Gold Standard for the Global Goals

METHODOLOGY ACTIVITY MODULE

SOIL ORGANIC CARBON ACTIVITY MODULE FOR APPLICATION OF ORGANIC SOIL IMPROVERS FROM PULP AND PAPER MILL SLUDGES

SDG 13

Publication Date **7.03.2022**
Version **1.0**
Next Planned Update **7.03.2025**

Contact details

The Gold Standard Foundation
International Environment House 2
Chemin de Balexert 7-9
1219 Châtelaine Geneva, Switzerland
Tel: +41 22 788 70 80
Email: standards@goldstandard.org

SUMMARY

This Soil Organic Carbon (SOC) Activity Module presents requirements and guidance to monitor and calculate the climate impact of the application of organic soil improvers from pulp and paper mill sludges. The module applies to activities that involve application of organic soil improvers from pulp and paper mill sludges to improve soil organic matter content in agricultural systems thus increasing soil organic carbon content (creating a soil carbon sink).

The Activity module is applicable to projects located in member states of European Union (EU). The project developer seeking application of this module to project activities located outside the member states of European Union (EU) shall seek revision to methodology.

Organic soil improvers are processed pulp and paper mill sludges and contain a large amount of organic C and nutrients. Organic soil improvers from pulp and paper mill sludges may be utilized in agriculture fields as soil improvers to increase soil organic matter, soil organic carbon, improve soil physical properties, provide nutrients, and increase soil pH. Positive effects of organic soil improvers from pulp and paper mill sludges on soil quality are primarily due to increased soil organic matter, aggregation, water holding capacity, infiltration rate, and cation exchange capacity.

According to pulp and paper mill sludges are produced from primary and secondary treatment of wastes derived from virgin wood fiber sources, recycled paper products, and non-wood fibers. Sludges and sludge composts may be utilized in agriculture as soil improvers to increase soil organic matter, soil organic carbon, improve soil physical properties, provide nutrients, and increase soil pH. According to the study by Camberato et al, annual or biennial applications of pulp and paper sludge at ≥ 45 Mg ha−1 increased soil C throughout the 5-year study. The increases in soil C at the end of the study were directly proportional to the cumulative applied sludge C. For example, annual application of sludge at 225 Mg ha−1 more than doubled soil C from its initial level of 4%[1].

Natural Resources Institute Finland has done research on the stability of pulp and paper mill sludge carbon in soils. They estimate (based on analyses, lab & field experiments & modelling) that 53 % of the carbon is consumed by soil microbes during the initial decomposition and 47 % of it is resistant to microbial decomposition. If these industrial residues aren't used as soil improvers, they are typically incinerated by pulp and paper mills, especially in Europe. In other parts of the world landfilling the industrial residues can still be the baseline situation. For example in Sweden, the common practice is incineration of bio-sludge with energy recovery followed by landfilling of ash[2]. Generally in Europe, due to legislation and increased taxes, landfills are quickly being eliminated as a final destination for pulp and paper production wastes, and incineration with energy recovery is becoming the main waste recovery method[3]. The moisture content of sludges is so high (60-75 %) that they have no energy value, and fossil or renewable fuels are needed to aid the incineration process. In the baseline scenario, no soil improvement fibers from industrial residues are used as soil improvers.

Relevant GHGs are CO_2 and CH_4. Applicable quantification approaches may include 1) on-site, direct measurement of baseline and project SOC stocks, or 2) peer-reviewed publications to quantify Baseline Scenario SOC stocks, other emissions reductions,

---

[1] Camberato et al. 2006. Pulp and paper mill by-products as soil amendments and plant nutrient sources. https://cdnsciencepub.com/doi/pdf/10.4141/S05-120

[2] Mohammadi, A, Sandberg, M, Venkatesh, G, et al. Environmental analysis of producing biochar and energy recovery from pulp and paper mill biosludge. Journal of Industrial Ecology 2019; 23: 1039 -1051. https://doi.org/10.1111/jiec.12838

[3] Monte MC, Fuente E, Blanco A, Negro C. Waste management from pulp and paper production in the European Union. Waste Manag. 2009 Jan;29(1):293-308. doi: 10.1016/j.wasman.2008.02.002. Epub 2008 Apr 10. PMID: 18406123.

and Project Scenario impact. Project developers shall apply the most specific approach possible with the data available, giving preference to local data sources and models.

