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USING TREES TO REDUCE DUST AND ODOUR EMISSIONS FROM POULTRY FARMS

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EMISSION ISSUES FACING THE USA POULTRY INDUSTRY

Emissions of dust, ammonia and odour from poultry operations are an increasing environmental concern for the poultry industry in many regions of world. Odour, dust, feathers, noises and visual aspects of poultry operations are additional issues that we 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 in the USA there have been an increasing number of legal cases involving nuisance complaints associated with neighbors next to and downwind tunnel-ventilated poultry houses. Compounding nuisance concerns is the increase in human population in many historic poultry producing areas. As many poultry and livestock producing areas of the USA become more urbanized, the likelihood of increased nuisance-related complaints will only increase. These issues are exacerbated as the size of poultry farms increase.

To further add to the poultry industry's future challenges, emissions from poultry houses in the USA may be regulated in the future. Both ammonia and dust emissions may fall under several existing laws that require reporting and/or reduction of these pollutants. Currently there are only several states that regulate odour, most of this focus to date has been associated with swine rather poultry operations.

WHY CONSIDER A TREE PROGRAM FOR POULTRY FARMS

The adoption of sound, practical, efficient and cost-effective technologies to address the issues above will be increasingly important in the poultry industry. One such technology is strategically planting trees around poultry houses. Although the poultry industry in the USA 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, as housing shifts to tunnel, black-out and windowless-type systems, this no longer a major concern.

There are three goals of a tree program for poultry farms (Figure 1). A tree program 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, odour, surface and groundwater nutrients leaving the proximity of farms and promote carbon sequestration. There are also possible **production** benefits of a designed tree program, particularly for tunnel-ventilated poultry farms. Trees strategically planted for windbreaks, shade and to filter air-borne pathogens may conserve energy and improved farmstead biosecurity.

USING TREES AS VEGETATIVE ENVIRONMENTAL BUFFERS

Although much is known about the aesthetic value, environmental and energy conservation benefits of trees for numerous applications, there has been little research on the merits of a designed tree program for poultry (and livestock) facilities. Since the tree program outlined in this report is intended to be more than a barrier, windbreak or shelterbelt, the term vegetative environmental buffer (VEB) will be used to describe the overall goals of this program.

Tree barriers around production sites have high aesthetic value with the potential of increasing property values of both the poultry farm and adjoining neighbors. It been suggested that trees increase residential property values by 5 to 20%. Planting trees creates a positive image and helps the farm take on a landscaped appearance. As the trees mature, the houses and routine activities are obstructed from view. The negative images of poultry operations by neighbors and the public is blocked by this visual screen and the "out-of-sight-out-of-mind' concept may well represent a major benefit of a VEB. In a recent survey of neighbors near swine operations in Pennsylvania, farms that were "attractive" were perceived by the neighbors as having less odour (Mikesell, et al., 2001).

The use of VEB around livestock facilities to mitigate odour and improve air quality has been recently reviewed by Tyndall and Colletti (2000). They concluded VEB have the potential to be an effective and inexpensive odor control technology particularly when used in combination with other odour control methods. VEB ameliorate odours by dilution of odour, encourage dust and aerosol deposition by reducing wind speeds, physical interception of dust and aerosols, and acting as a sink for chemical constituents of odour. They reported there are a number of barriers to adoption of VEB for livestock odour control. There is a lack of technical information on VEB (i.e. tree species best suited for shelterbelts, site prep and planting techniques and maintenance, and effective designs). Other barriers include a cost-benefit analysis, cost share opportunities, quantifying the efficacy for odour control and cultural barriers to erecting non-agricultural structures (trees) within the farmstead. In another recent report (Iowa State University and University of Iowa Study Group, 2002), tree barriers was one of four methods recommended to the Governor of Iowa for reducing emissions from animal feeding operations. The recommendations from these two reports for using trees as vegetative filters to mitigate emissions from animal facilities are supported by the following studies. Wind tunnel modeling of a three-row VEB has found reductions of 35% to 56% in the downwind transport of dust and aerosols (Laird, 1997; Thernelius, 1997). It is been well documented that odourous compounds are attached to dust particles (Burnett, 1969). Hartung (1985) suggested that filtering the dust from exhaust air could reduce odours from animal facilities up to 65%. Research on the efficacy of tree filters to dust, odour, and emissions from poultry houses is in its infancy.

Other environmental benefits of using trees to filter nutrients in runoff and groundwater, and capturing carbon dioxide (a greenhouse gas) has been well documented. Through root absorption or reduced overland flow, it is estimated a riparian buffer can remove more than 80% of nitrogen and phosphorus, thus keeping these nutrients from entering adjacent water courses.

