

# 2020 LTER Standard Sampling Report

## Main Cropping System Experiment (MCSE)

### **Soil**

Soil was regularly sampled on the LTER to a depth of 25 cm at each of 5 stations in all replicates (R) of all treatments (T) 1-8, CF, DF, and SF. Samples were taken once or twice each month, for a total of nine times between May 21 and November 18. Soil was sampled using a ¾" diameter push corer. Two cores were taken from each station with all 10 cores composited for each plot. In addition, T3 and T4 individual stations and prairie strip soil was sampled three times in 2020 (June, July, October). Inorganic nitrogen extractions and soil moisture determinations were done on subsamples from all soil sampled. Analysis of the extracts for nitrate and ammonium will be completed by Cathy McMinn during winter 2020-2021.

The May 21 soil samples will be air-dried and archived. The first April sampling is typically archived but COVID-19 pandemic restrictions delayed the start of soil sampling to May\*. A subsample from each of the July 13 soil samples and July 23 T3, T4 prairie strip soil samples was incubated in the field for 21 days and then inorganic nitrogen extracted to evaluate mineralization potential.

A post-harvest extensive grid soil sampling was done in all replicates of T1-6 and T8NT on November 12. This soil was air-dried and sent to the MSU Soil and Plant Nutrient Lab for standard analysis which includes pH, lime requirement, P, K, Ca, and Mg.

### **Gas**

Gas was sampled throughout the LTER using round static chambers between April 30 and November 11. Sampling typically starts in early April but was delayed due to COVID-19 pandemic restrictions\*. MCSE plots that were sampled include T1-7 R1-4, as well as the fertilized, untilled microplots in T7 R1-4 and prairie strips in T3, T4 (see MCSE Microplot section). Static chambers were also sampled in T8 R1-4 and all replicates of successional and forested sites, CF, DF, and SF. Sampling in the forest sites included the Nitrogen Deposition Study microplots. With a sample frequency of once or twice each month, gas samples were taken ten times during the 2020 field season. The MCSE (including T8) was sampled in the morning and forest sites sampled in the afternoon of the same day. Winter sampling began on December 9 and should continue monthly through March 2021. This sampling includes only T1-7 and DF. All chamber samples were put into Labco exetainers and transported back to the lab for analysis. They were analyzed for nitrous oxide, carbon dioxide and methane by Kevin Kahmark and Cathy McMinn using the Agilent/Gerstel automated GC in Academic 330.

Soil temperature and soil samples to determine moisture content were taken near each chamber when gas was sampled during the field season. Air temperature was logged both inside and outside, while light was measured outside, of some chambers using HOBO dataloggers.

### **Water**

Soil water samplers, or lysimeters, were used to collect water from the soil at about a 1m depth in T1-7 R2-4 and all replicates of CF, DF, and SF. Samplers were evacuated, and leachate collected

once or twice each month. Ten collections were made between April 23\* and November 5. The volume of leachate collected was recorded. When 20mL or more of leachate was collected, the sample was filtered and frozen for analysis and archive. Analysis for nitrate and ammonium of all leachate samples taken should be completed by Cathy McMinn during winter 2020-2021.

### **Plants**

Plant biomass samples were taken from plots prior to tillage, harvest, weed-control measures and at peak biomass. Plant species separations were completed for most but not all samplings. Red clover cover crop was sampled ahead of tillage in T3 on May 5 and T4 on May 12. The understory in T5 was sampled June 3-4 and again on July 27, ahead of mowing between poplar tree rows each time. Prairie strip samples were taken from T3 and T4 on June 18, just prior to mowing of the strips to control weeds. At peak biomass between July 30 and August 27, plant samples were taken from T6, T7, T8, and SF. Corn was sampled ahead of harvest in T1-4 on October 19-20 and 28-29. Poplar leaf litter was collected in ground traps from August 10-November 23. Leaf litter was collected in traps on the ground in CF, DF, and SF between August 28 and December 10. Leaf litter traps were checked, and leaves collected bi-weekly. In addition, in T5, since the trees were very small and ground traps may not have collected representative samples, leaf litter was collected directly from the ground on November 23 to compare to trap biomass. On November 6, post-frost biomass samples were taken from all T7 plots. All plant material from all samplings was dried at 60°C for at least 48 hours. All dried biomass will be weighed, ground and archived. Subsamples will be analyzed for carbon and nitrogen by Stacey VanderWulp.

