Document name	**RTRS EU RED Compliance Procedure for Producers** **Version 3.3**
Document reference	RTRS EU RED Compliance Requirements for Producers 3.3_ENG
Date	17th November 2017
Produced by	ProForest for the RTRS Executive Board and Biofuel WG With input from the RTRS Biofuels Working Group and GIZ (via use of their GTZ/IFEU *Guide to calculating greenhouse gas emissions under the biomass-electricity-sustainability-ordinance* (November 2009).) Update by E4tech in accordance with revision of EU RED and EU FQD via the iLUC Directive (2015/1513) in October 2016 and April 2017

This is a public document, for any comments regarding the content of this document or the RTRS Standard please contact the:

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The RTRS official languages are English, Spanish and Portuguese, however in case of any inconsistency between diferent versions of the same document, please refer to the English version as the official one.

Round Table on Responsible Soy Association

RTRS EU RED Compliance Requirements for Producers

I. Introduction

The RTRS EU RED Compliance Requirements for Producers has been developed on request of the RTRS Executive Board. It is part of the RTRS EU RED Scheme, which will allow soy producers and processors to meet the requirements for supplying soy-based biomass, biofuels and/or bioliquids to European Union member states. The *European Union Directive 2009/28/EC on the promotion of the use of energy from renewable sources* (also known as the 'EU RED') sets out the land use and carbon savings requirements for eligible biomass, biofuels and bioliquids. For biofuels produced in installations starting operation after 5 October 2015, the greenhouse gas emission saving from the use of biofuels shall be at least 60% compared to the fossil fuel reference. For biofuels produced in installations that were in operation on or before 5 October 2015, biofuels shall achieve a greenhouse gas emission saving of at least 35% compared to the fossil fuel reference until 31 December 2017 and at least 50% compared to the fossil fuel reference from 1 January 2018.

The EU has provided 'disaggregated default' values for most biofuel feedstocks which economic operators can use to calculate whether the fuel they are supplying meets the minimum savings threshold. However, for soy disaggregated default values do not meet the minimum GHG savings. In practice, this means that some supply chain operators will have to record and transmit actual values and calculations to show the minimum GHG savings is met.

II. Scope

This document sets out the requirements against which an economic operator in the soy supply chain will be assessed to demonstrate compliance with the EU RED. The soy supply chain includes the following operators: producers (growers), crush, refining, esterification and blending, and takes into account storage and transportation up until the point the product is delivered to the market. The RTRS EU RED Compliance Requirements for Producers applies to producers and the RTRS EU RED Supply Chain applies to all supply chain operators. The RTRS EU RED Compliance Requirements for Producers are mandatory for all producers (growers) seeking to supply soy, as well as soy-based biomass, biofuels and/or bioliquids to the EU biofuel market and wanting to communicate RTRS data to customers about land use and GHG emissions of their operations. Communication of RTRS EU RED data can only be made if the operator has been successfully assessed against the RTRS EU RED requirements. The unit of certification is the organization's physical site.

It is anticipated that the RTRS will either develop a GHG calculator, or will assess and approve an existing GHG calculator for use with these RTRS EU RED Compliance Requirements for Producers. Any approval of a calculator will be undertaken using the methodology set out in Section VII of this document and be subject to independent verification prior to approval. As of January 2017, the only approved GHG emissions calculator is BioGrace.

This document became effective on [DATE of EC APPROVAL] and shall be applicable worldwide.

III. Changes from previous version of this document

October 2016: Various adjustments in conformity with iLUC Directive (2015/1513) amending the Renewable Energy Directive and Fuel Quality Directive.

IV. How to use this document

The RTRS EU RED Compliance Requirements for Producers includes the following sections:

- V Definitions
- VI List of Acronyms
- VII Compliance Requirements for Producers
- VIII Guidance for Compliance Requirements
- IX Methodology for Calculating Greenhouse Gas Emissions of Soybean Production under the European Commission – Renewable Energy Directive (EU-RED)

Producers and auditors using this document to assess compliance must also refer to the RTRS EU RED Scheme: System Description.

V. Definitions

Agricultural residues	Residues that are directly generated by agriculture; they do not include residues from related industries or processing.
Biofuel	Liquid or gaseous fuel for transport produced from biomass.
Bioliquid	Liquid fuel for energy purposes other than for transport, including electricity and heating and cooling, produced from biomass.
Biomass	Biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste.
Continuous forest	Land spanning 1ha or more with canopy cover of more than 30 % and where some trees reach 5m in height (or are able to reach these thresholds in situ). It does not include land that is predominantly under agricultural or urban land use. Land under agricultural use in this context refers to tree stands in agricultural production systems, such as fruit tree plantations, oil palm plantations and agroforestry systems when crops are grown under tree cover.
Cropland	Land under agricultural production , namely annual crops whose stem is usually annually harvested
Criteria	The ’content’ level of a standard. Conditions that need to be met in order to achieve a Principle.
Grassland	Terrestrial ecosystems dominated by herbaceous or shrub vegetation for at least 5 years continuously. It includes meadows or pasture that is cropped for hay but excludes land cultivated for other crop production and cropland lying temporarily fallow. It further excludes continuously forested areas as defined in Article 17(4)(b) of Directive 2009/28/EC unless these are

	agroforestry systems which include land-use systems where trees are managed together with crops or animal production systems in agricultural settings. The dominance of herbaceous or shrub vegetation means that their combined ground cover is larger than the canopy cover of trees.
Highly-contaminated land	Subject to definition by the Commission. Definition will be updated once further information is available.
Highly-degraded land	Subject to definition by the Commission. Definition will be updated once further information is available.
Human intervention	Managed grazing, mowing, cutting, harvesting or burning;
Land designated for nature protection purposes	Land designated for nature protection purposes is: (a) designated by law or by the relevant competent authority for nature protection purposes; or (b) designated for the protection of rare, threatened or endangered ecosystems or species recognised by international agreements or included in lists drawn up by intergovernmental organisations or the International Union for the Conservation of Nature.
Indicators	The 'operational' level of a standard expressed in measurable statements which allow assessment of conformance.
Natural highly biodiverse grassland	Grassland that would remain grassland in the absence of human intervention and maintains the natural species composition and ecological characteristics and processes.
Non-natural highly biodiverse grassland	grassland that: (a) would cease to be grassland in the absence of human intervention; and (b) is not degraded, that is to say it is not characterised by long-term loss of biodiversity due to for instance over-grazing, mechanical damage to the vegetation, soil erosion or loss of soil quality; and (c) is species-rich, that is to say it is: (i) a habitat of significant importance to critically endangered, endangered or vulnerable species as classified by the International Union for the Conservation of Nature Red List of Threatened Species or other lists with a similar purpose for species or habitats laid down in national legislation or recognised by a competent national authority in the country of origin of the raw material; or (ii) a habitat of significant importance to endemic or restricted-range

	species; or (iii) a habitat of significant importance to intra-species genetic diversity; or (iv) a habitat of significant importance to globally significant concentrations of migratory species or congregatory species; or (v) a regionally or nationally significant or highly threatened or unique ecosystem.
Perennial cropland	Land under agricultural production, namely multi-annual crops whose stem is usually not annually harvested such as short rotation coppice and oil palm
Principles	The 'intent' level of the standard, expressed in fundamental statements about a desired outcome
Primary forest	Forest and other wooded land of native species, where there is no clearly visible indication of human activity and the ecological processes are not significantly disturbed.
Processing residue	Substance that is not the end product(s) that a production process directly seeks to produce; it is not a primary aim of the production process and the process has not been deliberately modified to produce it.
Salinised soils	Salinised soils comprise salinisation and sodification (accumulation of sodium) and are present when ○ soil horizons at or within 100 cm below the soil surface contain secondary accumulations of salts, which are more soluble than gypsum and produce electrical conductivity >4 dS m-1 in a soil-saturation extract, and ○ the sodified horizons together have a minimum thickness of 15 cm. or when ○ soil horizons at or within 100 cm of the soil surface have an exchangeable sodium percentage (ESP) of at least 15% and ○ the sodified horizons together have a minimum thickness of 15 cm.
Waste	Any substance or object which the holder discards or intends or is required to discard. Raw materials that have been intentionally modified, or contaminated, to count as waste (e.g. by adding waste material to a material that was not waste) are not covered by this definition. *See also: Article 3(1) of Directive 2008/98/EC of the European Parliament and of the Council.*
Wetland	Land covered with or saturated by water permanently or for a significant part of the year. *When evaluating wetlands, evidences provided shall take seasonal changes into consideration, e.g. temporary drought or flood.*

V. List of Acronyms

GHG	Greenhouse Gas
RED	Renewable Energy Directive
RTRS	Round Table on Responsible Soy

VI. Compliance Requirements for Producers Scope

1. Greenhouse Gas (GHG) emissions on the farm

1.1 Greenhouse gas (GHG) emissions from soy cultivation are measured and recorded

Farmers may use either a disaggregated default value (Option 1) or an actual value (Option 2).

Option 1 – Disaggregated default value

1.1.1 Farmers may use a disaggregated default value for cultivation. In such case, no GHG value shall be reported in the product documentation. However, use of default values may preclude the end product from meeting the minimum GHG savings as required in the EU RED (see guidance).

Option 2 – Actual value

1.1.2 Yield data is measured, monitored and recorded over the growing year. The moisture content of the crop yield is measured and recorded.

1.1.3 Electricity consumption is measured, monitored and recorded over the growing year.

1.1.4 Fertiliser use is measured, monitored and recorded over the growing year (see RTRS Standard for Responsible Soy Production Version 3.0, 5.5.1)

1.1.5 Pesticide use is measured, monitored and recorded over the growing year (see RTRS Standard for Responsible Soy Production Version 3.0, 5.5.1)

1.1.6 Soybeans used for planting are measured, monitored and recorded over the growing year.

1.1.7 Fuel use is measured, monitored and recorded over the growing year (see also RTRS Standard for Responsible Soy Production Version 3.0, 4.3.1).

