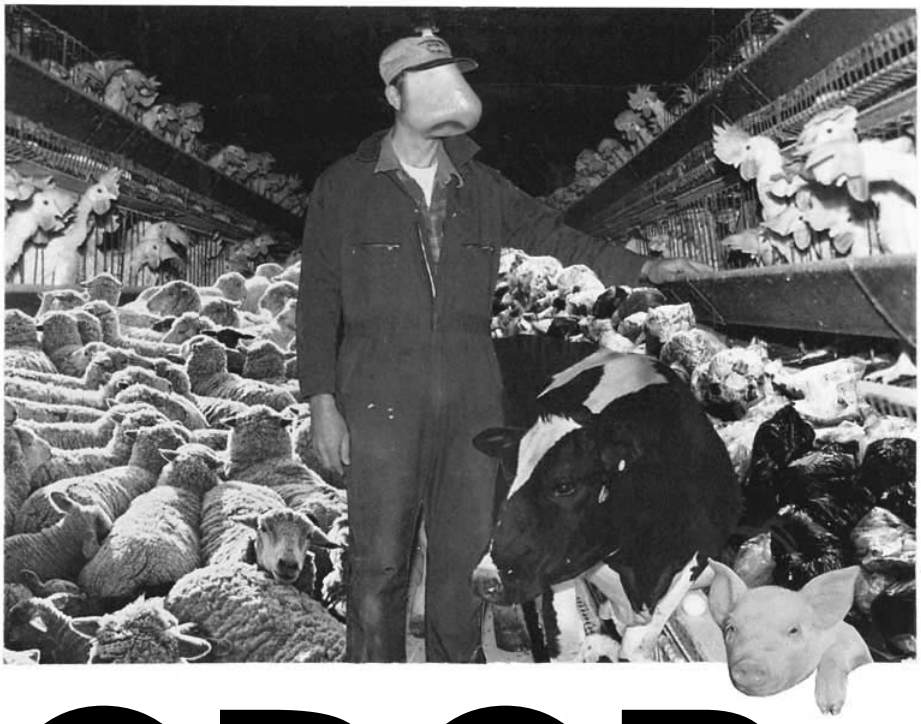
USDA Inside Agroforestry
National Agroforestry Center
Spring 2002



You may have heard it referred to as the "smell of money," but some people just think it stinks. It's part of any livestock operation, sewage treatment plant, industrial sites like paper mills, or landfills… *odor*. The good news is that agroforestry practices like windbreaks can help—-these *Working Trees* really earn their keep! Plant species, density, and placement are elements to consider when designing a buffer for odor. Keep in mind that a well-designed vegetative screen is also pleasing to the eye and can provide livestock benefits, too.

ODOR CAN TREES MAKE A DIFFERENCE?

Windbreaks ease tension

between poultry farmers & nearby community residents

Urban expansion into rural areas where livestock are produced makes maintaining good relationships a challenge. Planting trees and shrubs as a screen, however, can buffer odor, dust, noise, and unpleasant views. Installing a vegetative filter or windbreak is an opportunity for poultry producers to not only increase production efficiency, but to demonstrate their commitment to being a good neighbor and an environmental steward.

Demonstrate Proactive Environmental Stewardship

Dealing with ammonia emissions from poultry houses and its contribution to atmos-

see **POULTRY** on page 7

Inside

NAC Director's Corner

A commentary on the status of agroforestry by Center Director, Dr. Greg Ruark

A New World Odor

The U.S. continues to grow by more than 3,000,000 people each year. This population pressure is causing most of our cities to expand their boundaries. In addition, many families, in their search for open space, are constructing homes on small tracts of rural land. As urban and residential dwellers venture into areas that were previously rural in character, the differences in lifestyles between farmers and city folks are becoming painfully apparent.

Farmers and ranchers view odors and dust that emanate from livestock, chemical sprays, and fertilizers as integral to the practice of agriculture and they have come to accept them as a part of life. In recent years the movement towards increasingly larger operations for raising cattle, hogs, and poultry has resulted in situations where large volumes of odor are generated at a given location.

