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)

(2010/335/EU)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC [1], and in particular Annex V, part C, point 10 thereof,

Whereas:

(1) Directive 2009/28/EC lays down rules for calculating the greenhouse gas impact of biofuels, bioliquids and their fossil fuel comparators, which take into account emissions from carbon stock changes caused by land use change. Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC [2] includes corresponding rules as far as biofuels are concerned.

(2) The Commission should draw its guidelines for the calculation of land carbon stocks on the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories. Those Guidelines were intended for national greenhouse gas inventories and are not expressed in a form that is readily applicable by economic operators. It is therefore appropriate, where IPCC Guidelines for National Greenhouse Gas Inventories lack the necessary information for purposes of biofuel and bioliquid production or where such information is not accessible, to draw on other scientific sources of data.

(3) For the calculation of the carbon stocks in soil organic matter it is appropriate to take into account climate, soil type, land cover, land management and input. For mineral soils, the IPCC Tier 1 methodology for soil organic carbon is an appropriate method to use for this purpose as it covers the global level. For organic soils, the IPCC methodology addresses in particular carbon loss following soil drainage and does this only through annual losses. As soil drainage normally results in high carbon stock loss that cannot be compensated by the greenhouse gas saving of biofuels or bioliquids and as drainage of peatland soil is prohibited by the sustainability criteria laid down by Directive 2009/28/EC, it suffices to lay down general rules for determining soil organic carbon or carbon losses in organic soils.

(4) For the calculation of carbon stock in living biomass and dead organic matter a low complexity approach corresponding to IPCC Tier 1 methodology for vegetation should be an appropriate method. In accordance with that methodology it is reasonable to assume that all carbon stock in living biomass and dead organic matter is lost from the land upon conversion. Dead organic matter is usually of low significance in land conversion for the establishment of crops for the production of biofuels and bioliquids, but should be taken into account at least for closed forests.

(5) In calculating the greenhouse gas impact of land conversion, economic operators should be able to use actual values for the carbon stocks associated with the reference land use and the land use after conversion. They should also be able to use standard values and it is appropriate for these guidelines to provide them. It is not necessary, however, to provide standard values for improbable combinations of climate and soil type.

(6) Annex V to Directive 2009/28/EC sets out the method for calculating greenhouse gas impacts and contains rules for the calculation of annualised emissions of carbon stock changes from land use changes. The guidelines annexed to this Decision establish rules for the calculation of land carbon stocks, completing the rules laid down in the Annex V,

[1] OJ L 140, 5.6.2009, p. 16.
[2] OJ L 350, 28.12.1998, p. 58.

HAS ADOPTED THIS DECISION:

Article 1

The guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive 2009/28/EC are set out in the Annex to this Decision.

Article 2

This Decision is addressed to the Member States.

Done at Brussels, 10 June 2010.

For the Commission
Günther OETTINGER
Member of the Commission

ANNEX

Guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive 2009/28/EC

TABLE OF CONTENTS

1. INTRODUCTION

These guidelines establish the rules for the calculation of land carbon stocks, both for the reference land use (CS_R, as defined in point 7 of Annex V to Directive 2009/28/EC) and the actual land use (CS_A, as defined in point 7 of Annex V to Directive 2009/28/EC).

In point 2 rules are provided in order that land carbon stocks are consistently determined. Point 3 provides the general rule for the calculation of carbon stocks, which consist of two components: soil organic carbon and carbon stock in the above and below ground vegetation.

Point 4 provides detailed rules for determining the soil organic carbon stock. For mineral soils it provides the option of following a method that allows the use of values provided for in the guidelines, while the option of using alternative methods is also provided for. For organic soils methods are described, but the guidelines do not contain values for determining soil organic carbon stock in organic soils.

