NREC 2014-02284 • Multifunctional Buffers

Year End Research Report • 14 Feb 2017

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BACKGROUND

The Multifunctional Buffers research program focuses on opportunities to establish and evaluate different multifunctional perennial systems appropriate for marginal or sensitive areas (e.g. sloped land, floodplains, etc.) on Illinois farms. These buffers include monocultures and polycultures of perennial bioenergy crops, forages, shrubs producing fruits or floral cuttings, and corn/soy rotation with cover crops. From the treatments, we are evaluating the environmental benefits related to nitrogen recovery based on analysis of soil nutrients over time, subsurface leaching of nutrients, and abundance of specific soil microorganisms. In addition to recovering nutrients that pollute water resources and reducing greenhouse gas emissions, multifunctional buffer systems could diversify the landscape and the income stream for Illinois farmers, offering a win-win situation for both farmers and the public at-large.

SUMMARY OF RECENT ACTIVIES

In fall of 2015, the trials as St. Charles and Dixon Springs were terminated, as planned, due to consolidation of resources at the research stations for Crop Sciences. The data from the two years in which the trials were active are being summarized and written as a journal article focusing on "establishment phase" results.

Urbana. Activities have proceeded at the Urbana site, which is in the third year of production. Corn plots were sprayed with Roundup Powermax at 2 pts/A on April 26th, planted on May 22, and fertilized on May 25th. Soil samples were collected for nitrogen analysis and soil microbes on 25th from all plots. Spring forage plots were harvested on Jun 13th with a small plot harvester. Leachate samples were collected from all plots on July 2nd. Corn plots were sprayed with Roundup Powermax (2% solution between rows) on June 30, and the rye cover crop was planted into complex treatments. Corn was harvested on October 10, and yields averaged 104 and 98 bu/acre for simple and complex treatments, respectively. High variability in yield was the result of saturation of heavy clay soil in some plots. Soil samples were collected on Dec 9 for nutrient analysis. Due to poor success of shrubs in edible fruit treatments, black currants were replaced with Aronia shrubs, and new elderberry and Amelanchier shrubs were added. Microbial DNA from all 2015 and "establishment phase" soil samples have been extracted and purified, in preparation for analysis of microbial functional groups that are active in N cycling.

Forrest. On April 26, a new trial site was established in Forrest, IL (40˚48'N, 88˚24'W), with the full set of ten treatments matching the Urbana trial. Soybeans, forage, and bioenergy plots were planted at that time. Soil samples were collected and lysimeters installed at the Forrest location on May 23-25. All floral and fruiting shrubs were planted into plots on June 13, and fertilized with compost mulch on June 16. Despite efforts to curtail wildlife damage using repellant around shrubs, few shrubs had survived when evaluated on August 26. Shrubs for edible plots were transplanted on November 15, and 24" tree tubes were installed to avoid damage from rabbit and deer. Floral plots were transplanted on Dec. 12-13, as a result of late shipping from nursery due to unusually warm fall. Soybean harvest data in the establishment year was not available due to farmer over-running plots during harvest.

PRELIMINARY RESULTS

Urbana

The forage and bioenergy plots at the Urbana site continue to thrive, but some of the shrubs have struggled due to wildlife damage and constrained root growth likely from heavy soils. We would expect to be harvesting fruit from the shrubs in this year, but their growth setbacks have delayed harvesting. Pussy willow appears to be well-adapted to the conditions of the Urbana site, and floral cuttings from those plants could be harvested in the coming winter/spring.

Soil Nitrogen. Soil samples for nitrogen revealed few differences between treatments. The treatments with corn/soybean rotation typically contain the highest concentration of nitrogen, likely due to fertilizer additions in the years with corn. The cover crop (complex treatment in corn/soybean rotation) did not improve nitrogen uptake as it had in previous years, perhaps because the Vetch used in this rotation did not produce as much biomass. Some of the stored N may have been released, as well, since the burndown sprayed prior to planting may have allowed plants to begin to decompose.

