

Testing the Subterra Green prototype

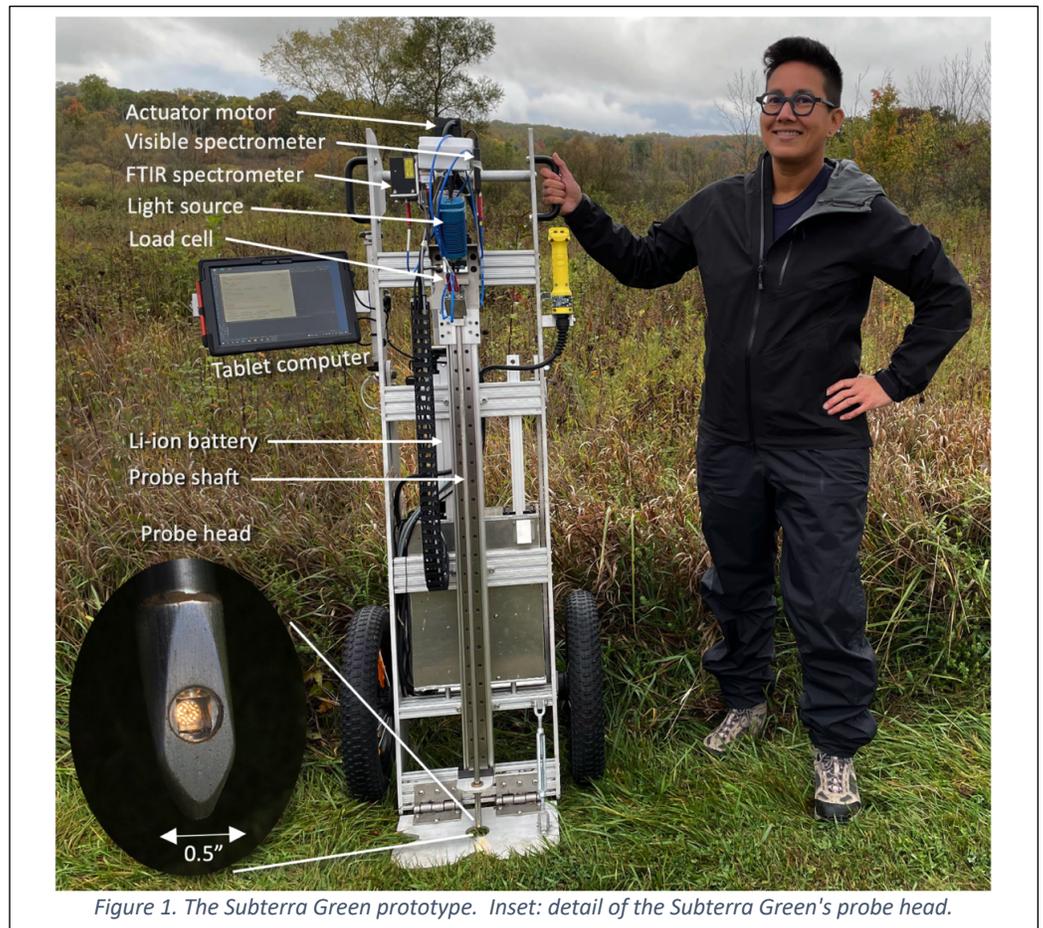
S4 Mobile Laboratories

Spring 2024

Beginning early spring 2024, S4 Mobile Laboratories will be testing a prototype of the Subterra Green, our exciting new technology that can **inexpensively and rapidly measure and map soil organic carbon content of agricultural soils** to a depth of approximately one meter. The goal of the testing is to verify and improve the accuracy of the Subterra Green's measurement of soil organic carbon content and to extend the range of soils on which the Subterra Green has been verified. We are looking for farmers/landowners who will allow us to test the Subterra Green on their land.

