NREC 2014-02284 • Multifunctional Buffers

Annual Research Report • 15 February 2014

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Background. This project is guided by the framework of 'landscape multifunctionality', which promotes the integration of a range of different functions or benefits into the working landscape, beyond just production. For Illinois farms, site-specific solutions including perennial buffers can be introduced into the less productive or marginal portions of the farm to provide environmental benefits such as nutrient scavenging, greenhouse gas reduction, and carbon sequestration, in addition to offering marketable products. This 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. The first objective was to establish replicated long-term field studies to compare multifunctional buffer systems at three of the University of Illinois Research Stations. 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 will evaluate 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 (Objective 2). The third objective will be to conduct a Life Cycle Assessment to study greenhouse gas (GHG) emissions and water quality impacts for the different buffer systems. For the fourth objective, the profitability of the systems will be compared and a prototype farm planning tool developed to assist farmers in decision-making regarding transitions to new cropping systems on marginal areas of the farm landscape. A final report will be prepared at the conclusion of the project to summarize results of each objective. This project is creative and original in developing solutions for farmers that could be both productive and environmentally beneficial. 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.

Project Participants. This multidisciplinary project relies on expertise of five UIUC investigators. PI Dr. Sarah Taylor Lovell will oversee the administration and management of the project, in addition to organizing the effort to establish the research plots (Objective 1) and to conduct Life Cycle Assessment to study Greenhouse Gas Emissions of the cropping systems (Objective 3). Co-PI Dr. Samuel Wortman is assisting in establishment of shrub and corn/soy/cover crop treatments (Objective 1), and he will be responsible for evaluating soil nutrient cycling over time (Objective 2). Co-PI Dr. DoKyoung Lee is involved in identifying, establishing, maintaining and evaluating site-appropriate perennial plant communities with biomass or forage potential (Objectives 1 & 2). Co-PI Dr. Nick Paulson will apply his background in managing risk/uncertainty and benefits of biofuel systems and fertilizer use, to integrate the economic data into the farm planning tool (Objective 4). Co-PI Dr. Anthony Yannarell (co-PI) is responsible for soil microbial sampling and laboratory analysis to characterize the populations of nitrogen-cycling bacteria (Objective 2).

Plot Establishment:

The full set of 10 treatments was established at the Urbana site, and a reduced list of treatments was established at Dixon Springs (bioenergy/forage comparison, trt 1-6) and St. Charles (edible/floral woody comparison, trt 1-2, 7-10). This design will allow for a minimum of 2 locations for each treatment, with the specific treatments selected based on the appropriateness of the site and local markets. As of summer 2014, the control and cover crop treatments are established at all locations. The full set of 10 treatments is listed below, set up as a split-plot design of simple (monoculture) and complex (polyculture) treatments:

1. Control: Corn-soybean rotation
2. Cover Crop Control: Corn(mustard/radish) –Soybean(rye) rotation
3. Monoculture forage crop: Virginia wildrye (*Elymus virginicus*)
4. Polyculture forage crop: Virginia wildrye + purple prairie clover +leafy prairie clover
5. Monoculture bioenergy crop: Switchgrass 'Kanlow'
6. Polyculture bioenergy crop: Switchgrass + big bluestem + Indiangrass + Prairie Cordgrass
7. Monoculture edible: Red Currant (*Ribes sativum* 'Perfection')
8. Polyculture edible: Red currant + Aronia (*Aronia melanocarpa* 'Viking') + Elderberry (*Sambucus nigra* 'Samdal')
9. Monoculture ornamental: Pussy willow (*Salix discolor*)
10. Polyculture ornamental: Pussy willow + Red osier dogwood (*Cornus sericea* stolonifera) + Snowberry (*Symphoricarpos albus*)

In control treatments, corn was planted parallel to the buffer zone for the 2014 season at all locations. Corn was fertilized following emergence using side-dress application by hand with granular urea or UAN incorporated with a toolbar. Virginia wildrye was planted as a ground cover in the shrub treatments and in the blank areas between plots. Composite soil cores were sampled at depths of 0-4" and 4-12" from each plot at all locations prior to planting. Samples will be analyzed for NO_3-N and NH_4-N in the lab of Dr. Wendy Yang in the Departments of Plant Biology and Geology. Subsamples from the 0-4" zone are also being stored for microbial analysis. Although beyond the scope of the current proposal, Dr. Yang collected greenhouse gas (GHG) data from the plots at the Urbana location – every 2 weeks in corn, bioenergy, and forage, and every 6 weeks in edible woody and floral woody plots. At the same time, a 0-10 cm depth soil plug was sampled for soil moisture and NO_3-N/ NH_4-N. In the fall, cereal rye was broadcast planted as a cover crop into standing corn at a rate of 120 lbs/acre. Specific information for each location is provided below.

