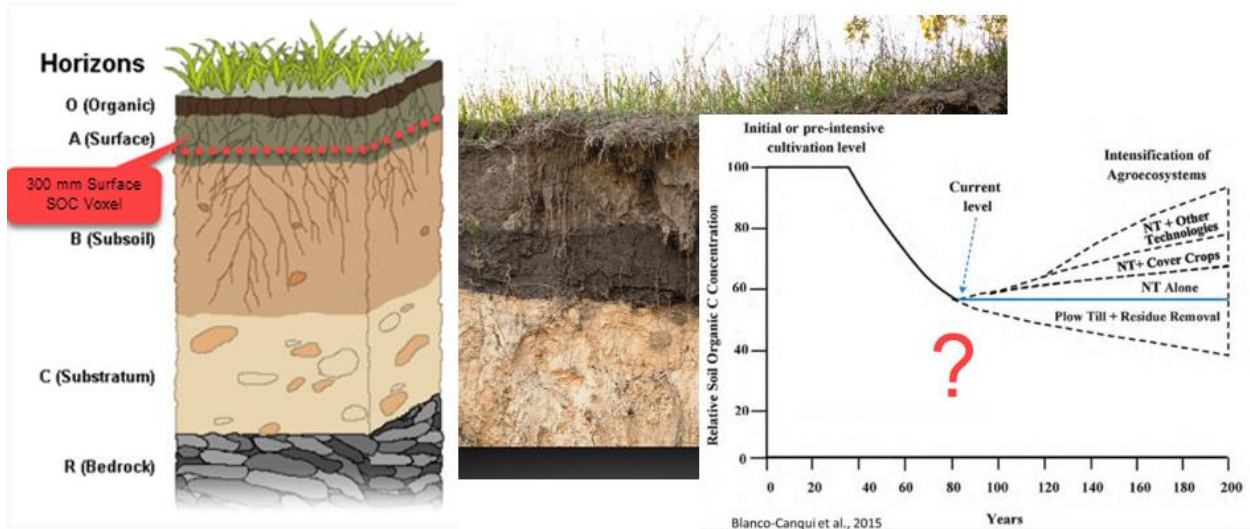


## Green Regeneration Revolution and the Soil Carbon Codex



### Background

Farming "with" nature through the regenerative sciences of agriculture leverages in-situ propensity of a farming system's carbon-cycle productivity versus "additionality" and "persistence" requirements for sequestered carbon ecoservice trading.

The regenerative farm are managers of cropping systems designed to feed the soil through the rapid cycling of soil organic matter (SOM) fueled by root exudates, the flush and death in living soil communities, and the digestion of residual surface trash and roots.

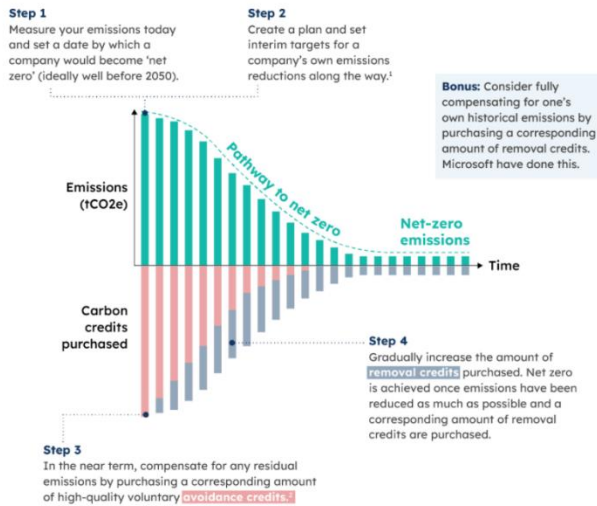
Farm carbon management is conversion of plant biomass into soil organic matter with a measurable ROI including the net-increase of the total SOC, the ecoservice dividend, as measured in the humic and hard flinty portions of the soil carbon profile. Setting soil microbes to purposed work while they annually process about six times more carbon than all anthropogenic emissions combined would seem to be part of the climate solution?

