Vegetative Shelterbelts on Poultry Farms for Air Emission Management

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Introduction

Animal agriculture faces increasing environmental challenges related to air and water quality. Ammonia and other emissions from poultry houses are commonly cited as air quality concerns, while dust and odors are at times considered nuisance issues for downwind neighbors. Dust particles are able to adsorb and transport substantial amounts of odorous compounds and ammonia. Properly positioned trees and shrubs, as well as other structures that disrupt air flow around the farm, provide the opportunity to reduce dust leaving the site and to reduce odor and other aerial emission concentrations by mixing and diluting with fresh air.

Benefits of Vegetative Shelterbelts for Air Quality

Vegetative buffers planted as windbreaks have been used for many years to reduce and redirect winds. Some applications include protecting crops or orchards from wind damage and minimizing pesticide drift from agricultural and forest sprays. In addition, providing a visual screen and improving the aesthetic appearance of a site is often recommended to reduce the potential for complaints from neighbors.

Approaches to minimize air pollution from livestock and poultry facilities include minimizing the production (i.e., phase feeding, diet manipulation), minimizing the amount emitted from facilities (i.e., biofilters for odor, acid scrubber for ammonia) and minimizing concentrations of what is released and observable by neighbors through dispersion and dilution.

Several physical and social dynamics have been related to vegetative buffers for livestock and poultry air emission management. These include (1) enhancement of vertical atmospheric mixing leading to enhanced dilution/dispersion, (2) filtration through particle interception and retention in the buffer, (3) particulate fallout due to gravitational forces enhanced by reduced wind speed and (4) improved producer-community relations using highly visible odor management practices. In recent years, well-designed and properly planted vegetative buffers have been recommended as one of the best management practices (USDA NRCS, 2007; Scott, 2007) in the eastern United States.

Vegetative Shelterbelt Vs. Structural Windbreak

A windbreak is a fence, wall, line or growth of trees, etc., that is designed to change how wind moves across a site. As wind blows against a windbreak, air pressure builds up on the windward (or upwind) side, and large quantities of air move up and over the top or around the ends of the windbreak. A vegetative shelterbelt (also called a vegetative buffer or windbreak buffer) is a strategic planting of a combination of trees and shrubs around poultry houses.

A structural windbreak (also called wind barrier or snow fence) can be built from artificial materials, like cloth, open synthetic material (curtain) or wooden slats of various porosities depending on design objectives. Structural windbreaks have been demonstrated on mechanically ventilated swine farms to mitigate and disperse air pollutants out of exhaust fans (Bottcher et al., 2000). Vegetative buffers have the advantage of typically being more aesthetically appealing than an artificial windbreak. When the benefits of a windbreak are needed immediately, an artificial windbreak has the advantage over a vegetative buffer. The use of artificial windbreaks is usually less expensive than planting large trees/shrubs and quicker than planting smaller plants and waiting for them to grow until they are effective. Conceptually, it is possible to install an artificial windbreak at the same time as smaller vegetation is planted. This would give immediate results and provide the time needed to grow an effective vegetative buffer. The remainder of this publication focuses on vegetative shelterbelts. For more information on structural windbreaks, contact your county Extension office.

General Design Considerations

The physical effectiveness of a vegetative shelterbelt in air emission mitigation is site specific and ultimately a function of a group of factors such as shelterbelt design, ambient weather conditions, landscape topography, direction and distance to the nearest neighbor and the amount of emissions. As opposed to other emission-mitigating technologies, such as air scrubbers and biofilters, that are mechanistic with higher maintenance requirements and cost, shelterbelts may increase in effectiveness over time. As the trees grow larger with more branches, their ability to mitigate odor through particulate filtration and create wind turbulence can become increasingly efficient.

Shelterbelts can be established on all sides of poultry houses, on selected sides such as those adjacent to a main access road or directly opposite tunnel ventilation fans. The movement of the poultry industry from natural ventilation to tunnel ventilation and solid sidewalls makes shelterbelts a more viable option than in the past, as natural air movement is no longer needed for ventilation. Ideally, a properly designed vegetative shelterbelt needs to account for prevailing summer and winter winds and key visual pathways. When the budget is a constraint to establish full windbreaks around a poultry farm, a cost-effective way to adopt this technology is to strategically select locations where benefits can most effectively be realized.