1.1.8 GHG emissions from cultivation are calculated and expressed in g CO_2 eq/ dry ton of soy.

Note: This calculation can be made using an RTRS approved on-line GHG-emissions calculator. As of January 2017, the only approved GHG emissions calculator is BioGrace.

1.2 Greenhouse gas (GHG) emissions from land use are calculated and recorded

1.2.1 Where expansion has occurred after January 2008 the carbon content per unit area of soil and vegetation before conversion into annual cropland land is recorded.

1.2.2 Where expansion has occurred after January 2008 the carbon content per unit area of soil and vegetation after conversion into annual cropland is recorded (see also RTRS Standard for Responsible Soy Production Version 3.0, 4.3.3 and 5.3.3).

1.2.3 Where expansion occurs on highly degraded or highly contaminated land, the following shall apply:

a) There is a reduction in soil contamination which is measured, monitored and recorded,

b) There is a continuous increase in the carbon stock and a reduction in erosion which is measured and recorded (see also RTRS Standard for Responsible Soy Production Version 3.0, 4.3.3 and 5.3.3),

c) There is evidence that the area was not being used for agricultural purposes in January 2008.

1.2.4 Changes in the carbon content per unit area as a result of soil accumulation via improved agricultural management are measured and recorded (see also RTRS Standard for Responsible Soy Production Version 3.0, 4.3.3 and 5.3.3).

1.2.5 GHG emissions from land use change are calculated according to the methodology in the EU RED Annex V and Commission Decision 2010/335/EU of 10 June 2010 and expressed in g CO_2 eq/ dry ton of soy. Emissions from using highly degraded or contaminated land are provided in EU RED Annex V as a bonus of 29 gCO2eq/MJ.

1.3 Greenhouse gas (GHG) emissions from transport of soybeans are calculated and recorded

This requirement is applicable only if a farmer has control of the transport of soybeans from the farm to the next economic operators (e.g. between production area and grain silo or crush).

Farmers may use either a disaggregated default value (Option 1) or an actual value (Option 2).

Option 1 – Disaggregated default value

1.3.1 Farmers may use a disaggregated default value for transportation. In such case, no GHG value shall be reported in the product documentation. However, use of the disaggregated default value will prevent the use of actual values for transportation in the supply chain and may preclude the end product from meeting the minimum GHG savings as required in the EU RED (see guidance).

1.3.2 Farmers may also use data on typical emissions from soy cultivation (e.g. NUTS2) submitted by Member States or competent authorities of third countries, provided these have been published in the unit g CO2eq/dry-ton of feedstock on the European Commission's website.

Option 2 – Actual value

1.3.3 Where transportation to the next economic operator is under the control of the farmer the following is measured and recorded:

a) the distance between the farmer and the next economic operator,

b) the type of transport used to transport the crop,

c) the quantity of soybean transported,

d) the moisture content of the transported crop

1.3.4 GHG emissions from transportation are calculated and expressed in g CO_2 eq/ dry ton of soy.

Note: This calculation can be made using an RTRS approved on-line GHG-emissions calculator. As of January 2017, the only approved GHG emissions calculator is BioGrace.

1.3.5 Farmers shall make available to auditors all relevant information concerning the calculation of actual GHG emissions in advance of the planned audit.

1.4 Greenhouse gas (GHG) emissions are calculated and communicated to the next economic operator in the supply chain.

1.4.1 The GHG emissions are communicated to the next economic operator in the supply chain including:

a) Soy cultivation

b) Soy land use change (where applicable)

c) Degraded land bonus (where applicable)

d) Transportation (where applicable)

1.4.2 Information on actual GHG emissions is provided for all relevant elements of the GHG emission calculation formula. Actual GHG emissions are expressed in g CO_2 eq/ dry ton of soy.

1.4.3 Records of GHG data and calculations are kept for at least 5 years.

2. Land Use

The following requirements shall be met. Criterion 4.4 of the RTRS P&C Version 1.0 shall also apply. The RTRS EU RED requirements set out below shall take precedence over the requirements RTRS P&C, where there is a conflict between the two. In particular, the cut-off date for land use change shall be January 2008.

2.1 There is no conversion of high biodiversity areas

2.1.1 There is evidence to confirm that soy was not obtained from land with high biodiversity value, namely land that had one of the following statuses in or after January 2008, whether or not the land continues to have that status:

- Primary forest and other wooded land, namely forest and other wooded land of native species, where there is no clearly visible indication of human activity and the ecological processes are not significantly disturbed;
- Areas designated by law or by the relevant competent authority for nature protection purposes unless evidence is provided that the production of that raw material did not interfere with those nature protection purposes;
- Natural or non-natural highly biodiverse grassland.

  (See definitions in Section V)

2.2 There is no conversion of high carbon stock areas

2.2.1 There is evidence to confirm that soy was not obtained from land with high carbon stock, namely land that had one of the following statuses in January 2008 and no longer has that status:

- Wetlands, namely lands covered with or saturated by water permanently or for a significant part of the year;
- Continuously forested areas, namely land spanning more than one hectare with trees higher than five metres and a canopy cover of more than 30 %, or trees able to reach those thresholds in situ;
- Land spanning more than one hectare with trees higher than five metres and a canopy cover of between 10 % and 30 %, or trees able to reach those thresholds in situ, unless evidence is provided that the carbon stock of the area before and after conversion is such that, when the methodology laid down in RED part C of Annex V is applied, the conditions laid down in paragraph 2 of RED Article 17 would be fulfilled.

The provisions of this paragraph shall not apply if, at the time the raw material was obtained, the land had the same status as it had in January 2008.

2.2.2 There is evidence to confirm that soy was not obtained from land that was peatland, in January 2008, unless evidence is provided that the cultivation and harvesting of that raw material does not involve drainage of previously undrained soil. For peatland that was partially drained in January 2008 the subsequent deeper drainage, affecting soil that was not fully drained, is prohibited.

2.3 Land use information is communicated to the next economic operator in the supply chain.

2.3.1 The status of the land in January 2008 and after is communicated to the next economic operator. Evidences shall be provided under the form of satellite images, official maps and registers, scientific surveys, field reports, international/independent land classification database, e.g. IBAT, HCV network, RAMSAR, etc.).

2.3.2 Records of land use status since January 2008 are kept for at least 5 years.

3. Communication of information

3.1.1 Farmers shall declare the names of all EC-approved schemes it participates in and make available to the auditors all relevant information, including the mass balance data and the auditing reports.

Note: This requirement applies to all voluntary schemes that the farmer is participating in.

VII. Guidance for Compliance Requirements

The guidance contained in this annex must be followed by:

I. auditors, evaluating compliance against the RTRS EU RED Compliance Requirements for Producers

II. organizations seeking to comply with the RTRS EU RED Compliance Requirements for Producers

Requirement	Guidance
1.1.1	The disaggregated default value of 19 gCO_2eq/MJ biodiesel is from Annex V of Directive 2008/28/EC. The disaggregated default value for cultivation is the same as the typical value for cultivation (the disaggregated default value is 40% higher than the typical case for processors). While there may be some gains from reporting actual values for cultivation, in practice the biggest GHG savings compared to the disaggregated default will be with processors further down the supply chain, who would have to use actual data/calculations if the cultivation disaggregated default was used in order for the end product to meet the minimum greenhouse gas savings set by the EU. Since the farm will not normally know whether downstream processors will use actual values, there is a significant risk that the savings will not be met if the disaggregated default for cultivation is used. Disaggregated default values for cultivation can be used when there is land use change, however the actual land use change values must be communicated (see 2.3.1 guidance)
1.1.2	Crop yield [kg yield/(ha*a)] is annual yield of the soybeans in kg per hectare in the growing year. The mass of the dried product shall be used for the calculation.
1.1.3	Electricity consumption [kWh/ha*a] is total electricity consumption per hectare in the growing year, including for example for drying and water pumps.
1.1.4	Fertiliser [kg/(ha*a)] is total annual quantity of the P_2O5, K_2O, CaO and any other fertilisers used per hectare in the growing year.
1.1.5	Pesticides [kg/(ha*a)] is the total annual quantity of the pesticide used per hectare in the growing year
1.1.6	Soy beans [kg/(ha*a)] is the total annual quantity in kilograms of soybeans planted per hectare in the growing year
1.1.7	Fuel [l/(ha*a)] is total annual quantity of fuel used, (for example for tractors, sprayers, harvesters and water pumps), per hectare in the growing year.
1.1.8	The options available for GHG calculations are: • Using the disaggregated default value of 19 gCO_2eq/MJ biodiesel for cultivation • Using cultivation averages for the particular geographical area where the soy was grown drawn up by a Member State

Requirement	Guidance
	• Using an RTRS approved RED GHG calculator. This is a software tool where input data is entered and the computer calculates the GHG emissions. As of January 2017, the only approved GHG emissions calculator is BioGrace. • Using manual calculations for cultivation, as set out in IX Methodology for Calculating Greenhouse Gas Emissions. The units used shall be gCO_2 eq/dry ton soybean. The actual data collected shall be provided to the next economic operator
1.2.1	See section 2.2.2 of Section IX Methodology for Calculating Greenhouse Gas Emissions of soybean production under the European Commission – Renewable Energy Directive (EU-RED) This can either be measured on site or taken from a scientific literature sources (e.g. IPCC Guidelines), and shall be calculated according to the Commission Decision of 10 June 2010 on guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive 2009/28/EC (notified under document C(2010) 3751) Actual values for land use change must be calculated even if a disaggregated default value has been used for cultivation.
1.2.2	See section 2.2.2 of Section IX. Methodology for Calculating Greenhouse Gas Emissions of soybean production under the European Commission – Renewable Energy Directive (EU-RED) This can either be measured on site or taken from a scientific literature sources (e.g. IPCC Guidelines), and shall be calculated according to the Commission Decision of 10 June 2010 on guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive 2009/28/EC (notified under document C(2010) 3751)
1.2.3	The EU Commission has not yet defined degraded land, and therefore the bonus of 29 g CO_2eq/MJ soy biodiesel for degraded land cannot be included until such a time where this has been formally defined. However, because of the challenges of retrospectively measuring, where producers think they may be eligible for the degraded land bonus, they should measure and record soil carbon measurements and contamination levels, as well as evidence that the area was not used for agriculture in January 2008. Producers should measure and record additional evidence to demonstrate that the land was unsuitable for cultivation of food and animal feed because of soil contamination, and/or that the land has been salinised for a long period or to which very little organic matter has been added and which is highly eroded. Highly-degraded land is likely to include some former agricultural land. This guidance will be updated once additional information is available from the Commission. Producers should note that even if they do measure and record evidence of soil contamination and degradation, until such a time as EU definitions are available, there is no guarantee that they will be eligible for the 29 g CO_2eq/MJ soy biodiesel bonus.

