

IOWA STATE UNIVERSITY

COLLEGE OF AGRICULTURE

Summary of Air Quality Research and Extension July 2006

Researchers in Iowa State University's College of Agriculture continue to look for ways to reduce odor and gas emissions from livestock operations. ISU Extension specialists work with producers as this research leads to new knowledge. Funding from farm and commodity groups, industry and state and federal government agencies is vital to making these efforts possible. Here are some examples of recent work.

- **Seventeen externally funded projects.** In 2005-2006, there were 17 externally funded projects that address research and extension issues on air quality/odor, animal waste and manure management. The projects are conducted by scientists in the College of Agriculture, as well as by ISU Extension.
- **Three-year internal funding commitment.** Air quality is one of six research initiatives that received special funding for three years from the College of Agriculture/Experiment Station. The air quality initiative received \$200,000 in its first two years and will receive an additional \$100,000 in 2007. This reallocation of funds provides additional resources to assist with the integrated research and extension efforts underway in the College to address air quality issues related to animal agriculture.
- **Poultry emissions modeling.** Iowa State University is participating with the University of California-Davis in a new project looking at modeling gaseous emissions from animal housing facilities. The effort is one of 11 air quality research projects the U.S. Department of Agriculture funded for 2006. Of the \$500,000 project, \$100,000 will come to Iowa State and be used for quantifying ammonia emission rates and emission dynamics by laying hens and manure storage as affected by environmental conditions and management practices. The data will be used for development and/or validation of ammonia emission models. (Hongwei Xin, Agricultural and Biosystems Engineering)
- **Laying hen varieties.** Iowa State is collaborating with Hy-Line International to quantify the effects of laying hen varieties on manure nutritional and physical characteristics and ammonia emissions. The study is funded by Hy-Line and the Midwest Poultry Research Program. (Xin, Robert Burns, Agricultural and Biosystems Engineering)
- **Laying hen production systems.** Iowa State is assessing the effect of laying hen production systems on indoor air quality and bird health. Systems being evaluated include floor and nest, high-rise cage and manure-belt cage. Funded in part by the Iowa Egg Council. (Darrell Trampel, Veterinary Medicine; Xin)
- **Laying hen manure moisture.** Iowa State is quantifying the effects of hen manure moisture content and air temperatures on ammonia emissions in a study funded in part by the Midwest Poultry Research Program. (Xin)

- **Laying hen diets trap nitrogen.** The Iowa Egg Council provided a gift that was used to conduct an evaluation of air emissions following the feeding of diets to laying hens at different stages of production that make the manure more acidic, which helps trap nitrogen. Results indicated the acidifying diets could reduce ammonia emissions by 39 percent but hydrogen sulfide emissions increased three-fold. Work is underway to modify the formulation to maintain ammonia emissions benefits while decreasing the negative impacts for hydrogen sulfide emissions. (Wendy Powers, Animal Science)
- **Dietary fiber for laying hens reduces emissions.** Researchers have found increasing dietary fiber in the feed of laying hens can lower manure ammonia emissions by 40 percent per hen without adversely affecting egg production. Hens were fed one of four types of diets — a standard corn-soybean meal control diet, plus three experimental diets that included corn distiller's dried grains with solubles, wheat middlings or soybean hulls. All three fiber diets resulted in lower ammonia emissions. (Kristjan Bregendahl, Animal Science)
- **Dietary fiber for swine.** A \$40,000 grant from the National Pork Board is funding a project to study air emissions from pigs when fed different dietary fiber contents. Corn co-products — distillers dried grains plus solubles, corn germ meal and de-hulled de-germed corn — will provide the varying fiber contents. This project began in June 2006 and will wrap up in October 2006. In conjunction with this project, the Iowa Pork Producers Association has funded a \$46,000 project to evaluate energy value of corn co-products and contribute data to the development of a metabolizable-based energy system for swine. These evaluations will take place in conjunction with the air emissions trial. (Powers, Ken Stalder, Animal Science)
- **Dietary strategies for turkey/laying hens/cattle.** Iowa State University is one of 11 institutions that received new funding in 2005 from the U.S. Department of Agriculture for air quality research. A four-year project involves studying dietary strategies to reduce gas emissions from turkey, laying hen and growing-finishing cattle operations. Iowa State is partnering with Purdue University on the \$482,000 grant. The first step is to establish baseline emission measures for gases and particulates when cattle, laying hens and turkeys are fed typical diets. Once baselines have been determined, dietary changes will be made to see if emissions can be reduced. The laying hen work was conducted in 2005. Turkey work will begin in June 2007, followed by emissions evaluation of cattle. (Powers, James Russell, Animal Science)
- **Dietary strategies for swine/broilers/cows.** The USDA funded a similar four-year project in 2004 for \$479,000 that covers growing swine, broiler chickens and lactating cows. Iowa State is the lead institution on this project that includes University of Maryland and University of California, Davis. Growing swine was the first species tested. Groups of pigs were fed one of three diets until reaching market weight. Preliminary results show ammonia concentrations declined as the level of protein in the swine diets declined. No differences in hydrogen sulfide emissions were found. Broiler chicken work began in August 2005 and concluded in May 2006. Work remaining on this project includes evaluation of emissions from dairy cows, which is scheduled to begin in January 2007. (Powers)

