Highlights of the Air Quality Education in Animal Agriculture Project

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Abstract. Through the Air Quality Education in Animal Agriculture (AQEAA) project, Land-Grant University specialists from across the U.S. have been collaborating in delivering applied, research-based air quality information to those who work with livestock and poultry producers. The AQEAA project developed Air Quality content on the Animal Manure Management eXtension website in collaboration with the Livestock and Poultry Environmental Learning Center (LPELC). The Air Quality web content makes widely accessible the educational resources produced by this project for use in developing the knowledge base and skills of professionals who interact [and pre-professionals who plan to interact] with livestock and poultry producers. The online materials include 18 written publications, 3 videos, and 16 recorded webinars (webcasts). Also made accessible are selected research and technology summaries as well as online content produced by other organizations. The AQEAA project also developed the skills of professionals regarding air quality topics via professional development events. Website usage information, participant polls, and stakeholder surveys provided evidence that the resources developed by this project are being utilized and that delivery of the information via eXtension has been an effective means of communicating information on this topic. Webcasts were especially effective in communicating information and providing continuing professional development. AQEAA-sponsored workshops were effective in providing in-depth air quality information and experiences to more than 300 professionals. Collaboration with the LPELC facilitated having a ready eXtension outlet for project materials and is providing continued, sustainable access to online information from this project.

Keywords. Emissions, regulations, policy, extension, information.
Introduction

Over the past three decades, animal agriculture in the United States has increasingly experienced many of the air quality concerns that were previously experienced by European counterparts, albeit in different economic, environmental regulation, production and social contexts. These growing air quality concerns produced a period of dedicated federal funding for air quality research and increased engagement by commercial enterprises in developing and marketing control technologies. New research and technologies produced a growing need to prepare and disseminate credible information to livestock and poultry producers. One major challenge to overcome in achieving these goals included the fact that Extension air quality specialists were relatively few in number and this expertise was thinly distributed across the U.S. Another challenge was that livestock and poultry producers still are relatively large in number, are not naturally inclined to look for information that does not pertain to the productive aspects of their operations, and generally do not normally interact directly with air quality specialists; so engaging them would be difficult.

In 2004, conversations began in earnest to form a national air quality extension team and to look at models being developed for delivering information to large audiences using electronic media. In 2005, following successful efforts in the water quality area, the concept of forming an Extension ‘community of practice’ around air quality emerged and a proposal was submitted to fund this effort during the early development of eXtension. Although the proposed project was not funded, the effort did get a critical mass of specialists and ideas in place to keep developing the concepts further. A subsequent pairing of extension and educational project objectives under the wings of the now-established Livestock and Poultry Environmental Learning Center (LPELC) resulted in USDA funding for what would become the Air Quality Education in Animal Agriculture (AQEAA) project. The goal of this project was that well-prepared professionals will equip livestock and poultry producers and other decision makers in making well-informed decisions based upon best-available research. Specific project objectives were to:

1) Provide a modular curriculum complete with educational materials on air quality to those who are educating pre-professional students in college courses, and make components of this material readily usable by those professionals who advise and interact with livestock and poultry producers;
2) Expand professional and pre-professional access to researchers and leading national air quality experts;
3) Provide professionals, pre-professionals, and lay audiences with on-demand access to timely, research-based information and educational materials on air quality in animal agriculture; and
4) Provide coordinated, focused air quality education and training, actively engaging professionals and pre-professionals in experiential learning.

Methodology

The approach utilized in this project was to work in small teams – organized around topics and key responsibilities – to produce extension/educational content, while collaborating with the LPELC to promote, disseminate, and evaluate these materials (Figure 1). Curriculum development teams met in person and virtually to outline what educational content was needed and what was feasible to produce, and to determine appropriate media with which to deliver the information (e.g. written publication, video, lab exercise, etc.). Each learning module leader was availed some grant funds to help coordinate team activity and facilitate content development.
An LPELC professional was employed part-time as Project Manager, which provided a very strong linkage between the project team and the LPELC. The Project Manager coordinated team communications, developed the Air Quality web pages and maintained their web content, facilitated production of many of the webinars, and coordinated stakeholder surveys and web utilization data for evaluation of the project. The project leadership team communicated by conference call on a biweekly basis, and the full project team met annually.