A project developer using this Activity Module may follow one of the three approaches outlined in the SOC framework methodology to identify, measure and quantify GHG emissions reductions/removals attributable to the project activities in an ex post fashion (SDG 13) following. However, this activity module recommends the approach 1 as preferred approach whereas the user may apply approach 2 providing sufficient justifications in line with the SOC framework methodology.

Documentation of contributions to carbon sequestration and greenhouse gas reduction (SDG 13) shall follow the requirements defined in the SOC Framework Methodology.

A project applicant using this Activity Module may identify, measure and quantify further beneficial ecosystem services towards other Sustainable Development Goals (SDGs), including:

i. Water supply and purification (SDG 6),

ii. Zero hunger (food security/stabilization of yield) (SDG 2),

iii. Responsible consumption and production (SDG 12),

iv. Life below water (SDG 14), and

v. Life on Land (biodiversity) (SDG 15).

The SDGs listed above are expected to have positive contributions from projects applying this methodology. However, contribution to the specific SDGs including above shall be specified at the project level following Principles & Requirements.

ACKNOWLEDGEMENT

Developer Name: Soilfood Oy

TABLE OF CONTENTS

1| Definitions and References

1.1 | Definitions

1.1.1 | In addition to the terms and definitions listed in SOC Framework Methodology, the following additional definitions shall apply, specific to this SOC Activity Module.

Term	Definition
Pulp and paper mill sludges	Organic waste residue streams from pulp and paper mills.
Organic soil improvers	Organic soil improver products that are processed, as required, from fiber residues from pulp and paper industries. These products are used to improve soil in agricultural systems, increasing soil organic carbon content (creating a soil carbon sink).

1.2 | References

1.2.1 | References are included as footnotes in the text.

2| Scope, applicability, and entry into force

2.1 | Scope

2.1.1 | This activity module is applicable to project activities that use soil improvers produced by processing and/or recycling of pulp and paper mill sludges from industrial operations in pulp and paper manufacturing to increase soil organic matter and soil organic carbon and improve soil physical properties without negatively affecting the soil health.

2.1.2 | This activity module is not applicable to reduced or avoided emissions from organic waste residue streams handling and management. To quantify and monitor the reduced or avoided GHG emissions from the avoided incineration or landfilling of the industrial residues, if applicable, the project developer shall apply an approved GS methodology and applicable GS4GG requirements for such emissions.

2.2 | Applicability

2.2.1 | 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):

2.2.2 | The Activity module is applicable under the following conditions:

a. Geographic location: Projects are eligible in EU member countries[4]. The project developer may submit a request for applicability expansion by submitting supporting peer reviewed literature and supporting studies.

Table – List of relevant publications (List is non-exhaustive)

AUTHORS	TITLE	EU	CANADA & USA	CHILE
Camberato et al (2006)	Pulp and paper mill by-products as soil amendments and plant nutrient sources		*	
Gallardo et al (2012)	Effect of pulp mill sludge on soil characteristics, microbial community and vegetal production of *Lolium Perenne*			*
Kätterer et al (2011)	Roots contribute more to refractory soil organic matter than above-ground crop residues, as revealed by a long-term field experiment	*		
Kinnula et al (2020)	Effects of mixed pulp mill sludges on crop yields and quality	*		
Mohammadi et al (2019)	Environmental performance of end-of-life handling alternatives for paper-and-pulp-mill sludge: Using digestate as a source of energy or for biochar production	*		
Monte et al (2009)	Waste management from pulp and paper production in the European Union	*		
Rasa et al (2020)	Pulp and paper mill sludges decrease soil erodibility	*		

b. Soil type: Project Area(s) shall not be comprised of organic soils (Histosols) as defined by the World Reference Base for Soil Resources (FAO 2015)[5]. Only mineral soil types are eligible[6,7].

c. The certified Project Area shall be limited to eligible areas, excluding riparian or other buffer zones located within such eligible areas, and

[4] Other geographical locations: revisions may be requested by providing relevant peer reviewed application.

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

[6] https://esdac.jrc.ec.europa.eu/content/european-soil-database-v20-vector-and-attribute-data

[7] https://esdac.jrc.ec.europa.eu/content/soil-atlas-europe

excluding areas set aside for conservation in accordance with LUF Activity Requirements.