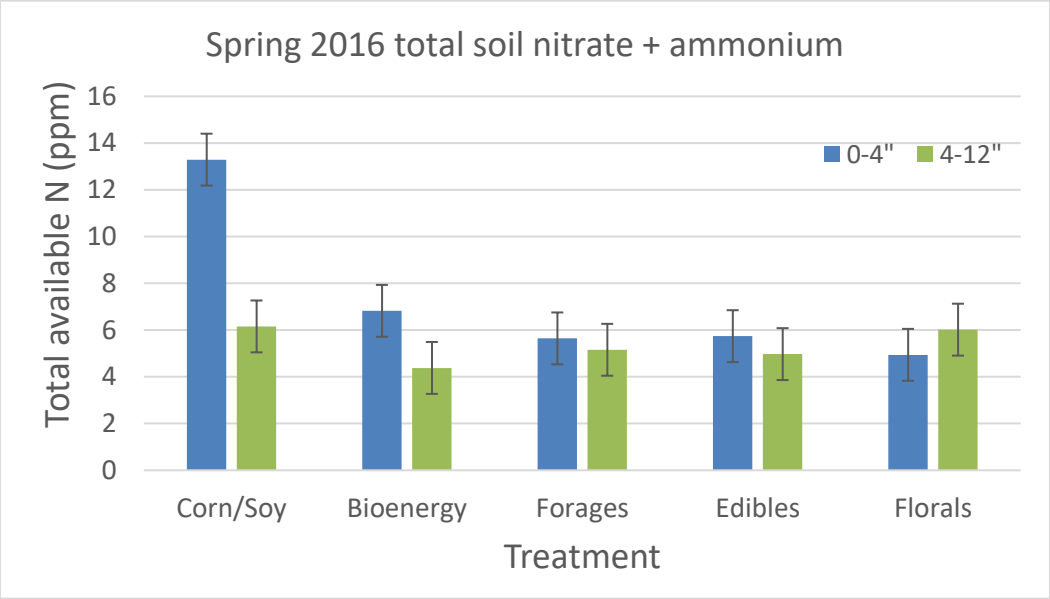
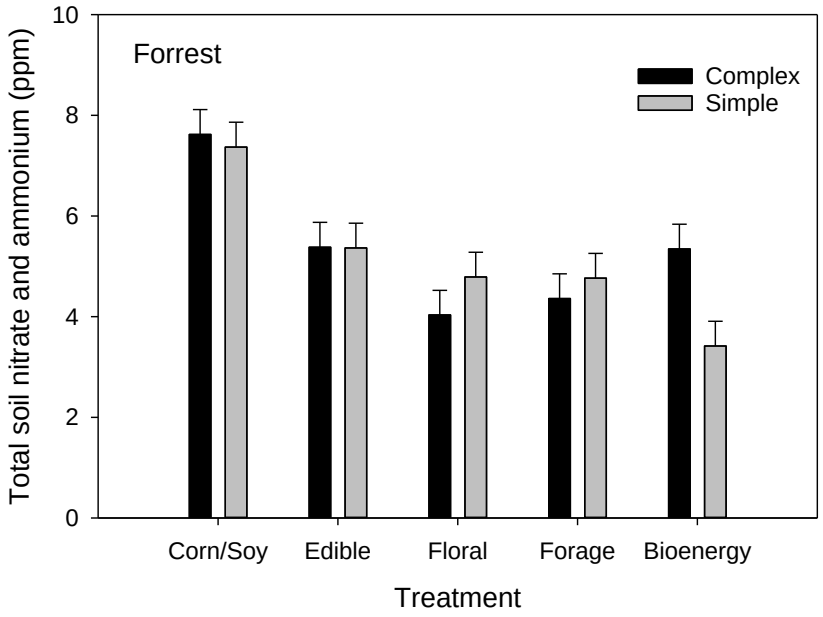


Figure 1. Total available nitrogen for buffer treatments in Spring 2016 at Urbana, IL. Complex and simple treatments for each cropping system were combined, since differences were not significant.



