AGROFORESTRY NOTES
AF Note — 41 April 2011

# Windbreaks: A "fresh" tool to mitigate odors from livestock production facilities

## Introduction

Windbreaks (shelterbelts, vegetative environmental buffers) placed around livestock production facilities as *Working Trees* can help mitigate the movement of odors and dust generated by these operations. Four primary factors are thought to contribute to these odor issues:

- Urban expansion has placed many more people into closer contact with agricultural operations.
- Large scale livestock confinement production has led to increased concentrations of manure.
- Heavy concentrations of odor emissions travel across highly modified landscapes relatively devoid of natural barriers.
- Market economics and regulatory policies create limited producer incentives to control activities beyond minimum regulatory requirements.

Windbreaks alone will not prevent these odor problems but can provide farmers and ranchers with a "fresh" environmental tool *(Figure 1)* to help reduce negative visual perceptions and the detection of smell by neighbors and surrounding communities.

**Figure 1.**
A windbreak can significantly change the appearance of livestock production facilities and help filter out odor particles.

Photo credit: Douglas Wallace, USDA NRCS

The potential of windbreaks to mitigate livestock odor arises from the tree/shrub impacts on the fundamental characteristics and physical behavior of the livestock odor plume. These livestock odor plume characteristics are:

- Odor plumes are typically at ground level; often have limited upward movement; are variable; and may be very extensive covering large land areas;
- Odors generated in animal facilities are intense and detectable at appreciable distances; often concentrate and travel on particulates; but odor perception by individuals is highly variable.

## Odor mitigation and management

Odor management should encompass all aspects of the farm operation. General maintenance of the buildings and the nutrition of the feed ration are normal farm management needs that can influence odor emissions. Livestock odor management techniques should address these areas:

- Preventing the generation of odor, including feed additives, aeration, and manure additives.
- Capturing and destroying the odor, including bio-filters, waste storage covers, and organic mats.
- Dispersing the odors, including vegetative or structural barriers, setback distances, and site selection.

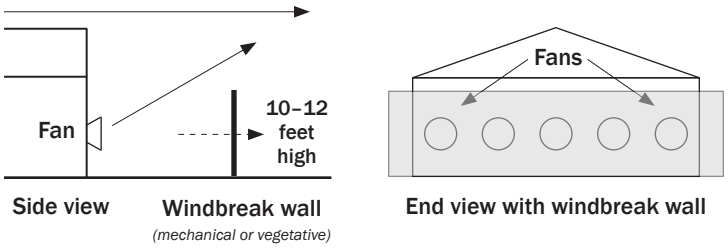


**Figure 2.** Example layout of a windbreak wall for a typical tunnel ventilated building. Windbreak walls should be placed at minimum four fan diameters downwind from the fans.
(Adapted from Bottcher et.al., 2000)

In particular, structural or vegetative barriers placed near exhaust fans on tunnel-ventilated livestock and poultry buildings appear promising, primarily because the air flow from the exhaust fans are diverted upward *(Figure 2)* and allow trapping of particulates in and on the barrier. These effects promote mixing of the odorous, dusty airflow with the wind passing over the building, so that the plumes of air pollutants originating from the fans are made larger and extend higher. In addition, by reducing the forward momentum of the exhausted air, dust and odor will settle out at lower air speeds near the building and on the barrier surfaces.

The location of the barrier affects the diversion of airflow from exhaust fans. Barriers that are designed as windbreak walls should be placed at minimum four fan diameters downwind from the fans or 50 feet, whichever is farther, to deflect fan airflow without back pressures, extend high enough to fully intercept the plumes of airflow issuing from the fans (i.e. 10 to 12 feet high for typical buildings) and to protect woody plantings from desiccation.

## Odor windbreak design

Windbreak design and planting plans will vary for each livestock facility and farm field site. When designing a windbreak for any facility, consider the following: landowner goals, design details including prevention of hazards, appropriate site preparation, planting details, and maintenance.

**Landowner goals**
Determine goals and objectives based on the landowner's desired future conditions for the planning area as compared to the existing conditions. This includes the desired resource uses, resource problem reductions, and on-site and off-site ecological protections. As resources are inventoried, their interactions analyzed, and alternatives formulated, objectives may need to be reviewed and modified. Items to consider for odor mitigation include optimizing visual screening, enhancing dilution, and promoting particulate interception.

**Design details**
Always design air quality windbreaks to not only optimize tree/odor bio-dynamics but also to prevent potential on-site hazards. While all sites are different, key potential hazards are:

- *Problematic snow deposition:* Prevention requires an understanding of prevailing winter wind direction(s), an understanding of windbreak snow dynamics across a range of species and planting configurations (e.g., spacing, number of rows, etc.), minimum planting distances from roads and other areas frequented by vehicles, buildings, and other structures (e.g., manure storage, feed structures, etc.).
- *Impeding site and building ventilation:* Prevention requires an understanding of summer and winter wind direction(s), an understanding of necessary wind flow through a site (e.g., naturally ventilated buildings require non impeded wind flow in the summer), and understanding the different building ventilation requirements to prevent unwanted back pressure. Adjust windbreak porosities/densities to meet air movement needs for naturally ventilated livestock confinement systems. For mechanically

ventilated buildings, allow adequate space from ventilation intakes and outlets or maintenance areas to keep airflow optimized.