2.2.3 | Under this activity module, organic soil improvers processed from pulp and paper mill sludges are applied to improve soil in agricultural systems, increasing soil organic carbon content (creating a soil carbon sink). The organic soil improvers must

a. be processed from pulp and paper mill sludges
b. be eligible for agricultural use according to local legislation
c. meet quality criteria set in local legislation[8] for fertilizer application (not limited to e.g. heavy metal content and microbiological quality as applicable)
d. be non-fossil fraction of an industrial waste[9].

2.3 | Entry into force

2.3.1 | The date of entry into force of this methodology is **7th March 2022**.

3| Additionality

3.1.1 | All Gold Standard projects shall demonstrate that they would not have been implemented without the benefits of carbon revenue. 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. These include optional means of demonstrating additionality including CDM Tools, Activity Penetration in the local area, or inclusion of the activity on a Positive List.

3.1.2 | Additionality assessment: The relevant Baseline Scenario is the continuation of historical cropping practices that have been practiced in at least the last 5 years before the project start date (business as usual (BAU) where, in the absence of the Project Activity, conventional soil amendment (use of manure and crop residues) use in the project boundary is done in a business as usual (BAU) manner. The Baseline Scenario should consider the level of national ambition in encouraging agricultural best practices to reduce GHG emissions.

4| Project Boundaries

4.1 | Spatial boundary:

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

---

[8] REGULATION (EU) 2019/1009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 5 June 2019 laying down rules on the making available on the market of EU fertilising products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009 and repealing Regulation (EC) No 2003/2003 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R1009&from=EN and possible national regulation

[9] CDM Definition of renewable biomass https://cdm.unfccc.int/EB/023/eb23_repan18.pdf

4.1.2 | Under this activity module, organic soil improvers from pulp and paper mill sludges are applied to improve soil in agricultural systems, increasing soil organic carbon content.

4.1.3 | Areas joining the project shall be areas within a farm (e.g. fields, parcels). Project area shall be stratified into modelling units (MU) by mineral soil type, climate zone, tillage practices, and level of vegetation cover.

4.1.4 | Risk of project areas leaving a project within crediting period are low, however any areas leaving the project shall be considered as full reversal following SOC framework methodology. At project level long-term storage of organic inputs will be ensured by a) using reduced or minimum tillage, where residue, mulch, or sod is left on the soil surface to protect soil and conserve moisture, and/or b) avoiding bare fallow periods by increasing vegetation cover.

4.2 | Temporal boundary:

4.2.1 | The maximum crediting period is ten (10) years. All project applying this module shall follow 5 year certification cycle.

4.3 | Carbon Pools

4.3.1 | This SOC Activity Module focuses on the soil organic carbon pool. The project shall account for carbon pools for assessment in line with the Gold Standard SOC Framework Methodology.

SCENARIO	CARBON POOLS	CO_2	CH_4	N_2O
Baseline scenario				
	The amount of soil carbon storage (SOC content)	Yes	No	No
Project scenario				
	The amount of soil carbon storage (SOC content)	Yes	No	No
	GHG emissions from the processing, transport and application of organic soil improvers from pulp and paper mill sludges	Yes	Yes[10]	Yes

[10] In the processing of organic residues from pulp and paper mill sludges, CH_4 and N_20 emissions are negligible, and can be considered zero in the calculations.

4.3.2 | Justification for inclusion of other carbon pools than SOC

- GHG emissions from the processing, transport and application of organic soil improvers from pulp and paper mill sludges shall be included in the project scenario. The processing, transport and application of organic biomass residue generate GHG emissions from fuel/energy including electricity use.
- Optional: GHG emissions from waste handling. Emissions of CO2 and CH4 in the baseline scenario from the use of pulp and paper mill sludges for incineration/energy purposes, or landfilling in case it is not incinerated. The incineration and landfilling generate GHG emissions that are avoided in the project scenario, hence it is conservative. However, if the project activity intends to claim avoided/reduced GHGs emission from waste disposal and/or treatment, the project shall take all relevant emission as per applicable methodology.
- Optional: The storage of C in landfills or other areas (in case all the sludge is not incinerated). Some C could be stored in landfill. Justification for the inclusion or exclusion of this optional pool is determined at the project level depending on the situational context and applicable methodology.