Requirement	Guidance
1.2.4	See 2.4 of Section XI. Methodology for Calculating Greenhouse Gas Emissions of soybean production under the European Commission – Renewable Energy Directive (EU-RED)
1.2.5	The EU Commission has not yet defined degraded land, and therefore the bonus of 29 g CO_2eq/MJ soy biodiesel for degraded land cannot be included until such a time where this has been formally defined. These options are available for GHG calculations: • Using an RTRS approved RED GHG calculator. This is a software tool where input data is entered and the computer calculates the GHG emissions. As of January 2017, the only approved GHG emissions calculator is BioGrace. • Using manual calculations for land use change, according to the Commission Decision of 10 June 2010 on guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive 2009/28/EC (notified under document C(2010) 3751). The units used shall be gCO_2 eq/dry ton soybean. The actual data collected shall be provided to the next economic operator.
1.3.1	If the disaggregated default value is used, it will prevent the use of actual values for transportation in the entire supply chain, as related to soy product from the producer being assessed. This is because the disaggregated default value provided by the EU for transportation includes the sum of all transport in the supply chain, starting with the farmer, through processing and delivery. It is therefore not possible to add actual values to the disaggregated default value. However, because the disaggregated default value provided by the EU is the same as the typical value, there may not be significant gains in using actual values. This differs from processing, where there is a 40% difference between typical and disaggregated default values.
1.3.2	a) The transport distances [in km] – distance, over which the biomass was transported to the next business or the next business site e.g. distance between the grower and the oil mill, including the (empty) return run. b) e.g. 40t diesel HGV c) The quantity of biomass transported in the particular type of transport (e.g. 40T) d) The mass of the dry crop shall be used for the calculation.
1.3.3	These options are available for GHG calculations: • Using an RTRS approved RED GHG calculator. This is a software tool where input data is entered and the computer calculates the GHG emissions. As of January 2017, the only approved GHG emissions calculator is BioGrace. • Using manual calculations for transport, as set out in Section IX Methodology for Calculating Greenhouse Gas Emissions. The units used shall be gCO_2 eq/dry ton soybean. The actual data collected shall be provided to the next economic operator

Requirement	Guidance
1.4.1	The disaggregated values for cultivation, land use change and transportation must be communicated. The degraded land bonus of 29 g CO_2eq/MJ soy biodiesel cannot be included until such a time where the Commission has provided further information and definitions. Disaggregated default values for cultivation can be used if there has been land use change since January 2008, however the actual land use change values must be communicated separately as units of g CO_2 eq/ dry ton soybeans. Where actual values are used, units for transportation must be expressed in g CO_2 eq/dry ton soybeans. Where a disaggregated default value for cultivation is used, the value of 19 gCO_2eq/MJ biodiesel must be communicated. It must be made clear to the next economic operator that the disaggregated default value has been used for a consignment. Information on actual GHG emissions shall be provided for all relevant elements of the GHG emission calculation formula. Relevant refers in this context to elements for which reporting is obligatory (e.g. e_l in case of land use change), all elements for which actual values should be used instead of disaggregated default values and all elements related to emission savings (if applicable). Records of communication must be available and kept for at least 5 years. This can include for example use of a computerised data tracking system operated by a third party.
2.1.1	See glossary for definitions. Areas designed by the European Commission for the protection of rare, threatened or endangered ecosystems or species are as per Article 18 (4) subparagraph 2 of Directive 2009/28/EC. Whereas Directive 2009/28/EC only prohibits conversion of highly biodiverse grasslands, the RTRS Standard prohibits the conversion of ANY grassland for soy production.
2.2.1	See glossary for definitions. Note that at the first stage in the supply chain (the farm) it is not possible to know whether the whole supply chain will meet the savings threshold because the supply chain will not normally be known. The savings shall be calculated at a later stage in the supply chain and any consignments which do not meet the minimum savings will not be identified as RTRS EU RED compliant.
2.3.1	The status of the land includes: • Cropland; • Perennial crops; • Non-highly biodiverse or high carbon stock areas (where there is evidence that 2.1 and 2.2 of this document, ‘EU RED Compliance Requirements for producers’, have been met) • Areas designated for nature protection purposes, where cultivation did not

Requirement	Guidance
	interfere with these purposes should be reported as 'protected'. • Areas designated for the protection of rare, threatened or endangered ecosystems or species recognised by the European Commission, where cultivation did not interfere with these purposes should be reported as 'protected'. Areas not designated for nature protection purposes should be reported as 'non-protected'. Land which has status as set out 2.1.1 and will fail to meet the requirements of the RTRS EU RED Compliance Requirements for Producers, and no information shall be communicated.
2.3.2	Records of the status of the land can include for example management plans showing area under cultivation in 2008, maps, aerial photographs etc. These records must not be discarded. Records of communication must be available. Records shall be kept for at least 5 years.

VIII. Methodology for Calculating Greenhouse Gas Emissions of Soybean Production under the European Commission – Renewable Energy Directive (EU-RED)1

The following methodology has been included as reference for the RTRS RED Indicators Add-On.

In practice, GHG calculations will not normally be undertaken by a farmer.

Computer software based on the following calculations is expected to be widely available. Any formal approval of a specific calculator by the RTRS will use the methodology set out below. As of January 2017, the only approved GHG emissions calculator is BioGrace.

Any calculator used by the RTRS will be independently verified against the following methodology prior to approval.

1 This document has been developed with permission using the ' Guide To Calculating Greenhouse Gas Emissions under the Biomass-Electricity-Sustainability Ordinance [Biomassestrom- Nachhaltigkeitsverordnung] (BioSt-NachV)' (November 2009) prepared by the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH [German Technical Cooperation] In cooperation with the Institut für Energie- und Umweltforschung Heidelberg GmbH [Heidelberg Institute for Energy and Environmental Research]

Content

1. Accurately-measured data

‘Measured data’ means data that are used to calculate the actual values. These data can either be ‘measured’ on site or taken from verifiable recognized literature sources or databases. Whenever available, the data (“standard calculation values”) published on the European Commission website[2] should be applied. In case alternative values are chosen this must be duly justified and flagged up in the documentation of the calculations in order to facilitate the verification by auditors.

The following data are regarded as being accurately-measured only if they are collected on site, in other words, the relevant quantities were taken from sources such as business documents:

- Quantity of kg of soybeans
- Quantity of chemicals used (e.g. pesticides, methanol, NaOH, HCl, hexane, citric acid, bleaching clay)
- Quantity of nitrogen (N), phosphate (P2O5), Potassium (K2) and lime (CaO)
- Fuel consumption, electricity consumption

Accurately-measured data collected in the field must be documented (field calendar, delivery notes and invoices etc). The following data are considered to be accurately measured if they are taken from a scientifically-recognized literature source (including statistical data from government bodies)::

- Calorific values of the main product and co-products,
- Emission factor of fertilisers, diesel in agricultural machinery, chemicals, electricity, thermal energy, for example and
- Emission factor of nitrous oxide (N_2O) from the use of nitrogen fertilisers

For values taken from literature sources or databases (calorific values, emission factors etc), the source (e.g. name of publication and author) and year of publication must be documented and shall be based on the most recent available data and updated over time. The data should be peer reviewed before publication and consistent with other existing data sources. Where there are appropriate regional emission factors available, those regional emission factors should be used.

Operators also always have the option of collecting data by taking measurements themselves. In this case, the method must be clearly documented and explained so that the calculations can be understood.

Figures for greenhouse gas savings are rounded to the nearest percentage point.

[2] https://ec.europa.eu/energy/node/74

2. GHG calculation methodology for EU-RED

According to the formula in Annex V of the EU-RED the greenhouse gas emissions for soy biodiesel shall be calculated as follows:

$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} - e_{ee}$

Where

E	= total emissions from the use of the soy oil
e_{ec}	= emissions from the cultivation of soy
e_l	= annualised emissions from carbon stock changes caused by land-use change
e_p	= emissions from processing
e_{td}	= emissions from transport and distribution
e_u	= emissions from the fuel in use
e_{sca}	= emission savings from soil carbon accumulation via improved agricultural management
e_{ccs}	= emission saving from carbon capture and geological storage
e_{ccr}	= emission saving from carbon capture and replacement
e_{ee}	= emission saving from excess electricity from cogeneration

Units:Actual values used for e_{ec}, e_l, e_p, e_{td}, e_u, e_{sca}, e_{ccs}, e_{ccr}, e_{ee} shall be expressed in g CO_2eq/dry ton of soy or intermediate product.

