

**Odor and Air Quality Research and Extension Summary**  
**December 2008**

Researchers at Iowa State University 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.

From 2003 through June 2008, Iowa State received grants totaling \$6.2 million for research on air quality and livestock odor. Broadening the grant awards to include manure management, the total for the same period increases to \$7.6 million. ISU's College of Agriculture and Life Sciences also invested \$435,000 in air quality and livestock odor research. In 2003-2008, 44 externally funded projects addressed research and extension issues on air quality/odor, animal waste and manure management.

Below are related examples of research and extension activities at Iowa State:

**Addressing air quality with a more complete understanding of emissions**

- **Air emissions from turkey barns.** Iowa State is leading a multi-state project, with University of Minnesota, to quantify air emissions from turkey barns in Iowa and Minnesota. The two-year, \$500,000 project is funded by the U.S. Department of Agriculture National Research Initiative – Air Quality Program and supplemented by the Iowa Turkey Federation. Data collection began in May 2007 for the Iowa site and October 2007 for the Minnesota site. (Hongwei Xin, Robert Burns, Hong Li, Steve Hoff, Jay Harmon, Jacek Koziel, *Agricultural and Biosystems Engineering*)
- **National Air Emissions Monitoring Study.** Iowa State is part of the first nationwide project to quantify emissions of ammonia, hydrogen sulfide and particulate matter from swine, poultry and dairy. The \$14.6 million project is funded by the National Pork Board, the National Chicken Council, the National Milk Producers Federation and the United Egg Producers, via a not-for-profit organization called the Agricultural Air Research Council. The study is led by Purdue University and is overseen by the U.S. Environmental Protection Agency. The study is conducted at 21 sites in nine states. Data collection in Iowa began in July 2007 at a swine gestation and farrowing operation and will continue until mid-2009. (Koziel, Hoff, Harmon)
- **Odor emissions and chemical analysis.** Iowa State is part of a multi-state project to quantify odor and odor-causing volatile organic compound emissions from swine and poultry barns in Iowa, Indiana and Minnesota. The two-year, \$460,000 project is funded by the U.S. Department of Agriculture National

Research Initiative – Air Quality Program and is conducted on selected sites participating in the National Air Emissions Monitoring Study. Data collection in Iowa began in December 2007. (Koziel, Hoff)

- **Development of reference methods for air emissions measurement.** Iowa State University is participating in a multi-national project that aims to develop reference methods for measuring air emissions from stationary and open sources associated with animal production operations. The two-year project is funded by the French government. (Xin)
- **Poultry emissions modeling.** Iowa State is participating with the University of California-Davis in a project looking at modeling gaseous emissions from animal housing facilities. Of the \$500,000 project, \$100,000 came to Iowa State to 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. (Xin)
- **Aerodynamics of airflow around livestock buildings.** Airflow around livestock buildings is more complex than previously assumed. National Soil Tilth Laboratory scientists in cooperation with Bill Eichinger from the University of Iowa have conducted studies over both swine grow-finish buildings and poultry buildings, funded by the Iowa Egg Council, to understand the airflow processes. These studies have shown the effect of tree barriers on the atmospheric turbulence, plus how turbulent structure changes when air encounters a building and then again as air moves downwind from the building. (John Prueger, Jerry Hatfield, *National Soil Tilth Laboratory*)
- **Wind tunnel simulations of air flow.** Wind flow around buildings is complex and conducting field scale studies is expensive and difficult to compare different building arrangements or landscape features such as tree barriers. A low wind-speed wind tunnel was developed in the National Soil Tilth Laboratory and is being used to quantify the effect of buildings and their arrangement on the landscape on the exchange processes. A combination of high frequency wind measurements with observations of smoke movement around the building are being used to calibrate air flow and dispersion models. (Tom Sauer, Hatfield)
- **Air quality over beef feedlots.** A cooperative study between the National Soil Tilth Laboratory and Kansas State University is being conducted over a beef feedlot in Kansas to evaluate the volatile organic compounds (VOC) and particulates emitted from the feedlot surface. These studies are being conducted throughout the year to capture the seasonal patterns of the emissions and the changes in VOC composition. (Steve Trabue, *National Soil Tilth 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. Ammonia and hydrogen sulfide concentrations also were monitored near and inside nearby residences. The monitoring showed ammonia and hydrogen sulfide levels within the homes were well below federal guidelines. Work has been conducted 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)
- **Mass transfer modeling validation for emissions.** Iowa State partnered with University of Minnesota to quantify air emissions from swine manure storage systems simulated with a microwind tunnel. The \$430,000 project was funded by the U.S. Department of Agriculture National Research Initiative – Air Quality Program. Data is being used to build predictive models for emissions of ammonia, hydrogen sulfide and odorous VOCs from manure. (Koziel)
- **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 and referred journal articles are available. Funded by the U.S. Poultry and Egg Association, Iowa Egg Council, Midwest Poultry Research Program and Agricultural Experiment Station. (Xin, Koziel; Kristjan Bregendahl, *Animal Science*)
- **Poultry emissions – Part 3.** Iowa State researchers led a \$1.1 million dollar project to quantify air emissions from poultry production houses. Emissions monitoring was conducted for one year at two broiler facilities in western Kentucky. The project was a joint effort with University of Kentucky and funded by Tyson Foods. A final report was produced in May 2007 that provides baseline data on ammonia emission rates from commercial broiler houses. (Burns, Xin, Li, Hoff, Lara Moody, *Agricultural and Biosystems Engineering*)