- **Odor dispersion – Part 1.** A USDA grant of \$480,000 is being used to investigate odor dispersion from swine facilities. Iowa State is the lead institution in a three-state effort that includes University of Minnesota and University of Nebraska. The project involves measuring downwind odors from swine production facilities and how those odors are affected by such things as weather patterns, season of the year, growth cycle and building design and management. (Steve Hoff, Jay Harmon, Agricultural and Biosystems Engineering)
- **Odor dispersion – Part 2** That project builds on an existing six-state, \$2.2 million air-quality study also funded by the USDA. State-of-the-art monitoring equipment was used to collect particulate and gas emissions from six types of animal confinement facilities from October 2002 through March 2004. A final report will be released in 2006. (Hoff, Jacek Koziel, Agricultural and Biosystems Engineering)
- **Odor dispersion computer model.** Calibration efforts continue on an odor dispersion model. The computer model will help determine how far odors from livestock production facilities will travel under a variety of atmospheric conditions. The model makes predictions based on historic weather patterns, type and size of facility, number of animals and kind of ventilation system. Funding from the Iowa Pork Producers Association and the Iowa Farm Bureau Federation. (Hoff)
- **Identifying gases that cause swine odor.** The Iowa Pork Producers Association provided \$40,000 to fund research to identify key gases that cause swine odor. To date, 295 gases have been identified as emitted from swine manure, including 188 new compounds not previously linked to swine manure. Only a handful of compounds were found to be responsible for swine odor. This information will help researchers improve odor control strategies by focusing their efforts on these compounds. (Koziel)
- **Dust size makes a difference.** Iowa State University researchers found in laboratory studies that small dust particles carry more odor per weight and surface area than coarse dust. Results of the study have been published. The researchers hope to obtain funding for a follow-up field experiment that would look for ways to reduce odor by controlling dust, with emphasis on controlling the smallest dust particles. (Koziel, Hoff)
- **Trees reduce emissions.** Monitoring began in April 2005 at a Sparboe Farms facility near Eagle Grove to study the use of trees, shrubs and other perennial plants to reduce ammonia, odor and dust around poultry and egg production facilities. A \$440,000 USDA grant is funding the three-year study, which also involves University of Delaware and Pennsylvania State University. A three-row “tree belt” composed of Eastern redcedar and hybrid willow was established at the Iowa site. Similar plantings were done in Pennsylvania and Delaware. Results of particulate capture and odor reduction are encouraging although more research is needed. Trees planted 25 feet from the exhaust fans are unhealthy. Based on the research, the best distance to plant the first row of trees from exhaust fans is 10-times the fan diameter. (Joe Colletti, John Tyndall, Jan Thompson, Natural Resource Ecology and Management; Hoff)