Location Specific Outcomes

Crop Sciences Research and Education Center – Urbana, IL

The trial in Urbana was established along the slightly sloped buffer zone of a drainage way off of Old Church Rd (Deers Rd), between Race St. and South First St. Soil cores were sampled on April 23 (0-4") and April 24 (4-12"), after the field was tilled but prior to planting. Corn was planted on May 5, using Pioneer 0987 AMX, and the crop emerged on May 11. Corn was treated with herbicides Roundup Powermax 22oz/A and Medal II 2pts/A on May 23, 2014, and fertilizer was applied on May 27 as 200#/A Urea. Planting for bioenergy and forage crops took place on May 6, and for Woody crops were watered on May 9. The bioenergy and forage crop treatments were cultipacked on April 24 and May, and selected plots were mowed Jun 13, Jul 7, and Sept 8, as needed for weed control. Ground cover in shrub plots was mowed on Jun 23 and August 11.

The arrangement of the treatments is shown in Figure 1.

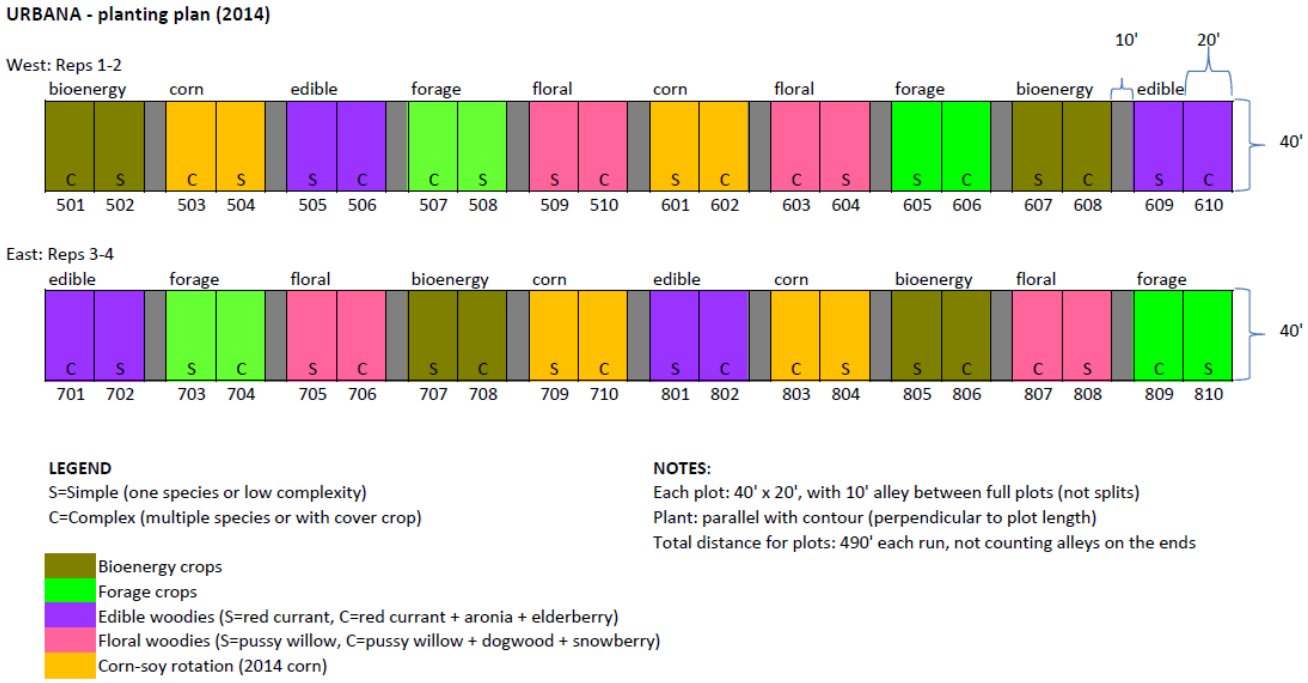

Figure 1. Plot and treatment arrangement of multifunctional buffers at Urbana, IL.

Figure 2. Drilling holes with tractor-mounted auger to plant woody plants at Urbana, IL.