At the last processing step, the total emissions (E) needs to be converted into the unit CO2eq/MJ of final soy biodiesel. For this transformation, the following formula should be applied to emissions from cultivation:

$$e_{ec}biofuel_a\left[\frac{gCO_2eq}{MJ\ biofuel}\right]_{ec} = \frac{e_{ec}\ feedstock_a\left[\frac{gCO_2eq}{kg_{dry}}\right]}{LHV_a\left[\frac{MJ\ feedstock}{kg\ dry\ feedstock}\right]} * Biofuel\ feedstock\ factor_a * \ Allocation\ factor\ biofuel_a$$

Where

$$Allocation\ factor\ biofuel_a = \left[\frac{Energy\ in\ biofuel}{Energy\ biofuel + Energy\ in\ co-products}\right]$$

$$Biofuel\ feedstock\ factor_a = [Ratio\ of\ MJ\ feedstock\ required\ to\ make\ 1\ MJ\ biofuel]$$

The following value shall be used:

- LHV: 23.5 MJ/kg dry soybeans

Note: The variables e_{sca}, e_{ccs}, e_{ccr} and e_{ee} are not included in this description for reasons of simplification.

2.1 Calculating the GHG emission values from soy cultivation (e_{ec})

To calculate the GHG emission from soy production e_{ec} , including the GHG emission from cultivation of soy beans and the GHG emissions from manufacture of the resources required for cultivation on the basis of accurately-measured data the following formula is used:

$$e_{ec}' = \frac{emission_{fertiliser}\left[\frac{KgCO_2}{ha*a}\right] + emissions_{pesticides}\left[\frac{KgCO_2}{ha*a}\right] + emissions_{soybeans}\left[\frac{KgCO_2}{ha*a}\right] + emission_{diesel}\left[\frac{kgCO_2}{ha*a}\right] + emission_{electricity}\left[\frac{kgCO_2}{ha*a}\right]}{yield_{mainproduc}\left[\frac{kgYield}{ha*a}\right]}$$

Where

$Emission_{fertiliser}$ = emissions from fertiliser usage in a growing year

$Emissions_{soybeans}$ = emissions from soy beans planted in a growing year

$Emissions_{pesticides}$ = emissions from pesticide usage in a growing year

$emission_{diesel}$ = emissions from diesel usage in a growing year

$emission_{electricity}$ = emissions from electricity usage in a growing year

$yield_{main\ product}$ = yield of the main product (dried soy beans)

The soybeans are a product of one stage in the manufacturing chain, which is followed by further processing in a subsequent process (stage).

Resources required by the process are materials or energy added to a process.

Components of the formula in detail:

$$emission_{fertiliser} = fertiliser\left[\frac{kg}{ha*a}\right]*$$

$$\left(emission\_factor_{manufacture}\left[\frac{kgCO_2}{kg}\right] + emission\_factor_{field}\left[\frac{kgCO_2}{kg}\right]\right)$$

$$emission_{diesel} = diesel\left[\frac{1}{ha*yr}\right]* emission\_factor_{diesel}\left[\frac{kgCO_2}{1}\right]$$

$$emission_{electricity} = electricity\left[\frac{kWh}{ha*a}\right]* emission\_factor_{national\_energy\_mix}\left[\frac{kgCO_2}{kWh}\right]$$

$$emissions_{pesticides} = pesticides\left[\frac{kg}{ha*a}\right]* emission\_factor_{pesticides}\left[\frac{kgCO_2}{kg}\right]$$

$$emissions_{soybeans} = soybeans\left[\frac{kg}{ha*a}\right]* emission\_factor_{soybeans}\left[\frac{kgCO_2}{kg}\right]$$

The GHG emissions formed during the following stages must be taken into account:

- Production and cultivation process
- Harvesting of soybeans and
- Chemicals and other products used (e.g. diesel).

For the calculation of e_{ec} at least the following detailed data must be collected on site, which means that the relevant quantities must be taken from sources such as business documents: (Please note that the variable 'a' refers to data values on a per annum basis)

- Fertiliser [kg/(ha*a)] – total annual quantity of the N, P2O5, K2O, CaO fertilisers used per hectare in the growing year.
- Pesticides [kg/(ha*a)] – total annual quantity of the pesticide used per hectare in the growing year
- Soy beans [kg/(ha*a)] – total annual quantity of the soy beans planted per hectare in the growing year.
- Diesel [l/ha*a)] – total annual quantity of diesel used for example for tractors and water pumps per hectare in the growing year.

- Electricity consumption – total electricity consumption per hectare in the growing year for drying and water pumps for example.
- Crop_yield_ product [kg yield/(ha*a)] – annual yield of the main product in kg per hectare in the growing year and its moisture content.

The mass of the dry crop shall be used for the calculation.

Where there are other emissions, these should also be recorded and included in the account. The data must be entered in the relevant places in the formula.

To calculate e_{ec} the following emission factors can be taken from a literature source or database:

- Fuel emission factor [kg CO_2/l diesel]
- Fertiliser production emission factor [kg CO_2/kg fertiliser] (differentiated according to N, P, K, Ca)
- Fertiliser field emission factor [kg CO_2/kg N-fertiliser]
- Pesticide production emission factor [kg CO_2/kg pesticides] (differentiated according to different pesticides used)
- Soy bean production emission factor [kg CO_2/kg soy seed]
- National or regional energy mix emission factor [kg CO_2/kWh].

These data points must be entered in the relevant places in the formula. Examples are given in Table 1.

All GHG emission data are expressed in mass units in relation to the main product (e.g. diesel [kg] /soybeans [kg]). e_{ec} is expressed in g CO_2 eq/dry ton of soy.

The formula does not take account of carbon fixation esca during cultivation of biomass.

It is estimated that the GHG emissions from cultivation can also be derived from average values, which are calculated for geographical areas smaller than those used to calculate the disaggregated default values and are covered by the NUTS2 reports. Whenever available, NUTS2 equivalent cultivation emission data provided by Member States, or competent authorities of third countries can only be applied when such data are published by the European Commission in the unit kg CO2eq/dry-ton of feedstock. The calculation of alternative averages for areas and crops which are covered by the NUTS 2 reports should under normal condition not be deemed appropriate as the appropriate averages have already been calculated by the national authorities.

2.2 Calculating the GHG emissions from land-use changes (e_l)

2.2.1 Land-use changes to be taken into account

If there is evidence that no land use change has taken place since January 2008, then e_l = 0.

GHG emissions from land-use change shall only be calculated if the land use change was a permitted change of land status as set out in the Section 2. Compliance Requirements for Land use (above):

2.1 There is no conversion of high biodiversity areas

2.2 There is no conversion of high carbon stock areas

A land-use change shall be taken into account when calculating the GHG emissions if, after the reference date[3]:

- continuously wooded areas with a crown cover of 10 to 30% are converted to areas of single-year or permanent crops;
- areas of perennial crops are converted to areas of single-year crops;

A land-use change shall be taken into account when calculating the GHG emissions if, after the reference date a change in terms of land cover between the land categories used by the IPCC[4] (forest land, cropland, settlements and other land) plus a seventh category of perennial crops (i.e. multi-annual crops whose stem is usually not annually harvested such as short rotation coppice) has taken place.

Cropland includes fallow land (i.e. land set at rest for one or several years before being cultivated again). A change of management activities, tillage practice or manure input practice is not considered land-use change.

2.2.2 Land-use change formulas[5]

The following formula is used to determine the GHG emissions, converted to an annual basis, resulting from land-use changes e_l, by evenly distributing the total GHG emissions over 20 years using the data passed on by the cultivation company:

$$e_1' = \frac{CS_R\left[\frac{kgC}{ha}\right] - CS_A\left[\frac{kgC}{ha}\right]}{yield_{main\_product}\left[\frac{kg}{ha}\bullet a\right]\bullet 20[a]} \bullet 3.664$$

Where:

CSR = Carbon content of the land before conversion; carbon stock per unit area associated with the reference land (measured as mass of carbon per unit area in soil and vegetation) at the reference date or 20 years before the production of the raw material, whichever date is the later.

CSA = Carbon content of the land after conversion; carbon stock per unit area associated with the actual land use (measured as mass of carbon per unit area in soil and vegetation). If the carbon stock increases over more than one year, the CSA value is the estimated carbon stock after 20 years or at the time the plants reach maturity, whichever is earlier.

2.2.1.1 Calculating CS_R and CS_A

(See also RED Annex V and Commission Decision 2010/335/EU of 10 June 2010)

For determining the carbon stock per unit area associated with CS_R and CS_A the following rules shall apply:

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[3] Note that the EU Directive also includes reference to continuously wooded areas which, as a result of the type of forest management, have a long-term high degree of crown cover (e.g. >80%) that are converted, as a result of a change in management, into areas which, in the long-term, have a significantly lower degree of crown cover (e.g. 40%) (land-use change within the area category of continuously wooded regions with more than 30% crown cover). A reduction in crown cover of over 20% is regarded as a significant change. However, since soy is not grown in continuously wooded areas, or areas with canopy cover at all, including requirements relevant to changes in crown cover is irrelevant.

[4] The IPCC also includes grassland and wetland land categories, but conversion of these is not permitted under 2.2 There is no conversion of high carbon stock areas.

[5] This section is taken directly from the COMMISSION DECISION of 10 June 2010 on guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive 2009/28/EC

(1) The area for which the land carbon stocks are calculated shall for the entire area have similar:

(a) biophysical conditions in terms of climate and soil type;

(b) management history in terms of tillage;

(c) input history in terms of carbon input to soil;

(2) The carbon stock of the actual land use, CS_A, shall be taken as:

– in the case of loss of carbon stock: the estimated equilibrium carbon stock that the land will reach in its new use;

– in the case of carbon stock accumulation: the estimated carbon stock after 20 years or when the crop reaches maturity, whichever the earlier.