## Addressing odors by feeding innovative animal diets

- **Dietary manipulation to mitigate air emissions from layer houses.** Iowa State is participating in a multi-state project that demonstrates the effects of different dietary strategies on gaseous emissions, hen performance, manure nutrient values and production economics under commercial production settings. ISU researchers will demonstrate the impacts of three diets (control diet, diet containing DDGS, and diet containing a proprietary formulation) on the response variables. The three-year, \$813,000 project is being funded by the USDA Natural Resources Conservation Service Conservation Innovation Grant program and matching funds from industry partners – American Egg Board, Iowa Egg Council, United Egg Association, US Poultry and Egg Association and National Corn Growers Association. Data collection began December 2007. (Xin, Li, Burns, Bregendahl; Stacey Roberts, *Animal Science*; Jim Kliebenstein, *Economics*)
- **Effects of DDGS on microbial populations in laying-hen intestine.** A study is ongoing that evaluates the effects of feeding dietary DDGS to laying hens on the populations of pathogenic bacteria in the hen's intestine. DDGS diet has previously been shown to reduce ammonia emissions of the laying hen. The purpose of this study is to learn the underlying mechanisms for the ammonia reduction. Funded by the Iowa Egg Council. (Xin, Roberts, Bregendahl; Darrell Trampel, *Veterinary Medicine*)
- **Federal-ISU swine diet research.** Scientists in the USDA-Agricultural Research Service Swine Odor and Manure Management Research Unit located at Iowa State are tackling swine odor at its source: inside the pig. The federal unit, in collaboration with ISU animal scientists and agricultural and biosystems engineers, is formulating diets that lessen odor-causing compounds. One way that's been found to control nitrogen-containing compounds such as ammonia is to reduce protein intake by giving pigs less soybean meal and balancing the diet with crystalline amino acids. Research shows for each 1 percent reduction in dietary crude protein, ammonia emissions are reduced 8 to 10 percent. The unit also is exploring how sulfur-containing odorants may be altered. (Brian Kerr, *ARS*; Xin, Burns, Koziel)

## Addressing air quality by building on innovative discoveries

- **Treatment of odorants and pathogens by catalytic photooxydation.** Iowa State is leading research to develop simultaneous treatment of odorous gases and airborne pathogen emissions with UV light. Research has been funded by Binational Agricultural Research and Development (\$48,000) and the National Pork Board (\$40,000). Up to 100% of odor and all target odorants were removed with short irradiation using UV light. Relative humidity, UV wavelength, energy dose and relative humidity affect the removal rate of target odorants. Preliminary cost assessments were made based on real ventilation rates and measured odorant concentrations. It was found the operational cost of UV would be a fraction of the cost of biofiltration. (Koziel, Hoff; Jeff Zimmerman, *Veterinary Diagnostic and Production Animal Medicine*; William Jenks, *Chemistry*; Johannes van Leeuwen, *Civil, Construction and Environmental Engineering*)

- **UV treatment of exhaust air.** Iowa Pork Producers Association provided \$40,000 for exploratory research in mitigation of ammonia in exhaust air with UV light. Preliminary experiments showed up to 65 percent removal of ammonia from air. Work will continue until fall 2009. (Jenks, Koziel, van Leeuwen)
- **Mitigation of odorous compounds in multistage scrubbers.** During a faculty improvement leave, Jacek Koziel is working with Dutch researchers at Wageningen University and Research Center on improved assessment of odor and odorous gases removal by full-size scrubbers treating exhaust air from swine and poultry barns in The Netherlands. Novel methods and approaches for monitoring and optimization of scrubber operation are being developed. The multistage scrubber technology is used for mitigation of ammonia, particulate matter and odor on an increasing number of Dutch farms. (Koziel)
- **Wireless H<sub>2</sub>S sensor network.** Efforts to develop a wireless hydrogen sulfide detection system for use in swine housing show more research is needed on a multi-point detection system to adequately monitor in-house Hydrogen sulfide (H<sub>2</sub>S) concentrations and gain more knowledge about the characteristics of H<sub>2</sub>S bursts released during slurry agitation. The objective of this project is to quantify the spatial distribution of H<sub>2</sub>S that workers and swine in pork production facilities are exposed to in different production facility types during different operating conditions. The network of sensors will be placed in deep pit swine facilities and used to collect data during normal operating conditions, as well as during pit agitation and pumping events. Simultaneous multiple-point H<sub>2</sub>S concentration data will be used to identify the spatial distribution of H<sub>2</sub>S concentrations that occur within the growing area of a swine facility. Results from this study will be used to make recommendations to increase worker and animal safety. Funded by the Iowa Pork Producers Association and the National Pork Board. (Burns, Xin, Hoff, Nir Keren, Ember Muhlbauer, *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, Burns)
- **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. (Trampel, Xin; Angela Green, *Agricultural and Biosystems Engineering*)
- **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, Green)
- **Odor dispersion.** A USDA grant of \$480,000 has been used to investigate odor dispersion from swine facilities. Iowa State was the lead institution in a three-state effort that included University of Minnesota and University of Nebraska. The project involved 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. That project built on