If well practiced, these healthy soil transitions can meet the COP 21 "[4 per 1000](#)" (4p1000) Initiative for both food security and climate change. The 4 in 1000 goal is about 333kg annual carbon increase per hectare per year (300lbs/ac/yr). How is the rest of the farming system's carbon footprint doing? Sounds so simple right?

It seems the Green Regeneration Revolution benefits from technical shifts toward no or minimal tillage, increased cropping systems temporal persistence and complexity, and new precision strategies of integrated pest and input management. These technical shifts provide both direct on-farm and secondary off-farm ecoservice benefits confirmed by modeling and/or measurement.

## Green Regeneration Revolution and the Soil Carbon Codex

### The role of high-quality carbon credits on the pathway to net zero



1. Ideally in line with the latest recommendations from IPCC. Plans can be 'certified' by SBTi.  
2. If one wants to also address forest and biodiversity loss, REDD+ credits certified by VCS and CCB are a great way to do this. Other high-quality avoidance credit types with high co-benefits tracked to SDGs can include cookstoves, boreholes and off-grid renewable energy in least developed countries.

The NET-zero off-farm economy of 2022 wants quality ecoservice carbon removals with effective long-term environmental secondary benefits that will scale while providing high confidence in their sequestration and economic performance. There is significant monetary and climatic value in hedging of the healthy soil dividend by the increasing of the nation's investments in the soil recalcitrant carbon pool.

Importantly, buyers anticipate the supplier to maintain the asset on their behalf for the agreed upon period. If damaged, then the understanding is the supplier is to recover lost stocks to ensure the buyer is made whole.

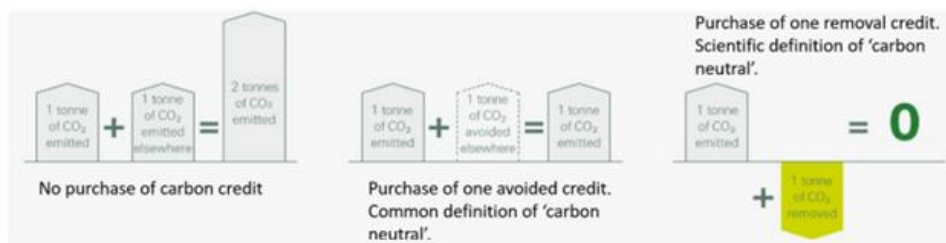
[Source – Respira International](#)

### Understanding Avoidance/Reductions versus Removal Carbon Credits

The semantics of the sources of carbon credits for transaction has created confusion and useless debate. The issue is around fundamental features of carbon accountancy. An AVOIDANCE credit is just that. They are considered as "offsets" for internal improvements in process and efficiency typically when an enterprise is sorting out their carbon budgets and goals. In cropping systems, leakages of N<sub>2</sub>O are problematic. By improvements in coating and farming techniques, N<sub>2</sub>O fugitive emissions can be reduced or eliminated. N<sub>2</sub>O has a GHG conversion to CO<sub>2</sub>e of 1:289. It is a very potent GHG. Reduction of fugitive N<sub>2</sub>O would be treated as an avoidance carbon credit opportunity.

Removal carbon credits are just that. They offer qualities such as additionality, persistence, and leakage effects. They are either biological such as in new orchard or woodlot planting, as sequestered soil organic carbon, or other ecoservices that can provide certified carbon removal. Removals also include other forms of mechanical storage or as chemical fixations.

### The NET-zero Accounting Policy Confusion ?



[Source – Swiss Re](#)

For NET-zero policy enterprise committed to construction of their detailed carbon foot-print there are three significant Scopes of Emissions:

**What are carbon markets?**



Scope 1 relates to the direct emissions linked to the products and ecoservices sold at the farm-gate.

Scope 2 requires carbon accounts for the indirect or up-stream services of electricity, the fugitive emissions such as anhydrous at the coop where you buy supplies as example.

