Department of Animal Science

USING VEGETATIVE BUFFERS FOR AIR EMISSION MANAGEMENT ON TENNESSEE POULTRY FARMS

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Agriculture has been identified as one of the anthropogenic (human origin) activities that produce substantial amounts of greenhouse gases (GHGs). Agricultural systems add carbon (C) to the atmosphere by burning fossil fuels in machinery, using chemicals and other inputs, and disturbing soil. Agriculture is considered one of the main sources of anthropogenic N_2O and CH_4 (Rivera and Chara, 2021). However, agriculture is also an accumulator of C, offsetting losses when organic matter accumulates in the soil. In addition, windbreaks used in support of agricultural production contribute to GHG mitigation through C storage in woody biomass and soils. Vegetative buffers used as windbreaks have been used for many years to redirect winds. In recent years, providing a visual screen and improving the aesthetic appearance of a site is an often-recommended practice to poultry growers to reduce the potential for complaints from many individuals. Well-designed and properly planted vegetative buffers are now a recommended best management practice for poultry growers in the eastern United States (Belt et al., 2007).

Benefits of vegetative buffers

Several **positive physical and social dynamics have been related to vegetative buffers** for livestock and poultry air emission management (Liang et al., 2011). These include 1) enhanced vertical atmospheric mixing leading to improved 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. Vegetative buffers (Figure 1) absorb ammonia, precipitate out dust and particulate matter by slowing wind speed from poultry house exhaust fans, and deflect the odor plume above the buffer. Odor tends to travel downwind in a plume near the ground. Disrupting that plume and diluting it with prevailing winds is important in today's highly charged atmosphere where many individuals have a negative attitude toward poultry farms.

Design considerations

It's best to have a multi-row (3-4 rows work well) vegetative buffer with different varieties in each row. A monoculture planting is dangerous in that a pest or disease could easily pass to

every plant with catastrophic results. A diverse variety of plant species can offer seasonal interest and the loss of one or two plants won't be as obvious. Species selected must be adapted to soils, site conditions and the climate zone (see Figure 2). Species must be tolerant of dust and ammonia emissions from exhaust fans. No plants on the Tennessee noxious weeds list (TN-EPPC Invasive Exotic Pest Plants in Tennessee, December 2009, 2nd Edition) shall be planted. Select and maintain tree and shrub species with foliar and structural characteristics to optimize interception and absorption of airborne chemicals and odors. For optimal carbon sequestration, **select plants that have higher rates of sequestration in biomass and soils** such as deciduous hardwoods with denser wood and faster growth such as sycamore, hawthorns, cottonwood and American elm. Minimize soil disturbance during establishment and maintenance of the windbreak/shelterbelt. Pollinator needs should be considered when selecting tree or shrub species. Species diversity, including use of native species, should also be considered to avoid serious losses due to species-specific pests or diseases. Consider enhancing aesthetics by using evergreen species or species with features such as showy flowers, brilliant fall foliage or persistent colorful fruits.

Shelterbelts near the vicinity of poultry house tunnel exhaust fans must endure the emissions from the fans. Therefore, several factors must be considered, including species selection, spacing between plants and rows, number of rows, distance from fans to shelterbelt, and long-term activities to maintain the shelterbelt. Also consider the following factors when choosing plants:

- Mature height and spread of the plants
- Soil type
- Drainage and moisture conditions
- Wind conditions
- Precipitation
- USDA hardiness range (see Figure 2)
- Growth rate
- Native or introduced species
- Farm layout (location of roads, loadout areas and neighbors)

Desired plant characteristics include numerous limbs near ground level to assist with screening; tolerance to full sun, drought, dust, and ammonia; hardy growth in the poultry production areas of the state; moderate to fast growth rate; non-invasive; and native is best. Evergreens with waxy leaves (hollies) or deciduous species should be the first row nearest the exhaust fans as these varieties **tolerate the high particulate load from the fans** better than other species. White and loblolly pines are poor choices in vegetative shelterbelts opposite tunnel ventilation fans because they cannot tolerate high ammonia levels.

