Monitoring Carbon in your Soils – Worksheet to Track Carbon Change

Use this worksheet as a guide to make calculations to a) convert % soil organic matter (SOM) to % soil organic carbon (SOC), b) calculate SOC concentration changes over time, c) measure and calculate bulk density, and d) calculate SOC stock changes over time.

Sampling for Soil Organic Matter and Soil Carbon

When Do I Sample?

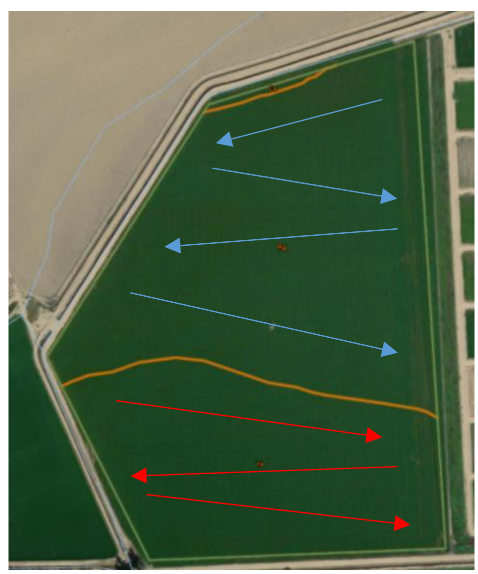
Short answer: when you can. Soil carbon levels, as we measure them, are dynamic and can fluctuate over the season. Considering this, be consistent about when you measure soil organic matter/soil carbon each year. If you collect your baseline samples in fall, then collect your endpoint samples around the same time in fall again, for example. The key is to be consistent.

Supplies

- Sample probe
- Sharpie
- Ziploc bags labeled with Field ID's and depth

How to Sample

1. Identify the fields you want to monitor for soil carbon, and identify sections within a field that you may want to sample separately. You may divide a field into pieces depending on soil type, topography (high or low spots), or soil moisture gradients (e.g., proximity to a waterway).
2. Identify the depth and depth fractions you want to sample. With a hand probe you will likely only be able to sample to a foot (30 cm) in depth. With a larger hydraulic probe like a Giddings probe (http://www.soilsample.com/; Giddings Machine Company), you can sample meters deep. Decide which depth fractions you would like to analyze; usually, cores are divided into foot-long fractions. For example, if you measured to two feet deep, you would have depth fractions of 0 to 1 ft, and 1 to 2 ft. You can cut the core in the probe with a flathead screwdriver, as shown in the picture above, then push each fraction out individually into separate bags.



3. Walk in an M-shaped pattern across the areas you have identified for sampling, collecting a representative number of samples across the path. Multiple cores/samples should be collected and mixed to make one sample, which we send for analysis. A general rule of thumb for number of samples per area is 10 samples/per acre, which are then mixed in a bag and sent to a lab for analysis.

Soil Carbon Concentration

CALCULATION WORKSHEET

Soil carbon concentration is a measure of the proportion of a soil that is carbon, by weight. Soil organic carbon (SOC) concentration is expressed in units of percent, parts per million (ppm), or g/kg. Soil organic matter (SOM) as reported by soil test labs is also expressed in terms of concentration, usually as % SOM. SOM is 58% carbon; therefore, % SOM can be converted to % SOC by multiplying % SOM by 0.58.

FIELD: _______________

SOIL CARBON CONCENTRATION

Baseline (Year 1; beginning of project)

1. Year 1 / Baseline: ___________

2. Year 1/Baseline SOM (from soil test): _____________ %

3. Convert SOM to SOC: (SOM% from line 2) _________ % x 0.58 = _________ % SOC

Endpoint (Year X; end of project)

4. Endpoint Year: ____________

5. Number of Years from Baseline: ______________

6. Endpoint Year SOM (from soil test): _____________%

7. Convert endpoint SOM to SOC: (SOM% from line 6) ________ % x 0.58 = ________% SOC

8. Calculate change in SOC concentration:

Endpoint % SOC ________ – Baseline % SOC __________ = _________ % SOC

(line 7) (line 3)

Sampling for Soil Bulk Density

Bulk density is a measurement of the density of soil; i.e., the weight of soil per volume. Bulk density is necessary for calculating soil carbon stocks and is also a good way to measure compaction in your soils. Bulk density is expressed in units of g/cm^3 OR $Megagrams/m^3$, which are equivalent. In other words, 1.5 g/cm^3 is equal to 1.5 Mg/cm^3.