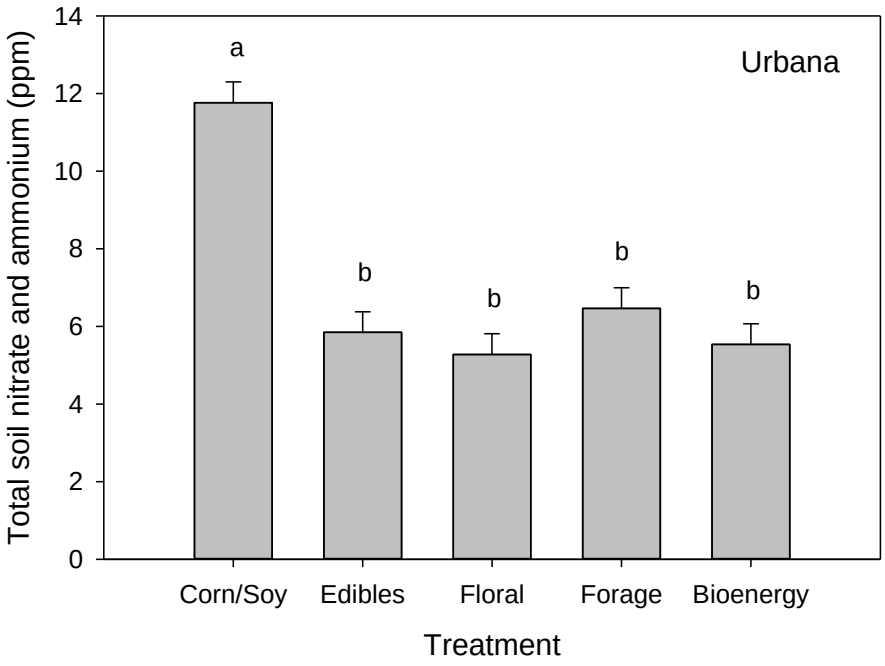


Figure 2. Total soil nitrate and ammonium at 0-12" deep during the fall post-harvest sample interval at the Forrest (top) and Urbana (bottom) locations. Complex = polyculture planting; simple = monoculture planting.

Leaching. In overall, based on two years' data at Urbana site, leachate nitrogen concentration in plots with buffer treatments was significantly lower than that in corn/soy rotation plots. In 2016, except for floral plots, all treatments showed lower leachate nitrogen concentration than that in 2015 (Fig. 3). Leachate samples from floral plots showed the lowest water nitrogen concentration (0.13 mg L-1) in 2015, and forage plots showed the lowest concentration (0.20 mg L-1) in 2016. The magnitude of nitrogen concentration reduction from treatments also varied among seasons (Fig. 4). Leachate nitrogen concentrations showed no differences between monoculture and polyculture except for corn/soy rotation plots. The corn/soy rotation with cover crop had significantly lower leachate nitrogen concentration (1.30 mg L-1) than that in corn/soy monoculture (3.19 mg L-1) (Figure 5). No differences between two slope levels (upslope and down slope) were detected (data not shown).