5| Emission Reduction Quantification Approach

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

5.1.1 | This SOC Activity Module focuses on the soil carbon pool. Calculations for overall benefits follow the equations set out in **Section 7** of the SOC

Framework Methodology. Sections below specify approaches and calculations specific to this SOC activity module.[11]

5.1.2 | 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. This activity module recommends approach 1, whereas approach 2 may be applied following SOC framework methodology requirements. If a different approach is used for baseline and project scenarios in a stratum, conservativeness and comparability have to be ensured.

a. Approach 1: On-site, direct measurement of Baseline Scenario and Project Scenario SOC stocks and emissions reductions from the application of fertilizers and other soil improvers.
b. Approach 2: Peer-reviewed publications to quantify Baseline Scenario SOC stocks, other emissions reductions, and Project Scenario impact. Project developers shall demonstrate that the research results are conservative and applicable to the proposed Project Area and management practice.

5.1.3 | See the specific quantification approaches for baseline and project activity emissions in sections 7 and 8.

6| Baseline Scenario

6.1 | General requirements

6.1.1 | As per the SOC Framework Methodology, the relevant baseline scenario is that as a continuation of historical cropping practices, in the absence of the project activity, no organic soil improvers from pulp and paper mill sludges are used in the baseline scenario.

6.1.2 | Organic soil improvers from pulp and paper mill sludges are mainly incinerated on site (in EU member states) or in some cases also landfilled

[11] GHGs avoidance and reduction may exist related to the avoidance of emissions from incineration of industrial residues and waste streams, or landfill methane due to the avoided disposal of those biomass waste products. Where applicable, the organic biomass residue disposal emission shall be supplemented by additional equations to estimate avoided emission from industrial residue disposal in compliance with a relevant GS approved CDM methodology. Relevant GS approved CDM methodologies with calculation equations for estimating incineration or waste landfilling emissions include, not limited to the following:
- ACM0001 "Flaring or use of landfill gas"
- ACM0006 "Electricity and heat generation from biomass"
- ACM0012 "Waste energy recovery"
- ACM0018 "Electricity generation from biomass in power-only plants"
- AM0057 / Version 03.0.1 "Avoided emissions from biomass wastes through use as feed stock in pulp and paper, cardboard, fibreboard or bio-oil production"
- AM0083 / Version 01.0.1 "Avoidance of landfill gas emissions by in-situ aeration of landfills"
- AM0093 / Version 01.0.1 "Avoidance of landfill gas emissions by passive aeration of landfills"

(mostly outside EU). To determine optional waste-related reduction in emissions, the project developer shall use one of the applicable CDM methodologies (section 5.1.1) taking into account the possible restrictions for transboundary movement of waste. In areas where the pulp and paper mill sludges are landfilled as the baseline, the project proponent should add whether the energy is captured or not, and what the effects of it are. However, the energy value is expected to be small or negligible also in landfills.

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

- Mineral soil type[12]
- Climate zone[13]
- Tillage practices
- Level of vegetation cover

6.1.4 | For each stratum (MU), SOC measurements shall be performed (Approach 1) and/or model parameters identified and verified (Approach 2) in the beginning of the project.

6.2 | Baseline Calculations

6.2.1 | Quantification for soil organic carbon in the baseline (SOCBL,y) shall follow the rules, approaches, calculations, and parameters set out in Section: Baseline Scenario of the *SOC Framework Methodology*.

7| Project Scenario

7.1 | General requirements

7.1.1 | Under the project scenario, organic soil improvers from pulp and paper mill sludges are applied in the project area to increase SOC and retain soil moisture. Other inputs are used and monitored similarly to baseline, and possible exceptions are reported. Expected emissions reductions would be achieved by both creating a soil carbon sink.

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

- Mineral soil type[14]

[12] European Soil Database https://esdac.jrc.ec.europa.eu/content/european-soil-database-v20-vector-and-attribute-data or other national soil database

[13] Köppen-Geiger climate classification or similar, e.g. https://edepot.wur.nl/197197

[14] European Soil Database https://esdac.jrc.ec.europa.eu/content/european-soil-database-v20-vector-and-attribute-data or other national soil database

- Climate zone[15]
- Tillage practices
- Level of vegetation cover

7.1.3 | For each stratum (MU), SOC measurements have to be performed (Approach 1) and/or model parameters identified and verified (Approach 2) during the project at least every 5 years (following certification cycle).