Supplies

- PVC or metal cylinder, 6 inches or 1 ft. long
- Rubber mallet
- Sharpie
- Ziploc bags labeled with Field ID's and depth

How to Sample

Identify an undisturbed sampling area on your ground; sample when ground is not too wet or too dry to either compact the soil in the core when you pound in the core, or to have extreme difficulty pounding in the core. Length of the cylinder should match the length of the depth fractions you identified for soil organic matter/soil carbon sampling (see above). Set the cylinder against the ground and pound in gently until the cylinder is completely filled with soil. Excavate the cylinder from the ground and cut the soil core until it is flush with the top and bottom edges of the cylinder, as shown in the picture at right. *If the soil in the cylinder is compacted while you are pounding in the cylinder, move to a different area and start over. A compacted core will result in an inaccurate measurement of bulk density.* Measure the inner diameter of the cylinder and record on the bulk density worksheet (page 4).

Put the soil core in a Ziploc bag labeled with the field and depth sampled. You do not need to keep the core intact while bagging and transporting. Take the soil to an oven, remove from the bag and place in an oven-safe container, and dry at 200 degrees F for 48 hours. Weigh the soil when dry, and record the weight in grams on the bulk density worksheet (page 4).

Sample bulk density at the beginning of your experiment, to correspond with sampling of the baseline soil carbon content, and at the end, to correspond with the endpoint soil carbon sampling.

BULK DENSITY

Baseline (Year 1; beginning of project)

9. Inner diameter of sampling cylinder: ____________ cm

10. Radius of sampling cylinder: diameter (line 1) ÷ 2 = __________ cm

11. Length of cylinder (1 inch = 2.5 cm; ℓ): _____________ cm

12. Weight of dry soil: ______________ g

13. Calculate volume of cylinder: $V = \pi r^2 \ell$

V = 3.1415*(_________)^2 x ___________ = ___________ cm^3

(line 10) (line 11)

14. Calculate baseline bulk density: BD = g/cm^3

BD = _________ g ÷ _________ cm^3 = ____________g/cm^3 (or Mg/m^3)

(line 12) (line 13)

Endpoint (Year X; end of project)

15. Inner diameter of sampling cylinder: ____________ cm

16. Radius of sampling cylinder: diameter (line 1) ÷ 2 = __________ cm

17. Length of cylinder (1 inch = 2.5 cm; ℓ): _____________ cm

18. Weight of dry soil: ______________ g (from weighing soil out of the oven)

19. Calculate volume of cylinder: $V = \pi r^2 \ell$

V = 3.1415*(_________)^2 x ___________ = ___________ cm^3

(line 16) (line 17)

20. Calculate endpoint bulk density: BD = g/cm^3

BD = _________ g ÷ _________ cm^3 = ____________g/cm^3 (or Mg/m^3)

(line 18) (line 19)

Soil Carbon Stocks

CALCULATION WORKSHEET

Soil carbon stock is an expression of the total weight of carbon in the soil, expressed in units of weight (kilograms, megagrams, lb, etc.). Soil carbon expressed as *stocks* are important for calculating soil carbon sequestration, or the amount of carbon stored long-term in soils. Soil carbon stocks are commonly used by scientists and policymakers in estimating CO_2 greenhouse gas emissions offsets, and for carbon credits. Soil carbon stock is calculated for a certain depth of soil, and reported as such. To calculate soil carbon stocks, you need to know a) the % SOC, and b) the weight of a hectare (metric units) of soil to 1 foot deep.

FIELD: _______________

SOIL CARBON STOCKS

Baseline (Year 1; beginning of project)

21. Year 1 / Baseline Weight of soil: 1 hectare of soil, 1 foot deep: Volume = 3048 m^3

22. Weight soil $_{\text{(1 hectare, 1 foot deep)}}$ = BD __________ (Mg/m^3) x 3048 m^3 = ____________ Mg
(line 14)

23. Weight soil $_{\text{(1 hectare, 1 foot deep)}}$ _________ (Mg) x % SOC __________ = _________ Mg/ha
(line 22) (line 3)

Endpoint (Year X; end of project)

24. Endpoint Year Weight of soil: 1 hectare of soil, 1 foot deep: Volume = 3048 m^3

25. Weight soil $_{\text{(1 hectare, 1 foot deep)}}$ = BD __________ (Mg/m^3) x 3048 m^3 = ____________ Mg
(line 20)

26. Weight soil $_{\text{(1 hectare, 1 foot deep)}}$ _________ (Mg) x % SOC __________ = _________ Mg/ha
(line 25) (line 7)

27. Calculate **change in SOC stocks** (positive = gain in C, negative = loss in C):

Endpoint C stocks ________ – Baseline C stocks __________ = _________ Mg C /ha
(line 26) (line 23)

28. Convert C stocks in Mg C /ha to tons C /acre:

________ (line 27) Mg/ha x 0.446 = _________ tons C/acre