Paul C. and Edna H. Warner Endowment Fund for Sustainable Agriculture
Interdisciplinary Grant Program for On-Farm Research

Report Form

Project Title: Application of Shallow Geothermal System for Season Extension in Ohio Greenhouses

Summary (Describe your project, its objectives and results in one or two sentences)

The objective of this study is to determine the heating and cooling capacity of low-energy geothermal heating for a greenhouse in Ohio to enable season extension. Specifically, this project will accomplish the following aims:
- Design, install, monitor, and assess an earth to air heat exchange system in the greenhouse at Oaks and Sprouts Limited in Urbana, Ohio.
- Conduct an energy audit of a geothermally heated greenhouse in comparison to conventional propane-heated greenhouse.
- Create a spreadsheet-based tool for economic feasibility analysis of geothermal season extension systems in Ohio for a range of production systems, greenhouse sizes, and supplemental heat scenarios.

What was done? (One paragraph describing the goals, experiments and how they were performed)

The first task required was to determine design parameters for the earth to air heat exchange system, primarily the insulative properties of the desired installation area, which is adjacent to the high tunnel greenhouse on the partnering farm, Oaks and Sprouts Limited located in Urbana, Ohio. To accomplish this task we needed to 1) determine a soil temperature profile from the surface to a depth of 2 meters through installing waterproof datalogging temperature sensors, and 2) determine the lag between external ambient temperatures and soil temperature at depth by correlating soil temperature changes with ambient temperature changes collected with a localized weather station.
To determine these and other important design parameters, we met with farmers discuss desired conditions inside the greenhouse at different seasons and siting of earth to air heat exchange system. We also began monitoring soil temperatures, ambient environmental conditions, and conditions inside the greenhouse. The graduate student installed a datalogging weather station (Davis Instruments Vantage Pro2 Weather Station and Data Logger) on site, and also installed a system to measure and record temperature profiles at depth (DS18B20 waterproof temperature sensors). Data on conditions inside the greenhouse were collected using a Pulse Pro Environmental Monitor.

What were the results? (One paragraph on the outcome of the experiments, what was learned from them)

The experiments to determine the insulative properties of the soil are still in progress, as it was necessary to observe the soil temperature profile and its correlation with ambient conditions through seasonal changes. We would expect soil temperatures to be cooler than external temperatures in spring and summer and warmer than external temperatures in fall. These seasonal shifts are the best candidates for season extension for greenhouse cultivation so are the most important commercially. We hope to be able to use data on the seasonal shifts from fall to winter and winter to spring to determine the external temperatures where the change-over of soil heating or cooling relative to external occurs, at which point we will also be able to use historical weather data to get a wider grasp on expected timelines to provide for the farmer's market garden management.

How have the results contributed or will they contribute to sustainable agriculture? (One paragraph on how will farmers use this research information and what difference will it make on their farm?

This project will pilot an earth to air heat exchange system in a medium-sized producer greenhouse in Ohio, which will provide a blueprint for future research and installation of earth to air geothermal greenhouse systems in Ohio. Additionally, the results of this research will lead to the development of a tool applicable to all greenhouse growers in Ohio. This spreadsheet-based tool will help demonstrate the efficiency of shallow geothermal resources for energy resource consumption reduction and increased profitability of farms. In turn, this will allow for increased access of Ohio communities to directly-marketed fresh and nutritious foods and opens possibility for more consistent retail-level supply of in-demand local products.