Corn was harvested on Sept 30, 2014, with 4 rows in 10ft sections harvested from each plot. Average population was 72.5 plants/plot (40ft), and average yield was 202 bu/acre. In this first establishment year, bioenergy, forage, edible and ornamental crops were not harvested. At the end of the season, blocks 500, 600, and 700 were well established. Block 800 (Farthest east plot) had a very high infestation of annual grasses, yet there are some plants that still remain (primarily the wild ryes). No fertilizer was applied in 2014 to either the forage or bioenergy plots. We intend to spray pre-emergent herbicides only on the forage plots and then 2,4-D and pre-emergent on the bioenergy in 2015. No stand counts were done in 2014, but will be done following emergence in 2015. The cereal rye cover crop was planted on September 23, and establishment was good.

Dixon Springs Agricultural Center

The trial at Dixon Springs was established at the back of the west site off of Rock Springs Lane (between Simpson and Robbs townships). The plots were located on a consistently sloped area along the stream. Soil cores were sampled on April 25 for 0-4" depth and May 21 for 4-12" depth. This location included treatments for corn (Pioneer 1498), bioenergy crops, and forage crops, all of which were planted on May 21. Corn was fertilized with a sidedress application of 150# of UAN on May 31. All bioenergy and forage plots were mowed on September 29.

Figure 3. Location of trial (left) and plot arrangement (right) at Dixon Springs, IL.

Corn was harvested on Oct 1, 2014 and yielded 95.9 bu/A average with a mean population of 56.5 plants/plot. At the end of the season, the perennial plots were well established, even though there were problems with severe erosion (see Figure 4) and herbicide drift. No fertilizer was applied in 2014 to either the forage or bioenergy plots. We intend to spray pre-emergent herbicides only on the forage plots and then 2,4-d and pre-emergents on the bioenergy in 2015. No stand counts were done in 2014, but will be done after emergence in 2015. The cereal rye cover crop was planted on October 1, and establishment was good.

Figure 4. Dixon Spring plots after planting showing severe erosion compared with adjacent area that remained in no-till.

St Charles Horticultural Research Center

At the St. Charles location, the trial was established along a drainageway for a retention pond. Soil sampling occurred on May 20, for 0-4" and 4-12" samples. Corn (Pioneer 0987 AMX) and Virginia wildrye cover were planted on June 5, and woody shrubs including edible and floral treatments were planted on June 6. The field received adequate rainfall following planting. Corn was fertilized and sprayed with glyphosate on July 8. Shrubs that did not survive were replanted on July 9 and July 16. Shrub plots were mowed, hoed and fertilized with compost on July 9. On Sept 24, plots and alleys were tilled, and Virginia rye (ground cover for shrubs) reseeded due to poor emergence/establishment. Corn was harvested on November 5, and yielded 178.4 bu/A average with a population density of 81.3 plants/plot (40ft). The cereal rye cover crop was planted on September 25, and establishment was good.

Figure 5. Location of trial at St. Charles (left) and shrub planting plan (right).

Preliminary Results

Due to the longer duration of this study, most of the results are yet available. We have been documenting the details of all activities for the development of a Life Cycle Analysis once the trial is complete. Analysis of soil samples will occur in the coming months as data are available from the soil analysis lab. At this time, we are able to report on the preliminary outcomes of global warming potential, soil moisture, and inorganic nitrogen from the Urbana trial (see below).