What to do? This is a question that many are now asking. This issue of *Inside Agroforestry* attempts to identify and summarize what is known about the potential of agroforestry technologies, particularly windbreaks, to attenuate odors. Although there have not been a lot of research studies done specifically on odor modification with trees and shrubs, there are numerous studies that were done for other purposes that suggest windbreaks can be designed to help alleviate some of the problem. For example, odor is attached to water and dust particles and is transported by wind . Windbreaks have been designed to modify wind movement and trap dust for many decades. Tree species, especially conifer types, have extensive leaf surface area that can interact with water vapor and particulates that carry odor. Similarly, denser plantings will have a greater ability to detain or deflect odors and agroforestry plantings that are properly located with respect to the sources of odor will be more effective.

It must be cautioned that there is still much to learn. For example, what are the relative benefits of placing windbreaks on the upwind and downwind sides of odor sources? What tree and shrub species are best and what planting densities and intervals are needed? What are the maintenance requirements? Will it be necessary to periodically rinse the windbreaks so their foliage can retain its exchange capacity? However, one limitation we already know is that, as with most things, if a livestock operation or other odor generating activity gets very large not even *Working Trees* can offer much help.


Agroforestry

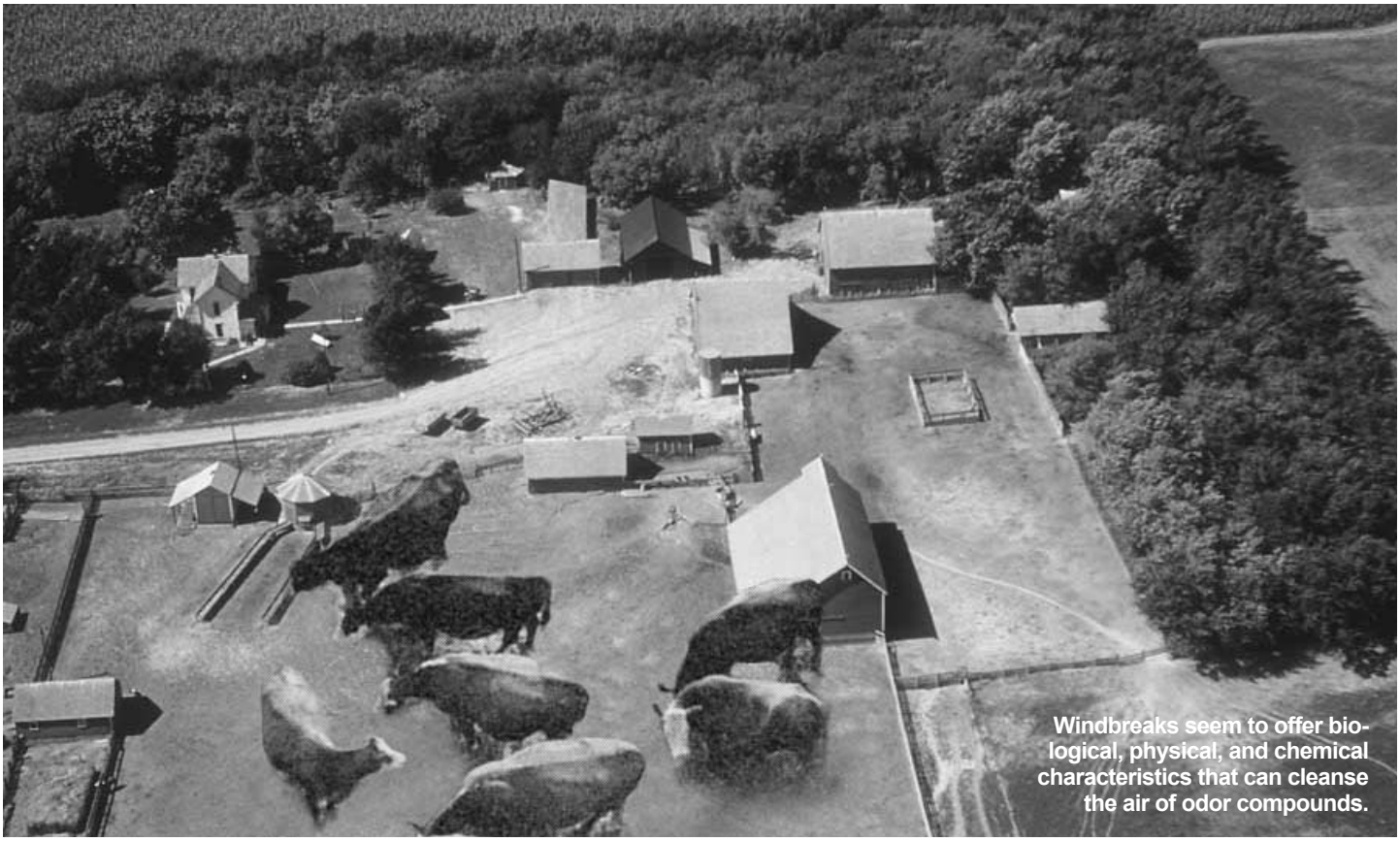
Working Trees for Communities

It's back!!! And it's better!!!

The already-popular *Working Trees for Communities* (WTC) brochure will make its second, new-and-improved debut this summer. As agroforestry awareness continues to grow so do NAC's *Working Tree* publications. The revised WTC brochure will address many of the same issues as the first brochure including: the rural/urban interface, screening, dust and noise control, and enhancing the environment for people, wildlife and recreation. But the new brochure will also address storm water management, wastewater management, and green infrastructure.

All of the *Working Trees* brochures are designed to help you inform and educate your clients including community members, landowners, youth, and others. They are written for the landowner and developed especially to aid you with publicity and technology transfer to get *Working Trees* applied on the ground.