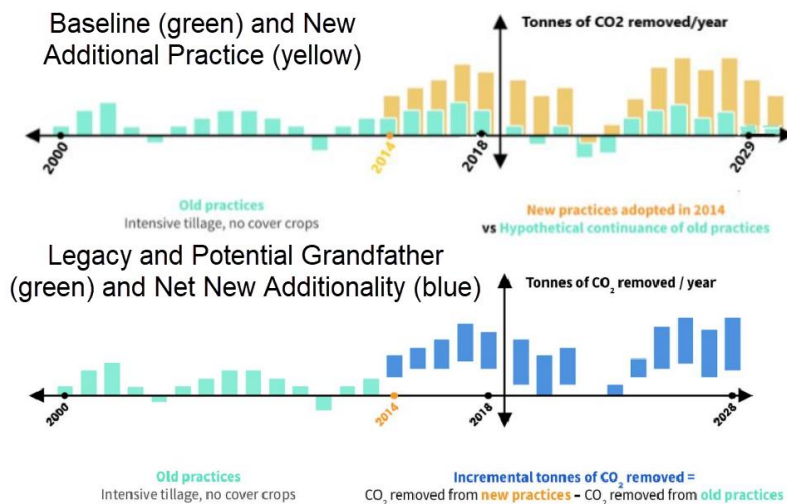


Scope 3 are for the carbon emissions in the

indirect up and down-stream carbon balancing. A farm supply outlet discovers that their client's nitrogen N2O emissions are related to its agronomy department's recommendations?

Soil Carbon Registries and Protocols or Methodology.

As 2022 opens there are a half-dozen primary soil carbon registries and several emerging registries along specialized ecoservice protocols. These are the initial [foundations](#) that have competitive differences and backing despite facing market forces demanding a common methodology and certification process that will provide redundant certifications of performance.



Source: NORI.com

They divide along two methodologies: full farm/ranch modeling versus benchmark and performance measurement.

The several protocols operating in pilot since 2019 are moving to a hybrid design that strengthens accounting standards for cropping and farming system disclosure, the reference history that drive a best modeling practice for soil carbon conservation and marketing planning. The addition of a baseline soil carbon survey and a performance with a directed sample design and analysis by the certifying registry provides greater certainty.

The addition of SOC measurement and its calibration of the working soil carbon conservation plan is described as an oracle, a third party, which offers certified posting to support a farm field project's blockchain baseline, performance, and carbon removal certificate award and termination history. The more entries as blockchain certifications to a field's carbon baseline and performance history, improves the confidence of the carbon inventory and conformance to the carbon project's terms.

For the model and model/measure hybrid protocol there is currently one dominate model, COMET-Farm, the official greenhouse gas quantification tool of USDA. COMET-Farm is scaled and interfaced to field and farm scaled carbon accounting in conformance to the modeling engine and architecture that accounts and projects the annual United States Reports to IPCC regarding our aggregate carbon situation.

Carbon Reduction Credit	
Score	Estimation Error (+/-)
9	+/- 10%
8	+/- 11% to 20%
7	+/- 21% to 30%
6	+/- 31% to 40%
5	+/- 41% to 55%
4	+/- 56% to 75%
3	+/- 76% to 100%
2	+/- 101% to 150%
1	>150%
0	Insufficient data or negative verification report

Soil Carbon Registry -> Whole Farm Ranch Model

[NORI](#) -> [COMET-Farm](#) / [Soil Metrics](#)

[IndigoCarbon](#) -> [Soil Metrics](#)

[Regrow Ag](#) -> [DNDC](#)

[CIBO](#) -> [SALUS](#)

Their published protocols govern the certification process to initiate a soil carbon project and the methodology to either model the field carbon cycling or directly measure the inventory via a baseline followed by a performance certified soil carbon survey. The protocols include 3<sup>rd</sup>-party designed soil sampling instructions to stratify carbon regimes within a field or paddock including 3<sup>rd</sup> party certified soil carbon surveyors as well as specific soil testing laboratories.

The Role of Oracles and Certified Soil Carbon Survey

An oracle within the community of soil carbon registries can be a certified soil analysis lab, certified soil carbon survey consultancy, or professional crop and soil consultants including their associations as examples. It may also include cross-checking for an identified field across other competitive soil carbon registries. Their purpose in the emerging ecoservice blockchain registries offers necessary linkages between the blockchain and the real world.