A stakeholder survey was conducted early in the project (2007) to assess topics of interest and specific needs for developing educational materials. Among the general findings gleaned from the survey responses was fairly clear evidence that stakeholders were most interested in understanding why issues were important or of concern and what can be done by individual operations to reduce the extent of the issue. Therefore, materials that addressed the issues or mitigation of pollutants were generally prioritized.

Special efforts were initiated (and supported via subawards) to produce videos within the ‘Issues’ learning module and to document field measurement methods utilized in the National Air Emissions Monitoring Study. Similar focused efforts were utilized to develop and deliver in-depth professional development training material.

All curriculum materials were subjected to peer review by review team members and/or others having expertise in the subject matter. Editing, layout and electronic publication services were provided by EdMedia staff at the University of Nebraska-Lincoln, or by subawardee institutions in the case of video productions. The webinars were coordinated through the LPELC and delivered using Breeze® and Adobe Connect® via webcasting services provided by Iowa State University.

Shortly after the project was underway, the LPELC migrated its web content over to the new eXtension platform under the community of practice moniker of Animal Manure Management. All AQEAA web content was placed under an Air Quality web content area within this Animal Manure Management eXtension umbrella.

In a modification of original plans, the in-depth professional development training was provided at large regional and national events in collaboration with other like-minded efforts rather than at new project-specific workshops. The main motivations for adopting this revised approach were to expand the participant base and to more efficiently and effectively utilize collective resources for organizing, promoting and delivering the knowledge- and skill-development sessions.
Data for evaluating the project consisted of web statistics and direct participant feedback. The web statistics were provided through eXtension using web traffic analysis tools such as Google Analytics, and included categorized information on the number of page views, bounce rates, and content viewing times. Direct participant feedback was collected via surveys of newsletter recipients (900-1,500 total over project period), online polls during live webinars, post-training event questionnaires, and voluntarily supplied comments.

Results and Impacts

The AQEAA project involved about 50 air quality professionals in one or more aspects of planning, developing, reviewing, and pilot-testing of the curriculum and producing online content. These professionals included extension specialists, university and USDA researchers, and employees of government agencies, such as the USDA Natural Resources Conservation Service (NRCS). Collectively, these professionals formed the National Air Quality Issues Team. While most of the work on this project occurred within smaller working groups, this overall team did fill an important void in that the resulting dynamic contact list provided a means by which air quality-related communications and notifications could be disseminated quickly.

Curriculum Materials

Fifteen written publications were available online as of 4/15/2012, with another three publications completed and in the queue for publication (See Table 1), and another five publications in review. These project publications were written and illustrated for use in college courses and by professional practitioners. The publications are 4-18 pages in length and include references for readers to find additional information.

Table 1. Listing of eXtension publications produced by the AQEAA project.

<table>
<thead>
<tr>
<th>Module</th>
<th>Publication title</th>
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<tbody>
<tr>
<td>Air Quality Issues</td>
<td>Atmospheric ammonia: Understanding its effects</td>
</tr>
<tr>
<td></td>
<td>Ammonia emissions from cattle feeding operations, Part 1 of 2: Issues and emissions</td>
</tr>
<tr>
<td></td>
<td>Dust emissions from cattle feeding operations, Part 1 of 2: Sources, factors, and characteristics</td>
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<td></td>
<td>Hydrogen sulfide emissions from open/dry-lot cattle-feeding operations*</td>
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<td></td>
<td>Air quality regulations and animal agriculture</td>
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<tr>
<td>Air Quality Measurement</td>
<td>Evaluating air quality in livestock housing environments*</td>
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<td></td>
<td>Bioaerosol sampling in animal environments</td>
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<tr>
<td>Pollutant Mitigation</td>
<td>Airborne emissions sources and management on animal agriculture production systems</td>
</tr>
<tr>
<td></td>
<td>Ammonia from cattle feeding operations Part 2 of 2: Abatement</td>
</tr>
<tr>
<td></td>
<td>Dust emissions from cattle-feeding operations, Part 2 of 2: Abatement.</td>
</tr>
<tr>
<td></td>
<td>Manure additives for improving hog farm air quality</td>
</tr>
<tr>
<td></td>
<td>Diet and feed management to mitigate airborne emissions</td>
</tr>
<tr>
<td></td>
<td>Poultry litter amendments</td>
</tr>
<tr>
<td></td>
<td>Covers for mitigating odor and gas emissions in animal agriculture: An overview</td>
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<tr>
<td></td>
<td>Impermeable covers for odor and air pollution mitigation in animal agriculture</td>
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<tr>
<td></td>
<td>Permeable covers for odor and air pollution mitigation in animal agriculture</td>
</tr>
<tr>
<td></td>
<td>Biofilters for odor and air pollution mitigation in animal agriculture</td>
</tr>
<tr>
<td></td>
<td>Wet scrubbers for mechanically ventilated animal facilities</td>
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</table>