At maturity, the vegetative buffer should extend to a minimum height that is several feet above the tops of the exhaust fans. This will ensure adequate mixing and disruption of the odor plume. Keep in mind that faster growing plants, which provide quick visual screening, are often short-lived and will require replacement sooner than slow growing species. Spacing between plants and rows will be determined by the expected size of the plants at maturity. Enough space must be left at planting for the plants to fill in this space as they mature. Stagger the plants in adjacent rows. This will allow additional room to grow but will also allow for a solid wind and visual screen at maturity. Faster growing plants should be placed farther apart than slower growing

plants. Recognize that the crown and root spread from hardwood species will be greater than from evergreens.

Some general guidelines for spacings between plants within the same row are as follows:

- Small shrubs 4 feet to 12 feet tall – 4 feet to 6 feet apart
- Large shrubs and small trees 12 feet to 30 feet tall – 6 feet to 10 feet apart
- Large trees over 30 feet tall – 10 feet to 14 feet apart
- Evergreen trees – 8 feet to 14 feet apart

It's likely that **some plants may not survive the initial shelterbelt establishment** and some replanting should be expected. Promptly replace any plants that do not survive for the first three years after establishment. A successfully functioning poultry windbreak depends on having all the rows full. Recognize the importance of proper care and management during the early years of shelterbelt establishment. Understand the importance of weed control and water (possibly an irrigation system) to successful establishment. There are numerous plant varieties that will work when establishing a poultry farm shelterbelt. However, there are several varieties that **ARE NOT** recommended for the Tennessee landscape. The table below lists these plants and why they should be avoided.

Table 1. Plants to avoid in Tennessee shelterbelts.

Plants whose use is strongly discouraged in Tennessee landscapes		
Common Name	**Scientific Name**	**Notes**
Japanese Holly	*Ilex crenata*	Susceptible to root rot
Red Tip Photinia	*Photinia x fraseri*	Susceptible to Entomosporium Leaf Spot
Pine (some species)	*Pinus spp.*	Loblolly pine subject to breakage, disease and insect damage from borer/bark beetles. White pine not suited to warmer regions of Tennessee.
Cherry Laurel	*Prunus laurocerasus* *Prunus caroliniano*	Prone to peach tree borer
Indian Hawthorn	*Rhaphiolepis*	Susceptible to Entomosporium Leaf Spot, intolerant of cold open sites, and subject to lace bug injury
Leyland Cypress	*xCupressocyparis leylandii*	**STRONGLY DISCOURAGED.** Susceptible to Seridium canker

Adapted from Reese et al., 2020.

The following table represents plants that have been planted as vegetative shelterbelts on poultry farms in the mid-Atlantic U.S. and have proven to tolerate passive ammonia absorption.

Table 2. Plants proven for shelterbelts on poultry farms.

Botanical Name	Common Name	Hardiness Zone	Size (height by width)	Growth Rate	Native Range
Gleditsia triacanthos	Honey locust	4-9	50 feet by 50 feet	Fast	Pennsylvania to Mississippi, west to Nebraska and Texas
Ilex cornuta x aquifolium	Nellie Stevens holly	6-9	20 feet by 15 feet	Fast	Asia, Europe
Ilex crenata	Japanese holly	6-9	8 feet by 4 feet	Moderate	Japan, Korea, China
Ilex opaca	American holly	5-9	40 feet by 20 feet	Slow to moderate	Massachusetts to Florida, west to Missouri and Texas
Juniperus virginiana	Eastern red cedar	3b-9	40 feet by 20 feet	Moderate	Maine to Florida, west to North Dakota, Colorado and Texas
Picea abies	Norway spruce	3b-7	50 feet by 25 feet	Moderate to fast	North-central Europe
Populus deltoides x nigra	Hybrid poplar	4-7	70 feet by 30 feet	Fast	Sterile hybrid
Salix matsudana	Austree hybrid willow	4-8	60 feet by 15 feet	Very fast	American/Asian hybrid (male)
Salix purpurea	Purpleosier willow	4-7	15 feet by 15 feet	Fast	Europe
Taxodium distichum	Bald cypress	5-9	70 feet by 20 feet	Slow to moderate	Delaware to Florida, west to Missouri and Louisiana
Thuja plicata x standishii	Arborvitae	5-7	60 feet by 20 feet		Hybrid

Adapted from Belt et al., 2007.