For the calculation of CS_R and CS_A the following rule shall apply:

$CS_i = (SOC + C_{VEG}) \times A$

where

CS_i = the carbon stock per unit area associated with the land use i (measured as mass of carbon per unit area, including both soil and vegetation);

SOC = soil organic carbon (measured as mass of carbon per hectare),

C_{VEG} = above and below ground vegetation carbon stock (measured as mass of carbon per hectare),

A = factor scaling to the area concerned (measured as hectares per unit area).

2.2.1.2 Calculating soil organic carbon stock

Mineral soils

For the calculation of SOC the following rule may be used:

$SOC = SOC_{ST} \times F_{LU} \times F_{MG} \times F_I$

where

SOC = soil organic carbon (measured as mass of carbon per hectare);

SOC_{ST} = standard soil organic carbon in the 0 - 30 centimetre topsoil layer (measured as mass of carbon per hectare);

F_{LU} = land use factor reflecting the difference in soil organic carbon associated with the type of land use compared to the standard soil organic carbon;

F_{MG} = management factor reflecting the difference in soil organic carbon associated with the principle management practice compared to the standard soil organic carbon;

F_I = input factor reflecting the difference in soil organic carbon associated with different levels of carbon input to soil compared to the standard soil organic carbon.

Values for SOC_{ST}, F_{LU}, F_{MG} and F_I are provided in Annex 1, Table 1- Table 8.

As an alternative to using the formula and values described above, other appropriate methods, including measurements, may be used to determine SOC. As far as such methods are not based on measurements, they shall take into account climate, soil type, land cover, land management and inputs.

Organic soils (histosols)

For determining SOC, appropriate methods shall be used. Such methods shall take into account the entire depth of the organic soil layer as well as climate, land cover and land management and input. Such methods may include measurements.

Where carbon stock affected by soil drainage is concerned, losses of carbon following drainage shall be taken into account by appropriate methods. Such methods may be based on annual losses of carbon following drainage.

2.2.1.3 Above and below ground vegetation carbon stock

Values for C_{VEG} are provided in Annex 1 for the following land use types: cropland, including perennial crops, grassland and forestland (Table 9 – Table 18).

As an alternative to using the values described above for C_{VEG}, for example where land use change includes one of the land uses not covered in the Annex, the following rule shall apply:

$C_{VEG} = C_{BM} + C_{DOM}$

where

C_{VEG} = above and below ground vegetation carbon stock (measured as mass of carbon per hectare);

C_{BM} = above and below ground carbon stock in living biomass (measured as mass of carbon per hectare), calculated as per 'Living biomass' below

C_{DOM} = above and below ground carbon stock in dead organic matter (measured as mass of carbon per hectare), calculated as per 'Dead organic matter' below

For C_{DOM} the value of 0 may be used, except in the case of forest land – excluding forest plantations – having more than 30% canopy cover.

Living biomass

For the calculation of CBM the following rule shall apply:

$C_{BM} = C_{AGB} + C_{BGB}$

where

C_{BM} = above and below ground carbon stock in living biomass (measured as mass of carbon per hectare);

C_{AGB} = above ground carbon stock in living biomass (measured as mass of carbon per hectare), calculated as per 'above ground living biomass' below

C_{BGB} = below ground carbon stock in living biomass (measured as mass of carbon per hectare), calculated as per 'below ground living biomass' below

Above ground living biomass

For the calculation of C_{AGB} the following rule shall apply:

$C_{AGB} = B_{AGB} \times C_{FB}$

where

C_{AGB} = above ground carbon stock in living biomass (measured as mass of carbon per hectare);

B_{AGB} = weight of above ground living biomass (measured as mass of dry matter per hectare);

C_{FB} = carbon fraction of dry matter in living biomass (measured as mass of carbon per mass of dry matter).

For cropland, perennial crops and forest plantations the value for BAGB shall be the average weight of the above ground living biomass during the production cycle.

For C_{FB} the value of 0.47 may be used.

Below ground living biomass

For the calculation of CBGB one of the following two rules shall be used:

1) $C_{BGB} = B_{BGB} \times C_{FB}$

where

C_{BGB} = below ground carbon stock in living biomass (measured as mass of carbon per hectare);

B_{BGB} = weight of below ground living biomass (measured as mass of dry matter per hectare);

C_{FB} = carbon fraction of dry matter in living biomass (measured as mass of carbon per mass of dry matter).

For cropland, perennial crops and forest plantations the value for B_{BGB} shall be the average weight of the below ground living biomass during the production cycle.

For CFB the value of 0.47 may be used.

2) $C_{BGB} = C_{AGB} \times R$

where

C_{BGB} = below ground carbon stock in living biomass (measured as mass of carbon per hectare);

C_{AGB} = above ground carbon stock in living biomass (measured as mass of carbon per hectare);

R = ratio of below ground carbon stock in living biomass to above ground carbon stock in living biomass.

Appropriate values for R set out in Annex 1 Tables 2 – Tables 5 may be used.

Dead organic matter

For the calculation of CDOM the following rule shall apply:

$C_{DOM} = C_{DW} + C_{LI}$

where

C_{DOM} = above and below ground carbon stock in dead organic matter (measured as mass of carbon per hectare);

C_{DW} = carbon stock in dead wood pool (measured as mass of carbon per hectare), calculated as per ‘Carbon stock in dead wood pool’ below

C_{LI} = carbon stock in litter (measured as mass of carbon per hectare), calculated as per ‘carbon stock in litter’ below

Carbon stock in dead wood pool

For the calculation of C_{DW} the following rule shall apply:

$C_{DW} = D_{OMDW} \times C_{FDW}$

where

C_{DW} = carbon stock in dead wood pool (measured as mass of carbon per hectare);

D_{OMDW} = weight of dead wood pool (measured as mass of dry matter per hectare);

C_{FDW} = carbon fraction of dry matter in dead wood pool (measured as mass of carbon per mass of dry matter).

For C_{FDW} the value of 0.5 may be used.

Carbon stock in litter

For the calculation of CLI the following rule shall apply:

$C_{LI} = D_{OMLI} \times C_{FLI}$

where

C_{LI} = carbon stock in litter (measured as mass of carbon per hectare);

D_{OMLI} = weight of litter (measured as mass of dry matter per hectare);

C_{FLI} = carbon fraction of dry matter in litter (measured as mass of carbon per mass of dry matter).

For C_{FLI} the value of 0.4 may be used

2.2.3 Bonus e_B

The EU Commission has not yet defined degraded land, and therefore the bonus of 29 g CO_2eq/MJ soy biodiesel for degraded land cannot be included until such a time where this has been formally defined.

This guidance will be updated once additional information is available from the Commission.

2.3 Calculating the variables e_u, e_{ccs}, e_{ccr}

The GHG emissions when using the liquid fuel (e_u) are set to zero for liquid biofuel.

The GHG emission savings from carbon capture and geological storage (e_{ccs}) and from carbon capture and geological storage (e_{ccr}) are not applicable. Therefore the value for e_{ccs} and e_{ccr} shall be zero.

2.4 Calculating emissions savings from soil carbon accumulation via improved agricultural management (e_{sca})

'Improved agricultural management' could include practices such as:

— shifting to reduced or zero-tillage;

— improved crop rotations and/or cover crops, including crop residue management;

— improved fertiliser or manure management;

— use of soil improver (e.g. compost).

Emission savings from such improvements can only be taken into account for measures implemented after January 1, 2008, and if evidence is provided that the soil carbon has increased, or solid and verifiable evidence is provided that it can reasonably be expected to have increased, over the period in which the raw materials concerned were cultivated.

Measurements of soil carbon can constitute such evidence, e.g. by a first measurement in advance of the cultivation and subsequent ones at regular intervals several years apart. In such case, before the second measurement is available, increase in soil carbon would be estimated using a relevant scientific basis. From the second measurement onwards, the measurements would constitute the basis for determining the existence of an increase in soil carbon and its magnitude.

The emission savings can be calculated by using a formula as indicated in 2.2.2, replacing the divisor '20' by the period (in years) of cultivation of the crops concerned.

2.5 Calculating the GHG emissions from transport (e_{td})

If the farmer has control of the transportation, the following formula is used to calculate the GHG emissions for transport e_{td} of biomass including all transport steps:

$$e_{td}' = \frac{\left(transport\_distance_{laden}[km] * FC_{laden}\left[\frac{1}{km}\right] + transport\_distance_{empty}[km] * FC_{empty}\left[\frac{1}{km}\right]\right) * emission\_factor_{fuel}\left[\frac{kgCO_2}{l}\right]}{transported\_biomass[kg]}$$

The GHG emissions already taken into account for raw material production and cultivation are not included in the calculations.

To calculate e_{td}

- the transport distances [in km] – distance, over which the biomass was transported to the next business or the next business site e.g. distance between the grower and the oil mill, including the (empty) return run.
- the means of transport (e.g. 40t diesel HGV) and
- the quantity of biomass transported in the particular means of transport (e.g. 40t) and the moisture content of the transported crop are stated.

The mass of the dry crop shall be used for the calculation.

To calculate e_{td},

- the emission factor fuel,
- FC_{laden}[l/km] – fuel consumption of the particular means of transport per km when laden and
- FC_{empty}[l/km] – fuel consumption of the particular means of transport per km on an empty run (return run)

are stated or taken from a scientific literature source which has been peer reviewed before publication and are consistent with other existing data sources,

Peer reviewed scientific publications are used as sources for emission factors, and are consistent with other available emission factor figures. Examples can be found in Table 1.

Emissions from transport shall be expressed in g CO_2 eq/dry ton of soy or intermediate product.

3. Averaging of GHG values in mixtures

If consignments of RTRS certified material are mixed, the GHG figures of these consignments cannot be averaged.

