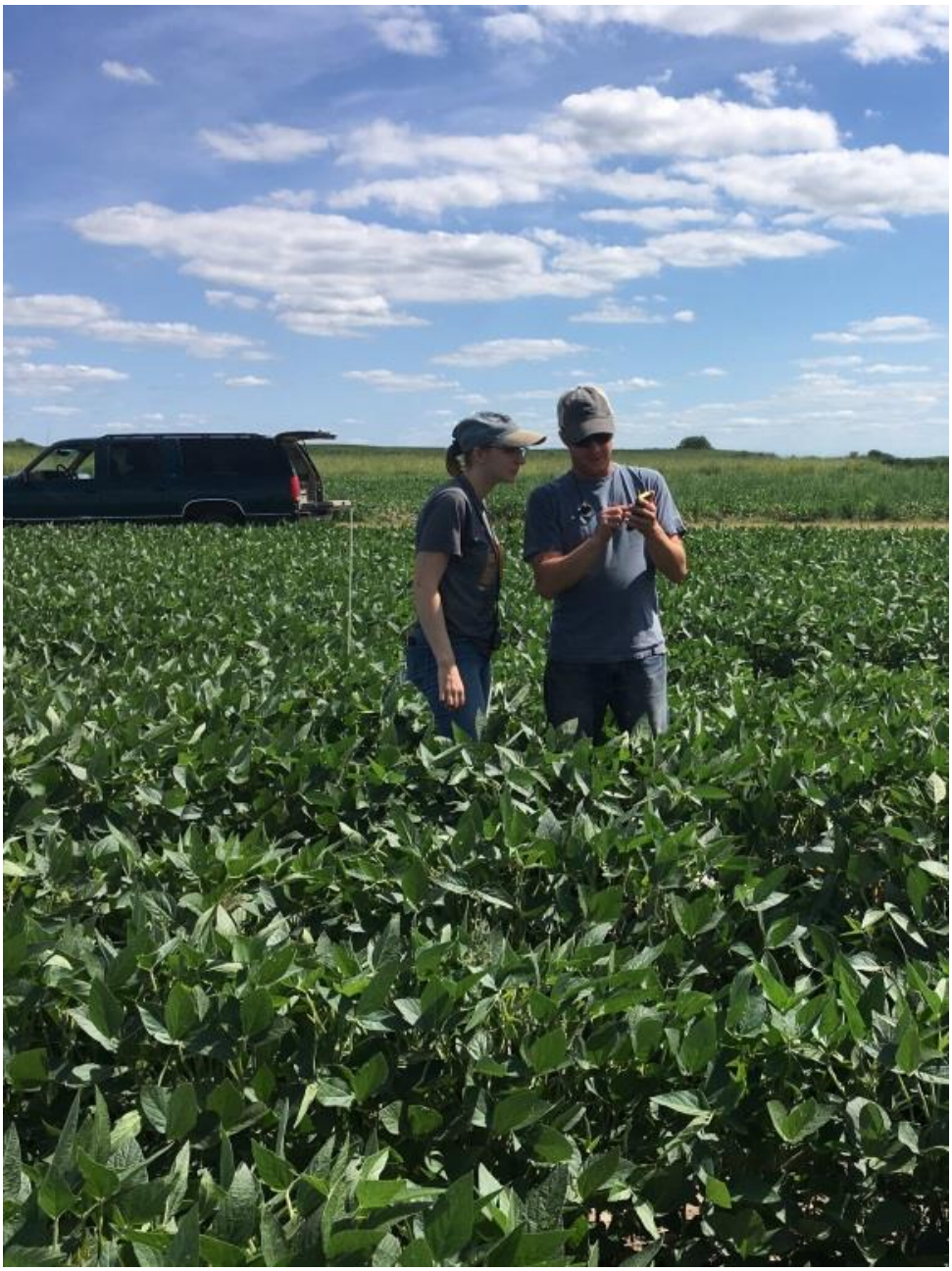
LC3M Progress in 2019-20

iSEE partners with the Leverhulme Centre for Climate Change (LC3M) at the University of Sheffield to investigate Enhanced Rock Weathering (ERW), a method for removing CO_2 from the atmosphere. Since 2016, crushed basalt rock has been applied to corn, soy, and miscanthus fields at the University of Illinois Energy Farm to measure the potential of Midwestern croplands to act as sinks for atmospheric CO_2, while still supporting the agriculture critical to the region. As ERW is a carbon-mitigation strategy, there is particular interest in determining the potential carbon savings in bioenergy crops, where the carbon reduction strategies can be combined for maximum effect. The first two years of the field-scale project have shown that basalt treated crops had lower nitrous oxide emissions and a small increase in grain yield in year one, which is of interest to both farmers and environmental science.