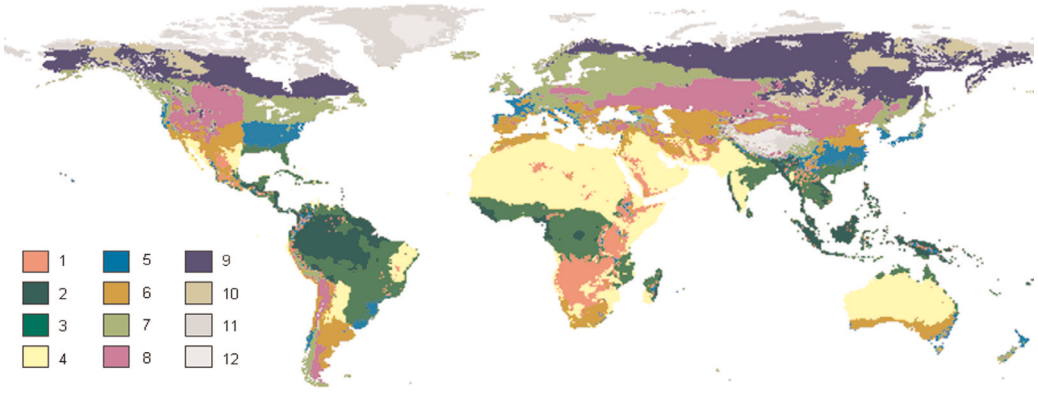
Point 5 provides detailed rules for carbon stock in vegetation, but is only relevant in the case the choice is made not to use values for above and below ground vegetation carbon stock provided in point 8 of the guidelines (the use of the values provided in point 8 is not obligatory and for certain cases it may not contain the appropriate values).

Point 6 provides the rules to select the appropriate values in case the choice is made to use the guidelines' values related to soil organic carbon in mineral soils (these values are provided in points 6 and 7). In these rules reference is made to data layers on climate regions and soil type available through the online Transparency platform established by Directive 2009/28/EC. Those data layers are detailed layers underlying figures 1 and 2 below.

Point 8 provides values for carbon stock in the above and below ground vegetation and related parameters. Points 7 and 8 provide values for four different land use categories: cropland, perennial crops, grassland and forest land.

Figure 1

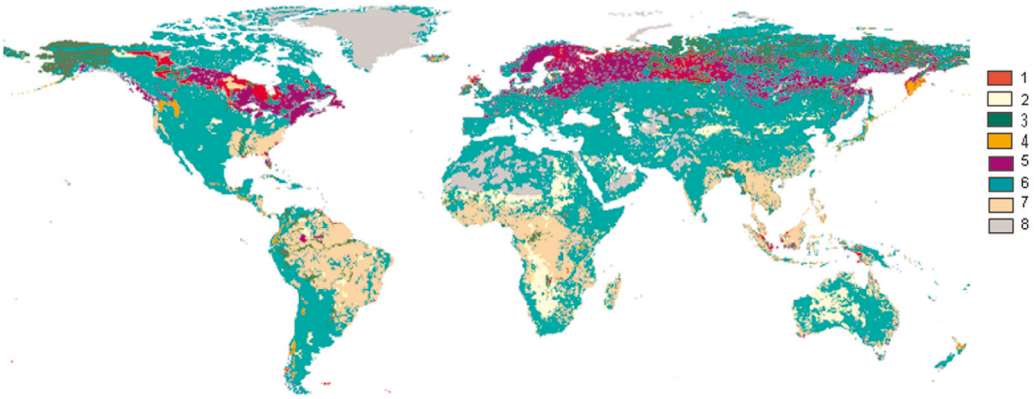
Climate regions



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.

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.

2. CONSISTENT REPRESENTATION OF LAND CARBON STOCKS

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

(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.

3. CALCULATION OF CARBON STOCKS

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), calculated in accordance with point 4;

C_{VEG} = above and below ground vegetation carbon stock (measured as mass of carbon per hectare), calculated in accordance with point 5 or selected from the appropriate values in point 8;

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

4. SOIL ORGANIC CARBON STOCK

4.1. **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.

For SOC_{ST} the appropriate values presented in point 6 shall apply.

For F_{LU}, F_{MG} and F_I the appropriate values presented in point 7 shall apply.

As an alternative to using the above rule, 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.

4.2. **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.

5. ABOVE AND BELOW GROUND VEGETATION CARBON STOCK

Except where a value for C_{VEG} set out in point 8 is used, for the calculation of C_{VEG} 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 in accordance with point 5.1;

C_{DOM} = above and below ground carbon stock in dead organic matter (measured as mass of carbon per hectare), calculated in accordance with point 5.2.

