Utilizing Warm-Season Grasses to Mitigate Poultry Tunnel Fan Emissions on the Delmarva Peninsula 2010 Progress Report

SUMMARY

The Delmarva Peninsula is home to one of the country's highest concentrations of poultry farms. The 2007 National Agricultural Statistical Service placed poultry and egg production as the most valued commodity in Maryland and Delaware and the second most valued commodity in Pennsylvania. On the Delmarva Peninsula, about 2,000 farms house approximately 25,000 birds per poultry house, and many farms have multiple houses. Poultry houses generate dust, odor and ammonia that are expelled from the houses by ventilation systems.

Dust is linked to respiratory effects in poultry workers[1], and can be a nuisance for neighbors who live near farms. Ammonia emitted from poultry houses has been linked to degradation of both air and water quality in the Chesapeake Bay. Emissions with particulate matter measuring 2.5 microns (PM 2.5 – microscopic particles) to 10 microns (PM 10 – visible particles such as dust) are regulated by the EPA.

The National Plant Materials Center is collaborating with researchers at the University of Delaware and Pennsylvania State University to test which plants can survive in the harsh environment associated with poultry house tunnel fans, absorb gaseous ammonia, and mitigate odors expelled from tunnel fans. Research conducted by Dr. Paul Patterson (Pennsylvania State University) has shown that a tree/shrub windbreak planted opposite tunnel fans reduced dust (particulate matter) by 67% at a distance of 20 feet downwind from a five row windbreak, and odor by 50%[2]. Major differences in dust reduction were associated with different plant species.

Figure 1. The Site S1 Farm June 2009. The grasses are effectively filtering tunnel fan emissions as evidenced by the larger 'Manhattan' Euonymus which has been sheltered from fan emissions. Initially, both plants were the same size, and planted at the same time.

There are a very limited number of woody species currently being used for poultry tunnel fan windbreaks that can tolerate the harsh conditions adjacent to tunnel fans. This study was designed to test the survivability of tall warm-season grasses planted closest to tunnel fans. Results of this study show that the selected grasses were able to tolerate the tunnel fan emissions and climatic conditions on the Delmarva Peninsula. Continuing studies will determine whether the selected grasses (see Table

1), which are used in a multi-row planting with shrubs and trees, are also effective for filtering dust and absorbing ammonia in these dry, heavily polluted environments.

EXPERIMENTAL DESIGN AND CONDUCT

It has been observed in numerous previous windbreak plantings that the first row of plants (closest to the tunnel fans) succumb to the harsh environment due to the matting of dust (primarily chicken dander) on the leaves. For this reason, we decided to test warm-season grasses, which allow the accumulation of dust during the spring and summer, and then go dormant (discarding the previous season's leaves which are full of dander). This process is then repeated the following spring. Warm-season grasses are more tolerant of dry, wet or compacted soils, as well as heat and drying winds. They also have a large number of stems and leaves, which provide a dense barrier to fan emissions. Acting as a filter of tunnel fan emissions, they are capable of slowing wind speed and sheltering the subsequent rows of shrubs and trees. Since warm season grasses do not have as stiff stems as shrubs and trees, they were planted in the first row closest to the tunnel fans. At our test sites the grasses were planted as close as 20 feet from the tunnel fans. At this distance (20 feet), effects on fan performance was not measured but no obvious effects were observed

This report will address the growth and survival of the test plants. The amount of nitrogen absorbed and dust trapped by the grasses will be addressed in a subsequent report.

Figure 2. The Site A Farm (June 2009). The flock is at its largest size and the highest amount of dust is accumulated on the leaves of the grasses.

Warm-season grasses were tested for the following reasons:

- very efficient C-4 photosynthetic pathway
- active growth during hot and dry periods of summer when the tunnel fans are most active
- deer resistant
- clump growth (plants will not spread and potentially become invasive)
- grasses tested were selected for their upright form and stiff stems which stood up to high wind speeds
- high dust filtering ability
- tolerance to heat and dry (xeric) conditions
- tolerance to wet, dry or compacted soils

All test site farms were broiler chicken houses on the Delmarva Peninsula. In the spring of 2008, two test site farms were planted, in 2009 an additional four test site farms were planted. In each planting, 5 different grasses (see Table 1) were randomly planted in groups of three plants with either two to three repetitions depending on the width of the tunnel fans at each farm. All plants were produced by division of parent plants and grown in a greenhouse the previous winter.