In all replicates of CF and DF, all trees with a dbh (diameter at breast height) greater than or equal to 5cm are marked with a unique numbered tag. The dbh of all tagged trees was measured in January 2020. The diameter of the leading stem of ten randomly chosen poplar trees in each T5 plot were measured at 15cm above the ground on December 4.

All replicates of T7 were burned on March 16 to help control woody growth. This was able to be completed just prior to the start of work travel restrictions due to the COVID-19 pandemic.

Switchgrass stand frequency was determined in May with stand counts done in all replicates of T6.

Yield data was collected from all mechanically harvested plots.

Drone flights for visual and multispectral imagery were only completed over portions of the MCSE, as requested by researchers. Drone flying was done by Kevin Kahmark. Most flights were for plant species identification work by Hsun-Yi Hsieh.

### **Insects**

The Landis lab continued to monitor generalist insect predators for spatial and temporal dynamics using the 2019 protocol, <https://lter.kbs.msu.edu/protocols/192>. Coordination of that research was done by Elizabeth D'Auria and the weekly survey was completed by two seasonal technicians. Being a corn year, T-posts and sticky cards were installed on June 4 and weekly sampling started on June 11. Sampling concluded on September 3. Agronomic work occasionally interrupted the survey, but T-posts were removed and replaced in a timely fashion and noted on datasheets.

Monitoring was conducted by attaching one yellow sticky card (Great Lakes IPM, IPM-CRW-100) to a T-post about 1.2m above the ground at each of the five stations within each replicate of T1-T7 and the nine forest plots. This was the second year for surveying insects within the prairie strips of T3 and T4. The survey is conducted concurrently with the main survey, but data are recorded separately. The prairie strip sticky cards are located at the 0-meter mark (strip center) on the North, Central, and South transects through all replicates of these two treatments. The target taxa consisted of 14 common to rare ladybug species (Order: Coleoptera, Family: Coccinellidae); soldier beetles (Cantharidae); fireflies (Lampyridae); scorpion flies (Order: Mecoptera); and other non-target generalist predators (e.g. 20 spotted ladybug).

A 22-foot-tall aphid suction tower onsite is part of a network of towers used to monitor regional aphid migration patterns in the Midwest. The fan on the tower was turned on and the first collection cup deployed on May 15, 2020. The collection cups were collected and replaced every Friday through October 23 at which time the tower was turned off. The samples were mailed to the University of Illinois at Urbana-Champaign for analysis.

### **MCSE Microplot Experiments**

**Herbicide-free Microplots (T1 R1-6, T2 R1-6):** These microplots ended in 2019.

**OLD Rainfall Manipulation Experiment (T1 R1-4, T2 R1-4):** Shelters were not installed in 2020 and no samples were taken. This experiment was maintained from 2014-2018.

**NEW Rainfall Manipulation Experiment (T1 R1-4, T2 R1, 3, 4 and 6, T7 R1-6):** The start of this experiment and deployment of rainout shelters was postponed to 2021 due to restrictions related to the COVID-19 pandemic\*.

Phoebe Zarnetske will use open-top chambers (OTCs) under rainout shelters in T7 to manipulate ambient air temperature and rainfall. OTCs were first placed in the T7 shelter footprints in late fall/early winter of 2019. A decision was made to remove them in late spring of 2020 because of the decision to postpone rainout shelter deployment to 2021. The OTCs were moved back to their plot locations in T7 on December 4, 2020 in anticipation of the experiment starting in spring 2021. Moriah Young collected soil from the Zarnetske T7 footprints on November 6, 2020. These soil samples were processed and then archived at -80 C. Their intended use is for soil microbial work.