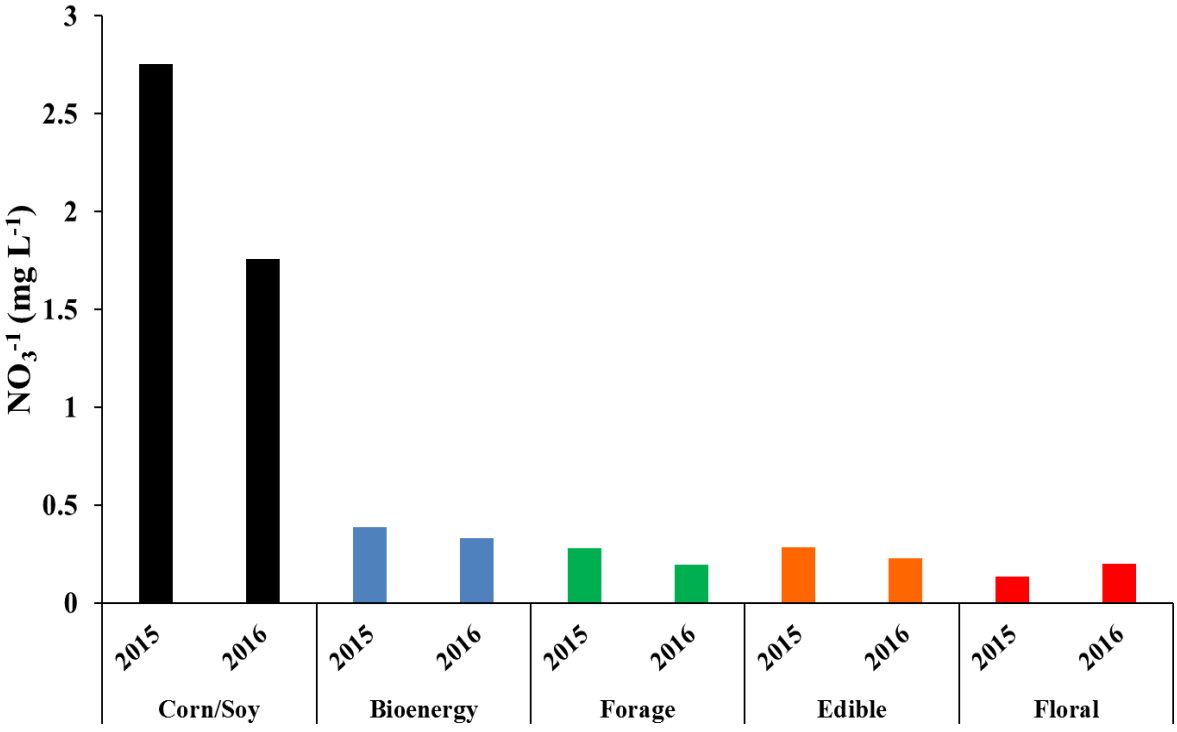


Figure 3. 2015 and 2016 leachate nitrogen levels comparing all treatments at Urbana.

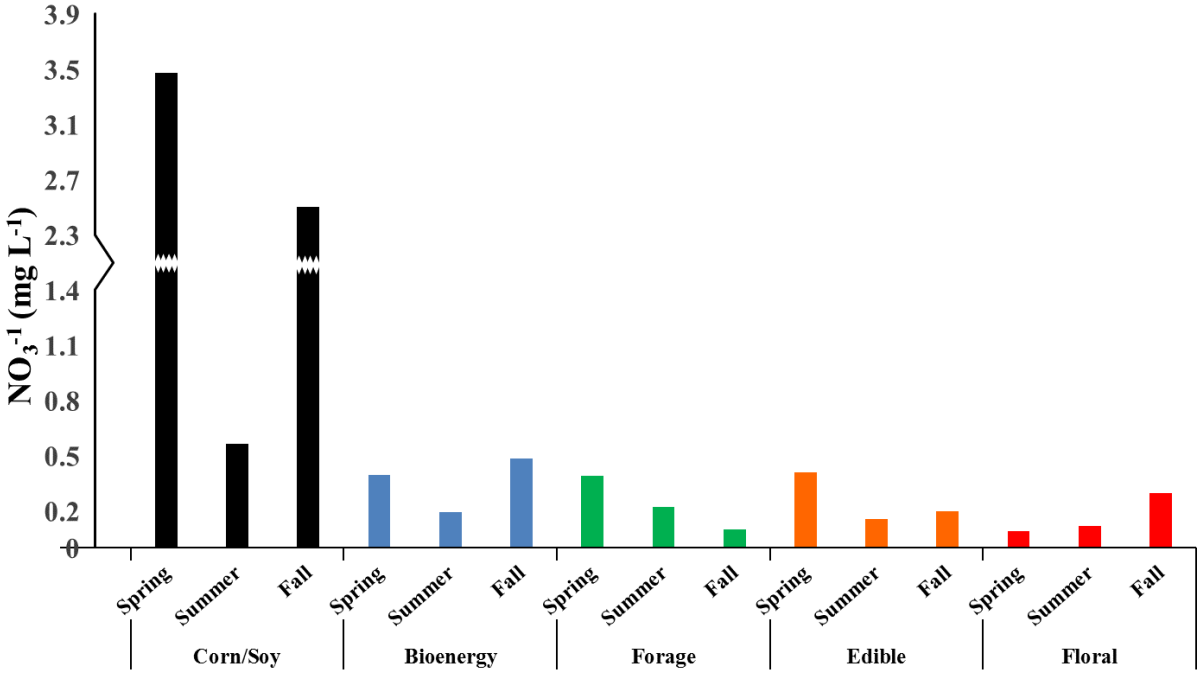


Figure 3. Year round leachate nitrogen levels comparing all treatments at Urbana.