Very little is known on how a designed tree planting around the perimeter of poultry farms might influence poultry production. It is believed, based on other applications that trees planted for windbreaks, shade and filters may offer the potential for energy conservation and improved biosecurity for poultry farms. Previous research for other applications suggest properly established windbreaks are an energy efficient, natural system, which can reduce winter heating costs 10 to 40%. When trees are planted to maximize shading of residential homes, summer cooling cost can be reduced up to 20%. Depending on porosity of the VEB, relative humidity may be 2 to 4 percent higher in sheltered areas compared to open areas (Brandle and Finch,1991). Potential energy benefits of a designed VEB for modern tunnel-ventilated poultry farms is only now being studied in the USA.

By filtering air-borne particulates, there is some speculation that trees surrounding poultry houses may block the transfer of air-borne diseases. Airborne transmission of several poultry disease has been recognized, including Salmonella enteriditis (Holt, et al., 1998), Newcastle disease (Hopkins and Drury, 1971; Hugh-Jones, et al., 1973) and infectious larynogtracheitis virus (Johnson, et.al., 2001). Johnson et al., (2001) recently found a relationship between wind direction and the spread of larynogtracheitis on Delmarva where distance of surrounding farms from the infected house(s) was not as important as wind direction. Farms located within the wind vector of a case farm had a four-fold increased risk in developing the disease within the next 14 days. Houses oriented north-south had 40% greater chance of infection than east-west orientation and conventional ventilated houses were 3½ times more likely than tunnel houses to be infected. It is speculated that using trees as VEB may reduce airborne disease transmission, particularly in highly concentrated production areas. However, there may be some health risk associated with trees around poultry houses, namely a potential increase in wild birds and rodents. The author is not aware of documented studies of increased disease incidence associated with wild bird populations due house surroundings (i.e., trees). On the contrary, Villafane et al. (2001) found lower rodent populations on poultry farms having trees with the speculation that trees may provide perches for raptors that feed on the rodents.

VEGETATIVE ENVIRONEMENTAL BUFFER RESEARCH IN THE USA

In December 2000 the University of Delaware starting working on an initiative of planting VEB (trees) around poultry farms and published an extension bulletin (Malone and Donnelly, 2001) which describe the potential benefits of a tree program, and recommendations on the type and requirements for planting trees around farms. The following is an update of numerous research and demonstration projects initiated over the past three years to better define a VEB program and to assess its potential environmental

and production benefits. These studies are on-going and the results should be considered *preliminary*!

To assess the efficacy of trees for capturing emissions, a 9 m wide, three row planting of 4.9 m high bald cypress (9 m from fans), 4.3 m high Leyland cypress (12.2 m from fans) and 2.4 m high red cedar (14.6 m from fans) were installed in April 2002 directly opposite from two tunnel fans. Emissions data has been collected the past two summers on this roaster farm. The following are some *preliminary* observations expressed as the relative change in concentration of emissions from the front to the backside of the VEB. This particular three-row tree planting reduced air velocities from the front to the backside of the trees by 99% (127.4 m/min. on the fan side of trees reduced to 1.5 m/min. on the back side of the tree line). It should be noted in the following discussion the reasons for changes in efficacy from Years 2002 and 2003 may relate to improved collection methodologies used in 2003, weather conditions (extreme drought in 2002 and extensive rainfall in 2003), and a change in crops planted immediately behind the tree lines (soybeans and corn in 2002 and 2003, respectively). Total dust was reduced 53 (0.659 vs. 0.333 mg/m^3) and 50% (1.039 vs. 0.527 mg/ m^3) in years 2002 and 2003, respectively. Ammonia was reduced by 67% (2.03 vs. 0.66 ppm) in 2002, but only 29% (6.31 vs. 4.48 ppm) in 2003. Odour concentrations were highly variable and did not follow the same pattern as ammonia. In 2002 the odour was 23% (102 vs. 79 odour units) less, yet in 2003 it was 5% (268 vs. 282 odour units) greater from the front to the backside of the trees. It is speculated there was a zone of stagnant air between the trees and corn field that may contribute to change in odor concentrations observed in 2003. Aerobic bacteria was determined in 2003 as an indicator of bioaerosols that might be captured by the vegetative filters. Although the number of aerosol bacteria were highly variable, they were consistently reduced by the vegetative filters (averaged 19% less). Wind patterns outside the house posed a major challenge in collecting accurate and consistent data for all parameters.