Rainout shelter construction continued in planning for deployment in 2021. Truss work was added to all shelter frames in 2020.

Footprints and subplots for T1 and T2 were surveyed using the Emlid RS2 GPS units with Michigan CORS correction with accuracy to 2cm. This was completed by Kevin Kahmark and Sven Bohm.

In December, Kevin Kahmark, David Weed, and Mir Zaman Hussian installed forty lysimeters (porewater samplers) in all press and control footprint subplots on T1 (four reps) and in only the control subplots of T2 press and average rainfall footprints. Thirty-two lysimeters in T1 and eight lysimeters in T2. Trenching of sampling line to alleyway utility boxes will be completed in 2021.

**Prairie strips (T3 R1-6, T4 R1-6):** Planted with a 22 species prairie mix in 2019, these are 15-foot-wide strips down the center of each T3 and T4 plot. Non-destructive species composition data was collected by the Haddad lab August 5-17. Also, in August, three plant samples were collected from each strip. One sample from each strip was sorted to species. T3 and T4 individual station and prairie strip soil was sampled three times in 2020 (June, July, October), see MCSE soil section. Soil sampled on June 3 will be air-dried and archived. Greenhouse gases were sampled seven times in the prairie strips, as detailed in MCSE Gas section above.

**Poplar Fertilization Gradient (T5 R1-6):** No sampling was done in 2020. These microplots were stopped with the harvest of poplars in 2018.

**Brome grass (T6 R1-6):** When the main T6 plots were planted to switchgrass in June 2019, a 30-foot-wide by 30-foot-long area in the northwest corner of each plot was left unplanted. Brome grass was planted there September 22, 2020. On May 29 and July 30, plant samples were taken from these microplots ahead of herbicide applications. Adjacent to the brome grass microplot, to the east, is a microplot of the same size. That area is planted to switchgrass and left unfertilized.

**Disturbance/Fertilization Microplots (T7 R1-6):** Started in 1989, these microplots are in the northwest corner of each T7 plot. There are four microplots in each plot; each microplot measures 5x5m. They combine disturbance/tillage and nitrogen fertilization in a full factorial design. Greenhouse gases were sampled eight times in the untilled, fertilized microplots of T7 R1-4, as detailed in MCSE Gas section above.

Fertilizing and plant sampling was led by Mark Hammond, working with Jen Lau. The fertilized microplots received urea on July 9. The T7 microplot plant biomass was sampled near its peak September 20-29. Species were separated for the tilled microplots only. All samples were dried and weighed.

Jen Lau and Jose Waterton (University of Indiana) lead a study with Mark Hammond in charge of sampling. They investigated whether 30 years of nitrogen addition altered *Setaria faberi* and/or *Chenopodium album* population's traits and fitness which could then lead to adaptation. They did a germination census and marked seedlings with toothpicks. Data collection included mortality census, non-destructive measurements of plant height and leaf number, date of first flower, specific leaf area sampling, and collection of fruits and seeds for a fitness measurement.

### **Nitrogen Deposition Study**

Nitrogen is applied to subplots at each of the three replicated sites of CF, DF, and SF. Fertilizer solutions were applied to the 1F, 3F and 10F subplots in this study on three dates. Urea (46% N) was applied on May 1-4, July 29 and October 8-9. Rates of fertilization are 1gN/m<sup>2</sup>/year for the 1F subplots, 3gN/m<sup>2</sup>/year for the 3F subplots, and 10gN/m<sup>2</sup>/year for the 10F subplots. Gas was sampled on a routine basis in this study; see the Gas section under MCSE.

### **Resource Gradient Experiment**

From March through November 2020, 80 water leachate samples were collected from the LTER Resource Gradient soil water samplers. These samples were analyzed for anions, cations, non-purgeable organic carbon (NPOC), total dissolved nitrogen (TDN), alkalinity, and NH<sub>4</sub>-N (via IC).