* Publication was in press as of 4/15/2012.
The AQEAA publications were well-received, with the online publications being accessed over 900 times within the first three months of 2012. The AQEAA project team also recently fielded a request to utilize these publications for use as curriculum resources in Canada.

Three videos were produced that present prominent air quality issues associated with animal agriculture, as listed below. A broad audience exists for understanding these issues – including high school students and the general public – for whom visual presentation and seeing the story are often essential, so videos were selected as the primary medium for disseminating this information. Each video is 10 to 15 minutes in length. The first video produced, which addressed ammonia deposition in Rocky Mountain National Park, was awarded an Extension Educational Material Certificate of Excellence by the American Society of Agronomy in 2009, as well as an ASABE Educational Aids Blue Ribbon in 2010.

- Ammonia deposition in Rocky Mountain National Park: What is the role of animal agriculture?
- Odors from livestock farms: A case study in Nebraska.
- Dust from cattle feedyards: A case study from Texas.

Laboratory exercises were also developed for teaching air quality modeling concepts. The exercises utilize a simple dispersion model (computer software) and graphical user interface. The model can be operated in connection with real-time measured weather inputs or independently using weather data files.

**Webcasts**

Sixteen web-based seminars (webinars) were produced and digitally recorded by this project. Each resulting webcast included individual presentations, recorded question-and-answer sessions, and resources (such as quizzes) for obtaining continuing professional development credit. The hour-long AQEAA webcasts are viewable on-demand at the Animal Manure Management eXtension website in their entirety or in shorter sessions by presentation.

- Ammonia, the Air-Water Interface;
- Hydrogen Sulfide, How Serious an Outdoor Air Quality Concern;
- Federal Air Quality Regulations and Update on the National Air Emissions Monitoring Study;
- National Air Emissions Monitoring Study (NAEMS) Selected Results, Discussion, and Significance;
- Air Emissions from Cattle Feedyards and Dairies;
- Greenhouse Gas Emissions from Animal Agriculture;
- Carbon Footprint of Animal Agriculture;
- Air Emissions after Manure Land Application;
- Greenhouse Gas Emissions Estimation and Reporting;
- Animal Ag’s Role in Greenhouse Gas Production: A Closer Look;
- Feeding Strategies to Reduce Animal Air Emissions;
- Planning Livestock & Poultry Facilities for Reduced Odor Risk;
- Mitigating Air Quality Issues Using Vegetative Environmental Buffers;
- National Air Quality Site Assessment Tool for Beef and Dairy;
- National Air Quality Site Assessment Tool for Swine and Poultry; and
- Controlling Ammonia and Air Emissions in Poultry Facilities.
Participation in the sixteen air quality webcasts was strong, averaging 130 attendees per live broadcast over the duration of the project. Viewing of archived webcasts was also strong as the aggregate of all LPELC archived webcasts were accessed over 1100 times per month. Web statistics for January – March of 2012 showed 506 visits to archived AQEAA webinars, even though the last live AQEAA webcast was recorded in September of 2011.

Clientele groups represented by webcast viewers included:

- Regulatory agency staff 18%
- Public sector - NRCS 17%
- Public sector - Cooperative Extension 13%
- Public sector - research 12%
- Private sector 11%
- Public sector - other 7%
- Producer 7%
- Environmental organization 3%
- Ag organization 4%
- Public policy/legislative 2%

During all of the air quality webcasts, we received 1800 responses to questions that asked “As a result of this presentation how much did you improve your knowledge about ____?” Results showed that 85% of the responders believed that their knowledge base on the subjects covered was improved moderately to significantly.