Visit our website for a preview of any of NAC's *Working Trees* brochures or coordinating displays: *www.unl.edu/nac.* You can also order publications from the website or, if you prefer, contact Nancy Hammond at: *nhammond@fs.fed.us* or fax her your request at 402-437-5712.



Windbreaks seem to offer biological, physical, and chemical characteristics that can cleanse the air of odor compounds.

Shelterbelts: an answer to GROWING odor concerns?

Joe Colletti and John Tyndall
Forestry Department, Iowa State University

In a March 24, 2002 editorial the Des Moines Register asserts that " . . . a clean environment is essential to the progress and prosperity in Iowa." They also indicate that Iowa could lead the nation in both hogs produced and clean air.

Because odor is very difficult to measure and human perception is variable, the odor issue is complex and requires numerous approaches to provide desired outcomes. The livestock industry uses a suite of technologies and management practices to deal with air quality issues. About 95 percent of livestock odor is controlled by standard manure management. Yet livestock odor control and clean air concerns continue to be hotly debated. So, what new technologies could be blended with standard livestock practices to enhance odor control?

An emerging technology is shelterbelts. Field-level shelterbelt and livestock odor control research is limited, so initial estimates of shelterbelt efficacy are based on allied research. Based on a large body of knowledge, shelterbelts have the potential to be an effective and inexpensive odor control device particularly when combined with other control methods.

The potential of shelterbelts is related to livestock odor characteristics, such as: odor sources are at ground level, odor travels as aerosols and dust, and the odor plume at times hugs the land. Because of these characteristics, shelterbelts of even modest heights (i.e. 20 to 30 feet) seem ideal for plume interception and disruption. Shelterbelts are also adaptable to most production and odor situations.

There are several ways that shelterbelts can ameliorate livestock odors:

- By facilitating dilution of odor into the lower atmosphere - Shelterbelts create surface turbulence that intercepts and disrupts odor plumes. They lower wind speeds over manure storage units allowing for slower release of odor.