At each farm, the distance from the fans and planting length varied due to the terrain, layout of roads, drainage ditches, size and age of the poultry house as well as other factors (see Table 2). Quart containers were used for all cultivars with the exception of the *Miscanthus x giganteus*. The giant miscanthus is the largest plant tested and also has the largest root size, so gallon pots were used. This plant is the only non-native plant used in the test. It has been used extensively in Europe as a biofuel, and unlike its close ornamental relative (*Miscanthus sinensis*), giant miscanthus is a sterile triploid, does not produce viable seed and therefore cannot become an invasive exotic plant.

The first two seasons of growth for warm-season grasses are primarily devoted to root growth and establishment. A 4-foot wide weed mat was used to limit weed competition (see Figures 1 and 2). Irrigation was beneficial to plant growth and survival and was used on three of the six test site farms. Although the grasses performed better with it, irrigation was not essential, at least during this study. In both 2008 and 2009, there was a good amount of rainfall, no lengthy droughts, and all plants survived whether or not they were irrigated.

Table 1. Cultivars Used, Container Size and Mature Size

Scientific Name	Common Name	Cultivar Name	Container Size	Mature Size (w x h)
Panicum virgatum	Switchgrass	'Northwind'	Quarts	2' x 6'
Panicum amarum var. amarulum	Coastal Panicgrass	'Atlantic'	Quarts	3' x 6'
Panicum virgatum	Switchgrass	'Kanlow'	Quarts	5' x 6'
Panicum virgatum	Switchgrass	'Thundercloud'*	Quarts	4'x 8'
Miscanthus x giganteus	Giant Miscanthus		Gallons	6' x 12'

*patented plant, propagated and tested with permission of developer

Table 2. Poultry Farms Test Site Variables

Producer	Length of Planting (feet)	Distance from Fans (feet)	Irrigation	Number and total width of fans (feet)	flock size	# flocks/yr.	Soil Classification
Site A	28, 20	20, 40	no	6, 28	31800	4–5	Matapeake Silt Loam
Site S1	40	37	yes	7, 42	30000	4-5	Fallsington Loam
Site G	30	24	yes	5, 29	24500	4-5	Hambrook Sandy Loam
Site S2	25, 15	30, 17	yes	3, 15	22000	6	Hambrook Sandy Loam
Site M	42	55	no	7, 42	40800	5	Hambrook Sandy Loam
Site R	40	32	no	7, 40	45000	5	Fallsington Sandy Loam

The photo on the left (May 2008) and on the right (June 2009) show that the grasses grew from two to three feet in just one year at the Site S1 farm.

The photo on the left (August 2008) shows that the 'Atlantic' coastal switchgrass has the quickest establishment. The photo on the right (October 2009) shows that the giant miscanthus (measuring seven feet tall) after a longer establishment period, has grown to be the largest and most robust grass tested.

Planting Design

Every poultry house will differ as to the arrangement of tunnel fans, access roads, drainage ditches etc. A minimum of two rows of grasses should be used. The rows should be planted two feet apart, using two-foot spacing between plants, with a staggered planting arrangement. The tallest cultivars should be planted furthest away from the fans to better catch fan emissions. The length of the rows should extend an additional 20 feet from the beginning and end of the tunnel fans. For example, if the width of the tunnel fans is 40 feet then the total length of the warm-season grass rows would be 80 feet (20 + 40 + 20). It also is advisable that producers use more than one species or variety of grass so that a single insect or plant pathogen won't devastate the entire planting.

Planting Distance from Fans

Dr. Paul Patterson's research[1] demonstrated that the ammonia concentration decreased sharply within a tree and shrub windbreak with greater distance from tunnel fans. Compared to measurements taken at the fan outlets, ammonia levels dropped exponentially (32 fold) when measured 16 feet away. Ammonia levels 30–150 feet downwind of the fans were nearly undetectable. Patterson's research also showed that significantly lower ammonia concentrations were recorded when trees were present downwind of the fans compared with when the trees were removed; suggesting a portion of the atmospheric ammonia was being held by the plants.