Table 2. Improvement in knowledge of air quality topic reported to be derived by participating in an AQEAA webinar [responses collected during all sixteen webinars].

<table>
<thead>
<tr>
<th>Extent of improvement</th>
<th>Responses</th>
<th>Share of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 (significantly improved)</td>
<td>302</td>
<td>16.8%</td>
</tr>
<tr>
<td>4</td>
<td>542</td>
<td>30.1%</td>
</tr>
<tr>
<td>3 (moderately improved)</td>
<td>684</td>
<td>38.0%</td>
</tr>
<tr>
<td>2</td>
<td>197</td>
<td>10.9%</td>
</tr>
<tr>
<td>1 (no improvement)</td>
<td>75</td>
<td>4.2%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,800</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Questions along the lines of, “How likely are you to _______?” (use a particular tool or recommend a particular practice) were asked on six occasions. The results showed that 79% of those responding were likely to implement or recommend implementation (Table 3) of the presented tool or practice, each of which was expected to have positive air quality impact.

Table 3. Likelihood of live AQEAA webinar viewers using or recommending the described air quality management tool or practice (responses collected during 6 webinars).

<table>
<thead>
<tr>
<th>Likelihood of use or recommendation</th>
<th>Responses</th>
<th>Share of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 (very likely)</td>
<td>20</td>
<td>12.4%</td>
</tr>
<tr>
<td>4</td>
<td>41</td>
<td>25.3%</td>
</tr>
<tr>
<td>3 (likely)</td>
<td>67</td>
<td>41.4%</td>
</tr>
<tr>
<td>2</td>
<td>23</td>
<td>14.2%</td>
</tr>
<tr>
<td>1 (not likely)</td>
<td>11</td>
<td>6.8%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>162</strong></td>
<td><strong>100.1%</strong></td>
</tr>
</tbody>
</table>

* Totals may slightly differ from 100% due to rounding off of values.
Opportunities for continuing education were regularly provided for webcast viewers, with nearly 200 individuals applying for continuing education credits. Professional engineers and certified crop advisors were the primary professionals taking advantage of these opportunities, but several other types of professionals have participated.

Webcast viewers reported that their main reasons for participating were for professional development, providing recommendations to producers, and influencing regulatory or policy development. Viewers of live webinars reported that they influence an average of 136 producers, so each live webinar had a potential sphere of influence of over 10,000 producers.

As a direct offshoot of these webcasts, a regional webcast series, Manure de Jour, was initiated in the Northeast (led by Penn State Extension faculty) in 2010. This offshoot program demonstrated stakeholder value in the imitated form of information delivery, and it furthered local dissemination and prospective implementation of information from national webcasts.

**Web Presence**

The AQEAA project facilitated the initial and continued development of the Air Quality web section of the Animal Manure Management eXtension website <http://www.extension.org/pages/Air_Quality_in_Animal_Agriculture>. The Air Quality web section contains and makes widely accessible the educational resources produced by this project. The online materials include written publications, videos and recorded webinars (webcasts). Abbreviated versions of videos and selected webinars were also produced and then made available as YouTube videos. Also accessible on the website are selected research summaries and technology summaries, as well as links to content developed by other collaborating organizations. In collaboration with USDA NRCS, six online courses were promoted and made accessible with four of these courses focusing on air quality. The on-line course series was awarded an ASABE Educational Aids Award in 2011.

- Air Quality, Climate Change, and Energy
- Why Should We Care About Air Quality?
- Air Quality Resource Concerns
- Greenhouse Gases and Carbon Sequestration

The Air Quality web content area grew to be a widely used source of science-based information and educational resources on air quality matters for animal agriculture. The main Air Quality webpage experienced over 1300 page views in 2010. In the first quarter of 2012 alone, the air quality information that was made available by this project (everything from webcasts, curriculum resources, research summaries, technology summaries, etc.) was viewed 4,059 times. Meanwhile, the Air Quality website has consistently had low bounce rates (percentage of page viewers who leave without looking at another page) and long average times spent on the webpages relative to other eXtension sites, which implies that most visitors are finding material that is of beneficial interest to them.

