Progress Report Summary

Reporting Period: March 1, 2013 – August 31, 2013

Award Identifying Number: 65-7442-12-350

Title: Demonstrating the Effect of Trees for Controlling Particulate Matter, Ammonia, and Odor from Poultry Buildings
Investigators: Drs. Sheryll Jerez and Joey Bray
Institution: Stephen F. Austin State University
Project Period: September 1, 2012 – September 30, 2015

Objectives: The objectives of this project are three-fold: (1) Evaluate the effectiveness of various tree species in particulate matter and ammonia uptake, and in reducing odor; (2) Assess the ability of trees to tolerate building emissions; and (3) Examine management and costs requirements of using vegetative shelterbelts.

Progress Summary/Accomplishment:
The second half of project year 1 was spent on conducting baseline sampling, purchasing the trees, designing and establishing the irrigation system, tree planting, and tree inspection. Baseline data on the concentrations of ammonia, odor, and particulate matter were collected during two flock cycles: one in March 2013 and the other in July 2013. The data are still being analyzed but they will be used to check any potential improvement in air quality due to the presence of trees. Preparation of the planting area, purchase of trees, and planning on layout of and materials for the irrigation were completed in late March. Planting of trees started in early April and continued until May 2013. Planting of all six species were completed but three of the six species (Rough leaf dogwood, Arizona cypress, and Eastern red cedar) were replaced and replanted. Due to the difficulty encountered in the first year to establish the trees, the priority in the second year is to replace Eastern red cedar and Rough leaf dogwood *in toto*, and partially replace Arborvitae. Replanting will commence in early October. In addition to replanting the aforementioned species, the control trees will also be planted in the inner fence that has been constructed behind the buildings or upwind of the exhaust fans. Once the trees have been established, measurements of the pollutants at the exhausts, at the fence line, and within the rows of plants as specified in the project plan will commence.

Annual Progress Report

Award Identifying Number: 65-7442-12-350

Demonstrating the Effect of Trees for Controlling Particulate Matter, Ammonia, and Odor from Poultry Buildings

Work Status and Progress

The second half of project year 1 was spent on conducting baseline sampling, purchasing the trees, designing and establishing the irrigation system, tree planting, and tree inspection. Baseline data on the concentrations of ammonia, odor, and particulate matter were collected during two flock cycles: one in March 2013 and the other in July 2013. The data are still being analyzed but they will be used to check any potential improvement in air quality due to the presence of trees. Preparation of the planting area, purchase of trees, and planning on layout of and materials for the irrigation were completed in late March. Planting of trees started in early April and continued until May 2013. Planting of all six species were completed but three of the six species (Rough leaf dogwood, Arizona cypress, and Eastern red cedar) were replaced and replanted. Additional replacement and replanting are scheduled in early October for Rough leaf dogwood, Eastern red cedar, and some Arborvitae and Arizona cypress.

Preliminary Work

Measurements of Building Flow Rates and Background Pollutant Concentrations

The concentrations of particulate matter, ammonia (NH_3), and odor were measured for two weeks in March and for one week in July. Prior to these measurements, the airflow rate of all fans in all four buildings were measured using a hot-wire anemometer. The flow rates of the fans will be used to calculate the building ventilation rates and consequently, together with the measured pollutants, will be used to determine the emission rates of the corresponding pollutant. Figure 1 shows the intake side of a bank of exhaust fans of one of the poultry buildings where ventilation rate measurement was performed. Figure 2 shows the measurement of the ventilation rate at the intake side of one exhaust fans. Since buildings 1 and 2 had exhaust boxes, the ventilation rate was measured at the intake and outlet sides of the fans in those two buildings. For buildings 3 and 4, the ventilation rate was measured only in the intake sides of the fans. Measurements of the ventilation rates were performed twice: before the beginning of the flock in March and July during which times the buildings were not populated with birds. By measuring the ventilation rates of each fan prior to the beginning of each flock, the total building ventilation rate during the time of sampling can be determined by knowing which fans were on and off. The status of each fan was monitored throughout sampling using Hobo dataloggers (Model UX90-004 Motor on/off, Onset Computer Corporation, Bourne, MA).