another 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. The monitoring data was used to provide calibration data for the Community Assessment Model for Odor Dispersion (CAM), a recently published odor modeling approach for making site selection decisions. (Hoff, Harmon, Koziel)

- **Odor dispersion computer model.** Calibration efforts continue on the Community Assessment Model for Odor Dispersion (CAM). The computer model helps 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)
- **Survey of CAM users.** A survey is being developed to help evaluate the effectiveness of the Community Assessment Model for Odor Dispersion (CAM). The survey will be sent to everyone who has had a CAM run done for a proposed facility. Questions will cover perceived accuracy, problems encountered, needed improvements and overall satisfaction with the process. Five to 10 producers will be asked to participate in a more detailed, one-on-one survey. After receiving the producer's approval, neighbors will be approached. Producers also will be asked to explain the results of the model to evaluate their level of understanding and determine what educational tools would be helpful. Information collected through this survey will be used to improve the process of using CAM from the producer's perspective. Funded by Iowa Pork Producers Association. (Harmon, Hoff; John Tyndall, *Natural Resource Ecology and Management*)
- **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)
- **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 funded 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 captured the most particulates, and although the trees were still alive, their leaf surfaces were completely encrusted. Trees at 35 and 45 feet from fans also captured particulates when compared to a control, although total particulate capture at these distances was less than that at 25 feet. (Tyndall, Joe Colletti, Jan Thompson, *Natural Resource Ecology and Management*; Hoff)

- **Wind tunnel and field tests of vegetative buffers.** With support from the National Pork Board, USDA National Soil Tilth Lab and ISU scientists are working in the field and in the lab to determine the effectiveness of vegetative wind breaks or buffers for capturing particles and reducing odor from swine production facilities. The project will provide needed information for this odor-mitigation practice, including selection of tree species, placement and cost estimates. Data from field experiments will provide direct measurement of efficiency of one buffer. Data from wind tunnel experiments will assess the relative effectiveness of many possible designs. The experiments will examine different tree species and three types of swine confinement buildings — natural ventilation, tunnel ventilation and curtain wall ventilation — under various spacings and wind direction. The study includes an economic analysis of costs associated with establishing and maintaining different windbreak designs. (Sauer, Tyndall, Trabue, Richard Pfeiffer, David James, *National Soil Tilth Laboratory*)
- **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)
- **Impact-based odor control.** Researchers are working on using on-site atmospheric stability conditions to control for odors, recognizing when and if odors might be present at neighboring locations. This technique controls for odors at only those times required, thus reducing operating costs for any odor control technology that mitigates odors emitted from barn fans. (Hoff, Harmon)
- **Olfactometry laboratory.** The Olfactometry Laboratory in the agricultural and biosystems engineering department uses trained panelists to evaluate the strength of odors from livestock sources. The lab evaluates odor-reduction technologies being tried at livestock facilities and helps producers determine when their management methods are effective. (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 analytical equipment.** The Iowa Egg Council provided \$15,000 towards acquisition of a state-of-the-art thermal desorption system that has been interfaced with an existing air analysis system. The Atmospheric Air Quality Laboratory developed quantification methods for air sampling and analysis for major odor-causing VOCs. This new analytical capability is being used on several air quality monitoring projects, development and assessment of

mitigation technologies, and development of waste management strategies (Koziel, Xin, Burns, Hoff)

