Efficacy of Vegetative Environmental Buffers to Mitigate Emissions from Tunnel-Ventilated Poultry Houses

G. Malone, G. VanWicklen, and S. Collier
University of Delaware

Species: Poultry (Broiler, Layer, Turkey)
Use Area: Animal Housing
Technology Category: Environmental Barriers
Air Mitigated Pollutants: Ammonia, Dust and Odor

Description:

Poultry farms are facing unprecedented challenges! Emissions of ammonia, dust, odor, and noise from poultry operations are an increasing concern from both a neighbor-relations and an environmental standpoint. Odor, dust, feathers, and noises associated with poultry operations are issues the poultry industry must deal with to maintain good neighbor-relations. With more frequent use of tunnel fans during warm weather and more outdoor activities by neighbors, summer is often a critical time for nuisance complaints to surface. During the past few years, there have been an increasing number of legal cases involving nuisance complaints associated with neighbors next to, and downwind of tunnel-ventilated poultry houses. At the same time we are seeing an increase in human population in many poultry producing areas. As many poultry producing areas in the USA become more urbanized, the likelihood of increased nuisance-related complaints will only increase. These issues are exacerbated as the size of our poultry farms increase.

To further add to the poultry industry's future challenges, emissions from poultry houses may be regulated in the future. The National Ambient Air Quality Standards under the Clean Air Act has been revised to include a particulate matter standard of 2.5 µm diameter. Both ammonia and dust may fall under this regulation. In some coastal areas of the U.S. there is the added concern that ammonia emissions from poultry houses may be a significant source of atmospheric nitrogen and this source of nitrogen may stimulate algae growth particularly during the summer.

The adoption of sound, practical, efficient, and cost-effective technologies to address neighbor-relations and environmental issues will be increasingly important in the poultry industry. One such technology is a vegetative environmental buffer (VEB). A VEB is a strategic planting of combinations of trees and shrubs around poultry houses to meet specific objectives on each side of the farm. The poultry industry has not previously recommended the planting of tall crops, shrubs, or trees around houses fearing they will interfere with natural ventilation during the summer in open sidewall housing. However, this no longer a major concern as industry shifts to tunnel ventilation, black-out, and totally enclosed housing systems.

The three basic goals in the design of a VEB planting are a visual screen, windbreak and shade, and vegetative filter (Figure 1). As described by Malone and Donnelly (2001), a VEB may foster improved **neighbor-relations** by filtering dust, feathers, odor, and noises from houses; provide a visual screen of the houses and the routine farm activities; and improve public perception of the industry via a proactive, "green" initiative. Potential **environmental** benefits include a reduction in ammonia, dust, odor, surface, and groundwater nutrients leaving the proximity of farms, and a practice that promotes carbon sequestration. A properly designed VEB program may also have **production** benefits for tunnel-ventilated poultry farms. Trees strategically planted for windbreaks, shade, and to filter air-borne pathogens offer potential energy conservation and improved farmstead biosecurity.

Mitigation Mechanism:

In the review by Tyndall and Colletti (2000), they reported shelterbelts ameliorate odors by dilution, encourage dust and aerosol deposition by reducing wind speeds, physical interception of dust and aerosols, and act as a sink for chemical constituents of odor. They also concluded shelterbelts have the potential of being an effective and inexpensive odor control technology particularly when used in combination with other odor control methods. Furthermore, plant foliage has the capability of utilizing ammonia through its stomata by means of glutamine synthetase-glutamate synthase pathways (Yin et.al, 1998). Patterson et al (2006) recently found a VEB consisting of hybrid poplar and Norway spruce opposite poultry house fans were able to trap aerial ammonia emissions in plant tissue. As shown in Figure 2, leaves, particularly conifers with complex leaf shape, also have the ability to capture particulates emitted from poultry house fans.

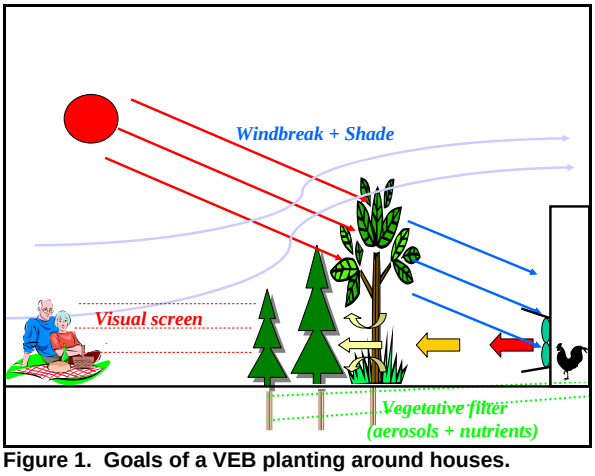

Figure 1. Goals of a VEB planting around houses.

Figure 2. Dust accumulation on conifers opposite fans.

Applicability:

Although the focus of this VEB research has been on mitigation of emissions from tunnel-ventilated poultry houses, it would also have application for other power-ventilated, totally enclosed livestock housing. In 2002 a three-row planting of trees was installed opposite two, 1.2 meter (4 ft) diameter tunnel fans to evaluate vegetative environmental buffers (VEB) as a means of mitigating emissions from poultry houses. The first row, 9.1 meters (30 ft) from the fans was 4.8 meter (16 ft) high bald cypress, followed by 4.3 meter (14 ft) high Leyland cypress and the outer most row of 2.4 meter (8 ft) high Eastern red cedar. Over the next six years the efficacy of these trees to reduce total dust, ammonia and odor was determined. Measurements were taken at 1.2 meter (4 ft) height on 47 days during peak fan operation with market-age broilers. The relative change in concentration across this 6.7 meter (22 ft) wide vegetative buffer found the VEB significantly reduced total dust, ammonia and odor by 56%, 54% and 26%, respectively. Wind direction relative to the fan plume and the type of crop next to the VEB appeared to influence the efficacy of vegetation to reduce odor. The reduction in odor by the VEB "appeared" to be less when winds were blowing towards the fans and when the crop adjacent to the VEB allowed better dispersion of the odor plume. Dust and ammonia concentration was influenced by these factors to a lesser degree.

