Agoro Carbon™ Research Brief

The Accuracy of Agoro Carbon's Soil Organic Carbon Measurement

Introduction

The integrity of a carbon credit depends on accurate measurement of the associated emission reductions or removals, as this directly affects its value and credibility.

For a soil carbon credit to be considered high-quality, it is essential that the carbon sequestration and emissions reductions resulting from regenerative agriculture practices—undertaken by farmers and ranchers—are precisely measured.

Agoro Carbon's Approach to Ensure Accurate Soil Carbon Measurements

Measuring soil organic carbon (SOC) stocks in agricultural fields presents significant challenges due to the inherent spatial and temporal variability across landscapes. This variability is influenced by factors like topography, soil type, vegetation cover, etc. Additionally, some uncertainties are associated with the methods used for sampling design, soil sampling collection and analysis, which can introduce errors if not well controlled. To address and minimize these uncertainties, Agoro Carbon uses scientifically rigorous methods according to Verra's VM0042 methodology for its SOC measurements.

Soil organic carbon is traditionally measured by taking soil samples from the grower's land. These soil samples may only represent a small fraction of a larger field, and soil properties can vary from one part of the field to another. Thus, in order to ensure the most accurate estimate of a field's soil organic carbon stocks, it is imperative to have a well-structured protocol for soil sampling.

To account for landscape variability, Agoro Carbon uses a stratified random sampling design to assign soil sampling locations. This approach uses state-of-the-art statistical models, aerial photos with 60-cm spatial resolution, multitemporal satellite imagery, digital elevation model, and climate geospatial data layers to subdivide or stratify variable fields into homogeneous zones or strata. Then, sampling points are randomly assigned to each zone to meet our accuracy target. This approach has been proven to significantly reduce the potential of bias and increase the reliability of SOC stock estimates.

Accurate SOC measurements depend not only on robust sampling design, but also on consistent and accurate soil collection and precise analysis of soil samples. Agoro Carbon prioritizes minimizing measurement errors by using credible, certified, third-party providers who are experts in soil sampling and trained to follow our Standard Operating Procedures (SOPs) for soil collection to ensure the samples are collected in a scientifically sound and consistent manner. Collected soil samples are processed at certified laboratories for SOC and dry mass determination. The SOC analysis is performed using the dry combustion method following ISO 10694:1995.

Additionally, Agoro Carbon utilizes a live soil sampling management platform, which enables our Data Team to monitor the entire soil sampling process in real time. The platform provides several key benefits: 1) Sampling location verification: the platform ensures the soil samples are collected at the pre-assigned locations. By tracking the GPS coordinates of each sampling point, it guarantees that no sample locations are skipped or misplaced; 2) Data integrity: The system records all relevant sample data (e.g., depth, date, field conditions), ensuring that

Carbon Sequestration Agricultural Practices

the correct protocol is followed. Any discrepancies, such as deviations from the sampling plan, can be flagged immediately for review and corrective action can be communicated to the sampling partners. Our Data Team also plays a crucial role in reviewing the laboratory results to ensure they meet the required standards for accuracy and consistency.

By combining a robust soil sampling design, reputable high-quality sampling and lab partners, real-time sampling tracking platform, high-standard QA/QC system, and constant assessment of lab results, Agoro Carbon is well positioned to generate highly accurate SOC measurements.

Agoro Carbon's Soil Organic Carbon Measurement Accuracy Level

Soil samples provide estimates of soil organic carbon (SOC) stocks over larger areas of a field, and to assess the accuracy of these estimates, we use the margin of error (MoE) statistic. In addition to the MoE, we calculate a confidence interval for each SOC estimate to indicate the likely range within which the true SOC value falls.

The MoE is a key indicator of measurement accuracy, representing the range around an estimated SOC value based on soil samples collected across the entire field. For example, if we set a 95% confidence level, the MoE shows that we are 95% confident the true SOC value lies within the range of the mean SOC value ± the MoE. A larger MoE suggests lower accuracy, meaning the true SOC value could differ more significantly from the estimate. The MoE can also be expressed as a percentage of the average SOC value, normalizing the error for clearer reporting and interpretation.