As a specific example of the website’s impact, during January of 2009, the page that addressed US EPA’s release of a final rule that clarified required reporting of air emissions under the Emergency Response and Community Right-to-Know Act (EPCRA) was the second most visited page on the entire eXtension system. Several thousand large CAFOs (concentrated animal feeding operations) across the U.S. were potentially impacted by this ruling, and indications were that a significant number of these operations accessed information via the Air Quality website.
**In-Depth Professional Development**

Early in the project period, AQEAA co-sponsored a national conference entitled Mitigating Air Emissions from Animal Feeding Operations, which was held in Des Moines, IA, May 19-21, 2008. This conference included 52 presentations that summarized mitigation systems and their applicability, limitations, and costs. In addition to conference proceedings, a booklet of one-page technology summaries was produced. The individual technology summaries were made publicly accessible in a searchable electronic format within the Animal Manure Management eXtension website. During the first quarter of 2012, these online technology summaries were still visited over 1,300 times.

The conference was attended by over 170 paid participants from across the U.S., plus exhibitors. Participants highlighted two aspects of the conference that were especially helpful in making decisions regarding mitigation technologies:
- Having cost [economic] information present in every presentation and paper; and
- Providing one-page technology summaries available for each technology presented.

AQEAA also supported the development and delivery of workshops/seminars on topics including:
- Evaluating opportunities to reduce air emissions on a livestock or poultry operation (using the National Air Quality Site Assessment Tool, NAQSAT);
- Using tools for assessing the carbon footprint of a livestock operation;
- Appropriate methods of measuring particulate matter from animal production sources; and
- Measuring bioaerosols in animal environments.

These workshops were introduced at the International Air Quality and Manure Management in Agriculture Symposium, which was held in Dallas, TX, September 13-16, 2010. As a co-sponsor of this symposium, the AQEAA project also brought in keynote speakers on air quality and facilitated a panel discussion of animal industry stakeholders on Perspectives on Implementing Control Technologies and BMPs. The four workshops each drew in 15 to 30 attendees. These workshops provided unique, in-depth professional development experiences for attendees, and project engagement in the symposium brought significant exposure to the project and forthcoming educational resources.

Finally, the AQEAA project supported delivery of these and additional air quality presentations at the Western Dairy Air Quality Symposium, which was held in Sacramento, CA, on April 20-21, 2011. Ninety to 110 attendees were present for the presentations. Attendees at this symposium, which included primarily state agency and dairy industry representatives, are engaged in discussions that are at the forefront of air quality regulation and management in the U.S. The AQEAA project saw events like this one as optimal ways to effectively engage the professionals who will drive change in policy and practice affecting animal agriculture with relevant research results and science-based information.

**Conclusion**

At the conclusion of the project, stakeholders (LPELC newsletter recipients) were invited to respond to a survey on the AQEAA project. Based upon the [fifty-eight] responses received, responders looked most often to live webinars and the AQEAA webpages for information. A clear majority of responders indicated that they found the live webinars AQEAA webpages to be “quite or very useful materials”, while each main category of AQEAA resource was found to be at least “somewhat useful” by a large majority of responders.
The following is an abbreviated listing of responder comments (all submitted anonymously) on how respondents plan to use the information gained from AQEEA materials:

“Very helpful in improving my knowledge when I am asked questions
“Its nice to have science-based, unbiased research and information easily accessible on this and many other topics.”
“This is a source for information I can feel confident is current and most correct.”
“Positive influence on farmers to volunteer the adoption conservation practices (BMP) to benefit their business, become farmer friendly in the community, and minimize the adverse effect on the environment.”
“Validation of where we are at and what we are doing in relation to others.”
“Easy access to current information, prompt reply from the ask an expert tool, convenience for attending presentation through the webinars.”
“The new fact sheets are great and are really coming in handy when we are trying to explain air quality basics and mitigation technologies.”

Long-term impacts of the developing curriculum can only be measured in terms of prospective benefits. Two indicators of current value are that several college faculty members have requested materials to pilot and subsequently use in their courses, and research teams have contacted our team to collaborate toward delivering extension resources in integrated programs.

Acknowledgements

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