- By encouraging dust and other aerosol deposition by reducing wind speeds - Wind tunnel modeling of a three-row shelterbelt quantified reductions of 35 percent to 56 percent in the downwind transport of dust. Pesticide drift research suggests that reduced wind speeds cause drift pesticide to drop (70 percent to 90 percent) from the air stream. Simulation of tall barriers around manure lagoons show reductions of 26 percent to 92 percent.

- By physical interception of dust and other aerosols - A forest cleans the air of micro-particles twenty-fold better than barren land. Leaves with complex shapes and large circumference to area ratios collect particles most efficiently.

- By acting as a sink for the chemical constituents of odor - Volatile Organic Compounds (VOC's) have an affinity to the cuticle of plant leaves. They are adsorbed and absorbed. Microorganisms on plant surfaces can metabolize and breakdown VOC's.

- By providing a visual & aesthetic screen - A well-landscaped livestock operation is much more accepting to the public than one that is not. Out of sight may be out of mind.

see **SHELTERBELTS** on page 7

ODOR IS MORE THAN WHAT MEETS THE NOSE

Livestock odor is becoming an increasingly contentious issue, primarily for two reasons:

1) Livestock operations are continuing to grow in size, and
2) More people are moving into rural areas, thus closing in on many livestock operations.

These two changes over the past couple of decades have set-up a collision course between farmers and non-farmers as well as neighbor against neighbor. Concerns about odors from large facilities goes beyond non-farm residents who may move toward the facilities, but also include many farm neighbors when a large confinement facility moves in next door. People do not like unpleasant smells especially from sources that do not provide them direct benefit.

To illustrate this dramatic change in livestock operations, the Environmental Protection Agency reports that the total number of animal units increased about 4.5 million (about a three percent increase) from 1987 to 1992. However, the number of livestock operations has decreased during the same period.

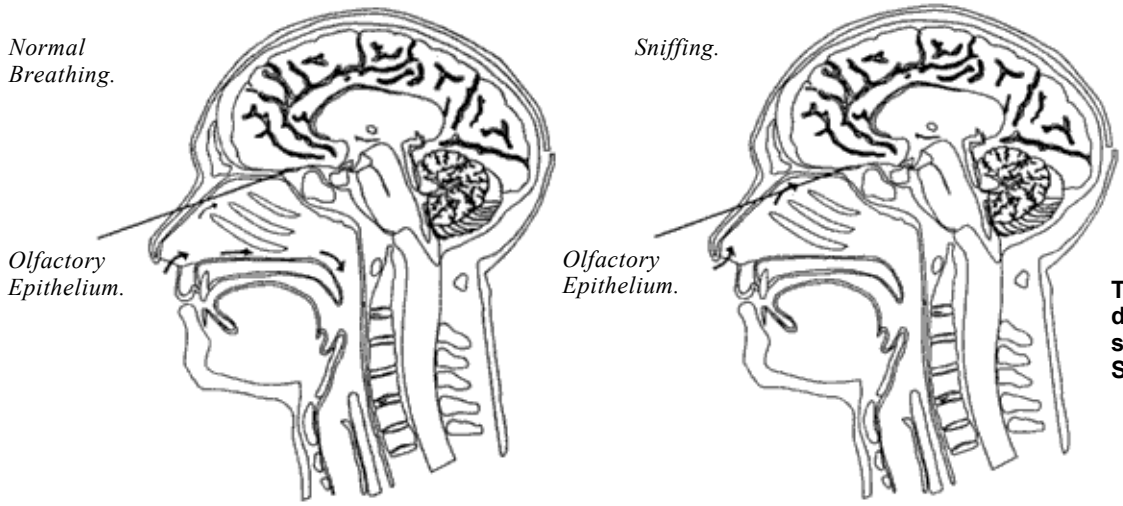
Confined animal feeding operations are major contributors in meeting the production demands of consumers for meat, milk, poultry, and eggs. For this economical flow of food to continue, producers must have access to the best cost-effective technology to produce the commodities while protecting natural resources including air quality.

