, constructive feedback for project focus.
- Co-investigators produced 50 manuscripts, made 38 presentations and recruited $807,000 in other grants or agency co-funding.