7.1.4 | In cases where a cropping change between the Baseline Scenario and Project Scenario occurs, the impact on SOC stocks in the medium term (following 5 year certification cycle) must be assessed. This shall be done considering the following:

- Agrochemical inputs, e.g. fertilizer or other nutrient inputs, pesticides, other additives;
- Change in hydrology, e.g. irrigation, draining and seasonal shift in crop coverage;
- Change in crop-related inputs, including plant residue and N-fixation;
- Change in crop management (e.g. tillage, machine use, treatments and harvest); and
- Seasonal management activities (e.g. harvesting, fallow periods, seasonal no cover).

7.2 | Project Calculations

7.2.1 | Quantification for soil organic carbon in the project scenario (SOCt,y) shall follow the rules, approaches, calculations, and parameters set out in Section 7: Project scenario of the *SOC Framework Methodology*.

7.3 | Other emissions

7.3.1 | Project activity emissions consist of CO_2 emissions from the transport emissions of pulp and paper mill sludges from the industrial facility to the processing facility, the processing emissions of organic soil improvers and the possible application emissions of organic soil improvers from pulp and paper mill sludges to the farms.

7.3.2 | Project emissions are determined as follows:

[15] Köppen-Geiger climate classification or similar, e.g. https://edepot.wur.nl/197197

$PE_y = \sum_i Q_{amend} \times (EF_{CO2e,trans1} + EF_{CO2e,process} + EF_{CO2e,trans2} + EF_{CO2e,applic}) + \sum_i Q_{ingredient} \times (EF_{CO2e,ingredient} + EF_{CO2e,trans3})$

Where[16]:

PE_y = total project emissions in year y (t CO2e)

Q_{amend} = Amount of organic soil improver product applied in the modelling unit i (t of organic soil improver product / ha of land)

$EF_{CO2e,trans1}$ = Emission factor for transport of the pulp and paper mill sludges to the processing site (tCO2e/t pulp and paper mill sludges)

$EF_{CO2e,process}$ = Emission factor for processing of the organic soil improvers from pulp and paper mill sludges at the processing site (tCO2e/t organic soil improver product)

$EF_{CO2e,trans2}$ = Emission factor for transport of the organic soil improver product to the farm i (tCO2e/t organic soil improver product)

$EF_{CO2e,applic}$ = Emission factor for the application of the organic soil improver product on the farm i (tCO2e/t organic soil improver product). The emission factor is calculated based on the fuel or electricity use (fuel consumption × area/distance travelled) of the application machinery of the soil improver product. If there are any other significant emissions from application, e.g. due to environmental conditions of the project, these should be taken into account in the emission factor.

$Q_{ingredient}$ = Amount of any other ingredients (e.g. lime) used for processing of organic soil improver products (ton of ingredient; sum each ingredient separately)

$EF_{co2e,ingredient}$ = Emission factor (tCO2e/t) for production of any other ingredients used for processing of organic soil improver products (each ingredient separately). The emission factor should also include CH4 and N2O emissions, if applicable. (tCO2e/t)

---

[16] Sources for estimation of emission factors are defined in Monitoring section

$EF_{co2e,trans3}$ = Emission factor for transportation of any other ingredients used for processing of organic soil improver products (each ingredient separately) (tCO2e/t ingredient)

8| Uncertainty

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

8.1.2 | Allocation of emissions reductions to a Gold Standard Compliance Buffer shall follow the rules set out in the SOC Framework Methodology.

9| Other Emissions

9.1.1 | 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 fossil fuel combustion, and other agrochemical emissions. Input of N fertilizer is not included since additional N fertilization is not necessary and in some cases N fertilization can even be reduced[17]. Calculation thereof shall follow the rules and equations set out in the *SOC Framework Methodology.* These emissions need to be subtracted from the soil organic carbon in the project scenario (SOCt,y).

10| Leakage

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

10.1.2 | As the Project Area is being actively maintained for commodity production during the project crediting period, yield-related leakage risks are expected to be 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

[17] https://journal.fi/afs/article/view/95600

productivity. All projects shall be designed to maintain or increase crop yield. In principle, LK_{t-0} is thus considered to be 0.[18]

10.1.3 | Risk of reducing yield is low when enough soluble N is available for the plants. Baseline N fertilization levels are adequate and can even be reduced in some cases. [19] When applied in the autumn, organic soil improvers from pulp and paper sludges can immobilize excess soluble N and prevent nutrient leaching. Immobilized N may be mineralized to plant available N next growing seasons and then increase yields.[20]. After application of organic soil a improvers from pulp and paper sludges into the field, the next crop is typically sowed in the spring.