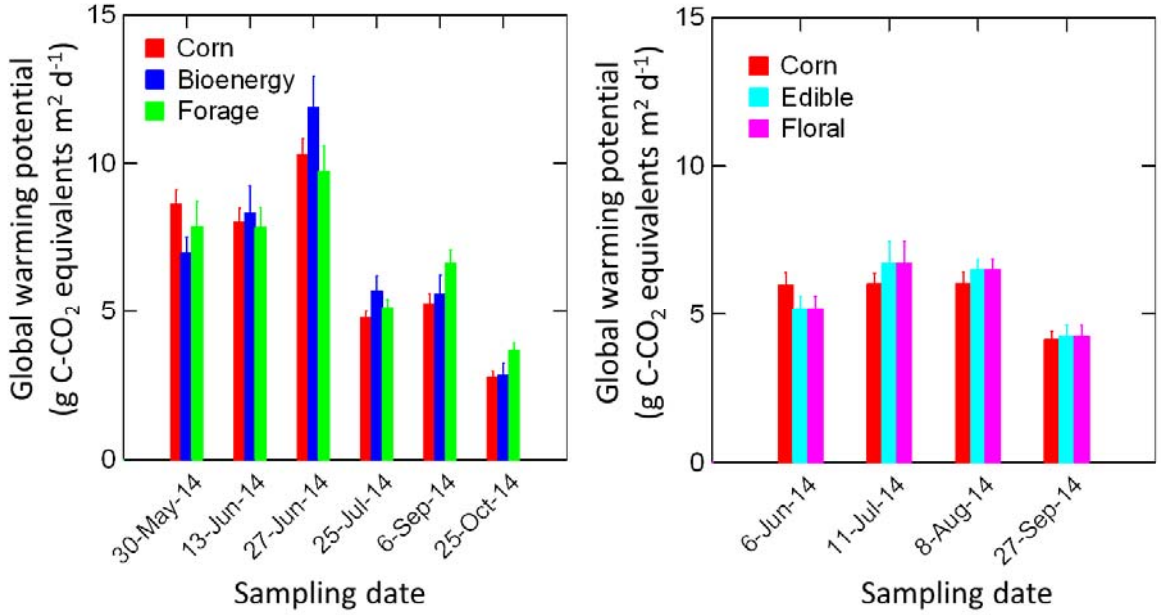

Figure 5. Global warming potential (GWP) of treatment at Urbana site. GWP of corn was greatest only at the beginning of the growing season.

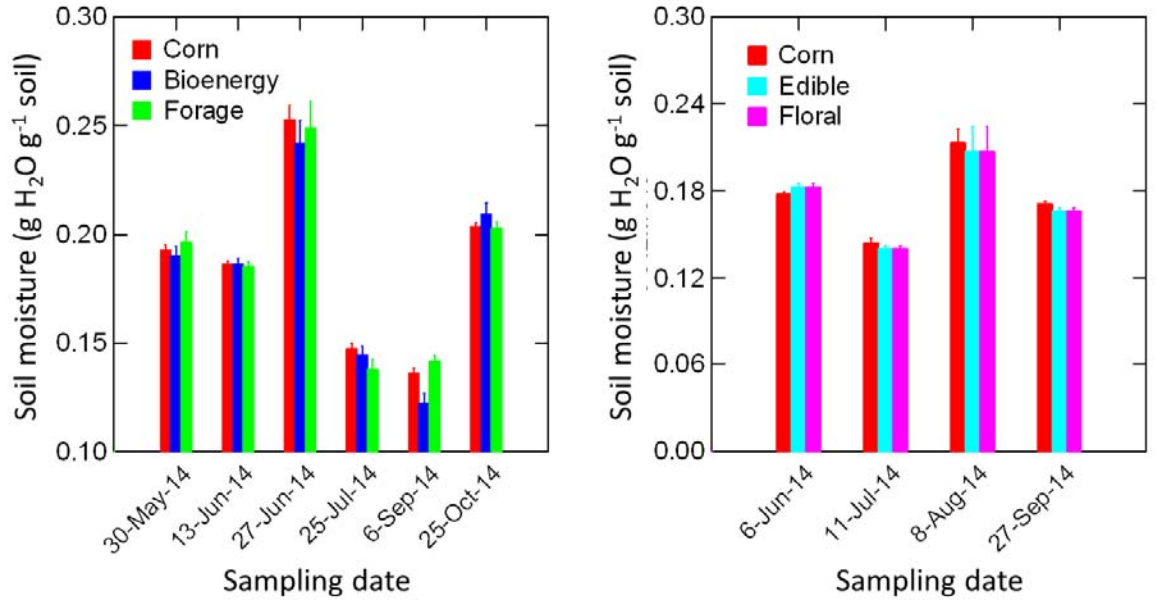

Figure 6. Soil moisture at several dates at Urbana site. Treatments did not consistently differ in moisture levels.