- **Improved technology for downwind sampling.** Iowa State is collaborating with Microanalytics, a company developing improved tools and technologies for odor and odor-causing compounds sampling and analysis. The one-year, \$340,000 project is funded by the U.S. Department of Agriculture – Small Business Innovation and Research. The project is designed to develop and test novel alternative materials for odor bags. Improved materials will help the field of odor measurement, particularly livestock odor assessment and mitigation. (Koziel)
- **A look inside cow's stomach.** Iowa State researchers developed a novel gas probe for real-time sampling of gases inside a cannulated cow's stomach. Most of the odor-causing gases were then measured inside the rumen's headspace. This approach also could be used to evaluate metabolism of certain feed amendments. (Koziel, Xin)
- **Finding one odor source among many others.** Iowa State collaborated on novel field odor sampling and analysis work to locate and identify an intermittent offensive odor source in a general area with several other sources of potentially offensive odor. The approach uses field sampling with solid phase microextraction and analysis on gas-chromatography-mass spectrometry-olfactometry to resolve this long-standing, unresolved odor issue with respect to downwind citizenry in a uniquely complex, diverse and densely co-located source industry mix. (Koziel)
- **National air quality self-assessment tool.** Iowa State, in conjunction with 10 other states, has partnered to develop an air quality assessment tool through a Conservation Innovation Grant from NRCS. The result of the two-year project will allow producers and/or third party assessors to walk through a livestock operation and determine where a mitigation practice can have the greatest impact on air quality. Producers will select an emission of interest or odor as their primary reduction objective and from there decide where to implement a mitigation strategy as well as estimate the benefit of strategies considered. The multispecies tool will be available to producers considering a new operation or an expansion, or who want to reduce emissions from an existing operation. Tool development is expected to be complete by summer 2009. (Harmon, Shawn Shouse, Kris Kohl, Kapil Arora, Greg Brenneman, *Agricultural and Biosystems Engineering*; David Stender, *Animal Science*; Angela Rieck-Hinz, *Agronomy*)

### Addressing odor through responsive extension and service

- **What is that smell?** The October 2008 issue of Nature magazine published a feature article on Jacek Koziel, associate professor in the agricultural and biosystems engineering department, as a 'master of odor' and highlighted his group's work on livestock odor. Steve Hoff, professor of agricultural and biosystems engineering, also was quoted in the article, the first one by this prestigious magazine to address livestock odor. (Koziel, Hoff)
- **Conference on mitigating air emissions.** The Iowa State University College of Agriculture and Life Sciences in conjunction with University Extension hosted a

national conference in May 2008 on mitigating air emissions from animal feeding operations. The conference provided practical information related to mitigation of air emissions to technical service providers, extension personnel, industry consultants and facility owners and operators. It included 60 technical presentations in the areas of emission prevention, emission capture or treatment, emissions masking or dispersal and facility management and siting. It is expected the proceedings will serve as a practical reference on available mitigation options for some time. There were 272 individuals in attendance from 34 states and five countries. Conference proceedings are available through Midwest Plan Service. (Burns)

- **Faculty serve on national air quality task force.** Hongwei Xin, Robert Burns and Jerry Hatfield are among 25 people appointed in October 2008 to serve two years on a national task force on air quality. Task force members review research that addresses air quality issues related to agriculture and provide recommendations to the U.S. Secretary of Agriculture on the development and implementation of air quality policy and research needs. Other responsibilities include working to ensure intergovernmental coordination in establishing policy for agricultural air quality, assisting federal agencies in correcting erroneous data with respect to agricultural air quality, and ensuring air quality research related to agriculture receives adequate peer review and considers economic feasibility.
- **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.
- **Egg Industry Center.** A new Egg Industry Center has been established in Iowa State's College of Agriculture and Life Sciences. The Center will seek science-based answers on developing more efficient and environmentally friendly production practices, plus growing existing markets, exploring new uses and new markets and enhancing nutrition for the benefit of consumers. The Iowa Egg Council made a \$2 million gift commitment to establish the endowed egg industry program. Hongwei Xin serves as center director.
- **Lending a hand for siting.** Iowa State's Iowa Pork Industry Center continues to assist farmer-clients of the Coalition to Support Iowa's Farmers by providing information and assistance on siting new livestock facilities. In 2008, IPIC had 62 contacts regarding new or existing facilities. Staff made 23 farm visits and conducted 34 Community Assessment Model runs. Ninety percent of the contacts were related to relatively new or potential new farms and 99 percent were swine-related.
- **U.S. Pork Center of Excellence.** Iowa State is home for the U.S. Pork Center of Excellence, a 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. (Rieck-Hinz)
- **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>. (Rieck-Hinz; Ken Stalder, Maynard Hogberg, *Animal Science*)
- **Swine air quality management on the Web.** Iowa State, through contracts totaling \$113,871 with the National Pork Board, has created and is updating 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. The database is available at <http://environmentalmanagement.pork.org/>. (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 and Life Science’s Air Quality Issue Team. The site at <http://www.extension.iastate.edu/airquality/> gets about 10,000 hits per month and averages 3,500 visitors 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. The newsletter includes articles related to nutrient management, 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>.