10.1.4 | Risks to soil health are linked to quality of organic soil improvers from pulp and paper sludges, main risks being heavy metals and microbiological contaminations. However, these risks are taken into account in local fertilizer legislations and are mitigated using approved soil improver products only. Monitoring of soil health using heavy metals markers as indicators (parameter ID 15) is required at least once at each certification renewal (i.e. every fifth year of the project).

11| Monitoring

11.1.1 | Monitoring approach and parameters shall be followed as set out in the *SOC Framework Methodology*. Also, the project owner shall collect and document evidence that this SOC activity module’s applicability conditions are met at all times.

11.1.2 | In addition to the data and parameters listed in the SOC Framework Methodology, the following parameters need to be monitored and recorded.

a. Data and parameters not monitored

Data/parameter ID	OSI 1
Data / Parameter:	$EF_{FFC,MT}$
Data unit:	t CO2e / liter of fuel
Description:	The emission factor for diesel / gasoline / light fuel oil used in transport vehicles and agricultural machinery (per machine type)
Source of data:	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2 Chapter 3 Table 3.3.1
Any comment:	

[18] Section 11. Leakage in SOC Framework Methodology

[19] Kinnula et al. (2020 Effects of mixed pulp mill sludges on crop yields and quality. Agricultural and Food Science, 29(4), 276–286. https://doi.org/10.23986/afsci.95600, https://journal.fi/afs/article/view/95600

[20] Camberato et al. (2006) Pulp and paper mill by-products as soil amendments and plant nutrient sources. Canadian Journal of Soil Science . DOI: 10.4141/S05-120

b. Data and parameters monitored

Data/parameter ID	**OSI 2**
Data / Parameter:	$Q_{SOC,prod}$
Data unit:	%
Description:	The content of organic carbon (C) in the processed organic biomass residue product
Source of data:	Direct C-content measurements at the organic soil improvers production company
Monitoring frequency:	Annually
QA/QC procedures:	Direct analyses according to SFS-EN 13039 standard performed by an independent laboratory
Any comment:	The level of uncertainty as per test results determined by independent laboratory shall be taken into account.

Data/parameter ID	**OSI 3**
Data / Parameter:	Q_{amend}
Data unit:	t of organic biomass residue product / ha of land
Description:	The amount of organic biomass residue product applied to each modelling unit in the project activity
Source of data:	Amount applied by organic soil improvers producer to the farmers in the modelling units (book-keeping of organic soil improvers producer company)
Monitoring frequency:	Annually
QA/QC procedures:	Verifying data entry and analysis techniques, ensuring data maintenance and archiving for project time (20 years)
Any comment:	

Data/parameter ID	**OSI 4**
Data / Parameter:	$D_{trans,industry}$
Data unit:	km
Description:	The distance from each industrial facility to the organic soil improvers processing facility, multiplied by the amount of transportation trips. Amount of transportation trips is calculated by dividing the total amount of pulp and paper mill sludges delivered by the average load of residues per truck. This parameter is used in the calculation of the emission factor $EF_{CO2e,trans1}$.
Source of data:	Organic soil improvers processing company. The PD should ensure, that data sharing agreement among all parties involved is in place where applicable.
Monitoring frequency:	Annually

QA/QC procedures:	Verifying data entry, and ensuring data maintenance and archiving for project time (20 years)
Any comment:	

Data/parameter ID	**OSI 5**
Data / Parameter:	$D_{trans,farm}$
Data unit:	km
Description:	The distance from the organic soil improvers processing facility to each farm in the project activity scenario, multiplied by the amount of transportation trips. Amount of transportation trips is calculated by dividing the total amount of organic soil improvers delivered by the average load of residues per truck. This parameter is used in the calculation of the emission factor $EF_{CO2e,trans2}$.
Source of data:	Organic soil improvers processing company
Monitoring frequency:	Annually
QA/QC procedures:	Verifying data entry, and ensuring data maintenance and archiving for project time (20 years)
Any comment:	