Figures 3 and 4 show the setup for the measurement of ammonia and particulate matter with diameters of equal to or less than 2.5 microns ($PM_{2.5}$) and equal to or less than 10 microns (PM_{10}), respectively. The concentrations of NH_3 and odor were measured both at the exhaust sides of the fans and at the fence line while the concentrations of $PM_{2.5}$ and PM_{10} were

Figure 1. Preparing for ventilation rate measurements at the intake side of a bank of exhaust fans of building 1.

Figure 2. Measuring the ventilation rate at the exhaust side of one of the fans. The instrument shown in the picture is the hot-wire anemometer that measures and stores the data every 2 seconds.

measured only at the exhausts. Measuring the concentrations of PM at the fence line may not be useful due to the fact that the effect of the activities in the area, including traffic, are impossible to separate from the contribution of the poultry buildings alone to the measured concentrations. The measured concentrations of the aforementioned pollutants will serve as the background concentrations and will be used in quantifying the potential reductions in concentrations brought about by the presence of trees.

Figure 3. Sampling setup for the measurement of ammonia concentrations in front of one exhaust fan (left) and in one of the locations along the fence line (right). Encircled are the detector tubes used in the measurements and were mounted on the tripods.

Figure 4. Sampling setup for the measurements of $PM_{2.5}$ and PM_{10} using two EPAM-5000 that measure and record the measurements every second.

Preliminary Planting of a Shelterbelt of Six Tree Species

Planting of the six tree species (Yaupon, Rough leaf dogwood, American holly, Eastern red cedar, Arizona cypress, and Arborvitae) in front of the four poultry buildings was completed in late May. Planting of trees to be used as controls is rescheduled for October. The project team encountered difficulty finding five of the six tree species in nurseries in East Texas; the only exception was for Yaupon. Planting materials for Arizona cypress, Arborvitae, and Eastern red cedar were about 12 to 18 inches in height while the planting materials for the other tree species (Yaupon, Rough leaf dogwood, and American holly) were between 2 to 5 ft in height. Figure 5 shows the tree species planted directly in front of the exhaust fans of poultry buildings 1 and 2. The first batch of Arizona cypress that was planted in May was replaced with another batch that was planted in late June.