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.

5.1. **Living biomass**

For the calculation of C_{BM} 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 in accordance with point 5.1.1;

C_{BGB} = below ground carbon stock in living biomass (measured as mass of carbon per hectare), calculated in accordance with point 5.1.2.

5.1.1. *Above ground living biomass*

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

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

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);

CF_B = 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_{AGB} shall be the average weight of the above ground living biomass during the production cycle.

For CF_B the value of 0,47 may be used.

5.1.2. *Below ground living biomass*

For the calculation of C_{BGB} one of the following two rules shall be used:

(1) $C_{BGB} = B_{BGB} \times CF_B$

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);

CF_B = 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 CF_B 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 point 8 may be used.

5.2. **Dead organic matter**

For the calculation of C_{DOM} 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 in accordance with point 5.2.1;

C_{LI} = carbon stock in litter (measured as mass of carbon per hectare), calculated in accordance with point 5.2.2.

5.2.1. *Carbon stock in dead wood pool*

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

$C_{DW} = DOM_{DW} \times CF_{DW}$

where:

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

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

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

For CF_{DW} the value of 0,5 may be used.

5.2.2. *Carbon stock in litter*

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

$C_{LI} = DOM_{LI} \times CF_{LI}$

where:

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

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

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

For CF_{LI} the value of 0,4 may be used.

6. STANDARD SOIL CARBON STOCK IN MINERAL SOILS

A value for SOC_{ST} shall be selected from table 1, based on the appropriate climate region and soil type of the area concerned as set out in points 6.1 and 6.2.

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

6.1. **Climate region**

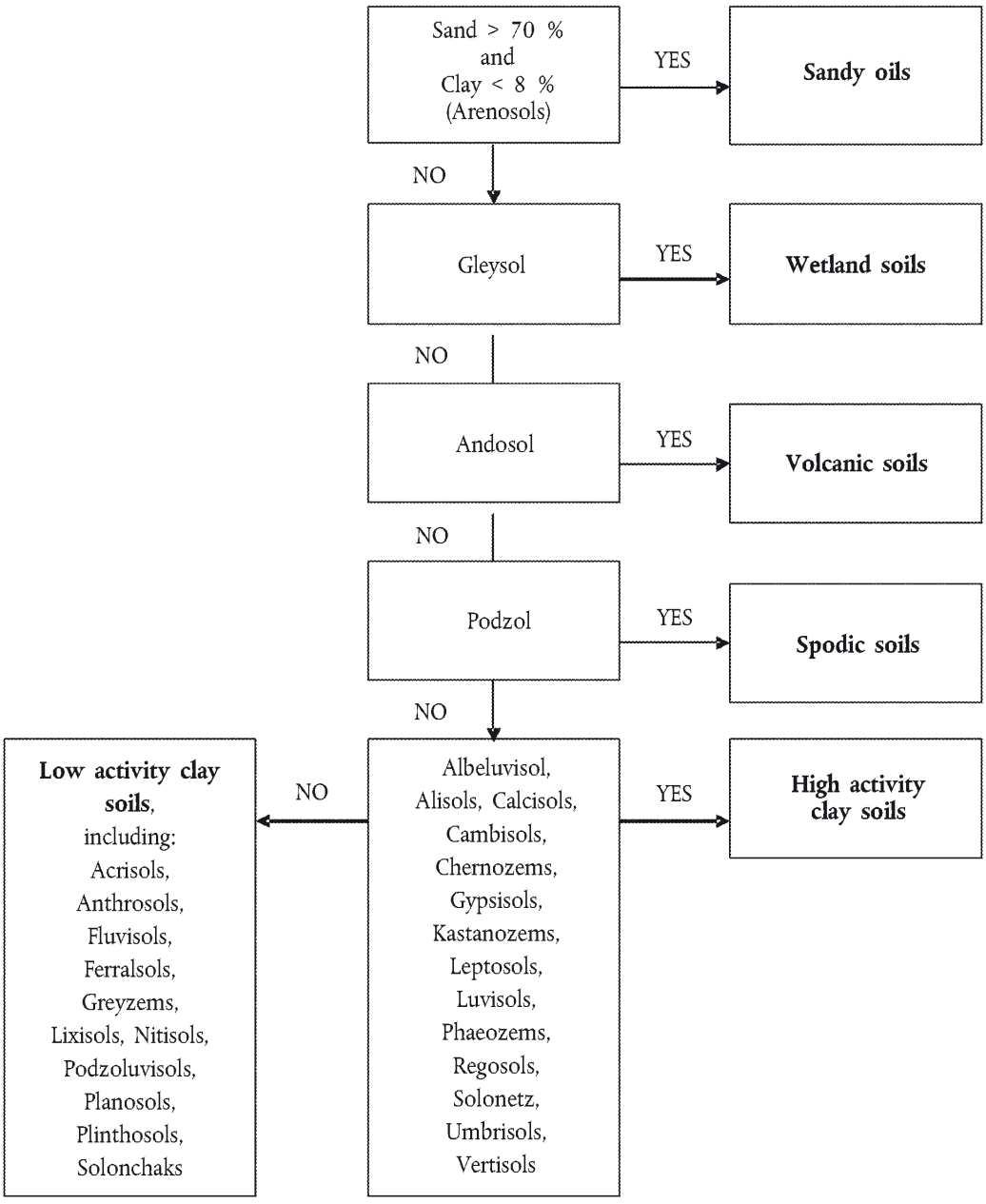
The appropriate climate region for the selection of the appropriate value for SOC_{ST} shall be determined from the climate region data layers available through the Transparency platform established by Article 24 of Directive 2009/28/EC.

