Gold Standard for the Global Goals

# GOLD STANDARD FOR THE GLOBAL GOALS

## Soil Organic Carbon Activity Module:

# Increasing Soil Carbon Through Improved Tillage Practices

(This Activity Module must be applied in conjunction with the Gold Standard Soil Organic Carbon Framework Methodology>>.)

**Version 1.0**

**Published January 2020**

**SDG: 13 Climate Action**

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## ACKNOWLEDGEMENT:

**Developed by: TREES Consulting**

TREES*

# 1. Methodology Summary

This Soil Organic Carbon (SOC) Activity Module presents requirements and guidance to quantify greenhouse gas (GHG) emissions from agriculture by changing soil tillage practices within agricultural systems. Activities can achieve avoidance of emissions as well as sequestration of carbon in the soil, both of which result in increased SOC content. This activity module shall be applied in conjunction with the Soil Organic Carbon Framework Methodology.

This Activity Module incentivizes and captures benefits from tillage improvements. It is applicable for a wide area of technological levels, from low tech land use to industrialized land management, using a variety of improved tillage techniques. As tillage techniques and scientific knowledge of their impact are constantly changing, the methodology does not require a specific approach but provides flexibility to apply the most current and best-fit systems. Where local information is unavailable, project owners may use data or models from other scientific sources.

Mangalassery et al., 2014 summarizes the importance of agricultural land use and tillage with regards to climate change: "Globally, agriculture accounts for 10–12% of total anthropogenic emissions of greenhouse gases (GHGs) estimated to be 5.1–6.1 Gt $CO_2$eq $yr^{-1}$ in 2005. Conservation tillage is one among many different mitigation options suggested to reduce GHG emissions from agriculture. Conservation tillage practices such as reduced/minimum/no tillage, direct drilling and strip cropping are also widely recommended to protect soil against erosion and degradation of structure, create greater aggregate stability, increase soil organic matter content, enhance sequestration of carbon, mitigate GHG emissions and improve biological activities."

In many countries conventional tillage methods are still in use today, applying instruments such as harrows, mouldboard ploughs, offset harrows, subsoilers, and rippers for extensive seedbed preparation. Conventional tillage methods cause great soil disturbance such as soil compaction, loss of organic matter, degradation of soil aggregates, death or disruption of soil microbes and other organisms including mycorrhiza, arthropods, and earthworms, and soil erosion where topsoil is washed or blown away[1]. Also, it leaves little plant residues on the surface and thus lead to not only greenhouse gas emissions but also moisture loss/imbalances and in many cases nutrient efflux. It is thus essential that – while ensuring food security and sustainability – incentives are provided to improve the relevant practices.

Under this SOC Activity Module, conservation tillage methods are introduced to project areas previously under more conservative management. This includes forms of minimum or reduced impact tillage which causes less soil disturbance than conventional forms of tillage and where residue, mulch, or sod is left on the soil surface to protect soil and conserve moisture. After planting, at least 30 percent of the soil surface remains covered by residue to reduce soil erosion by water (compare applicability chapter).

# 2. Definitions and References

1 Lichtfouse, E., Hamelin, M., Navarrete, M., Debaeke, P., 2011; Sustainable Agriculture Volume 2

## 2.1 Definitions

In addition to terms and definition listed in the SOC Framework Methodology the following definitions apply for the purposes of this activity module:

**Conservation tillage**: Includes any form of minimum or reduced tillage, where residue, mulch, or sod is left on the soil surface to protect soil and conserve moisture. After planting, at least 30 percent of the soil surface remains covered by residue to reduce soil erosion by water.

**Conventional tillage**: Seedbed preparation using cultivation instruments such as harrows, mouldboard ploughs, offset harrows, subsoilers, and rippers. Conventional tillage methods, involving extensive seedbed preparation, cause the greatest soil disturbance and leave little plant residues on the surface.

**No tillage:** A way of growing crops or pasture without tillage (no turning of topsoil), minimizing soil disturbance. Also called no-till farming or zero tillage.

## 2.2 References

This SOC Activity Module is based on and replaces the Gold Standard Agriculture Methodology for Increasing Soil Carbon Through Improved Tillage Practices V0.9 (released for road testing).

In addition to the methodologies, methodological tools, guidelines, and key sources listed in the SOC Framework Methodology, this Activity Module refers to the following key publications:

- Batjes, N.H. (2010)[2]: A global framework of soil organic carbon stocks under native vegetation for use with the simple assessment option of the Carbon Benefits Project system (Ver. 1.0) ISRIC - World Soil Information.
- Batjes, N.H. (2011)[3]: Soil organic carbon stocks under native vegetation – Revised estimates for use with the simple assessment option of the Carbon Benefits Project system. Agriculture, Ecosystems and Environment, 142, 365– 373.