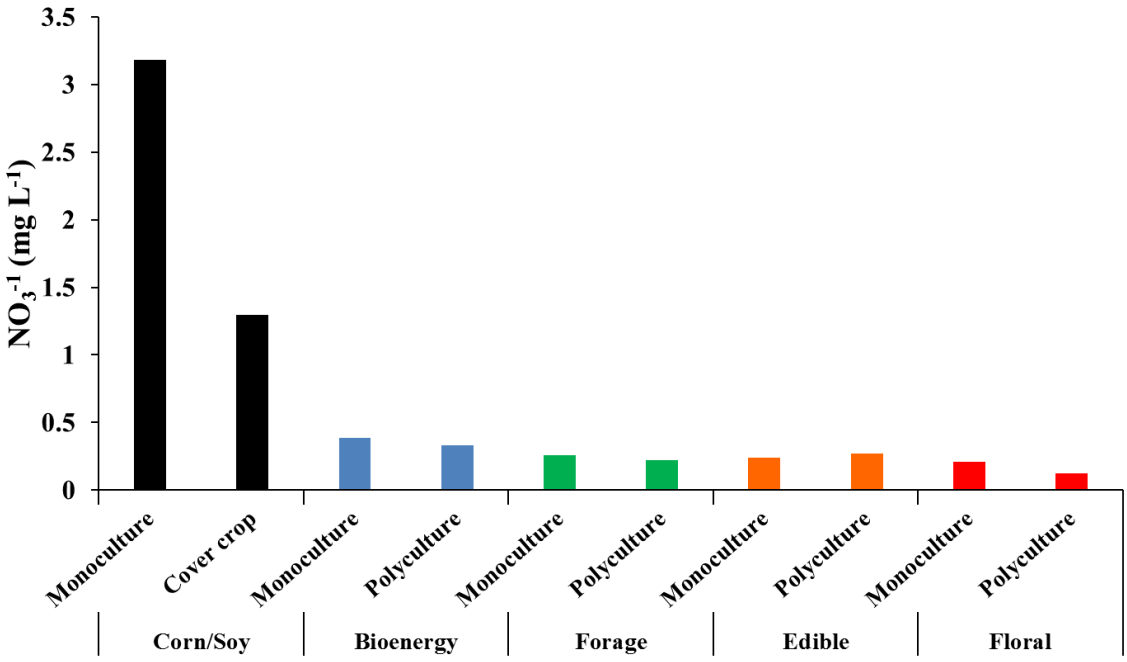


Figure 4. Leachate nitrogen levels in different plot complexity levels

Harvest. Forages and bioenergy crops were harvested at Urbana in spring and fall 2016, and results are shown in Figure 5. Bioenergy crops showed a higher biomass yield in 2016. In overall, polyculture treatment showed no differences comparing to monoculture. The first forage harvesting was comparable to last year's harvest. The warm-season grasses in the polyculture forage plots may benefit from the early summer precipitation and high temperature in the fall, therefore resulting in a higher biomass yield in the 2nd harvest compared to last year. The low biomass yield from the forage monoculture plots (largely missing) is likely due to the poor performance of cool season grass.