4. Examples

Table 1: Examples of background data for determining e_{ec} and e_{td}

	Value	Unit	Source:
Cultivation of e_c			
E-Factor diesel (manuf. &use)	87.64	kg CO_2eq/MJ diesel	European Commission Standard Calculation values v1.0
E-Factor N-fertiliser (manuf.)	5.88	kg CO_2eq/kg N-fertiliser	European Commission Standard Calculation values v1.0
E-Factor P2O5-fertiliser (manuf.)	1.01	kg CO_2eq/kg P2O5-fertiliser	European Commission Standard Calculation values v1.0
E-Factor K2O fertiliser (manuf.)	0.576	kg CO_2eq/kg K2O- fertiliser	European Commission Standard Calculation values v1.0
E-Factor CaO-fertiliser (manuf.)	0.130	kg CO_2eq/kg CaO- fertiliser	European Commission Standard Calculation values v1.0
E-Factor field emission N-fertiliser	4.87	kg CO_2eq/kg N-fertiliser	IPCC[6]
E-Factor emission soybeans	390	gCO_2/kg soybeans	IFEU
National electricity mix (EU)	0.129	kg CO_2-eq./MJ electricity	European Commission Standard Calculation values v1.0
Transport e_{td}			
E-Factor diesel (manuf. and use)	87.64	kg CO_2eq/MJ diesel	European Commission Standard Calculation values v1.0
Fuel consumption (laden)	0.49	litres / km	TREMOD (goods train with max. 24t useful load)
Fuel consumption (empty)	0.25	litres / km	TREMOD

6 Note: An appropriate way to take into account N_2O emissions from soils is the IPCC methodology, including what are described there as both 'direct' and 'indirect' N_2O emissions. All three IPCC tiers could be used. However, Tier 3, which relies on detailed measurement and/or modelling, seems more relevant for the calculation of 'regional' cultivation values (cf. Section 3.3 of this Communication) than for other calculations of actual values.

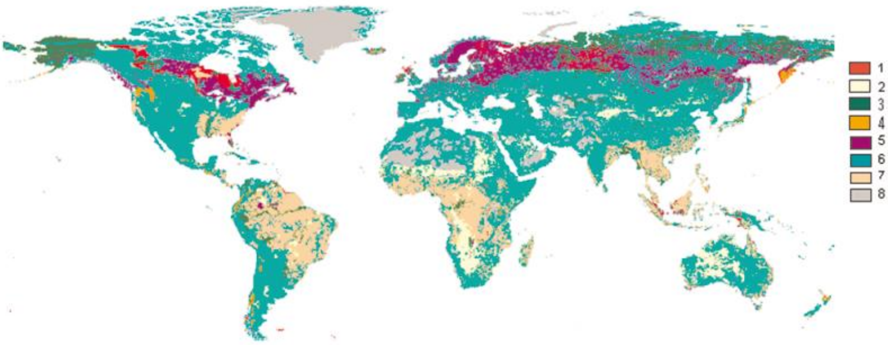
Annex 1 Values for GHG land use calculations

The following figures and tables are taken from the Commission Decision on guidelines for the calculation of land carbon stocks for the purpose of Annex V of Directive 2009/28/EC.

Figures 1 and 2 below provide the context to select the appropriate values in Tables 1 – 18 related to soil organic carbon in mineral soils. Data layers on climate regions and soil type available through the online Transparency platform established by Directive 2009/28/EC, and are the detailed layers underlying figures 1 and 2 below.

Figure 2

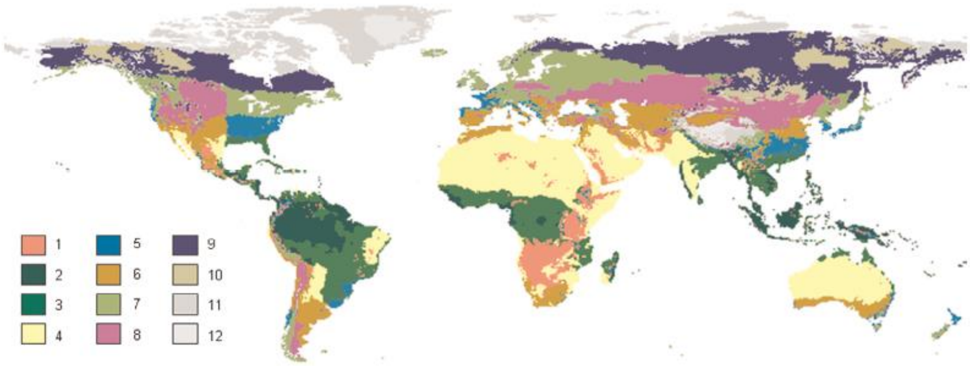
Geographic distribution of soil types



Legend: 1 = Organic; 2 = Sandy Soils; 3 = Wetland Soils; 4 = Volcanic Soils; 5 = Spodic Soils; 6 = High Activity Clay Soils; 7 = Low Activity Clay Soils; 8 = Other Areas.

Figure 1

Climate regions



Legend: 1 = Tropical, montane; 2 = Tropical, wet; 3 = Tropical, moist, 4 = Tropical, dry; 5 = Warm temperate, moist; 6 = Warm temperate, dry; 7 = Cool temperate, moist; 8 = Cool temperate, dry; 9 = Boreal, moist; 10 = Boreal, dry; 11 = Polar, moist; 12 = Polar, dry.

Table 1: SOC_{ST}, standard soil organic carbon in the 0 - 30 centimetre topsoil layer (tonnes of carbon per hectare).

Climate Region	Soil type					
	High activity clay soils	Low activity clay soils	Sandy soils	Spodic soils	Volcanic soils	Wetland soils
Boreal	68	-	10	117	20	146
Cold temperate, dry	50	33	34	-	20	87
Cold temperate, moist	95	85	71	115	130	87
Warm temperate, dry	38	24	19	-	70	88
Warm temperate, moist	88	63	34	-	80	88
Tropical, dry	38	35	31	-	50	86
Tropical, moist	65	47	39	-	70	86
Tropical, wet	44	60	66	-	130	86
Tropical, montane	88	63	34	-	80	86

Table 2: Factors for cropland

Climate region	Land use (F_{LU})	Management (F_{MG})	Input (F_I)	F_{LU}	F_{MG}	F_I
Temperate/Boreal, dry	Cultivated	Full-tillage	Low	0.8	1	0.95
			Medium	0.8	1	1
			High with manure	0.8	1	1.37
			High without manure	0.8	1	1.04
		Reduced tillage	Low	0.8	1.02	0.95
			Medium	0.8	1.02	1
			High with manure	0.8	1.02	1.37
			High without manure	0.8	1.02	1.04
		No till	Low	0.8	1.1	0.95
			Medium	0.8	1.1	1
			High with manure	0.8	1.1	1.37
			High without manure	0.8	1.1	1.04
Temperate/Boreal, moist/wet	Cultivated	Full-tillage	Low	0.69	1	0.92
			Medium	0.69	1	1
			High with manure	0.69	1	1.44
			High without manure	0.69	1	1.11
		Reduced tillage	Low	0.69	1.08	0.92
			Medium	0.69	1.08	1
			High with manure	0.69	1.08	1.44
			High without manure	0.69	1.08	1.11
		No till	Low	0.69	1.15	0.92
			Medium	0.69	1.15	1
			High with manure	0.69	1.15	1.44
			High without manure	0.69	1.15	1.11
Tropical, dry	Cultivated	Full-tillage	Low	0.58	1	0.95
			Medium	0.58	1	1
			High with manure	0.58	1	1.37
			High without manure	0.58	1	1.04
		Reduced tillage	Low	0.58	1.09	0.95
			Medium	0.58	1.09	1
			High with manure	0.58	1.09	1.37
			High without manure	0.58	1.09	1.04
		No till	Low	0.58	1.17	0.95
			Medium	0.58	1.17	1
			High with manure	0.58	1.17	1.37
			High without manure	0.58	1.17	1.04
Tropical, moist/wet	Cultivated	Full-tillage	Low	0.48	1	0.92
			Medium	0.48	1	1
			High with manure	0.48	1	1.44
			High without manure	0.48	1	1.11
		Reduced tillage	Low	0.48	1.15	0.92
			Medium	0.48	1.15	1
			High with manure	0.48	1.15	1.44
			High without manure	0.48	1.15	1.11
		No till	Low	0.48	1.22	0.92
			Medium	0.48	1.22	1
			High with manure	0.48	1.22	1.44
			High without manure	0.48	1.22	1.11
Tropical Montane	Cultivated	Full-tillage	Low	0.64	1	0.94
			Medium	0.64	1	1
			High with manure	0.64	1	1.41
			High without manure	0.64	1	1.08
		Reduced tillage	Low	0.64	1.09	0.94
			Medium	0.64	1.09	1
			High with manure	0.64	1.09	1.41
			High without manure	0.64	1.09	1.08
		No till	Low	0.64	1.16	0.94
			Medium	0.64	1.16	1
			High with manure	0.64	1.16	1.41
			High without manure	0.64	1.16	1.08

Table 3 provides guidance for selecting appropriate values from Tables 2 and 4.

Table 3: Guidance on management and input for cropland and perennial crops

Management / Input	Guidance
Full-tillage	Substantial soil disturbance with full inversion and/or frequent (within year) tillage operations. At planting time, little (e.g. <30%) of the surface is covered by residues.
Reduced tillage	Primary and/or secondary tillage but with reduced soil disturbance (usually shallow and without full soil inversion) and normally leaves surface with >30% coverage by residues at planting.
No till	Direct seeding without primary tillage, with only minimal soil disturbance in the seeding zone. Herbicides are typically used for weed control.
Low	Low residue return occurs when there is due to removal of residues (via collection or burning), frequent bare-fallowing, production of crops yielding low residues (e.g. vegetables, tobacco, cotton), no mineral fertilization or nitrogen-fixing crops.
Medium	Representative for annual cropping with cereals where all crop residues are returned to the field. If residues are removed then supplemental organic matter (e.g. manure) is added. Also requires mineral fertilization or nitrogen-fixing crop in rotation.
High with manure	Represents significantly higher carbon input over medium carbon input cropping systems due to an additional practice of regular addition of animal manure.
High without manure	Represents significantly greater crop residue inputs over medium carbon input cropping systems due to additional practices, such as production of high residue yielding crops, use of green manures, cover crops, improved vegetated fallows, irrigation, frequent use of perennial grasses in annual crop rotations, but without manure applied (see row above).