Shelterbelts established in the vicinity of tunnel ventilation fans need to be able to endure the dusty emissions from the discharge fans. Several factors need to be considered, including plant species, spacing, number of rows, distance from fans and long-term management activities such as pruning. The plant characteristics desired for the vegetative shelterbelt species include plenty of limbs near ground level, moderate to fast growth, drought tolerance to survive dry and rocky soils (as typically found in Arkansas' poultry production areas), tolerance to full sun, dust and ammonia tolerance, hardy growth throughout Arkansas, minimum wild bird attraction, non-invasive and, if possible, native. Research has recommended mixing the species used for increased diversity to reduce the risk of wholescale pest/pathogen loss and to achieve a balance of rapid growth and longer healthy life for a robust shelterbelt system. The minimum distance of the shelterbelts from fans (to avoid impacting fan airflow) appears to be 10 times the fan diameter. Deciduous species or evergreens with waxy leaves planted as the first row opposite fans tend to withstand the high-particulate loads best. Plant spacing both within and between rows is determined by the expected diameter of the plantings when mature. Staggering or offsetting of the plants in adjacent rows provides them room to grow while still providing a solid wind and visual barrier. When mature, the vegetative buffer should extend from the ground surface to several feet above the tops of the fans. A taller buffer would provide additional screening of the houses if desired.

Costs

Costs for vegetative shelterbelts are highly variable and site/design specific. The three categories of expenses are (1) site preparation costs (plowing, spraying, disking), (2) tree establishment costs (purchase, planting and mulching) and (3) long-term maintenance costs (replanting, weed and pest control, irrigation). The majority of the total cost is upfront and is tied to the cost of the initial planting stock. Older, larger nursery stock can be considerably more expensive than bare-root seedlings. But this higher investment may "buy time" in shelterbelt establishment, especially if a companion short- to mid-term artificial windbreak is not desired. The long-term maintenance cost will be associated with how hardy and well suited the plants are for the site.

Demonstration Findings

A vegetative shelterbelt system consisting of a four-row, 100-foot-long planting of trees was installed downwind of four 48-inch tunnel cone fans on the south side of House #1 at the University of Arkansas (UA) Applied Broiler Research Farm near Savoy, Arkansas (Fig. 1). The total width of this planting was 30 feet. The distance between the first row of trees and fans was approximately 60 feet. The crape myrtle (*Lagerstroemia* sp.), a popular woody ornamental shrub/small tree known throughout southeastern U.S. landscapes, was planted in two staggered rows, comprised of twenty-five 6.8-foot plants (7-gallon containers). Ten 4.5-foot Green-Giant Arborvitae (15-gallon containers) and an equal number of Cryptomeria (commonly called Japanese Cedar) were planted as the third and fourth rows (Fig. 2). Since the shelterbelt was installed as part of a three-year demonstration project, larger plants were used than would normally be planted (Fig. 3).

Fig. 1. Aerial photo showing the location of the discharge fans and vegetative shelterbelt installed at the UA Applied Broiler Research Farm.

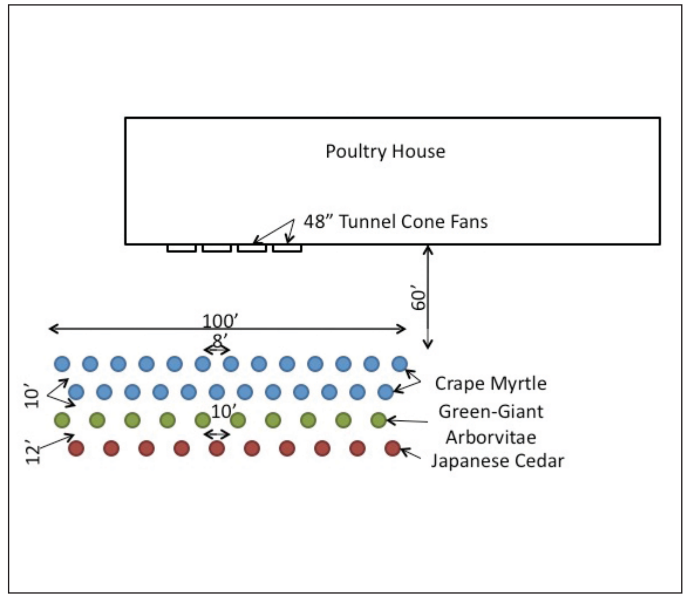

Fig. 2. Diagram of the vegetative shelterbelt planting at the UA Applied Broiler Research Farm showing distance from the fans, spacing in-between and within rows for different plant varieties.