6.2. **Soil type**

The appropriate soil type shall be determined according to figure 3. The soil type data layers available through the Transparency platform established by Article 24 of Directive 2009/28/EC may be used as guidance to determine the appropriate soil type.

Figure 3

Classification of soil types



7. FACTORS REFLECTING THE DIFFERENCE IN SOIL ORGANIC CARBON COMPARED TO THE STANDARD SOIL ORGANIC CARBON

Appropriate values for F_{LU}, F_{MG} and F_I shall be selected from tables in this point. For the calculation of CS_R the appropriate management and input factors are those that were applied in January 2008. For the calculation of CS_A the appropriate management and input factors are those that are being applied and will lead to the equilibrium carbon stock concerned.

7.1. **Cropland**

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

Climate region	Land use (F_{LU})	Management (F_{MG})	Input (F_I)	F_{LU}	F_{MG}	F_I
		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 fertilisation 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 fertilisation 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).

7.2. **Perennial crops**

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

Climate region	Land use (F_{LU})	Management (F_{MG})	Input (F_I)	F_{LU}	F_{MG}	F_I
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

Climate region	Land use (F_{LU})	Management (F_{MG})	Input (F_I)	F_{LU}	F_{MG}	F_I
		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 3 in point 7.1 provides guidance for selecting appropriate values from Table 4.

7.3. **Grassland**

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

Climate region	Land Use (F_{LU})	Management (F_{MG})	Input (F_I)	F_{LU}	F_{MG}	F_I
		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. fertilisation, 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).

7.4. **Forest land**

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 reclearing.

8. CARBON STOCK VALUES FOR ABOVE AND BELOW GROUND VEGETATION CARBON STOCK

For C_{VEG} or R the appropriate values laid down in this point may be used.

8.1. **Cropland**

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

8.2. **Perennial crops, namely multi-annual crops whose stem is usually not annually harvested such as short rotation coppice and oil palm**

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

8.3. **Grassland**

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 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

8.4. **Forest land**

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

Domain	Ecological zone	Continent	C_{VEG} (tonnes carbon per hectare)	R
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

Domain	Ecological zone	Continent	C_{VEG} (tonnes carbon per hectare)
	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

Domain	Ecological zone	Continent	C_{VEG} (tonnes carbon per hectare)	*R*
	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

Domain	Ecological zone	Continent	C_{VEG} (tonnes carbon per hectare)	R
	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

Domain	Ecological zone	Continent	C_{VEG} (tonnes carbon per hectare)	*R*
	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