Table 4: Factors for perennial crops, namely multi-annual crops whose stem is usually not annually harvested such as short rotation coppice and oil palm

Climate region	Land use (F_{LU})	Management (F_{MG})	Input (F_I)	F_{LU}	F_{MG}	F_I
Temperate/Boreal, dry	Perennial crop	Full-tillage	Low	1	1	0.95
			Medium	1	1	1
			High with manure	1	1	1.37
			High without manure	1	1	1.04
		Reduced tillage	Low	1	1.02	0.95
			Medium	1	1.02	1
			High with manure	1	1.02	1.37
			High without manure	1	1.02	1.04
		No till	Low	1	1.1	0.95
			Medium	1	1.1	1
			High with manure	1	1.1	1.37
			High without manure	1	1.1	1.04
Temperate/Boreal, moist/wet	Perennial crop	Full-tillage	Low	1	1	0.92
			Medium	1	1	1
			High with manure	1	1	1.44
			High without manure	1	1	1.11
		Reduced tillage	Low	1	1.08	0.92
			Medium	1	1.08	1
			High with manure	1	1.08	1.44
			High without manure	1	1.08	1.11
		No till	Low	1	1.15	0.92
			Medium	1	1.15	1
			High with manure	1	1.15	1.44
			High without manure	1	1.15	1.11
Tropical, dry	Perennial crop	Full-tillage	Low	1	1	0.95
			Medium	1	1	1
			High with manure	1	1	1.37
			High without manure	1	1	1.04
		Reduced tillage	Low	1	1.09	0.95
			Medium	1	1.09	1
			High with manure	1	1.09	1.37
			High without manure	1	1.09	1.04
		No till	Low	1	1.17	0.95
			Medium	1	1.17	1
			High with manure	1	1.17	1.37
			High without manure	1	1.17	1.04
Tropical, moist/wet	Perennial crop	Full-tillage	Low	1	1	0.92
			Medium	1	1	1
			High with manure	1	1	1.44
			High without manure	1	1	1.11
		Reduced tillage	Low	1	1.15	0.92
			Medium	1	1.15	1
			High with manure	1	1.15	1.44
			High without manure	1	1.15	1.11
		No till	Low	1	1.22	0.92
			Medium	1	1.22	1
			High with manure	1	1.22	1.44
			High without manure	1	1.22	1.11
Tropical Montane	Perennial crop	Full-tillage	Low	1	1	0.94
			Medium	1	1	1
			High with manure	1	1	1.41
			High without manure	1	1	1.08
		Reduced tillage	Low	1	1.09	0.94
			Medium	1	1.09	1
			High with manure	1	1.09	1.41
			High without manure	1	1.09	1.08
		No till	Low	1	1.16	0.94
			Medium	1	1.16	1
			High with manure	1	1.16	1.41
			High without manure	1	1.16	1.08

Table 5: Factors for grassland, including savannahs

Climate region	Land Use (F_{LU})	Management (F_{MG})	Input (F_I)	F_{LU}	F_{MG}	F_I
Temperate/Boreal, dry	Grassland	Improved	Medium	1	1.14	1
			High	1	1.14	1.11
		Nominally managed	Medium	1	1	1
		Moderately degraded	Medium	1	0.95	1
		Severely degraded	Medium	1	0.7	1
Temperate/Boreal, moist/wet	Grassland	Improved	Medium	1	1.14	1
			High	1	1.14	1.11
		Nominally managed	Medium	1	1	1
		Moderately degraded	Medium	1	0.95	1
		Severely degraded	Medium	1	0.7	1
Tropical, dry	Grassland	Improved	Medium	1	1.17	1
			High	1	1.17	1.11
		Nominally managed	Medium	1	1	1
		Moderately degraded	Medium	1	0.97	1
		Severely degraded	Medium	1	0.7	1
Tropical, moist/wet	Savannah	Improved	Medium	1	1.17	1
			High	1	1.17	1.11
		Nominally managed	Medium	1	1	1
		Moderately degraded	Medium	1	0.97	1
		Severely degraded	Medium	1	0.7	1
Tropical Montane, dry	Grassland	Improved	Medium	1	1.16	1
			High	1	1.16	1.11
		Nominally managed	Medium	1	1	1
		Moderately degraded	Medium	1	0.96	1
		Severely degraded	Medium	1	0.7	1

Table 6 provides guidance for selecting appropriate values from Table 5.

Table 6: Guidance on management and input for grassland

Management / Input	Guidance
Improved	Represents grassland which is sustainably managed with moderate grazing pressure and that receive at least one improvement (e.g. fertilization, species improvement, irrigation).
Nominally managed	Represents non-degraded and sustainably managed grassland, but without significant management improvements.
Moderately degraded	Represents overgrazed or moderately degraded grassland, with somewhat reduced productivity (relative to the native or nominally managed grassland) and receiving no management inputs.
Severely degraded	Implies major long-term loss of productivity and vegetation cover, due to severe mechanical damage to the vegetation and/or severe soil erosion.
Medium	Applies where no additional management inputs have been used.
High	Applies to improved grassland where one or more additional management inputs/improvements have been used (beyond that is required to be classified as improved grassland).

Table 7: Factors for forest land having at least 10% canopy cover

Climate region	Land use (F_{LU})	Management (F_{MG})	Input (F_I)	F_{LU}	F_{MG}	F_I
All	Native forest (non degraded)	n/a*	n/a	1		
All	Managed forest	All	All	1	1	1
Tropical, moist/dry	Shifting cultivation-shortened fallow	n/a	n/a	0.64		
	Shifting cultivation- mature fallow	n/a	n/a	0.8		
Temperate/Boreal, moist/dry	Shifting cultivation-shortened fallow	n/a	n/a	1		
	Shifting cultivation- mature fallow	n/a	n/a	1		

* n/a = not applicable; in these cases F_{MG} and F_I shall not apply and for the calculation of *SOC* the following rule may be used: $SOC = SOC_{ST} \times F_{LU}$

Table 8 provides guidance for selecting appropriate values from Table 7.

Table 8: Guidance on land use for forest land

Land use	Guidance
Native forest (non degraded)	Represents native or long-term, non-degraded and sustainably managed forest.
Shifting cultivation	Permanent shifting cultivation, where tropical forest or woodland is cleared for planting of annual crops for a short time (e.g. 3-5 years) period and then abandoned to regrowth.
Mature fallow	Represents situations where the forest vegetation recovers to a mature or near mature state prior to being cleared again for cropland use.
Shortened fallow	Represents situations where the forest vegetation recovery is not attained prior to re-clearing.

Table 9: Vegetation values for cropland (general)

Climate region	C_{VEG} (tonnes carbon/hectare)
All	0

Table 10: Vegetation values for sugar cane (specific)

Domain	Climate region	Ecological zone	Continent	C_{VEG} (tonnes carbon per hectare)
Tropical	Tropical dry	Tropical dry forest	Africa	4.2
			Asia (continental, insular)	4
		Tropical scrubland	Asia (continental, insular)	4
	Tropical moist	Tropical moist deciduous forest	Africa	4.2
			Central and South America	5
	Tropical wet	Tropical rain forest	Asia (continental, insular)	4
			Central and South America	5
Subtropical	Warm temperate dry	Subtropical steppe	North America	4.8
	Warm temperate moist	Subtropical humid forest	Central and South America	5
			North America	4.8

Table 13: Vegetation values for grassland - excluding scrubland (general)

Climate region	C_{VEG} (tonnes carbon per hectare)
Boreal – Dry & Wet	4.3
Cool Temperate – Dry	3.3
Cool Temperate –Wet	6.8
Warm Temperate – Dry	3.1
Warm Temperate –Wet	6.8
Tropical – Dry	4.4
Tropical - Moist & Wet	8.1

Table 14: Vegetation values for miscanthus (specific)

Domain	Climate region	Ecological zone	Continent	C_{VEG} (tonnes carbon per hectare)
Subtropical	Warm temperate dry	Subtropical dry forest	Europe	10
			North America	14.9
		Subtropical steppe	North America	14.9

Table 11: Vegetation values for perennial crops (general)

Climate region	C_{VEG} (tonnes carbon per hectare)
Temperate (all moisture regimes)	43.2
Tropical, dry	6.2
Tropical, moist	14.4
Tropical, wet	34.3

Table 12: Vegetation values for specific perennial crops

Climate region	Crop type	C_{VEG} (tonnes carbon per hectare)
All	Coconuts	75
	Jatropha	17.5
	Jojoba	2.4
	Oil palm	60

Table 15: Vegetation values for scrubland, namely land with vegetation composed largely of woody plants lower than 5 meter not having clear physiognomic aspects of trees.