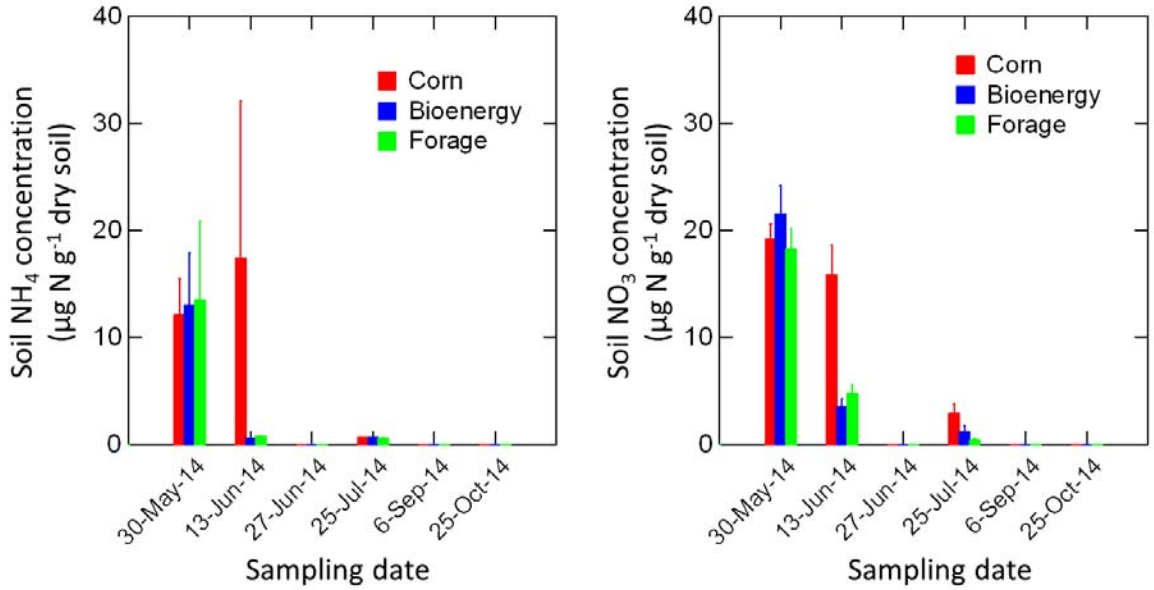

Figure 7. Inorganic nitrogen concentrations were greatest in corn plots only on one sampling date.

Challenges: Soil sampling deep cores was the greatest challenge encountered to date. A tractor-mounted probe was attempted at both Urbana and Dixon Springs, but the soils were too heavy with clay to extract consistent cores. The decision was made to focus on the top 12" of soil, where most of the nitrogen activity would occur. The lysimeters will provide the necessary information on nitrogen leaching to deeper levels. Weed control is likely to be an ongoing challenge, particularly considering the variety in treatments. At the St. Charles site, for example, the first replication had a heavy infestation of Canada thistle, and the best herbicides are not safe for planting shrubs back in.

Outreach: A summary of the proposal has been shared with stakeholders interested in perennial buffer systems. The website for the Multifunctional Landscape Analysis & Design (MLAD) lab was updated to include a new page dedicated to the NREC project. Updates will be posted regularly at: http://multifunctionallandscape.com/Multifunctional_Buffers.html. Dr. Lovell and Dr. Wortman presented the trial at the St. Charles Vegetable Grower Annual Twilight Meeting on July 17, 2014. The group of approximately 40 visitors expressed great interest in the project. Dr. Lovell presented preliminary results at the 2014 IL Water Conference on October 15, 2014.

Budget: In the request for year 2 funding, we proposed that a portion (6-months) of the funding designated for a Graduate Research Assistantship would go to an Academic Professional, since the student cannot begin on the project until July 1. No other changes are required at this time.

Budget Report

The following page contains the official report provided by UIUC Grants & Contracts for the period ending December 31, 2014. The balance does not include additional encumbered wages for that period, which result in an actual current balance of $3,798.77. We also have yet to pay the soil analysis lab $3,600 for work completed last year, because they have not set up the billing system.

NUTRIENT RESEARCH AND EDUCATION COUNCIL
"Multifunctional Buffers on Marginal Farmland to Improve the Environmental Profile of Agriculture and Diversity Production Opportunities"
Award Period: January 1, 2014 - December 31, 2014
Current Reporting Period: May 01, 2014 - December 31, 2014
INTERIM FINANCIAL REPORT/Contractual Modification Pending

INVESTIGATOR: Sarah Lovell

EXPENDITURES:	**PRIOR PERIOD EXPENSES**	**CURRENT PERIOD EXPENSES**	**CUMMULATIVE EXPENSES**
Salaries & Wages	$5,244.61	$24,783.43	$30,028.04
Fringe Benefits	$2,249.61	$5,115.46	$7,365.07
Material & Supplies	$1,611.10	$28,169.68	$29,780.78
Equipment	$0.00	$7,726.00	
Travel	$0.00	$6,624.81	$6,624.81
Services	$0.00	$303.98	$303.98
Total Direct	$9,105.32	$72,723.36	$74,102.68
Indirect	$999.76	$8,072.35	$9,072.11
Total	$10,105.08	$80,795.71	$90,900.79

AWARD:	
01/01/14-12/31/14	$110,658.00
Interest Accrued	$1.10
	$110,659.10
Less Expenditures	$90,900.79
BALANCE	$19,758.31

This report was prepared from
financial records of the
UNIVERSITY OF ILLINOIS
GRANTS AND CONTRACTS OFFICE

Sandra Moulton

Sandra Moulton
Senior Director, Post Award Administration