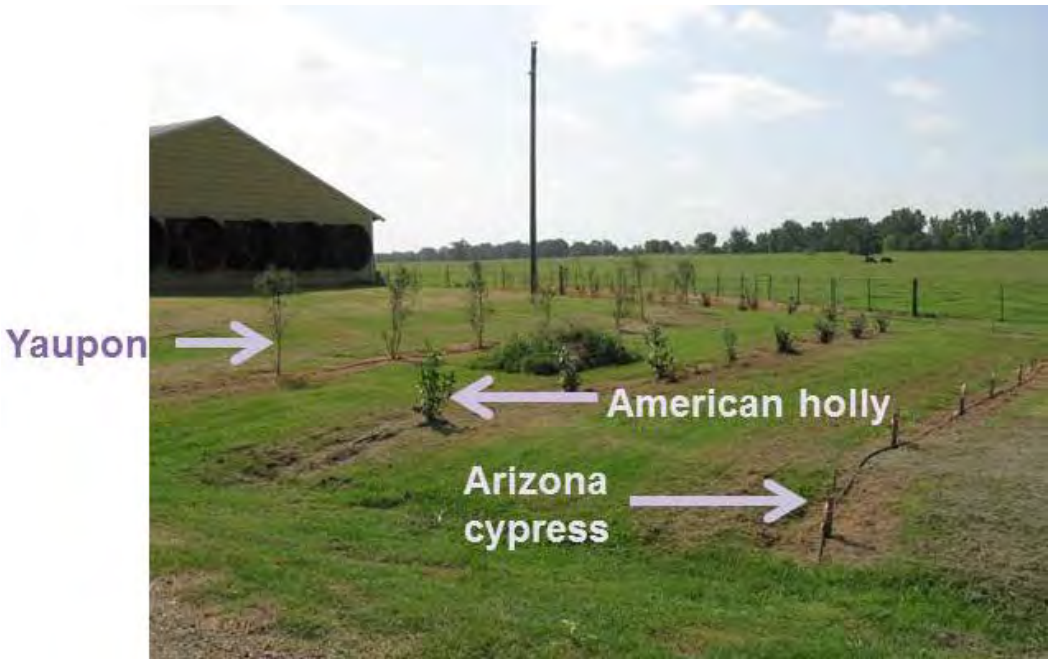

Figure 5. Tree species (Yaupon, American holly, and Arizona cypress) that were planted immediately in front of the exhaust fans of poultry buildings 1 and 2.

Figure 6 shows the tree species that were planted in three rows in front of buildings 3 and 4. Rough leaf dogwood was planted in late April and they all died, thus, were replaced in early July. Observations in August showed that they may not survive again and replacements were ordered for delivery and planting in early October. Eastern red cedar has not been replaced but observations showed that they may have to be replaced. Similarly, a new batch of Eastern red cedar was ordered for delivery and planting in early October. In case of Arborvitae, majority of the plants are alive and initial observations in early August indicated that at least eight (8) of the plants have to be replaced. Replacement plants are available and replanting will commence in early October.