- **Biofilters reduce emissions.** Researchers are working on lowering odor emissions from a swine barn's ventilation air by using biofilters. Continued funding comes from the Iowa Pork Producers Association and the USDA. The idea is to exhaust air filtered through compost, which has been shown to reduce odors by up to 90 percent. Researchers now are studying ways to run the fans through the filters only when it's needed the most. (Hoff, Harmon)
- **Olfactometry laboratory.** The Olfactometry Laboratory in the agricultural and biosystems engineering department continues to be heavily used. Trained panelists evaluate the strength of odors from livestock sources. The lab evaluates an estimated 60-70 percent of all odor samples from livestock in the United States. The lab evaluates odor-reduction technologies being tried at livestock facilities and helps producers determine when their management methods are effective. (Hoff)
- **Emissions laboratory.** A campus lab has been equipped to measure hydrogen sulfide and ammonia. Methods are being developed to collect gas samples from the field to bring to this lab for analysis. A full-time research associate has been hired with funding provided by the Iowa Pork Producers Association. (Hoff)
- **Atmospheric air quality laboratory.** The Atmospheric Air Quality Laboratory in the agricultural and biosystems engineering department has a unique, multidimensional GC-MS-Olfactometry system where trained panelists analyze air samples for chemical content and simultaneously evaluate for odor. This instrumentation is used in several projects aimed at identifying gases that cause livestock and poultry odor. Novel approaches for odor and volatile organic compounds emissions control are being developed and tested. (Koziel)
- **New equipment for poultry monitoring.** The Iowa Egg Council funded the purchase of a thermal desorption system for air quality monitoring, mitigation of odor and volatile organic compound emissions and development of waste management strategies at poultry operations. The \$15,000 grant co-funded the purchase of this instrument for the Atmospheric Air Quality Laboratory.
- **Deep-bedded swine emissions.** The National Pork Board funded a project to establish baseline survey data on downwind concentrations of ammonia, hydrogen sulfide and odor from deep-bedded swine facilities. Six sites were visited monthly to establish "typical" levels. Single-point monitors were used to continuously measure hydrogen sulfide levels 100 feet downwind. Results have been presented at two symposia and will be compared to a similar study on deep-pit finishing. (Harmon)
- **Emissions monitoring near swine facilities.** Research funded by the National Pork Board monitored hydrogen sulfide concentrations near swine production systems and at nearby residences. Ammonia and hydrogen sulfide concentrations also were monitored inside nearby residences. The monitoring showed ammonia and hydrogen sulfide levels within the homes were well below federal guidelines. Work is underway in the Air Dispersion Laboratory to test the impact such things as cleaners, pet accessories and smoking may have on ammonia concentrations within a home. (Hoff)