- *Impeding on-site traffic visibility:* Prevention requires an understanding of key on-site truck and other vehicle "sight lines" needed to and from access roads.

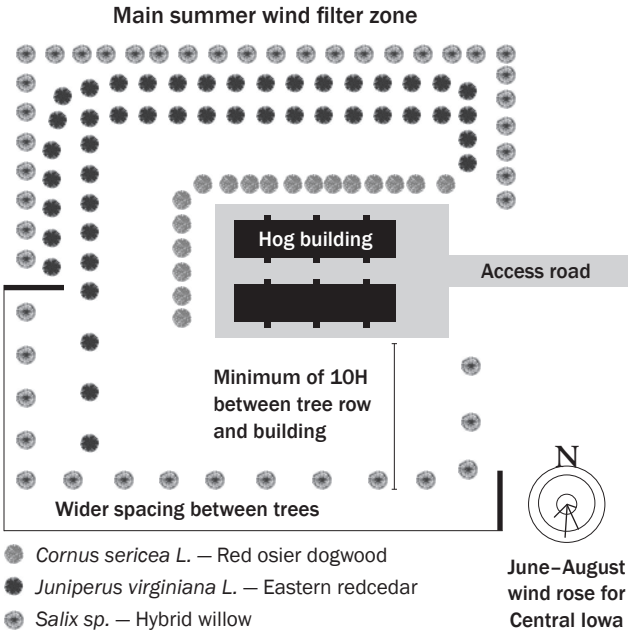


**Figure 3.** Diagram of a windbreak system planted around a hypothetical naturally ventilated (side curtain) hog facility. Planting orientation is guided by the summer wind patterns for the area. Predominant summer winds originate from south to slightly southeast. Plantings to the south and south-west/east show wider spacing between trees, this is to allow for adequate summer wind to vent the buildings. The windbreaks along the north-west and north show three rows and tighter spacing to provide a zone of filtering surface area and turbulence to aid in dilution of odor plume. Three species are shown for visual and biodiversity.
(Adapted from Tyndall, J.C. and J.P. Colletti. 2007)

Windbreaks should consist of at least one to three rows of conifer and deciduous species *(Figure 3)*. Two to three rows of trees can provide an ideal 60 percent windbreak density (or 40 percent porosity) for odor control. Windbreaks may be wider with more tree rows to incorporate design needs or address additional objectives, such as improved wildlife habitat. Shrubs are generally planted in the outside or inside rows, followed by conifers with deciduous hardwoods towards the middle or along the downwind side where they can grow more efficiently. Tree varieties and placement for the windbreak should be managed to maximize odor interception and dilution of air, and reduce odor leaving the source. Where site and facility conditions merit and allow, place plantings (not necessarily windbreaks) around the entire perimeter of the odor source. Even a site with a windbreak on one side that is strategically placed and designed can make a difference.

**Retrofitting windbreaks:** Many retrofits are land limited and will require additional land incorporation (and therefore added expense) in order to have successful tree plantings. The ideal situation is to incorporate tree plantings into initial site designs so as to best prepare the site for tree planting and to allow for comprehensive plantings.

Livestock buildings and manure storage areas are best located within the quiet zone, 50 to 100 feet downwind of the windbreak. Windbreaks should also be at least 50 to 100 feet from access roads and driveways to prevent snowdrifts from blocking farm vehicles during winter and create visual impairment zones. Always remember that hazard risk changes as trees grow. What is not a hazard initially can become one as trees grow larger. Use wide "between row spacing" to increase particle surface area contact, enlarge canopy areas, and to help accelerate plant growth.

## Odor windbreak planting and maintenance

**Appropriate site preparation**

Most animal facilities, particularly on windbreak retrofit situations, are effectively construction sites with highly compacted soils, minimal top soil and poor drainage. Appropriate site preparation will reduce tree mortality, increase tree growth and ultimately save money and time. Depending on the site any or all of the following may be necessary:

- deep plowing or subsoiling
- summer fallow (chemical carry-over)
- cover crops
- drainage practices
- buffer strips
- vegetation control
- bedding

**Planting details**

Selection of trees and shrubs to plant should vary for each livestock facility. Species selection should be based on site characteristics, (e.g. soil type, drainage, common wind conditions—speed and direction, annual precipitation), species adaptation and land user objectives.

Select several species of trees and shrubs for use in windbreaks to prevent loss or destruction of the entire windbreak if outbreaks of insect pests or tree diseases occur. Having diversity also offers a better chance for tree survival and offers increased wildlife benefits. To maximize particulate trapping, select species with high leaf surface roughness (plants with leaf hairs, leaf veins, small leaf size), complex leaf shapes, large leaf circumference to area ratios and medium to rapid growth rates.

**Maintenance**

Once established, the windbreak should be maintained at a density of 50 to 65 percent for best results for wind management. Weed management is absolutely critical during the first five years of tree establishment (maintain until the trees are free to grow) for optimum growth and plant health. Monitor vegetation for insect, disease, dust accumulation, and death problems and treat accordingly (e.g. chemical spraying, pruning, replanting, foliage washing). Supplemental watering may also be necessary to allow for high survival and adequate growth.

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