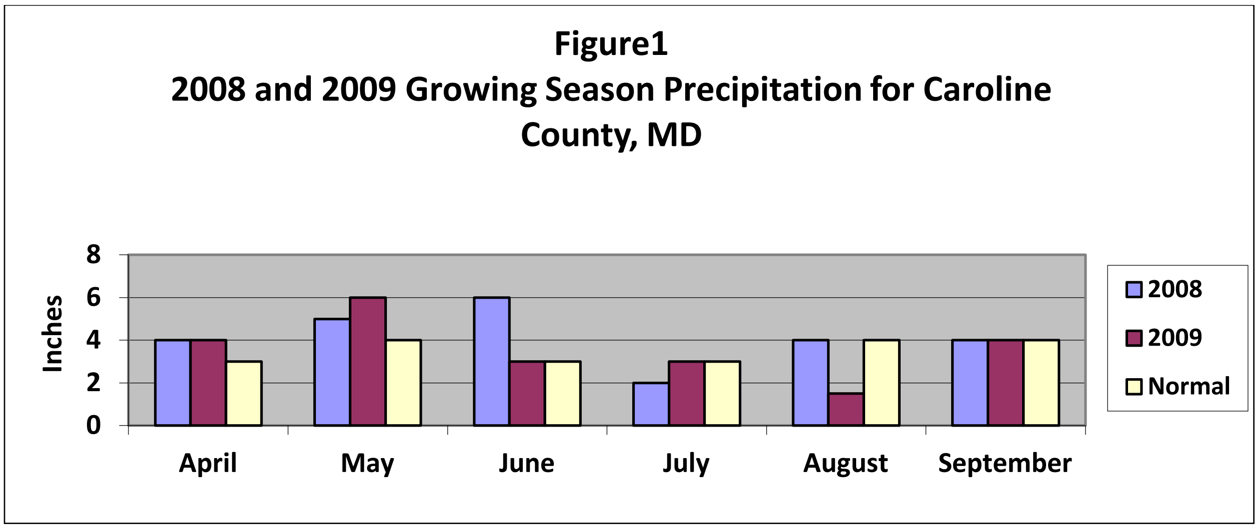
Therefore, to absorb the most atmospheric ammonia and dust, grasses should be planted as close as possible to the tunnel fans without affecting fan performance. In our test sites, we determined that 20 feet away from the fans was the closest at which all plants survived with no obvious negative effects observed.

Maintenance

In order to maximize plant growth, competition from weeds should be kept to a minimum; weed mat was used at our test sites with good results. Care should be used with glyphosate applications around the perimeter of the poultry houses. One producer was applying the herbicide when the ventilation fans unexpectantly started. One clump of giant miscanthus was affected but not killed. If weed mat is used for weed control the openings will need to be enlarged as the grasses grow so that the mat does not constrict growth. After the grasses have gone dormant, as early as October and as late as mid April, the stalks will need to be cut back or mowed to about 6 inches from ground level. Some farmers have used the cut stalks of the grasses for duck blinds, and there is great potential for use of the stalks for biofuels.

PRECIPITATION

The precipitation amounts in Caroline County (where the majority of test sites were located) are shown by monthly totals in Figure 1for the trial period growing seasons. In the 2008 growing season, there was overall above average precipitation by four inches. Precipitation in 2009 was also above average but only by one-half inch.



RESULTS AND DISCUSSION

Due to the challenges and scrutiny that poultry producers are now facing, there is a large demand for plants (especially natives or plants which will not pose a threat to native ecosystems) which can be easily grown, are tolerant to fan emissions, and do not require a large amount of land. Warm-season grasses fit these requirements and may also help to filter poultry house emissions. Determining how much ammonia is absorbed, and the potential for odor and dust reduction, has yet to be determined by future studies.

CONCLUSION

'Northwind', 'Thundercloud', and 'Kanlow' switchgrasses; 'Atlantic' coastal panicgrass; and giant miscanthus can be established and will survive in the harsh environment associated with poultry house tunnel fans. .

References

[1]Donham, K.J.; Cumro, D; Reynolds, S.; Synergistic effects of dust and ammonia on the occupational health effects of poultry production workers. 2002 J. Agromed, 2: 57-76.

[2]Patterson , P.H.; Adrizal, A.; Hulet, R.M.; Bates, R.M.; Despot, D.A.; Wheeler, E.F.; Topper, P.A.; The Potential for Plants to Trap Emissions from Farms with Laying Hens. 1. Ammonia. 2008 Journal Applied Poultry Research, **17**: 54-63

Adrizal, A.; Patterson, P.H.; Hulet, R.M.; Bates, R.M.; Myers, C.A. ; Martin, G.P.; Shockey, R.; Van Der Grinten, M.; Anderson, D.A.; Thompson, J.R.; Vegetative Buffers for Fan Emissions from Poultry Farms; 2 Ammonia, Dust, and Foliar Nitrogen. 2008 Journal of Environmental Science and Health Part B **43** 96-103

Pyter, R.; Voigt, T.; Heaton, E.; Dohleman, F.; Long, S., University of Illinios; Growing Giant Miscanthus in Illinois. On line publication: **miscanthus**.illinois.edu/wp-content/uploads/growersguide.pdf

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This document should be cited as:
Belt, Shawn 2010. Utilizing Warm-Season Grasses to Mitigate Poultry Tunnel Fan Emissions on the Delmarva Peninsula 2010 Progress Report. USDA, NRCS, Norman A. Berg National Plant Materials Center, Beltsville, MD. 7p.

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July 2010