Silicate and total dissolved phosphorus (TDP) will also be analyzed on these samples. Dave Weed was responsible for sampling and analysis.

Soil samples were not taken in 2020.

The LTER Resource Gradient experiment automated trace gas system remained dormant in 2020.

Yield data was collected from mechanical harvest.

### **Interaction Experiment**

Rainout shelter work led by Sarah Roley and Carmella Vizza did not resume in 2020 due to COVID-19 pandemic related restrictions on travel.

Switchgrass stand frequency was determined in May with stand counts done in plots 1-16, except 9, 11, 14, and 15.

Yield data was collected from mechanical harvest. A subsample of the harvested biomass was dried and will be ground and analyzed for carbon and nitrogen by Stacey VanderWulp.

### **Biodiversity Study**

On July 23, sorghum sudan grass was planted in all plots to close out the study. Deep soil cores (1m depth) were sampled in late October and early November 2020 using a Geoprobe 540MT pulled behind a Gator. Two cores (one from the sorghum sudan grass row, one from between rows) were taken from all 4 replicates of B2, 5, 8, 11, 13, 15, 18 and 21, for 64 cores total. All cores will be sectioned (0-10, 10-25, 25-50 and 50-100cm) and length, mass and moisture measurements taken for bulk density calculations. The soil will be air-dried and archived.

*Capsella bursa-pastoris*, *Arabidopsis thaliana*, and *Draba verna* plants were selected to investigate possible adaptation of plant populations from growing in different agronomic treatments of the biodiversity plots for 20 years. Individual plants were harvested (aboveground biomass only) when seeds were mature for each of the three species from all four replicates. Fifteen of the treatments (B6-B20) were selected for study. Plants were harvested from April through June. Individual plants were processed for their seeds. The height of each plant was also measured, stem number was counted, and reproductive structures (buds, flowers, fruits) were counted as a surrogate for fitness. Sample collection and processing was done by Mark Hammond with help from three volunteers. Samples are currently stored at KBS and Indiana University with Jen Lau.

Yield data was collected from mechanical harvest.

### **Cellulosic Biofuel Experiment**

Yield data was collected from mechanical harvest.

\*The COVID-19 pandemic greatly altered the way most sampling and sample processing could be completed in 2020. The start of the sampling season was delayed from early April to late April/early May 2020 due to pandemic-related restrictions. However, most standard sampling was able to be completed.

Written by Stacey VanderWulp with contributions from Elizabeth D’Auria, Mark Hammond, Kevin Kahmark and Dave Weed

### Archived Material

Experiment	sample type	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
LTER MCSE	leachate											
LTER MCSE	plants											
LTER MCSE	T7 microplot plants											
LTER MCSE	surface soil											
LTER MCSE	T7 microplot surface soil											
Experiment	sample type	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LTER MCSE	leachate											
LTER MCSE	plants											
LTER MCSE	T7 microplot plants											
LTER MCSE	surface soil											
LTER MCSE	T7 microplot surface soil											
LTER MCSE	deep core soil											
LTER Biodiversity Study	surface soil											
LTER Resource Gradient	surface soil											
Experiment	sample type	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
LTER MCSE	leachate											
LTER MCSE	plants											
LTER MCSE	T7 microplot plants											
LTER MCSE	surface soil											
LTER MCSE	T7 microplot surface soil											
LTER MCSE	deep core soil											
LTER Biodiversity Study	surface soil											deep core
LTER Resource Gradient	surface soil											

### Agronomic Soil Analysis

Experiment	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
LTER MCSE													
LTER Resource Gradient													
GLBRC BCSE main												GI-3	GI-3
GLBRC BCSE micro												GI-3	GI-3
GLBRC BCSE deep core													
GLBRC Scale-up												L1, M1	L1, M1
GLBRC MLE													
GLBRC Switchgrass Gradient													