2 https://pdfs.semanticscholar.org/6512/4d60f6556c4cdce6a673367ba7dd3ba03759.pdf

3 https://www.sciencedirect.com/science/article/abs/pii/S0167880911001988

- Mangalassery et al (2014)[4]: To what extent can zero tillage lead to a reduction in greenhouse gas emissions from temperate soils? Scientific Reports 4, article number 4586.
- Lichtfouse (Editor; 2011)[5]: Genetics, Biofuels and Local Farming Systems. Springer, Sustainable
- West and Post (2002): Soil Organic Carbon Sequestration Rates by Tillage and Crop Rotation: A Global Data Analysis. Soil Sci. Soc. Am. J. 66:1930–1946.

In addition to the references above, sources listed in Annex B were consulted for the development of the original tillage methodology.

# 3. Applicability

A project applying this Activity Module shall comply with the applicability conditions specified below and within the SOC Framework Methodology. In addition, the project shall comply with applicable Land Use & Forests Activity Requirements (hereafter LUF Activity Requirements) and the Gold Standard for the Global Goals Principles & Requirements. (hereafter Principles & Requirements).

a. Soil type:
   - Proposed projects on sites with organic soils (Histosols), as defined by the World Reference Base for Soil Resources (FAO 2015)[6], are ineligible. Only mineral soil types are eligible.

b. Cropping system:
   - Managed cropping systems (e.g. single crop or crop rotation) must have been in place for at least 5 years prior to project implementation, i.e. the project does not lead to land use change.

c. Tillage practice:
   - Under this Activity Module, conservation tillage methods are applied, meaning forms of minimum or reduced tillage, where residue, mulch, or sod is left on the soil surface to protect soil and conserve moisture. After planting, at least 30 percent of the soil surface remains covered by residue to reduce soil erosion by water.

4 http://www.nature.com/srep/2014/140404/srep04586/full/srep04586.html

5 https://www.springer.com/gp/book/9789400715202

6 World reference base for soil resources 2014 (Update 2015): http://www.fao.org/3/i3794en/I3794en.pdf

- Due to the uncertainties on the actual carbon benefits of no-till techniques, this activity module is not applicable to no-till techniques, including strip tillage and direct drill practices.

# 4. Project Boundaries

## 4.1 Spatial boundary

For spatial boundaries, rules and requirements defined in the SOC Framework Methodology apply.

## 4.2 Temporal boundary

The project crediting period shall be fixed ten years[7] and cannot be renewed.

## 4.3 Carbon Pools

This SOC Activity Module focuses entirely on the soil carbon pool. The project shall account for carbon pools for assessment in line with the SOC Framework Methodology.

# 5. Emissions Reduction Quantification Approaches

Calculations for overall benefits follow the equations set out in ***Section: Emissions Reduction Quantification Approaches*** of the SOC Framework Methodology. Sections below specify approaches and calculations specific to this SOC activity module.

## 5.1 Approaches for baseline and project scenario quantification

To accommodate that soil measurements are not always available to projects, especially for small community-based activities, this SOC Activity Module allows selection of any of the three approaches to baseline and project activity quantification as described in the SOC Framework Methodology. If a different approach is used for baseline and project scenarios in a stratum, conservativeness and comparability have to be ensured.

***Approach 1:*** Requires on-site measurements to directly document pre-project and project SOC stocks.

***Approach 2:*** Uses peer-reviewed publications to quantify pre-project SOC stocks and project impact. Project owners shall prove that the research

[7] The crediting period is defined based on results from key peer reviewed scientific publications. Mangalassery et al (2014) found that increases in soil organic matter occurred within five years following conversion from conventional tillage to zero tillage: http://www.nature.com/srep/2014/140404/srep04586/full/srep04586.html). West and Post (2002) in similar work recorded a large increase in soil between 5–10 years.

results are conservative and applicable to the project site and management practice.

***Approach 3:*** Applies default factors to quantify SOC changes from improved tillage, relating to the general methodology described in the IPCC 2019 Guidelines for National Greenhouse Gas Inventories (IPCC 2006a). However, instead of IPCC default SOC reference values ($SOC_{REF}$), a project-oriented $SOC_{REF}$ value shall be used in connection with IPCC impact factors.

Generally, project owners shall apply the most specific approach possible with the data available, giving preference to local data sources and models. A decision tree to determine an eligible approach is provided in the SOC Framework Methodology.