NRES Undergraduate Haley Ware and Plant Biology Technician Mike Masters make field measurements of soil respiration in Summer 2019 at the University of Illinois Energy Farm.

The 2019 research season marked third year of the field-scale research project — and the first year of soybean production in the basalt-treated maize/soybean fields as part of scheduled crop rotation at the Energy Farm. Basalt application and tillage of maize/soy fields occurred in the fall after the 2018 maize harvest, and basalt was surface-applied to miscanthus before plant emergence in the spring of 2019. Measurements of greenhouse gas production from soils, soil carbon and nitrogen, soil water chemistry, and plant biomass and yield were carried out through the growing season, while eddy covariance towers monitored gas exchange for each of the crops. Soil and soybean roots and nodules were collected in 2019 to investigate microbial community responses to basalt application that could alter the nitrogen cycle in these soils.

Field measurements in 2019 confirmed that nitrogen fertilizer is the source of much of the N_2O lost in these systems — in 2019, when unfertilized soybeans were planted in place of heavily-fertilized maize, site-wide N_2O production was extremely limited in both control and basalt-treated plots. Miscanthus, fertilized at 1/3 the rate of maize, cycles nitrogen tightly, resulting in N_2O emissions comparable to unfertilized soybeans. A major focus of the 2019 research was to investigate the potential mechanisms that reduce N_2O production with basalt, particularly soil pH and phosphorus supply. The ecosystem model DayCent was used to make projections of N_2O production with different qualities of basalt, demonstrating that maize systems respond to both changes in pH and phosphorus supply. In the spring of 2020, a liming project was initiated alongside basalt application in maize to investigate individual inputs to the mechanism described by the DayCent model.

Illinois LC3M team members made one conference presentation in 2019-20:

- **DeLucia, E.H.**, **Kantola, I.B.**, Blanc-Betes, E., **Masters, M.D.**, Val Martin, M., **Bernacchi, C.J.**, Beerling, D.J., **Long, S.P.** "Basalt Application for Carbon Sequestration Reduces Nitrous Oxide Fluxes from Croplands." 2019 American Geophysical Annual Meeting, San Francisco, Calif., December 2019.

Illinois researchers also had five invited talks:

- **DeLucia, E.** "Managing Agricultural Land to Reduce the Emission of Greenhouse Gases to the Atmosphere." U.S. Department of Energy Genomic Sciences Program PI Meeting, Virginia, February 2019.
- **DeLucia, E.** "The Role of U.S. Agricultural in the Carbon Cycle." Chicago Botanic Garden, 2019.
- **DeLucia, E.** "Enhanced Weathering as a Carbon Reduction Strategy for Agriculture." New Phytologist Trust Symposium, Royal Botanic Gardens, Kew, UK, 2019.
- **DeLucia, E.** "Carbon and Nitrogen Cycling in Intensive Agriculture." Leverhulme Centre for Climate Change Mitigation Annual Meeting, Sheffield, UK, September 2019.
- **Kantola, I.B.** "Farming with Rocks: Fertilization, Productivity, and Greenhouse Gases in Basalt-Amended Crops." Leverhulme Centre for Climate Change Mitigation Annual Meeting, Sheffield, UK, September 2019.

In addition, the Centre had three major publications:

- Beerling, D.J. "Can Plants Help Us Avoid Seeding a Human-Made Climate Catastrophe?" *Plants, People, Planet* 1, 1-5 (2019). DOI: 10.1002/ppp3.10066.
- Cox, E., Edwards, N.R. "Beyond Carbon Pricing: Policy Levers of Negative Emissions Technologies." *Climate Policy* 19:9, 1144-1156 (2019). DOI: 10.1080/14693062.2019.1634509.
- Kelland, M.E., Wade, P.W., Lewis, A.L., et al. "Increased Yield and CO_2 Sequestration Potential with the C4 Cereal *Sorghum bicolor* Cultivated in Basaltic Rock Dust-Amended Agricultural Soil." *Global Change Biology* 26: 3658-3676 (2020). DOI: 10.1111/gcb.15089.