Domain	Continent	C_{VEG} (tonnes carbon per hectare)
Tropical	Africa	46
	North and South America	53
	Asia (continental)	39
	Asia (insular)	46
	Australia	46
Subtropical	Africa	43
	North and South America	50
	Asia (continental)	37
	Europe	37
	Asia (insular)	43
Temperate	Global	7.4

Table 16: Vegetation values for forest land - excluding forest plantations - having between 10% and 30% canopy cover,

Domain	Ecological zone	Continent	C_{VEG} (tonnes carbon per hectare)	*R*
Tropical	Tropical rain forest	Africa	40	0.37
		North and South America	39	0.37
		Asia (continental)	36	0.37
		Asia (insular)	45	0.37
	Tropical moist forest	Africa	30	0.24
		North and South America	26	0.24
		Asia (continental)	21	0.24
		Asia (insular)	34	0.24
	Tropical dry forest	Africa	14	0.28
		North and South America	25	0.28
		Asia (continental)	16	0.28
		Asia (insular)	19	0.28
	Tropical mountain systems	Africa	13	0.24
		North and South America	17	0.24
		Asia (continental)	16	0.24
		Asia (insular)	26	0.28
Subtropical	Subtropical humid forest	North and South America	26	0.28
		Asia (continental)	22	0.28
		Asia (insular)	35	0.28
	Subtropical dry forest	Africa	17	0.28
		North and South America	26	0.32
		Asia (continental)	16	0.32
		Asia (insular)	20	0.32
	Subtropical steppe	Africa	9	0.32
		North and South America	10	0.32
		Asia (continental)	7	0.32
		Asia (insular)	9	0.32
Temperate	Temperate oceanic forest	Europe	14	0.27
		North America	79	0.27
		New Zealand	43	0.27
		South America	21	0.27
	Temperate continental forest	Asia, Europe (≤ 20 y)	2	0.27
		Asia, Europe (>20 y)	14	0.27
		North and South America (≤ 20 y)	7	0.27
		North and South America (>20 y)	16	0.27
	Temperate mountain systems	Asia, Europe (≤ 20 y)	12	0.27
		Asia, Europe (>20 y)	16	0.27
		North and South America (≤ 20 y)	6	0.27
		North and South America (>20 y)	6	0.27
Boreal	Boreal coniferous forest	Asia, Europe, North America	12	0.24
	Boreal tundra woodland	Asia, Europe, North America (≤ 20 y)	0	0.24
		Asia, Europe, North America (>20 y)	2	0.24
	Boreal mountain systems	Asia, Europe, North America (≤ 20 y)	2	0.24
		Asia, Europe, North America (>20 y)	6	0.24

Table 17: Vegetation values for forest land - excluding forest plantations - having more than 30% canopy cover

Domain	Ecological zone	Continent	C_{VEG} (tonnes carbon per hectare)
Tropical	Tropical rain forest	Africa	204
		North and South America	198
		Asia (continental)	185
		Asia (insular)	230
	Tropical moist deciduous forest	Africa	156
		North and South America	133
		Asia (continental)	110
		Asia (insular)	174
	Tropical dry forest	Africa	77
		North and South America	131
		Asia (continental)	83
		Asia (insular)	101
	Tropical mountain systems	Africa	77
		North and South America	94
		Asia (continental)	88
		Asia (insular)	130
Subtropical	Subtropical humid forest	North and South America	132
		Asia (continental)	109
		Asia (insular)	173
	Subtropical dry forest	Africa	88
		North and South America	130
		Asia (continental)	82
		Asia (insular)	100
	Subtropical steppe	Africa	46
		North and South America	53
		Asia (continental)	41
		Asia (insular)	47
Temperate	Temperate oceanic forest	Europe	84
		North America	406
		New Zealand	227
		South America	120
	Temperate continental forest	Asia, Europe (≤ 20 y)	27
		Asia, Europe (>20 y)	87
		North and South America (≤ 20 y)	51
		North and South America (>20 y)	93
	Temperate mountain systems	Asia, Europe (≤ 20 y)	75
		Asia, Europe (>20 y)	93
		North and South America (≤ 20 y)	45
		North and South America (>20 y)	93
Boreal	Boreal coniferous forest	Asia, Europe, North America	53
	Boreal tundra woodland	Asia, Europe, North America (≤ 20 y)	26
		Asia, Europe, North America (>20 y)	35
	Boreal mountain systems	Asia, Europe, North America (≤ 20 y)	32
		Asia, Europe, North America (>20 y)	53

Table 18: Vegetation values for forest plantations

Domain	Ecological zone	Continent	C_{VEG} (tonnes carbon per hectare)	*R*
Tropical	Tropical rain forest	Africa broadleaf >20 y	87	0.24
		Africa broadleaf ≤ 20 y	29	0.24
		Africa Pinus sp. >20 y	58	0.24
		Africa Pinus sp. ≤ 20 y	17	0.24
		Americas Eucalyptus sp.	58	0.24
		Americas Pinus sp.	87	0.24
		Americas Tectona grandis	70	0.24
		Americas other broadleaf	44	0.24
		Asia broadleaf	64	0.24
		Asia other	38	0.24
	Tropical moist deciduous forest	Africa broadleaf >20 y	44	0.24
		Africa broadleaf ≤ 20 y	23	0.24
		Africa Pinus sp. >20 y	35	0.24
		Africa Pinus sp. ≤ 20 y	12	0.24
		Americas Eucalyptus sp.	26	0.24
		Americas Pinus sp.	79	0.24
		Americas Tectona grandis	35	0.24
		Americas other broadleaf	29	0.24
		Asia broadleaf	52	0.24
		Asia other	29	0.24
	Tropical dry forest	Africa broadleaf >20 y	21	0.28
		Africa broadleaf ≤ 20 y	9	0.28
		Africa Pinus sp. >20 y	18	0.28
		Africa Pinus sp. ≤ 20 y	6	0.28
		Americas Eucalyptus sp.	27	0.28
		Americas Pinus sp.	33	0.28
		Americas Tectona grandis	27	0.28
		Americas other broadleaf	18	0.28
		Asia broadleaf	27	0.28
		Asia other	18	0.28
	Tropical shrubland	Africa broadleaf	6	0.27
		Africa Pinus sp. >20 y	6	0.27
		Africa Pinus sp. ≤ 20 y	4	0.27
		Americas Eucalyptus sp.	18	0.27
		Americas Pinus sp.	18	0.27
		Americas Tectona grandis	15	0.27
		Americas other broadleaf	9	0.27
		Asia broadleaf	12	0.27
		Asia other	9	0.27
	Tropical mountain systems	Africa broadleaf >20 y	31	0.24
		Africa broadleaf ≤ 20 y	20	0.24
		Africa Pinus sp. >20 y	19	0.24
		Africa Pinus sp. ≤ 20 y	7	0.24
		Americas Eucalyptus sp.	22	0.24
		Americas Pinus sp.	29	0.24
		Americas Tectona grandis	23	0.24
		Americas other broadleaf	16	0.24
		Asia broadleaf	28	0.24
		Asia other	15	0.24
Subtropical	Subtropical humid forest	Americas Eucalyptus sp.	42	0.28
		Americas Pinus sp.	81	0.28
		Americas Tectona grandis	36	0.28
		Americas other broadleaf	30	0.28
		Asia broadleaf	54	0.28
		Asia other	30	0.28
	Subtropical dry	Africa broadleaf >20 y	21	0.28

Subtropical	Subtropical humid forest	Americas Eucalyptus sp.	42	0.28
		Americas Pinus sp.	81	0.28
		Americas Tectona grandis	36	0.28
		Americas other broadleaf	30	0.28
		Asia broadleaf	54	0.28
		Asia other	30	0.28
	Subtropical dry forest	Africa broadleaf >20 y	21	0.28
		Africa broadleaf ≤ 20 y	9	0.32
		Africa Pinus sp. >20 y	19	0.32
		Africa Pinus sp. ≤ 20 y	6	0.32
		Americas Eucalyptus sp.	34	0.32
		Americas Pinus sp.	34	0.32
		Americas Tectona grandis	28	0.32
		Americas other broadleaf	19	0.32
		Asia broadleaf	28	0.32
		Asia other	19	0.32
	Subtropical steppe	Africa broadleaf	6	0.32
		Africa Pinus sp. >20 y	6	0.32
		Africa Pinus sp. ≤ 20 y	5	0.32
		Americas Eucalyptus sp.	19	0.32
		Americas Pinus sp.	19	0.32
		Americas Tectona grandis	16	0.32
		Americas other broadleaf	9	0.32
		Asia broadleaf >20 y	25	0.32
		Asia broadleaf ≤ 20 y	3	0.32
		Asia coniferous >20 y	6	0.32
		Asia coniferous ≤ 20 y	34	0.32
	Subtropical mountain systems	Africa broadleaf >20 y	31	0.24
		Africa broadleaf ≤ 20 y	20	0.24
		Africa Pinus sp. >20 y	19	0.24
		Africa Pinus sp. ≤ 20 y	7	0.24
		Americas Eucalyptus sp.	22	0.24
		Americas Pinus sp.	34	0.24
		Americas Tectona grandis	23	0.24
		Americas other broadleaf	16	0.24
		Asia broadleaf	28	0.24
		Asia other	15	0.24
Temperate	Temperate oceanic forest	Asia, Europe, broadleaf >20 y	60	0.27
		Asia, Europe, broadleaf ≤ 20 y	9	0.27
		Asia, Europe, coniferous >20 y	60	0.27
		Asia, Europe, coniferous ≤ 20 y	12	0.27
		North America	52	0.27
		New Zealand	75	0.27
		South America	31	0.27
	Temperate continental forest and mountain systems	Asia, Europe, broadleaf >20 y	60	0.27
		Asia, Europe, broadleaf ≤ 20 y	4	0.27
		Asia, Europe, coniferous >20 y	52	0.27
		Asia, Europe, coniferous ≤ 20 y	7	0.27
		North America	52	0.27
		South America	31	0.27
Boreal	Boreal coniferous forest and mountain systems	Asia, Europe >20 y	12	0.24
		Asia, Europe ≤ 20 y	1	0.24
		North America	13	0.24
	Boreal tundra woodland	Asia, Europe >20 y	7	0.24
		Asia, Europe ≤ 20 y	1	0.24
		North America	7	0.24