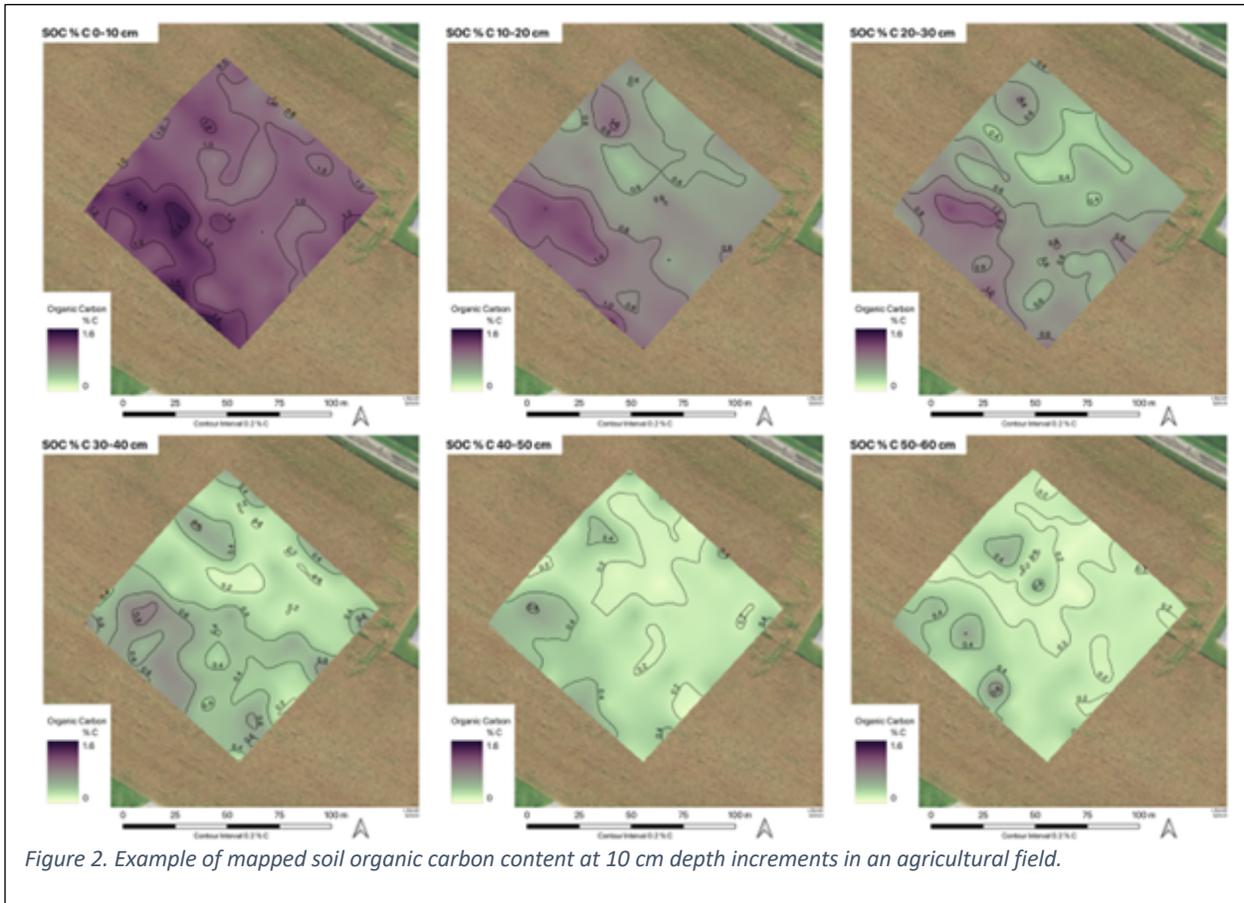
The Subterra Green (Figure 1) is able to measure soil organic carbon content by means of light reflected from the soil through a ½-inch diameter fiber-optic probe which is inserted into the soil to a depth of about one meter. The method is relatively rapid (about 1.5 minutes per probe insertion), so we are able to sample more densely than would typically be done conventionally, which allows us to produce a detailed map of organic carbon content (Figure 2).

Because we are still testing the Subterra Green prototype, for this year we will also need to extract conventional soil samples, which will be sent to a commercial lab to be measured for organic carbon content. The conventional measurements will be compared to measurements obtained by the Subterra Green. We will share all of the data (both from the Subterra Green and from the conventional sampling) obtained



from fields where testing takes place with the landowner.