Limitations:

The selection of plant material and their arrangement must be designed for each side of the poultry house, for each farm and must address the following goals of the program; vegetative filter, visual screen and shelterbelt. The minimum distance of the VEB from fans appears to be 10 times the fan diameter. Deciduous trees or evergreens with waxy leaves planted as the first row opposite fans tend to withstand the high-particulate loads best. To insure livability and maximize growth of the VEB, an effective irrigation and weed control program is essential. Poultry farmers are strongly encouraged to seek technical assistance in the design, implementation and maintenance of a VEB. Retrofitting a VEB around existing houses poses many challenges due to boundary, structural, traffic patterns and other land-use restrictions. The ideal time to plan and install a VEB is before construction of the poultry houses.

Cost:

Average cost for implementing a VEB on an existing broiler farm is ~$5,500. Cost range from $1,500 for a limited one-row planting to provide a visual screen of the farm, and up to $12,000 for multi-row plantings around the outside perimeter of the poultry houses. There is limited information on design and efficacy of VEB plantings between houses. Locally, cost-share programs have provided support to cover most of the costs associated with implementing this program.

Implementation:

Plantings to address neighbor-relations have been a driving factor in VEB establishment. An estimated 1/3 of all poultry farms have established VEB on the Delmarva Peninsula. A VEB is also a requirement for a new house loan from one of the major lending institutions. In an effort to be responsive to escalating neighbor-relations and emissions issues, the local poultry industry has hired a coordinator to promote, develop literature (*i.e*. VEB Tool-Kit, 2007); and facilitate in the design, installation and maintenance of VEB on poultry farms. Other regions of the USA such as Pennsylvania and Iowa are also actively involved in research and implementation of VEB for poultry and livestock farms.

Technology Summary:

Vegetative environmental buffers appear to be a practical and cost-effective technology to partially abate emissions from modern tunnel ventilated poultry houses. Research to date suggests a properly designed VEB will disperse, capture, assimilate and/or dilute ammonia, dust and odor emitted from fans. They tend to be more effective for ammonia and dust abatement than for odor. Adoption of this practice by the Delmarva poultry industry has been driven primarily by its neighbor-relations benefits. The visual screen aspect of a VEB coupled with a proactive measure to address increasing urban encroachment and air quality issues are driving forces in acceptance of this technology. Poultry farmers are encouraged to seek technical assistance in the design, implementation and maintenance of a VEB. In addition to cost-share and technical assistance from local and state agencies, the regional poultry industry trade association for the Delmarva Peninsula has hired a coordinator to assist with adoption of this program on poultry farms.

Additional Resources:

The Benefits of Planting Trees Around Poultry Farms. http://www.rec.udel.edu/Poultry/tree_buffer.pdf
VEB Tool-Kit. http://www.dpichicken.org/download/VEBTK.pdf
Using Shelterbelts to Reduce Odors Associated with Livestock Production Barns.
http://www.omafra.gov.on.ca/english/crops/facts/info_odours.htm

Acknowledgments:

The University of Delaware received funding to support VEB research from the following:
US EPA Section 319 funds
US Poultry and Egg Association
USDA, NRCS Agro forestry
NRI Air Quality grant with Iowa State and Penn State Universities

References:

Patterson, P.H., Adrizal, R.M. Hulet, R.M. Bates, C.A.B. Myers, G.P. Martin, R. Shockey and M. van der Grinten. 2006. Pages 453-457 in Proc. Workshop on Agric. Air Quality: State of the Science (June 5-8, 2006). Potomac, MD, USA.

Yin, Z-H., W. Kaiser, U. Heber, and J. A. Raven. 1998. Effects of gaseous ammonia on intracellular pH values in leaves of C3- and C4- plants. Atmosp. Environ. 32:539-544.

Tyndall, J., and J. Colletti. 2000. Air Quality and Shelterbelts: Odor Mitigation and Livestock Production: A Literature Review. Final Report. Forestry Department, Iowa State University, Ames, IA, USA.

Malone, G.W. and D. Abbott-Donnelly. 2001. The Benefits of Planting Trees Around Poultry Farms. University of Delaware Bulletin #159. http://www.rec.udel.edu/Poultry/tree_buffer.pdf

VEB Tool-Kit. A Guide to Vegetative Environmental Buffers for Tunnel-Ventilated Poultry Houses. 2007. Published by Delmarva Poultry Industry, Inc. http://www.dpichicken.org/download/VEBTK.pdf

Point of Contact:

George Malone
University of Delaware
16483 County Seat Hwy
Georgetown, DE 19947
USA
(302) 856-7303
malone@udel.edu
http://www.rec.udel.edu/Staff/malone/malone.htm

As published in the proceedings of:
MITIGATING AIR EMISSIONS FROM ANIMAL FEEDING OPERATIONS CONFERENCE
Iowa State University Extension
Iowa State University College of Agriculture and Life Sciences
Conference Proceedings
Sponsored by:
NRI Air Quality Extension & Education
Iowa Farm Bureau Federation
Iowa Egg Council
Iowa Pork Industry Center
Iowa Pork Producers Association
U.S. Pork Center of Excellence