Odor Sources & Transmission

With a larger number of livestock in greater concentrations, larger quantities of animal waste need to be processed. The United States annually produces about 130 times more animal waste than human waste. Livestock odors occur as gases that are released from microbial decomposition of manure and other organic matter. These gases can include from 80 to 200 different compounds that can cause odor. Some odors can be detected at extremely low concentrations. Ammonia and hydrogen sulfide (rotten egg smell) are two particularly troublesome odors. With so many possible odorous compounds, the interactions among the different combinations can cause either more or less odor than a direct sum of the individual gases. Odors can also be absorbed and transmitted by dust particles.

There are a variety of livestock odor sources including livestock buildings, manure storage facilities, and during land application of the waste material. These sources can cause odor continuously or only during certain times or conditions. For example, the odor from a livestock building is generally constant, but odor from land application of livestock waste will occur periodically and vary due to the weather conditions at the time.

However, predicting odor impacts can be a difficult process. Because the odorous gases and dust are transported by the wind, the impact area and magnitude can change frequently depending on the wind direction and speed. Some of the gases are heavy and travel more closely to the surface while the lighter ones will disperse higher into the atmosphere. The roughness of the surrounding ground surfaces can vary through the year and will impact how much of the odorous dust can be trapped.



The flow of air through the nose during normal breathing and sniffing. Used by permission of St. Croix Sensory, Inc. (1997).

Odor Effects

People respond to odor differently. Although the human olfactory organ is quite sensitive, the response to odor is related more to past memories or cultural experiences. There is not very much information about the impact of odors on human health. Most of the existing information refers to the adverse health effects individual gases, e.g. ammonia, or dust, but no specific information about odors. One study did show that odors from a swine facility had a negative effect on the moods of neighbors such as anger and frustration. These psychological impacts can be as significant as a person's physical health. Due to these concerns, effort is warranted to minimize odors thus benefiting the community and the livestock producers alike.

Assessing Odor

Measuring odor is a complex process. Although work is underway to develop an effective measuring device, the most common assessment approach, to date, involves the use of panels of people who sniff odors captured by an instrument from a particular site. The panel will define the smell based on several different parameters including:

- Concentration or threshold - what is the mini mum detectable concentration level
- Intensity - the strength of the odor above a certain threshold
- Persistence - the rate of change of the intensity of the odor
- Character - what the odor smells like such as earthy, fruity, rotten, chemical, etc.
- Hedonic tone - the degree of acceptability or offensiveness of the odor

The measurements of odor are further complicated by the variables that can occur at a site during sampling such as different weather conditions. Because of these variables, the odor intensity at the time of sampling can easily be more or less than one hour earlier.

Managing Odor

Odor management is a result of the overall management 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. Waste management plans have become a standard part of livestock operations in recent years. Livestock odor management techniques fall into three areas:

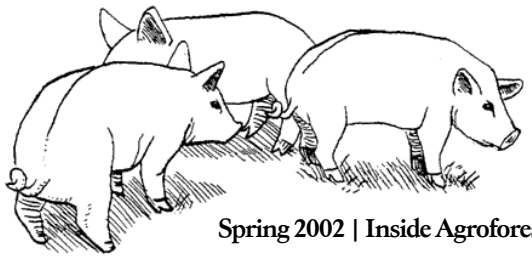
- Preventing the generation of odor - including feed additives, aeration, manure additives, etc.
- Capturing and destroying the odor - including biofilters, waste storage covers, organic mats, etc.
- Dispersing or disguising the odors - including vegetative or structural windbreaks, setback distances,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

The cost of several of the above techniques currently presents significant economic barriers to implementing them. There are also some unanswered questions about the effectiveness of some of the techniques. Additional research is needed to refine the different approaches and find the most technically and economically effective methods.