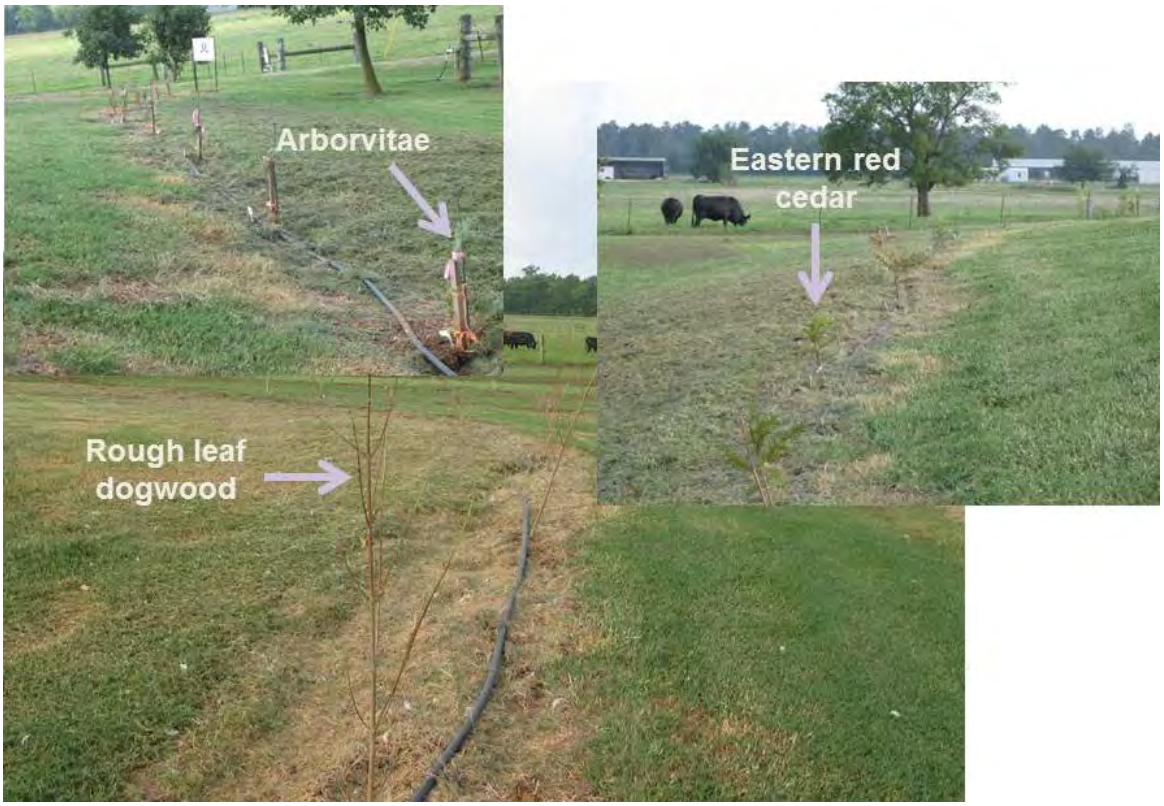

Figure 6. Tree species (Rough leaf dogwood, Eastern red cedar, and Arborvitae) that were planted immediately in front of the exhaust fans of poultry buildings 3 and 4.

In addition to planting the six species directly in front of the exhaust fans of the four buildings, they were also planted inside of the two inner fences that were constructed next to buildings 1 and 4 (figure 7). Inner fences will prevent the cows from reaching the planting areas. The trees planted in these inner fences will capture the emissions from the exhaust fans located on the sidewalls of buildings 1 and 4.

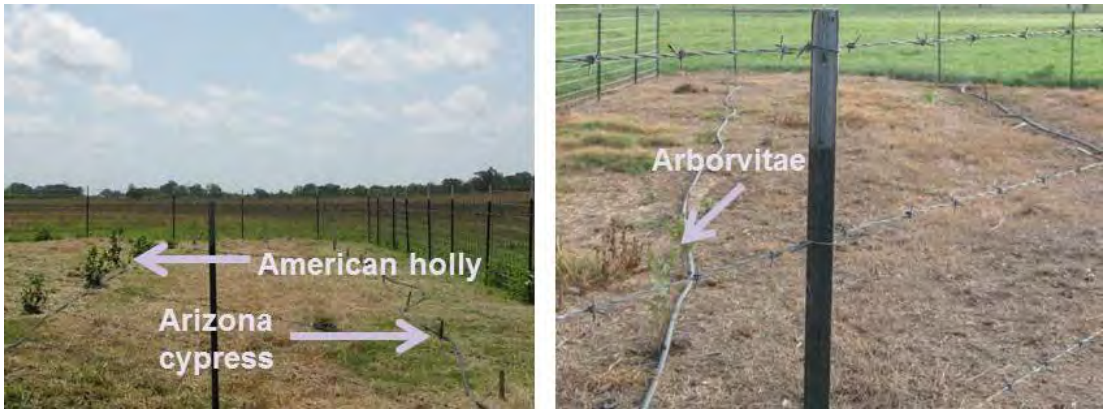

Figure 7. The six tree species were also planted on the two inner fences located next to buildings 1 and 4 to cover the exhaust from the fans located on the sidewalls of those two buildings. Note that the other tree species are not shown above.

All planting were done manually with spades to dig the holes as shown in Figures 8 and 9. A drip irrigation system shown in Figure 10 was installed in June 2013 to automate the watering of the plants. Prior to the installation of the irrigation system, the plants were manually watered in the morning and late afternoon. The automatic irrigation system was programmed to run for 2 hours at 6 AM and 6 PM. All plants were later covered with mulch to retain moisture and control weeds.

Figure 8. Planting the Arizona cypress commenced in April 2013. Spades were used to dig the holes for planting.

Figure 9. Planting the American holly commenced in May 2013. Spades were used to dig the holes for planting.

Figure 10. One of the emitters that were located next to the root system of each plant to keep them well irrigated throughout the year.

Future Plans

Due to the difficulty encountered in the first year to establish the trees, the priority in the second year is to totally replace Eastern red cedar and Rough leaf dogwood, and partially replace Arborvitae. Replanting will commence in early October. In addition to replanting the aforementioned species, the control trees will also be planted in the inner fence that has been constructed behind the buildings or upwind of the exhaust fans. Once the trees have been established, measurements of the pollutants at the exhausts, at the fence line, and within the rows of plants as specified in the project plan will commence.