Drip irrigation was installed after planting and used in the first and third summer (2008, 2010) when it was extremely dry.

After a week of tunnel fan use, trees were covered with dust exhausted from fans of the chicken houses (Fig. 4). Crape myrtles, which were planted as the two front rows, were heavily loaded. This indicated that a vegetative buffer planted strategically on a poultry farm is effective in trapping and depositing dust in the adjacent area and, as a result, potentially reduces odor dispersion. Rain was able to wash the dust off the leaves and branches.

Forty-four out of 45 trees survived. On average, the crape myrtles grew 40 percent (from 6.8 to 9.4 feet) cumulatively in height over three growing seasons (2008 to 2010), while the Green-Giant Arborvitae and Japanese Cedars (Cryptomeria) grew 135 percent (from 4.5 to 11.2 feet) (Fig. 5).

Fig. 3. Rows of trees planted opposite a bank of tunnel ventilation fans.

Fig. 4. Leaves of crape myrtle were covered with dust blown from the tunnel fans of the chicken houses.

Fig. 5. Vegetative shelterbelt established on the poultry farm after three growing seasons.

Trees were mulched with woodchips each spring to prevent weed growth and preserve moisture in the root zone. A fungal disease (tip blight) was diagnosed on several Japanese Cedars in March, 2009 (Fig. 3). Fungicide sprays (Broad Spectrum Lawn and Garden Fungicide) were applied five times between late March and mid-April. The branches with obvious tip blight were pruned to prevent infection progressing into underlying shoots. Such pruning should be done during a period of dry weather (a couple of days pre- and post-pruning). Japanese beetle infestation on crape myrtles was observed for a short period (two weeks) in summer 2008 but prevailed from late June to early August in 2009 and 2010. In all years, insecticide sprays (Liquid Carbaryl Garden Spray) were applied to protect the foliage. The selection of hardy native species may reduce the need for long-term maintenance compared to the ornamental varieties used in this demonstration. We chose the ornamentals due to the need to purchase larger plants to accelerate the results of the demonstration.

Planting Procedure and Management Considerations

Proper site preparation will decrease tree mortality and increase tree growth. A well-prepared site will ultimately save time, money and effort for replanting. Site preparation includes strip-killing existing vegetation and disking or cultivating soil. Irrigating young trees should minimize losses and can be accomplished in various ways. Drip lines with emitters provide the most efficient form of irrigation and prove to be a good investment. An automatic timer may also be a wise investment to avoid any additional management burden. As the trees mature, the need for irrigation should diminish.

Three alternatives are available for weed control: chemical control, mechanical control and mulch. The use of various herbicides to control weeds around trees is an effective tool, provided the proper herbicide is selected and all label instructions are followed. Always seek advice from your local greenhouse, garden center or county Extension office on which herbicide and application procedure is best suited to your own needs. Cutting weeds with a rotary mower or string trimmer is a common method of mechanical weed control. It is a cost-effective approach with less environmental concern. However, mowing is also a major cause of tree loss, with young seedlings being the most vulnerable. Mulch around your plants offers a no-hassle, environmentally friendly means of weed management and decreases the chances of plant damage from mowing and trimming equipment. Mulch can consist of natural materials (woodchips, shredded bark), specially designed weed-suppressing fabrics or plastic films. A 48-inch-wide roll of black plastic or landscape fabric that runs the entire length of the row provides an easily maintained weed barrier.

Summary

A well-designed and positioned vegetative shelterbelt on a poultry farm can be used as a practical air emission mitigation technology. It not only provides a means of filtering and disrupting air transport downwind but also adds appealing landscape to the facility, demonstrating producers' environmental stewardship. Shelterbelt alone is unlikely to solve the air quality issues, but it may provide producers with one more tool, used together with other best management practices, to reduce the environmental impact.

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