To assess potential production benefits of having trees around poultry houses, a cooperating poultry complex provided production data on tunnel-ventilated roaster farms that were identified as being in either an open or wooded setting. Based on the "first" preliminary assessment of farms in these categories (approximately 650 flocks of data using the history of the last 6 flocks for each farm), it does not appear farm setting has any major influence on most production parameters. Additional statistical analysis, sorting the farm types into matched sets will be needed to accurately assess this data set. The microclimate around houses in an open and wooded setting has been under evaluation for the past year. As observed in other research with shelterbelts/windbreaks, there may be ~3 % increase in relative humidity concentrations outside houses totally surrounded by trees. A VEB that uses dense evergreens on the north and west sides of the houses with a combination of deciduous trees that has less density on the south and east sides may be more desirable (Note: prevailing winter winds in our region are from the northwest). On very cold, windy days it appears the open farms had greater wind chill (lower temperature factor) than wooded farms. Reduced wind speeds and higher mid-day temperatures on wooded farms was a major reason for these differences. Since trees reduce wind speed next to houses, they may have the potential to reduce backpressure on fans during windy

days, thus maintaining optimum fan efficiency. To simulate the mean (8.8 km/hr.) and maximum (24 km/hr.) average wind speeds for Delmarva, air was blown directly into a tunnel fan to create these two sets of conditions. Limited observations with one style cone tunnel fan suggest a 8.8 and 24 m/hr. wind may decrease fan output by 3.5 and 15.5%, respectively.

Numerous tree plantings have been installed to assess such issues as livability of different species of trees in high emission loading areas, an assessment of misting water on trees at tunnel fan exhaust, and implications of planting trees between houses to capture emissions from sidewall fans. Early results suggest white pine may be sensitive to high emission areas. Visual observations also suggest some of the greatest dust concentrations on trees at distances the maximum air velocity impact of the fans. Since the distance a single fan will move air in ambient conditions is ~ 10 times the blade diameter, planting trees 12 to 17 m out from tunnel fans may be appropriate.

Three universities in the USA (Delaware, Pennsylvania and Iowa) have received a National Research Initiative grant for a comprehensive study of VEB to mitigate odour and aerosol pollutants emitted from meat and layer production facilities. This study will more fully document VEB efficacy, design criteria, mode(s) of action and outreach programs for successful implementation.

Local and federal cost-share assistance has been approved in our local production area to help implement VEB on poultry farms. Up to 75% of the cost associated with preparing, implementing and maintaining a VEB program for several years may be provided by the various agencies. The potential neighbor-relations benefit appears to the number one reason most growers are considering this program. Some growers have opted to install the practice on their farms without cost-share assistance. For those growers that have implemented the program, it is not without challenges. These include the cost of a program that has no immediate and documented financial benefits, finding trees that have been written for their plan, knowledge and equipment to plant trees, and maintenance (ie. weed control, irrigation). Having a regional VEB coordinator that can provide poultry growers with a low-cost, low maintenance, turn-key tree program that involves minimum effort by landowner would help facilitate this initiative.

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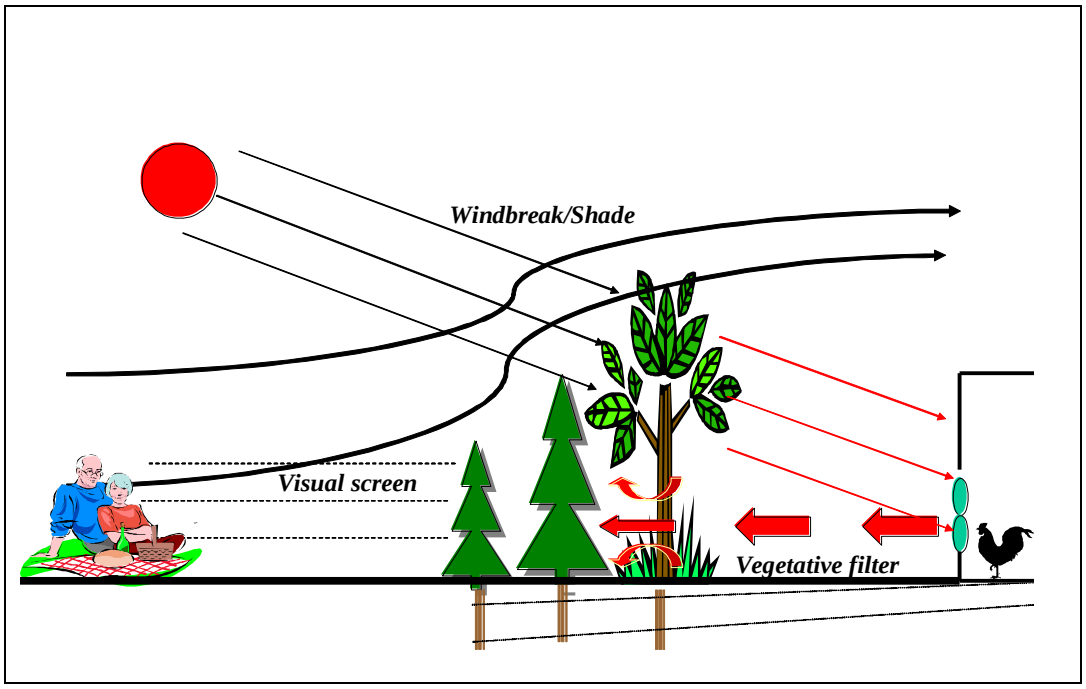

Figure 1. Objectives of vegetative environmental buffers around poultry houses.