What does the future hold for the co-existence of livestock feeding facilities and the surrounding communities? The generation of livestock odor is a fact of life and will probably never completely disappear. However, the science and technology of managing odors is continuing to develop. For example, the University of Minnesota has developed the *Odor from Feedlots Setback Estimation Tool* to aid Minnesota livestock producers in siting new livestock facilities. This tool is the result of four years of data collection and field testing with a variety of livestock facilities in Minnesota.

Windbreaks fall into this developing category. Preliminary information suggests that windbreaks may be able to provide some odor mitigation. For more information about windbreaks and odor, see *Shelterbelts Answer to Growing Odor Concerns* on page 3.

Adapted from Understanding Livestock Odors *by Ronald Sheffield, Animal Waste Specialist and Robert Bottcher, Professor and Ventilation Extension Specialist, Biological and Agricultural Engineering Publication AG-589, North Carolina State University and* Offset: Odor From Feedlots Setback Estimation Tool *by Larry Jacobson, David Schmidt and Susan Wood, Dept. of Biosystems and Ag. Eng. University of Minnesota Extension Service. Publication FO-07680-GO, 2001.* www.extension.umn.edu/distribution/livestocksystems/DI7680.



Forest Edges Trap Airborne Pollutants from Adjoining Fields

Forest edges are a lot like windbreaks in that they represent a sudden and dramatic change in vegetation and surface structure that effect wind speed and direction. Researchers at the *Institute of Ecosystem Studies* investigated the effects of forest edges, as a result of forest fragmentation, on wind-borne nutrients and pollutants.

This study examined the concentrations of sulfur, nitrogen, calcium and water at the forest edge, in the adjacent field and in the forest interior. All of the edge measurements were taken within 10 feet of forest edge and the interior measurements were taken between 75-90 feet of the forest edge. During the study period the concentration of water was not discernably different in the study zones. However, there was a marked increase in total sulfur, dissolved inorganic nitrogen and calcium at the forest edge over the amounts found in either the adjacent field or forest interior. These researchers "…demonstrate that forest edges adjoining agricultural or urban landscapes are effective at scavenging and concentrating airborne nutrients and pollutants and that the intensity of this effect is partly determined by the structure of the forest edge. These filtering and concentrating functions may have important ramifications for below canopy ecological processes." This research also indicates that the active filtering processes occur close to the forest or windbreak edge and that windbreaks may not need to be extremely wide, greater than 90 feet, to have an influence on trapping airborne pollutants.

"In fact , the forest edges have been shown to act as "hotspots" of deposition, showing up to a four-fold increase in the rate of atmospheric delivery compared with nearby areas without edges. Much of this enhanced deposition is thought to result from the dry deposition of particles and gases from the deposition of horizontally driven fog or cloud droplets. In these cases, it is the abrupt structure of the forest edge that creates a trap for horizontally driven materials."

This research and similar research efforts indicate that windbreaks may be an effective tool in managing odors in urban and rural landscapes.

Adapted from "Forest Edges as Nutrient and Pollutant Concentrators: Potential Synergisms between Fragmentation, Forest Canopies, and the Atmosphere," Weathers, Cadenasso, Pickett: Conservation Biology, vol. 15, No. 6, December 2001, pages 1506-1514.

Should you be receiving and reading Inside Agroforestry?

Inside Agroforestry covers the latest agroforestry news and information, and reaches an average of 9,500 natural resource professionals across the country and internationally three times per year. We've covered topics like:

Green Infrastructure & Communities, Specialty Forest Products, Wildlife, Carbon, Marketing Agroforestry, Small Farms, Water Quality, Wildlife, and of course, **Riparian Forest Buffers, Windbreaks, Living Snowfences, Silvopasture, and Alley Cropping.**

If you or someone you know would like to be added to our database or have updates to your address, please contact Nancy Hammond at *nhammond@fs.fed.us* or fax information to her at 402-437-5712.