From Agoro Carbon's initial MoE analysis on the measured SOC of 5,147 soil samples collected from 53 growers, we have found that:

- Our average MoE exceeds industry standards, with an MoE of 6.9% at 95% a confidence level, or 5.4% at 90% confidence level. For example, BCarbon's MoE targets are 10%; also per BCarbon standard, the estimated carbon mass needs to be adjusted or deducted if the MoE is larger than 10%

- Our results also show that 45 out of 53 growers' MoE are under 10% at a confidence level of 95% (Fig. 1); but most (52 out of 53) growers' MoE are under 10% if a 90% confidence level is used (Fig. 2).

Our results show a MoE of 411.8 gram/m2, at 95% confidence level, with a mean SOC estimate of 6,136.6 gram/m2. The analysis indicated that for all these collected samples, we are 95% confident that the true SOC stock lies between 5,724.8 and 6,548.4 grams/m2.

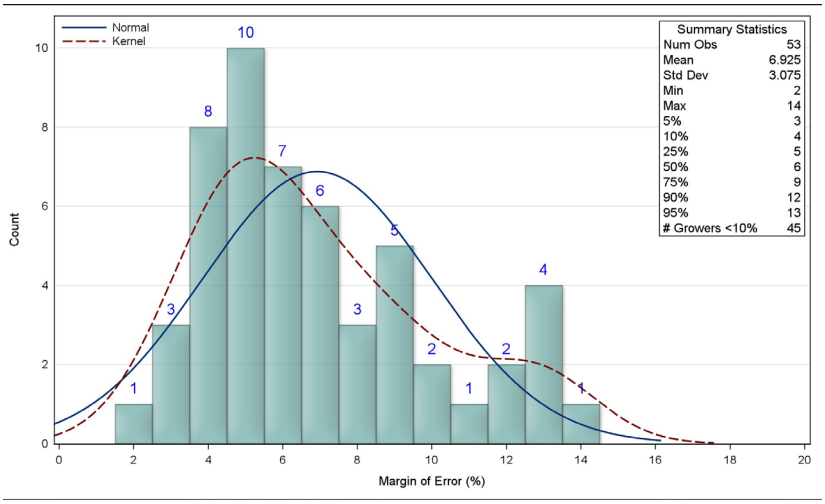

Fig 1. MoE distribution histogram of all 53 growers at a Confidence level of 95%

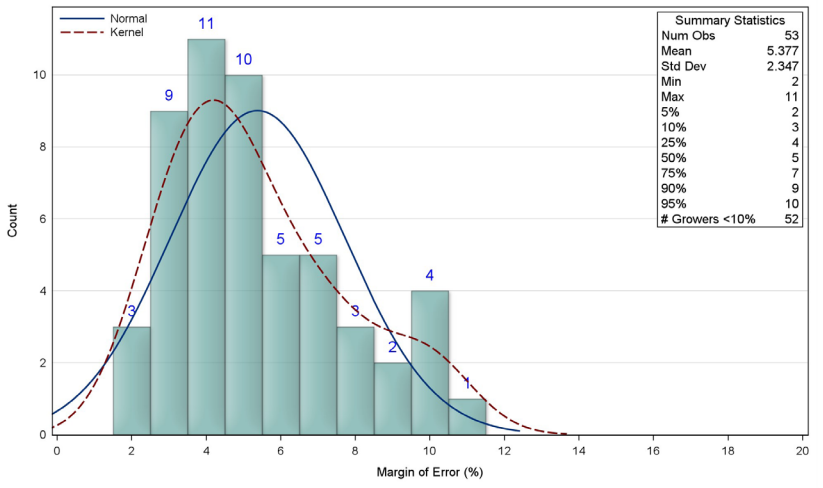

Fig 2. MoE distribution histogram of all 53 growers at a Confidence level of 90%

Agoro Carbon's Data Team

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1 BCarbon is a nonprofit carbon registry which started in 2019 at Rice University's Baker Institute for Public Policy, where a working group was formed to expand soil carbon sequestration efforts across the state of Texas. They have developed their own soil organic carbon measurement protocol which can