Planting and management considerations

Choosing the **proper site and adequate preparation will decrease tree mortality** and increase tree growth. Proper site preparation includes strip-killing existing vegetation and disking/cultivating the soil. A well-prepared site will save time, money and effort for replanting (Liang et al., 2011). Plan on an **irrigation system for young trees** to minimize losses. Drip lines and emitters (perhaps with an automatic timer to lessen management chores) are the most efficient form of irrigation. Irrigation needs should lessen as the trees mature. Consider technical assistance in the design, implementation and maintenance of a vegetative buffer. It's a big investment and you want it to be successful.

Weed control is a must and the options include chemical control, mechanical control and mulch. Various herbicides offer good weed control, provided the correct herbicide is chosen and label recommendations are followed. If unsure, seek advice from your local county Extension office

on the correct herbicide and application rate for your situation. Mechanical control (mowing and/or weed eating) is quite common but can be dangerous and is a major cause of tree loss or damage, particularly with young seedlings. Mulch, which may consist of natural materials like wood chips, bark, plastic films or weed suppressing fabrics, also works well and is less dangerous to the plants than mowing or trimming.

Depending on the design and species plantings used, vegetative buffers can deal with various temporal changes to provide long-term, year-round plume interception with increasing effectiveness as the buffer grows. Tyndall and Colletti (2007) indicate ways that vegetative buffers can mitigate livestock odors including:

- Physical interception and capture of dust and other aerosols as well as gases by trees and shrubs.
- Dilution and dispersion of downwind odor concentrations.
- Land deposition of dust and other aerosols from reduced wind speeds.
- Biological sinks for the chemical constituents of odor after interception.
- Enhancement of aesthetics of poultry production sites and rural landscapes.

As an alternative to various tree species, tall warm-season grasses such as switchgrass and giant miscanthus are also known to tolerate tunnel fan emissions. These grasses have a variety of advantages including:

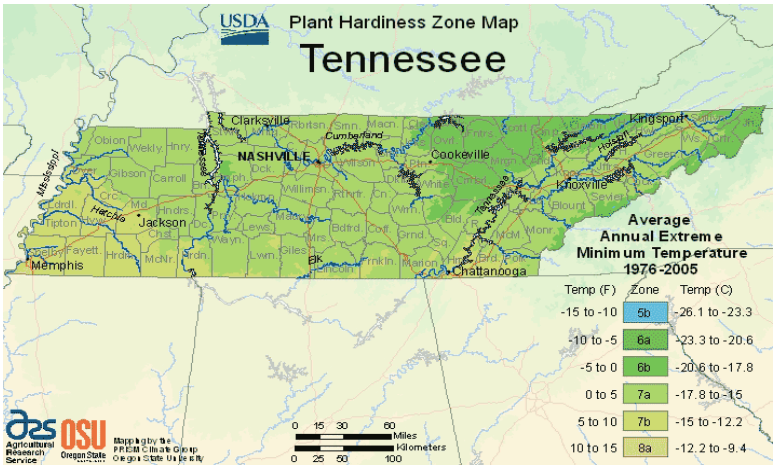
- Active growth during hot and dry periods of summer when tunnel fans are often in use.
- An efficient C-4 photosynthetic pathway.
- Tolerance to hot and dry conditions.
- Tolerance to wet, dry or compacted soils.
- Deer resistance.
- A clump growth pattern (will not spread and become invasive).
- Upright form with stiff stems that can withstand high winds.

Warm-season grasses can be planted as close as 20 feet from the tunnel fans with no reduction in fan performance. Another option related to vegetative environmental buffers that is gaining popularity across the country is **including pollinator-friendly habitats near poultry houses**, expanding the places where bees and other pollinating insects can thrive by including flowering plants in association with the buffer. This can decrease mowing because the pollinator plot area will only need to be mowed once in the fall after the first frost. In addition, pollinator plots will **give a boost to bee populations** and will benefit any local crop farmers in the area whose crops will profit from natural pollination.

Poultry farms can utilize a well-designed and positioned vegetative buffer as a practical air emission mitigation strategy. It adds an appealing landscape to the poultry production facility while filtering and disrupting air transport downwind. Vegetative buffers also demonstrate a producer's **commitment to environmental stewardship**. While a buffer is unlikely to solve all air quality issues, it is one more tool that producers can use together with other best management practices to lessen the impact of poultry farming on the environment.

Figure 1. Vegetative buffer located near poultry house fans.

Figure 2. USDA Plant Hardiness Zone Map.



Source: USDA-ARS https://planthardiness.ars.usda.gov/pages/map-downloads

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