Poultry
continued from page 1

pheric nitrogen and fine particulates is representative of challenges that all animal-related agriculture may face in the future. Trees strategically planted on poultry farms may help reduce ammonia emissions by physically capturing both ammonia gas and the ammonia-laden dust particles.

The roots of trees are effective in absorbing nutrients. More than 80 percent of nitrogen and phosphorus can be kept from entering adjacent water courses through root absorption or reduction in overland flow. Trees also have the ability to clean the air by capturing carbon dioxide.

Increasing Production Efficiency

Properly established windbreaks are an energy-efficient, natural system that can reduce heating costs as much as 10 to 40 percent and reduce cooling costs by 20 percent for poultry houses.

Windbreaks can also serve as a living snowfence. A tree windbreak can capture up to 12 times more snow per foot of height than a picket fence, and it is 90 percent less expensive.

Another potential benefit may be improved biosecurity. By restricting airborne particulates, trees may aid in blocking airborne poultry diseases from entering, as well as exiting, your farm.

Although trees around the perimeter of poultry houses offer many potential advantages, there are some negative aspects to consider. These include: some land will be taken out of production, cost of the trees, labor for planting and maintenance, restricted view of poultry houses, limited farm access to designated roadways, and a potential habitat for wild birds.

Of course, success depends on individual farm situations, house orientation, type of ventilation system, available tree species and width of the windbreak. Service roads, loadout areas and anticipated width of the tree spread at maturity are all factors when considering tree spacing. Allow for property lines, dwellings, traffic visibility, surface and subsurface drainage rights-of-way, and overhead and below-ground utilities when placing trees.

Desirable features of trees for use with poultry farms include maximum vegetative density with complex leaf shapes, waxy or "hairy" leaves for efficient filtering ability, tap or deep roots, wind tolerance, low maintenance and care, medium to fast growth and tolerance to nutrients found around houses. Shrubs and trees that attract wild birds due to seeds or nesting site and those with a wide crown that obstruct traffic may be undesirable for some operations.

Extracted from "The Benefits of Planting Trees Around Poultry Farms." By George Malone, Extension Poultry Specialist and Dorothy Abbott-Donnelly, Extension Agent-Renewable Resources. University of Delaware Extension Bulletin 159. www.rec.udel.edu/Poultry/tree_buffer.pdf