# 6. Baseline Scenario

Under the additionality and applicability conditions set in the SOC Framework Methodology and this SOC Activity Module, the relevant baseline scenario is the continuation of the historical cropping practices where, in the absence of the project activity, conventional tillage is done in a business as usual (BAU) manner.

To determine the baseline of the eligible project area the land shall be stratified into modelling units (MU) according to:

- Mineral soil type
- Climate zone
- Land management / cropping system
- Input levels (e.g. fertilization)
- Tillage practices

For each stratum (MU), SOC measurements have to be performed (*Approach 1*) and/or model parameters identified and verified (*Approach 2 or 3*).

## 6.1 Baseline Calculations

Quantification for soil organic carbon in the baseline ($SOC_{BL,y}$) shall follow the rules, approaches, calculations, and parameters set out in *Section: Baseline Scenario* of the SOC Framework Methodology.

# 7. Project Scenario

Under the project scenario, SOC relevant practices are applied in the project area.

As with the baseline, the eligible project area shall be stratified into modelling units (MU) according to

- Mineral soil type
- Climate zone
- Cropping systems

- Input levels (e.g. fertilization)
- Tillage practices

For each stratum (MU), SOC measurements have to be performed (*Approach 1*) and/or modelling parameters identified (*Approach 2 or 3*).

### 7.1 Project Scenario Calculations

Quantification for soil organic carbon in the project scenario ($SOC_{t,y}$) shall follow the rules, approaches, calculations, and parameters set out in Section: Project scenario of the SOC Framework Methodology.

## 8. Uncertainty

Calculation of uncertainty shall follow the rules and equations set out in the SOC Framework Methodology.

## 9. Other Emissions

Significant additional greenhouse gas emissions (>5% total) due to the project activity need to be accounted for. For this SOC Activity Module, this explicitly includes emissions from increased fertilizer input, fossil fuel combustion, and other agrochemical emissions. Calculation thereof shall follow the rules and equations set out in the SOC Framework Methodology.

## 10. Leakage

Calculation of leakage shall follow the rules and equations set out in the SOC Framework Methodology.

For this SOC activity module, leakage from C runoff is considered 0 as projects are not allowed on wetlands. Also, as the project site is being actively maintained for commodity production during the project-crediting period, yield-related leakage risks are relatively small. Crop producers are commonly risk averse and are unlikely to intentionally suffer reduced crop yields. Moreover, according to LUF Activity Requirements, projects shall not lead to a decrease in agricultural productivity, thus all projects shall be set up to maintain or increase yield. Thus for initial project calculations, $LK_{t-0}$ is considered equal 0.

If a reduction in yield is detected in a performance certification, it is assumed that the lost production capacity will have to be made up for on land outside the project area. Emissions caused by such a shift shall be accounted for as leakage according to the equation listed in the SOC Framework Methodology.

## 11. Project Buffer

Allocation to Gold Standard Compliance Buffer shall follow requirements defined in GHG Emissions Reduction & Sequestration Product Requirements and in the SOC Framework Methodology.

# 12. Additionality

All Gold Standard projects shall demonstrate that they would not have been implemented without the benefits of carbon certification. Specific rules and guidelines on how to assess additionality can be found in the Additionality section LUF Activity Requirements and the AGR Additionality (AGR projects) Template.

# 13. Sustainable Development Goals

Documentation of contribution to SDG 13 shall follow the requirements defined in the SOC Framework Methodology. Contribution to further specific Sustainable Development Goals (SDGs) is not defined here as it is specified at the project level following Principles & Requirements.

# 14. Monitoring

Monitoring approach and parameters shall be followed as set out in the SOC Framework Methodology. In addition to the data and parameters listed in the SOC Framework Methodology, the following parameters need to be monitored and recorded:

## 14.1 Data and Parameters collected for baseline calculation and when project areas (farms/land parcels) are being added and at renewable of crediting period if required

| **Data/parameter:** | $F_{MG,BL,y}$ |
|---|---|
| Unit | [dimensionless] |
| Description | tillage factor before project start in stratum y |
| Source of data | IPCC defaults or national / local studies (preferred) |
| Value(s) applied | |
| Measurement procedures | |
| Monitoring frequency | Project start |
| QA/QC procedures | |
| Additional comments | |

## 14.2 Data and Parameters monitored

| **Data/parameter:** | $F_{MG,PR,y}$ |
|---|---|
| Unit | [dimensionless] |
| Description | tillage factor after project start in stratum y |
| Source of data | IPCC defaults or national / local studies (preferred) |
| Value(s) applied | |

| | |
|---|---|
| Measurement procedures | |
| Monitoring frequency | Annually |
| QA/QC procedures | |
| Additional comments | |