Data/parameter ID	**OSI 6**
Data / Parameter:	$FFC_{trans,\ wp,j,i,t}$
Data unit:	liters
Description:	Consumption of fossil fuel type j in the project for transport i in year t. This parameter is used in the calculation of all of the transport-related emission factors mentioned in section 7.2.3.
Source of data:	Fuel efficiency factors can be obtained from the 2019 Refinement to the IPCC 2006 Volume 2 Chapter 3. Alternatively national or literature studies can be used[21].
Monitoring frequency:	Annually
QA/QC procedures:	Verifying data entry, and ensuring data maintenance and archiving for project time (20 years)
Any comment:	

[21] e.g. in Finland http://lipasto.vtt.fi/yksikkopaastot/indexe.htm

Data/parameter ID	OSI 7
Data / Parameter:	$FFC_{applic, wp,j,i,t}$
Data unit:	liters
Description:	Consumption of fossil fuel type j in the project for application at farm i in year t. This parameter is used in the calculation of the emission factor $EF_{CO2e,applic}$.
Source of data:	Fuel efficiency factors can be obtained from the 2019 Refinement to the IPCC 2006 Volume 2 Chapter 3
Monitoring frequency:	Annually
QA/QC procedures:	Verifying data entry, and ensuring data maintenance and archiving for project time (20 years)
Any comment:	

Data/parameter ID	OSI 8
Data / Parameter:	$FFC_{process}$
Data unit:	liter of fuel
Description:	The amount of fuel used for processing of the organic soil improvers from pulp and paper mill sludges. Record also the type of fuel used. This parameter is used in the calculation of the emission factor $EF_{CO2e,process}$.
Source of data:	Organic soil improvers processing company
Monitoring frequency:	Annually
QA/QC procedures:	Verifying data entry, and ensuring data maintenance and archiving for project time (20 years)
Any comment:	

Data/parameter ID	OSI 9
Data / Parameter:	$EF_{CO2e,ingredient}$
Data unit:	t CO2e /t of ingredient
Description:	Emission factor for production of other ingredients used in the processing of the organic biomass residue products. Record emission factors for any other ingredients needed in processing of the organic biomass residue products. In case of recycled residues the value is considered to be zero.
Source of data:	Organic soil improvers processing company
Monitoring frequency:	Annually
QA/QC procedures:	Verifying data entry, and ensuring data maintenance and archiving for project time (20 years)
Any comment:	

Data/parameter ID	OSI 10
Data / Parameter:	$Q_{ingredient}$
Data unit:	t of ingredient
Description:	Amount of other ingredients used in the processing of the organic soil improver products. Specify each ingredient separately.
Source of data:	Organic soil improvers processing company
Monitoring frequency:	Annually
QA/QC procedures:	Verifying data entry, and ensuring data maintenance and archiving for project time (20 years)
Any comment:	

Data/parameter ID	OSI 11
Data / Parameter:	$FFC_{ingredient}$
Data unit:	liter of fuel
Description:	The amount of fossil fuel in transportation of any other ingredient (used for processing organic soil improver products). Record consumption of fossil fuel needed for transportation of any other ingredients needed in processing of the organic soil improver products. Record also the type of fuel used. This parameter is used in the calculation of $EF_{co2e,trans3}$.
Source of data:	Transportation company
Monitoring frequency:	Annually
QA/QC procedures:	Verifying methods used to collect data, verifying data entry, and ensuring data maintenance and archiving for project time (20 years)
Any comment:	

Data/parameter ID	OSI 12
Data / Parameter:	$SH_{HM,MC}$
Data unit:	mg / kg solids
Description:	Soil health is monitored using changes in content of heavy metal marker compounds as the indicator. Project developers shall assess possible heavy metal related risks posed by organic soil improvers products to be used in the project. Relevant marker compound or compounds (e.g. Pb, Cd, Hg etc.) are identified and selected based on the assessment and monitored by testing content of marker compounds in soil samples per modelling unit. Content of heavy metal marker compounds should not rise significantly in the soil samples during the project.
Source of data:	Laboratory test results
Monitoring frequency:	At least once at each certification renewal (i.e. every fifth

	year of the project)
QA/QC procedures:	Verifying selection of heavy metal marker compounds, verifying methods used to test heavy metal marker compounds in soil samples, verifying data entry into project book-keeping, and ensuring data maintenance and archiving for project time (20 years)
Any comment:	