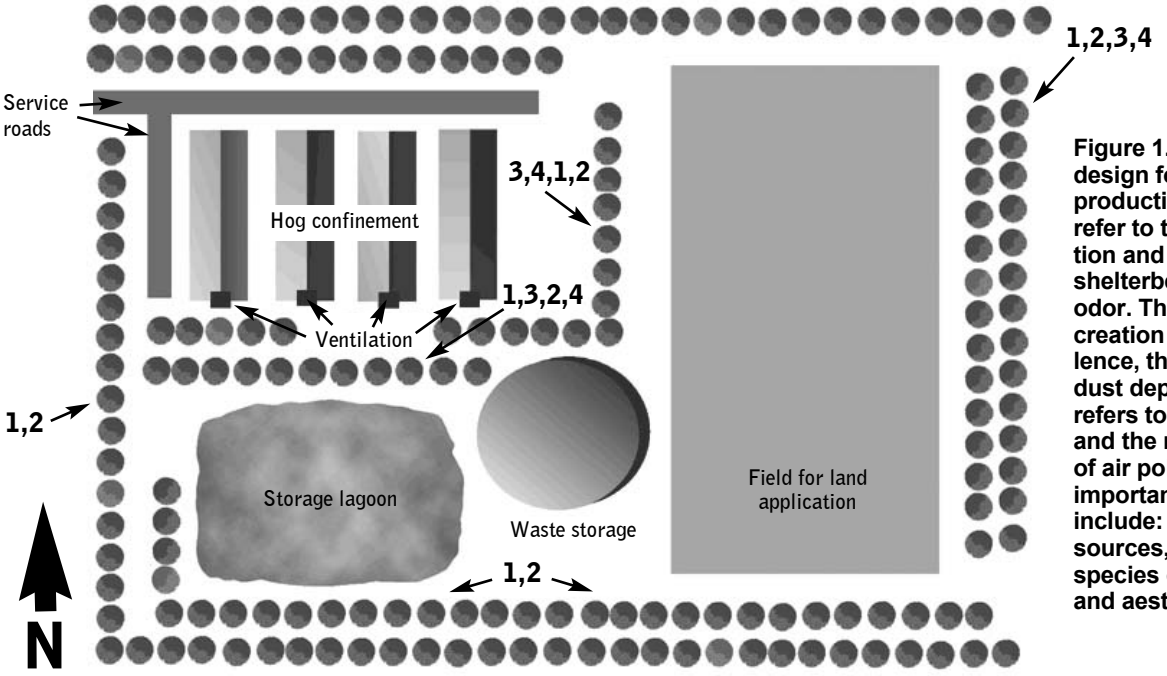


Figure 1. A shelterbelt system design for a hypothetical swine production facility. The numbers refer to the functional interaction and means by which the shelterbelt will mitigate livestock odor. The number 1 refers to creation of air mixing turbulence, the number 2 refers to dust deposition, the number 3 refers to particulate interception, and the number 4 refers to sites of air pollution sinks. Other important design considerations include: livestock type, odor sources, air/wind patterns, the species of trees/shrubs used, and aesthetics/screening.

Shelterbelts
continued from page 3

A generalized windbreak is shown in **Figure 1**. This design provides "buffering" around the sources of odor and is adaptable for most types of livestock systems.

Based on some direct and mostly indirect analysis, shelterbelts seem to offer biological, physical, and chemical characteristics that can cleanse the air of odor compounds. Also, they are flexible in design. Further, they are relatively low cost adding only pennies (<$0.20) per animal and seem to provide psychological-aesthetic values as well. Researchers agree that multiple control strategies increase the effectiveness of odor reduction. Clearly much work needs to be done to quantify the efficacy of specific shelterbelts and livestock operations, but compelling evidence exists that they will help to further reduce odor.

For more information, contact Joe Colletti, Associate Professor of Forest Economics or John Tyndall, Research Assistant, Forestry Department, Iowa State University, (515) 294-4912 or visit our website at http://www.forestry.iastate.edu/res/odor_mitigation.html

Upcoming Events

June 27, 2002
Pacific Northwest Special Forest Products Council Workshop. Springfield, OR. Contact: John Hegg, 541-683-6644, *jhegg@or.blm.gov*

July 13-17, 2002
Soil and Water Conservation Society 2002 Annual Conference. Indianapolis, IN. Contact: Nikki McClain, 765-747-5531, *www.hoosierchapterswcs.org/activities/settingpace*

July 20, 2002
Association for Temperate Agroforestry Annual Meeting. Lanesboro, MN. Contact: Dean Current, 612-624-4299, *curre002@tc.umn.edu.*

August 23-24, 2002
Special Forest Products Production and Marketing Conference. Sinsinawa, WI. Contact Mike Bolin, 217-333-2778, *m-bolin@uiuc.edu.*

October 5-9, 2002
Society of American Foresters National Convention. Winston-Salem, NC. *www.safnet.org/calendar/presentations.*

October 25-26, 2002
Special Forest Products Production and Marketing Conference. Cape Girardeau, MO. Contact: Julie Rhoads, 573-882-3234, *RhoadsJ@missouri.edu.*

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Mission

The USDA National Agroforestry Center (NAC) is a partnership of the Forest Service, Research & Development (Rocky Mountain Research Station) and State & Private Forestry and the Natural Resources Conservation Service. The Center's purpose is to accelerate the development and application of agroforestry technologies to attain more economically, environmentally, and socially sustainable land-use systems. To accomplish its mission, the Center interacts with a national network of partners and cooperators to conduct research, develop technologies and tools, establish demonstrations, and provide useful information to natural resource professionals.

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