Their role is to post or confirm real world off-chain information that is complementary to the emergence of [mainnet](#) blockchains like Ethereum and its smart contracts. They can also function as on-chain embedded access designs allowing a query to get real world information into block chained smart contracts. This could be anything from editions in the disclosed carbon accountings, confirming observation of ownership and tenant agreements, cropping systems in-season changes, and weather reports. The creation of a confirming Soil Carbon Inventory Certification Oracle can also be bi-directional, used to "send" data out to the real world as changes accrue.

The Ethereum smart contracts community and their role in ecoservices listings are enablers of confidence.

January 3, 2022

“Oracles expand the types of digital agreements that blockchains can support by offering a universal gateway to off-chain resources while still upholding the valuable security properties of blockchains. Oracles provide a way for the decentralized Web 3.0 ecosystem to access existing [data sources](#), legacy systems, and advanced computations. Decentralized oracle networks (DONs) enable the creation of [hybrid smart contracts](#), where on-chain code and off-chain infrastructure are combined to support advanced decentralized applications that react to real-world events and interoperate with traditional systems.”

### Soil Health / Soil Carbon

Soil organic carbon inventory is divided into two voxels by de facto acceptance that the top-most 300mm (12 inches) represents the active SOM profile where soil health goals are managed. The balance of the one-meter core sample, 700mm, has important merit to monitor and inventory the more persistent deep profile SOC increase. The Commonwealth of Australia and its Carbon Farming Initiative (CFI) follows this one-meter core partition for CFI assigned sample points within a candidate field.

An important feature of the Commonwealth’s Emissions Reduction Fund is the assignment of the Commonwealth’s methodology for spatial soil sampling design. The baseline CFI points of carbon inventory are assigned by the CFI oracle based on known reference surfaces. The farm determines their level of initial confidence to baseline carbon stock by increasing or decreasing the sample points necessary to describe the field’s carbon spatial distribution and its uncertainty.

The CFI sampling design “oracle” is based on established Commonwealth soil knowledge surfaces that will allow an enrolling grower to set the confidence interval for their baseline inventory, say +/- 5 percent on the aggregated SOC stocks and likely propensity to sequester SOC.

This measurement process yields two soil carbon profiles: topmost horizon as the actively managed soil volume (voxel) and the deeper more persistent SOC domain. The SOM fraction representing the most fragile as well as dynamic inventory, aka the caldron of rapid conversion of exudates, decomposing surface aftermath and roots, and biome life cycles. The aggregated SOC within the top-most meter of the enrolled landscape solum will be the arbitrator of soil carbon stocks.

The SOM forms of the total SOC stock are the most labile and fragile fraction that over a period of three years eventually convert towards humic and flinty deeper profile structures. They are the regenerative farm’s ecoservice working stock. The biome’s relative health and its propensity for improvement influencing production decisions and soil health performance.

Within the SOM is the soil health / productivity management ROI, the regenerative benefit from the shifting of certain inventories of critical fertility elements, N, P, and others into the living biome. Stable soil has a 10:1 C:N ratio and therefore a one mt SOM increase embodies an additional 100kg N. How the biome and cropping system leverages these stocks requires soil health survey strategies that will include census of the living biome’s creatures, fungi, and bacteria.

### Certified Soil Carbon Baseline and Performance Survey

In the coming years, carbon performance measurements will likely allow for several levels Soil Carbon Survey and Performance which can be issued along with financial statements disclosures of Audit,

Review, and Compilation. Soil Carbon stock oracle reports to include: Baseline Compilation, Performance Review, and Certified Soil Carbon Survey?

These types of carbon stocks reports will depend on what the client needs. For large farms, they may be required to make annual disclosures in their regulation to provide NET-zero emissions planning. And given the potential liabilities and exposure related to carbon-foot-printing all publicly held companies must have audited financial statements.

Alternatively, privately held farms will also find they gain strength when they use the third-party carbon confirmed stocks in their financial statements, conservation planning, and other investments strategies. As the value of in-situ carbon inventory becomes more certain and of interest to food and fiber consumers anticipate that buyers, credit line banks, or commodity buyers will require confirmation that carbon stocks and soil health are included. This sort of disclosure will also likely be required for access to established and new Federal Government carbon conservation as well as their procurement vehicles or specific contract RFPs.