Also, the project owner shall collect and document evidence that this SOC activity module's applicability conditions are met at all times, especially that:

- Measures are taken to prevent soil erosion
- Adequate input of organic crop residue, mulch, sod or other organic C source is applied to the project area fields

## Annex A: Soil Carbon Accumulation Examples

The following section is an extract of the original non-binding Annex of the 2016 approved Gold Standard methodology "Increasing Soil Carbon Through Improved Tillage Practices" which is replaced by the SOC Framework Methodology and this SOC Activity Module.

At the time of the methodology approval (2016), a background review covering international literature on improved tillage techniques and effects on carbon stock in soils showed the annual rates of soil carbon sequestration per hectare under some different environmental and climate patterns as listed in Table A-01. It indicates the variation across climate and soil types as well as the rather broad ranges within these categories. This corroborates that in order to apply such parameters, projects must match the sources conditions, i.e. climate, soil, cropping system and any other parameters in the reference (e.g. soil clay content). It is the project owners' responsibility to provide evidence that this requirement is met.

Please note that the results in table A-01 are focused on India and Africa (with examples from other regions), with the intention to provide startup information for smallholder projects common in these regions. Yet these values are rough indications only, with more specific research needed for individual projects.

To expand on this, the literature listed below is sourced more broadly; including temperate climates for which a broad variety of information is available (e.g. studies in America and Europe). However, it is recommended for project developers to conduct an up-to-date literature research to capture new sources.

**Table A-01:** Soil carbon (SOC) accumulation for improved tillage approaches for climate and soil combinations

| IPCC Climate Zone | IPCC Soil Type | Country | SOC accumulation range ($tCO_2e$ $ha^{-1}$ $yr^{-1}$) | Crop - Biomass productivity | Reference |
|---|---|---|---|---|---|
| Tropical Dry | HAC | India | 0.83 | No change | Kurothe et al., 2014 |
| Tropical Dry | LAC | India | 1.94 to 2.24 | No change | Bhattacharyya et al., 2009 |
| Tropical Dry | LAC | India | 0.89 to 1.38 | No change | Das et al., 2013 |
| Tropical Dry | LAC | India | 1.36 | Higher | Bhattacharyya et al., 2012 |
| Tropical Dry | Sandy | Zimbabwe | 2.57 | N/A | Thierfelder et al., 2012 |
| Tropical Moist | LAC | Brazil | 0.44 to 1.03 | N/A | Costa Junior et al., 2013 |
| Tropical Moist | LAC | Brazil | 1.28 | N/A | Metay et al., 2007 |
| Tropical Montane | HAC | Zimbabwe | 5.32 | Higher | Thierfelder and Wall, 2012 |
| Tropical Montane | LAC | Zambia | 5.35 to 6.53 | Higher | Thierfelder et al., 2013 |
| Tropical Montane | Sandy | Zimbabwe | 5.79 | No change | Thierfelder et al., 2012 |
| Tropical Montane | Sandy | Zimbabwe | 2.93 to 5.87 | No change | Thierfelder and Wall, 2012 |
| Tropical Wet | LAC | Nigeria | 2.25 | N/A | Lal, 1997 |
| Warm Temperate Dry | HAC | Morocco | 1.14 | N/A | Mrabet et al., 2001 |
| Warm Temperate Dry | HAC | Spain | 1.32 | N/A | Lopes and Fando Pardo, 2011 |
| Warm Temperate Dry | HAC | Tunisia | 1.47 to 2.79 | N/A | Jemai et al., 2012 |
| Warm Temperate Dry | HAC | Argentina | 3.30 | Higher | Bono et al., 2008 |
| Warm Temperate Dry | HAC | Slovakia | 0.69 | N/A | Macák et al., 2010 |

| | | | | | |
|---|---|---|---|---|---|
| Warm Temperate Moist | HAC | Madagascar | 2.78 to 4.92 | N/A | Sá et al., 2006 |
| Warm Temperate Moist | LAC | Madagascar | 2.53 | N/A | Razafimbelo et al., 2008 |

## Annex B: Additional References

In addition to the references listed in section 2.2, the following sources were consulted for the development of the original Gold Standard methodology "Increasing Soil Carbon Through Improved Tillage Practices".

***NOTE: This list is provided for information only and has not been updated since its original release. As soil and tillage research is progressing rapidly, this list does not replace a thorough literature review for up-to-date studies and results.***

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