

August 21, 2020

Dear Sami and CAR Soil Enrichment Protocol team,

There have been numerous concerns raised over the initial soil sampling protocols in both the public comments and in working group member comments that seem to have been refuted with the publication of Appendix B in the newly released draft protocol. On July 16, 2020, you specifically asked for my opinion on sampling to 40 cm to accommodate for tillage induced redistribution of soil organic carbon (SOC). I responded by adding another reason to sample deeper than 30 cm – in order to make a so-called equivalent soil mass correction.

I appreciate the thought that went into Appendix B as a solution to the sampling depth issue. However, I do not think this negative list test is sufficient. Disk and chisel tillage methods are often conducted at 10" (as noted in Table B2) and even greater depths. Ten inches (25 cm) does not give sufficient soil depth below the plow layer. Additionally, the definition and depth columns in Table B2 are inconsistent (i.e. moldboard say 2-10" in the description but assigns a depth of 30 cm). A much simpler application of this negative list test would be to require the depth of tillage to be reported for the historic period. This should be easy information to gather as it is strictly a function of farm equipment (what size disks or chisels are on your plow?).

Equivalent soil mass correction is an important issue in SOC accounting. If you are actively building SOC, you are also fluffing up the soil so that there is less soil mass in the upper 30 cm under the improved management. Since SOC stock is $OC\% \times \text{soil mass}$, you are "losing" soil mass with some SOC in it by always sampling to the same depth. Conversely, if the soil is compacted and there is no change in SOC, fixed depth sampling will result in an apparent sequestration. Both of these scenarios are easily corrected for, especially if you collect an extra depth increment, and there are several good publications (including this recent [paper by von Haden and colleagues](#)) suggesting how to do it. The Australian Carbon Farming Initiative methods for SOC require reporting SOC by equivalent mass and describe a simplified approach (<https://www.legislation.gov.au/Details/F2018L00089>). Models actually implicitly assume an equal soil mass through time because they are initialized to a baseline mass of SOC (contained within the baseline year volume of soil), so this type of field data would be more consistent with model output.

The revised protocol draft is not clear on these issues. In section 6.5 (p 69), the protocol states "SOC measurement will by necessity include calculation of SOC based on bulk density, as well as the determination of SOC stocks based on either %C by mass, or use of the equivalent soil mass method." But then the minimum standards only specify a single 0-30 cm sample with measurement of bulk density seeming to be optional (p 72 – "If bulk density methods are being used to convert soil carbon concentration to soil carbon stocks, coarse (>2mm fraction) content corrections to bulk density must be

made.”). How do you convert from concentration to stock without measurement of bulk density? Good bulk density measurement is critical to SOC accounting and should be spelled out in the protocol. The Reserve claims to have addressed this in response to the public comments (p22 of the summary of comments documents) but this response has not made its way into the new draft.

The highlighted statement on p 69 in itself is confusing (“SOC stocks based on either %C by mass, or use of the equivalent soil mass method”) – was this sentence meant to read “based on either %C by **volume**, or...”? While my preference is to require equivalent mass reporting, the protocol should at a minimum provide guidance as to how to do equivalent mass reporting.

I understand the desire to use a model driven approach so farmers can be credited annually but I also find the “models cannot simulate deeper than 30 cm” argument against mandating soil sampling deeper than 30 cm to be a red herring. Perhaps only models that can simulate deeper than 30 cm should be allowed. Alternatively, if models can only simulate to 30 cm (and some of the most widely used models actually only simulate the top 20 cm), then any gains or losses below model depth can be added or subtracted during the true-up period to compensate for changes happening below the historic plow layer. This would further alleviate concerns about including shifts to no-till practices.

Sampling to at least 40 cm with a minimum of two increments along with robust measurement of bulk density will eliminate much of the debate around inclusion or exclusion of no-till adoption and allow for the requirement of equivalent mass reporting of SOC stocks. By incorporating information on SOC change in the deeper soil layer during the true-up period, this could eliminate the shortcoming of models only simulating the top 30 cm.

Sincerely yours,



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