We are doing this testing to fulfill our obligations as recipients of a USDA SBIR Phase II grant (2023-2025), and will be following the protocols of the grant proposal. As much as possible, we will be selecting land that is used or has recently been used for growing crops, and is located in our priority counties (Figure 3).



Landowner Frequently Asked Questions

1. What are the goals of the testing activity?

- We have two major goals:
 - To **verify and improve the accuracy** of the Subterra Green prototypes' measurement of soil organic carbon content in agricultural soils, and
 - To **extend the range of soil types** on which the Subterra Green's measurement of soil organic carbon has been verified.

2. How does the Subterra Green measure soil organic carbon?

- The Subterra Green pushes a ½-inch diameter probe into the ground. The probe shines a light onto the soil in contact with the probe’s window and measures the amount of light reflected in selected wavelengths using spectrometers. The pattern of the reflected light is used to determine the amount of organic carbon present in the soil.
- The Subterra Green takes measurements of the light reflected at short distance intervals between the soil’s surface and a depth of about 90 cm. We can therefore determine how the organic carbon content of the soil is arranged with depth.
- We repeat the probe insertions and measurements at a large number of locations within a field in order to produce a detailed map of the spatial variability of soil organic carbon content in the soil.

3. Since the Subterra Green measures soil organic carbon content spectroscopically, do you also need to take soil core samples?

- Yes, we will also take soil core samples that will be analyzed for soil organic carbon content in a conventional laboratory. We use the soil cores so that we can compare measurements obtained spectroscopically to measurements