- **Emissions sampling techniques.** Research is being conducted on sampling techniques for assessing odors and gases. A wireless sampling system has been developed that can remotely sample air at locations up to 10 miles from a transmitter. Samples are initiated with prescribed weather patterns as dictated by research needs. (Hoff)
- **Poultry emissions – Part 1.** Work has been completed to develop baseline information on ammonia emission factors for poultry operations as influenced by housing, manure management and time of year. House-level emission factors for laying hens and broilers have been established by monitoring 10 layer houses and 12 broiler houses for one year. Study findings have been disseminated to producers, poultry industry professionals and the academic community via presentations, extension publications, Web publication, educational workshops and journal articles. Funded by the USDA, in collaboration with the University of Kentucky and Pennsylvania State University. (Xin)
- **Poultry emissions – Part 2.** Work is in progress that seeks practical means to mitigate ammonia and odor emissions from poultry manure. To date effects of dietary manipulation and surface application of some manure amendments have been evaluated, with promising results. Several intermediate reports are available. Funded by the U.S. Poultry and Egg Association, Iowa Egg Council and Agricultural Experiment Station. (Xin, Koziel, Bregendahl)
- **Poultry emissions – Part 3.** Iowa State researchers are leading a \$1.1 million dollar project to quantify air emissions from poultry production houses. Emissions monitoring began in 2006 at broiler facilities in Kentucky. The project is a joint effort with University of Kentucky and funded by Tyson Foods. It will provide baseline data on ammonia emission rates from commercial broiler houses. (Burns, Xin, Hoff)
- **Air quality part of new curriculum.** A National Comprehensive Nutrient Management Plan (CNMP) Development Core Curriculum was completed by Iowa State University, in a collaborative extension education effort with University of Tennessee, Michigan State University, Purdue University, University of Idaho and the Natural Resources Conservation Service. Air quality is one of the 10 curriculum modules. The module includes presentations and learning exercises on air quality concerns and technologies. The \$290,000 project was funded by a USDA/CSREES Extension Education Water Quality grant. (Burns, Lara Moody, Agricultural and Biosystems Engineering)
- **ISU professor leads national panel.** Iowa State is coordinating a 14-member national environmental scientific panel that provides research-based information resources, technical advice and recommendations for the United Egg Producers regarding air emissions for the U.S. egg industry. The panel consists of representatives from the egg industry, the USDA and leading researchers of land-grant universities. It is chaired by Iowa State's Hongwei Xin.

- **U.S. Pork Center of Excellence.** Iowa State is home for the U.S. Pork Center of Excellence, a new focal point for national pork industry research and producer education. Air quality is the center's first research priority. The new center was developed as a collaboration of 20 land-grant universities, the U.S. Department of Agriculture and national pork industry groups, and opened in July 2005.
- **Manure applicator training.** The Iowa Manure Applicator Certification program mandates annual training for confinement site and commercial manure applicators. The Iowa Department of Natural Resources contracts the program to ISU Extension. Iowa State faculty, staff and field specialists plan and conduct workshops that provide information on regulatory requirements and odor control management practices. (Angela Rieck-Hinz, Agronomy)
- **Best management practices on the Web.** A \$47,000 grant from the National Pork Board was used to collate research on best management practices (BMP) for minimizing air quality concerns and to create a searchable database on effectiveness, economics, advantages and disadvantages of BMPs. An online, interactive "decision tree" allows users to select a substance (ammonia, hydrogen sulfide, odor) and a specific area of concern (housing practices, storage practices, application practices) before clicking on possible solutions. Go to <http://www.extension.iastate.edu/airquality/practices/homepage.html>. (Stalder, Powers, Rieck-Hinz; Maynard Hogberg, Animal Science)
- **Swine air quality management on the Web.** Iowa State, through a \$103,000 contract with the National Pork Board, is creating a Web-accessible and searchable catalog of research efforts related to environmental management practices used in pork production facilities. There is a section on air quality management practices and the majority of the research papers in the database are related to air quality at pork production facilities. (Burns, Moody, Raj Raman, Agricultural and Biosystems Engineering)
- **Air quality and animal agriculture on the Web.** The Animal Agriculture and Air Quality Web page is updated continuously. It includes a policy and regulations page, plus links to current news, research reports, publications and ISU faculty serving on the College of Agriculture's Air Quality Issue Team. The site at <http://www.extension.iastate.edu/airquality/> gets about 1,150 hits per month. (Rieck-Hinz)
- **Free quarterly newsletter on the Web.** The *Iowa Manure Matters - Odor and Nutrient Management Newsletter* is a quarterly, eight-page publication made available at no cost to subscribers. Currently 7,700 copies are distributed. The newsletter includes articles related to odor control strategies, air quality issues and regulations. It is available at <http://www.extension.iastate.edu/Pages/communications/EPC/>. (Rieck-Hinz)
- **More air quality publications on the Web.** ISU Extension publications regarding air quality best management practices, producer practices, odor measurement and the science of odor are available on the Web at <http://www.extension.iastate.edu/airquality/pubs.html>.