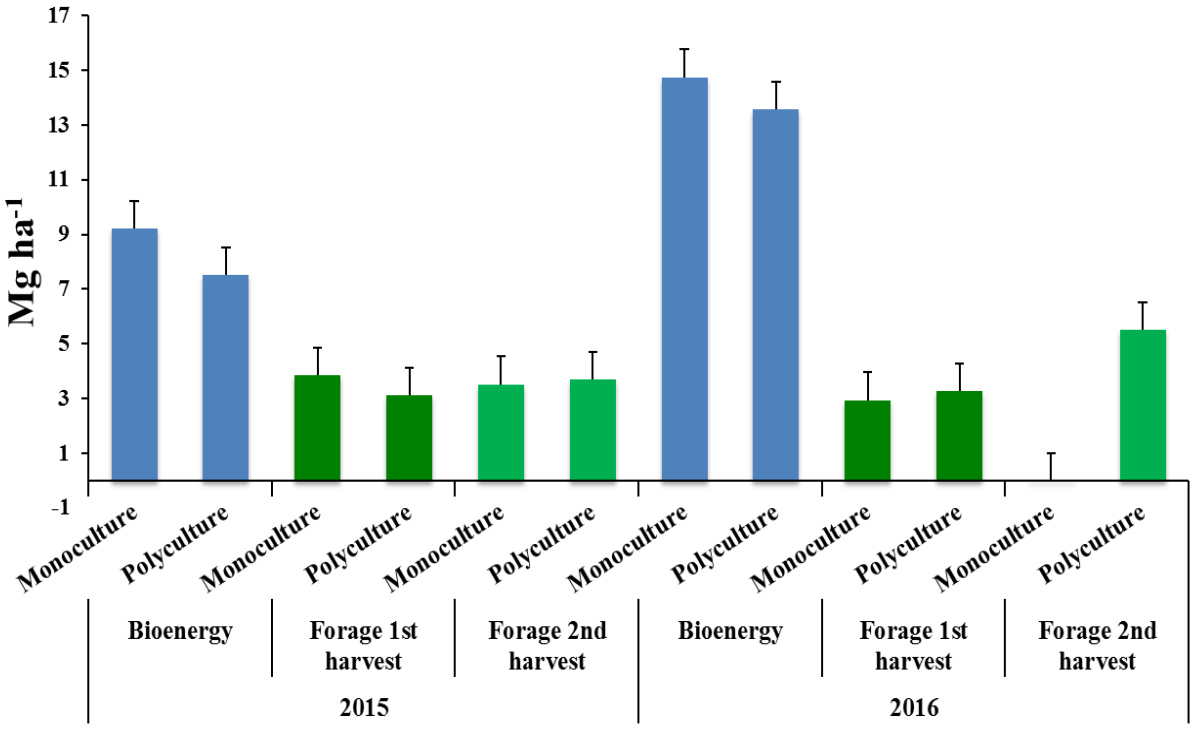


Figure 5. Forage and bioenergy crop biomass yield affected by mixture during 2015 and 2016 at Urbana

Forrest

Establishment. The new trial at Forrest was successfully established in 2016 (Figure 6).

Figure 6. Forrest location on August 26th, 2016 (left), and fall edible planting protection on November 15th, 2017 (right)

Leaching. For Forrest site, the summer leachate nitrogen concentrations were much lower than that in spring. Most of the plots planted with bioenergy and forage crops showed leachate nitrogen concentration lower than 0.2 mg L^{-1}. Fall season leachate was not sampled due to a lack of moisture in the soil.

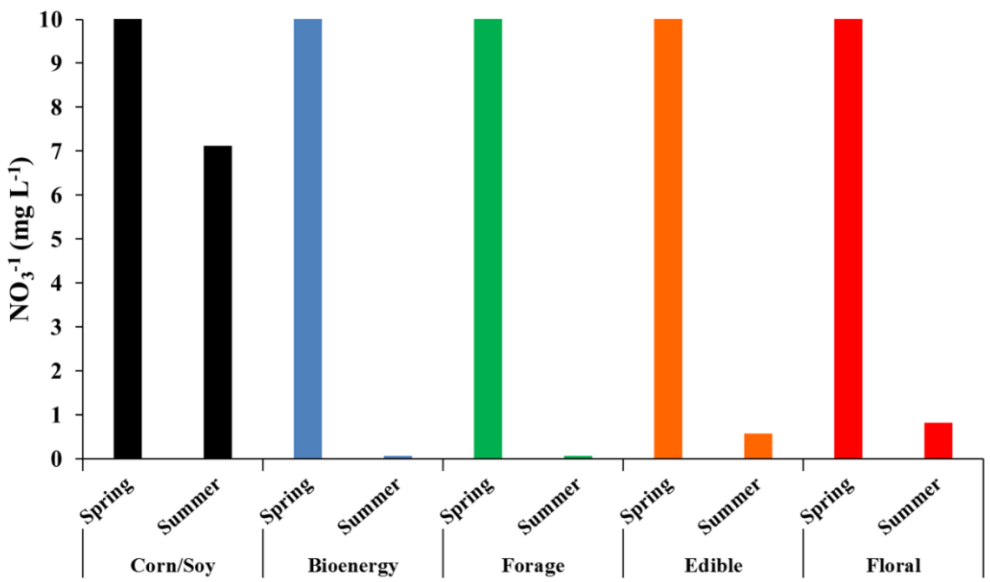


Figure 7. Leachate nitrogen levels comparing all treatments at Forrest.

CONCLUSIONS

The success of shrub plantings seems to be highly dependent on the conditions of the site. Wildlife damage is a major factor, and the use of cages and other protection strategies may be necessary to avoid browsing from deer, clipping from rabbits, and girdling by voles. Some species appear to be much more tolerant the of "buffer" conditions than others. Performance of pussy willow has been good, while that of red currant has been particularly disappointing.

Figure 7. Examples of the condition of red currant (left), aronia (center), and pussy willow (right) at Urbana.

Challenges: Our primary challenges of 2016 were related to the complexity of establishing the new site in Forrest, on a cooperator's farm. We were unable to get into the field for the ideal timing to plant shrubs in the spring, and those plants struggled throughout the season due to poor establishment and wildlife damage. The decision was made to replace shrubs in the late fall for the floral and edible treatments. We expect the use of tree tubes will help to protect the plants for the coming year.

Outreach: Graduate student, Jia Guo, presented the results of the work to date at 2016 ASA annual meeting, with the title, "Evaluating the benefit of prairie filter strip related to nitrogen recovery and biomass production on corn-soybean rotation cropland".

Budget: No changes are required at this time.