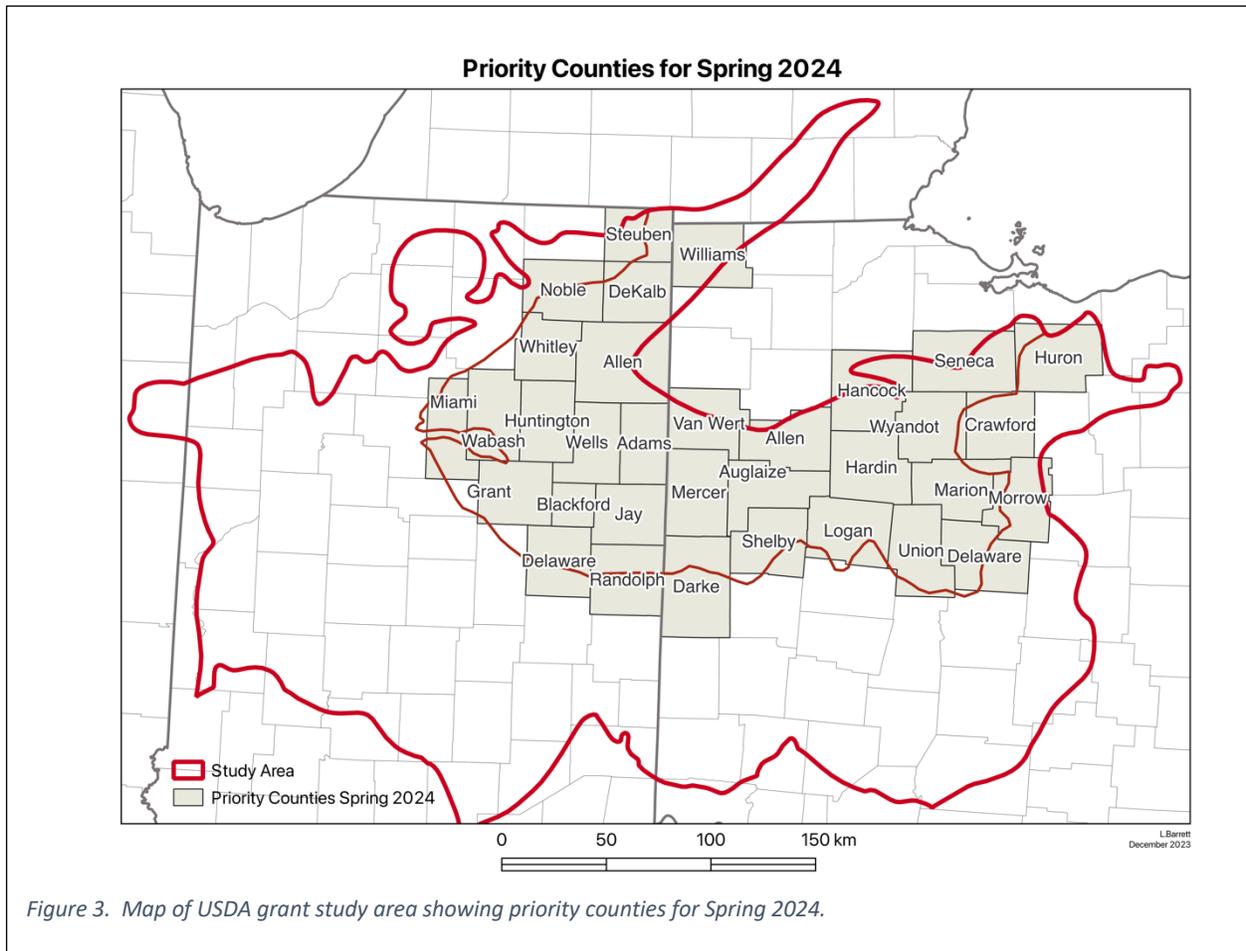


Figure 3. Map of USDA grant study area showing priority counties for Spring 2024.

obtained through conventional laboratory analysis. We also use the soil core measurements to update and improve our spectroscopic models. Although in the current testing phase we take a relatively large number of cores, in the future only a few will be needed as a quality check.

4. How long will it take for the S4 team to complete their work on my land?

- At most sites, work can be completed within two to three field days. A few sites will be sampled more intensively, and would require three to five field days. We will work with the landowner to coordinate the timing of the field work.

5. What is involved in the field work that the S4 team will do?

- At most sites, we will insert the Subterra Green's probe at around 15 selected locations in a field of between 50 to 250 acres. The locations are selected so that we sample the variety of soil conditions present in the field. We will also take a 1½ inch diameter soil core to a depth of 1 meter using a hand-operated soil corer from each of these 15 locations.
- For those sites selected to be sampled more intensively, we will use the Subterra Green prototype to measure and map soil organic carbon stock in an area of about 12 acres. In this area we will insert the Subterra Green's probe approximately 220 times in a grid pattern, with a grid spacing of about 15 meters (about 18 probe insertions per acre). At about 60 of the probe insertion locations we will also take a 1½ inch diameter soil core to a depth of 1 meter using a hand-operated soil corer.
- The Subterra Green prototype has two wheels and is hand-positioned. We will coordinate with farmers and landowners about the timing of the sampling activities and how and when we access the land.

6. What can the landowner expect to receive from S4?

- S4 will share the Subterra Green-determined organic carbon content from the locations on your land. This can be done both as georeferenced point locations for the samples and shown on a map of the field. We will also share the georeferenced results from conventional soil cores.

7. Can the Subterra Green be used to measure other soil properties in addition to organic carbon content?

- In principle, yes, the Subterra Green could be used to measure other soil properties. However, developing the model for each additional property is resource-intensive because it requires a large number of conventional laboratory measurements from a wide variety of soils. Due to the importance of soil organic carbon content in soil health and in the carbon credit market, S4 Mobile Laboratories has chosen to focus on soil organic carbon in the initial stages of development for the Subterra Green.

8. Who is S4 Mobile Laboratories?

- S4 Mobile Laboratories (<https://www.s4laboratories.com/>) is a technology startup company based in Akron, Ohio. We are dedicated to providing you with the best soil testing solutions available.

9. Where can I find out more information?

- Feel free to contact Principal Scientist Dr. Linda R. Barrett (lbarrett@s4laboratories.com) for more information about testing of the Subterra Green prototype. General questions about logistics or scheduling can be directed to Senior Field Director Morgan Revels (mrevels@s4laboratories.com).