The differences between the three levels have to do with the amount of scrutiny that the supplier's soil carbon conservation plan and its performance will undergo in the certification of these ecoservices are legitimate and secure. There are also significant differences in time, effort, and cost to consider.

**Baseline Compilation:**

In a compilation, the certified carbon conservation planner (CCCP) or advisor is providing the most basic level of assurances and rigor to the soil carbon conservation plan. The carbon conservationist reviews the baseline disclosure and additionality assumptions offered to the model. The advisor will consider and advise the planning utility inclusion for legacy soil sampling if any. They make adjusting entries into the baseline production disclosures in review prior to submission of the carbon conservation plan and projected modeling. They review annual registry reporting preparation. The in-situ carbon baseline accounting and tests for additionality and the accompanying report are issued in accordance with commonly accepted practices as defined within the leading registries. It contains no assurance from the carbon conservationist that they were prepared to conform to CCCP standards as may be determined. This is the most common type of report issued for soil carbon projects and their protocol. Footnotes to the baseline production disclosure are not required with a compilation, so long as there is a paragraph in the compilation report stating that management has elected to omit the disclosures.

**Performance Review:**

This is the process that creates the certification of the baseline disclosure and the annual additions versus the original SCCP Compilation. The advisor will perform inquiry and analytical procedures and must remain independent during the engagement. If the farm has employed high density kinematic direct SOC and other qualities sensorization, the Soil Health Consultant can create X-Y continuous surface pedotransfer of SOC within the SOM management and deep SOC sequestration voxels. The performance review specifically includes review of bulk density assumptions and changes. The inquiry and analytical procedures are not as involved as those performed during an audit. The CCCP states in their reports that they did not become aware of any material modifications that should be made in order for the soil carbon stocks statements to conform to commonly accepted practices, aka as expressing limited assurance. Reviewed soil carbon conservation accounts and plans are prepared for

third parties such as conservation districts, state and federal environmental regulators, banks, landlords/tenants, outside investors, or creditors that require more assurance than a compilation provides, but not certified and audited statements.

**Soil Carbon Survey and Audit:**

The Soil Carbon Inventory Audit provides the highest level of assurance service a registered Certified Soil Carbon Accountant (SCCA) and/or Soil Health Consultant (SHC) can provide. The Soil Carbon Survey and Audit performs all the procedures incorporated in performance and baseline review engagements, plus also perform additional verification and substantiation procedures. These will include: direct contact soil core sampling at client sites; verification that prescribed survey points-of-sample have been properly received and the appropriate field visitation and core extraction protocol exist and are in-use; transferring the sample cores within a chain-of-evidence to identified and certified soil analysis labs; auditing of enrolled carbon project(s) for location, ownership, tenants, and local extensionists to verify transaction. An audit also includes an in-depth review of the client’s internal controls and control risk.



[Verra \(vm0021\) Soil Carbon Quantification Methodology V1.0](https://verra.org/methodology/vm0021-soil-carbon-quantification-methodology-v1-0/)

<https://verra.org/methodology/vm0021-soil-carbon-quantification-methodology-v1-0/>



[Climate Action Reserve - Soil Enrichment Protocol](https://www.climateactionreserve.org/how/protocols/soil-enrichment/)

<https://www.climateactionreserve.org/how/protocols/soil-enrichment/>



[Commonwealth of Australia - Carbon Farming Initiative – Measurement and Models: Methodology Determination 2021](https://www.legislation.gov.au/Details/F2021L01696)

<https://www.legislation.gov.au/Details/F2021L01696>



[BCarbon: A New Soil Carbon Storage Standard](https://bcarbon.org/our-standards)

<https://bcarbon.org/our-standards>



[NORI Cropland Methodology 1.2](https://nori.com/resources/croplands-methodology)

<https://nori.com/resources/croplands-methodology>

# Five Emerging Soil Carbon Ecoservice Protocols