# Estimating GHG emissions and removals from SOM in mineral soils applying the IPCC Inventory Software

*29 November, 2022*

***IPCC TFI TSU***

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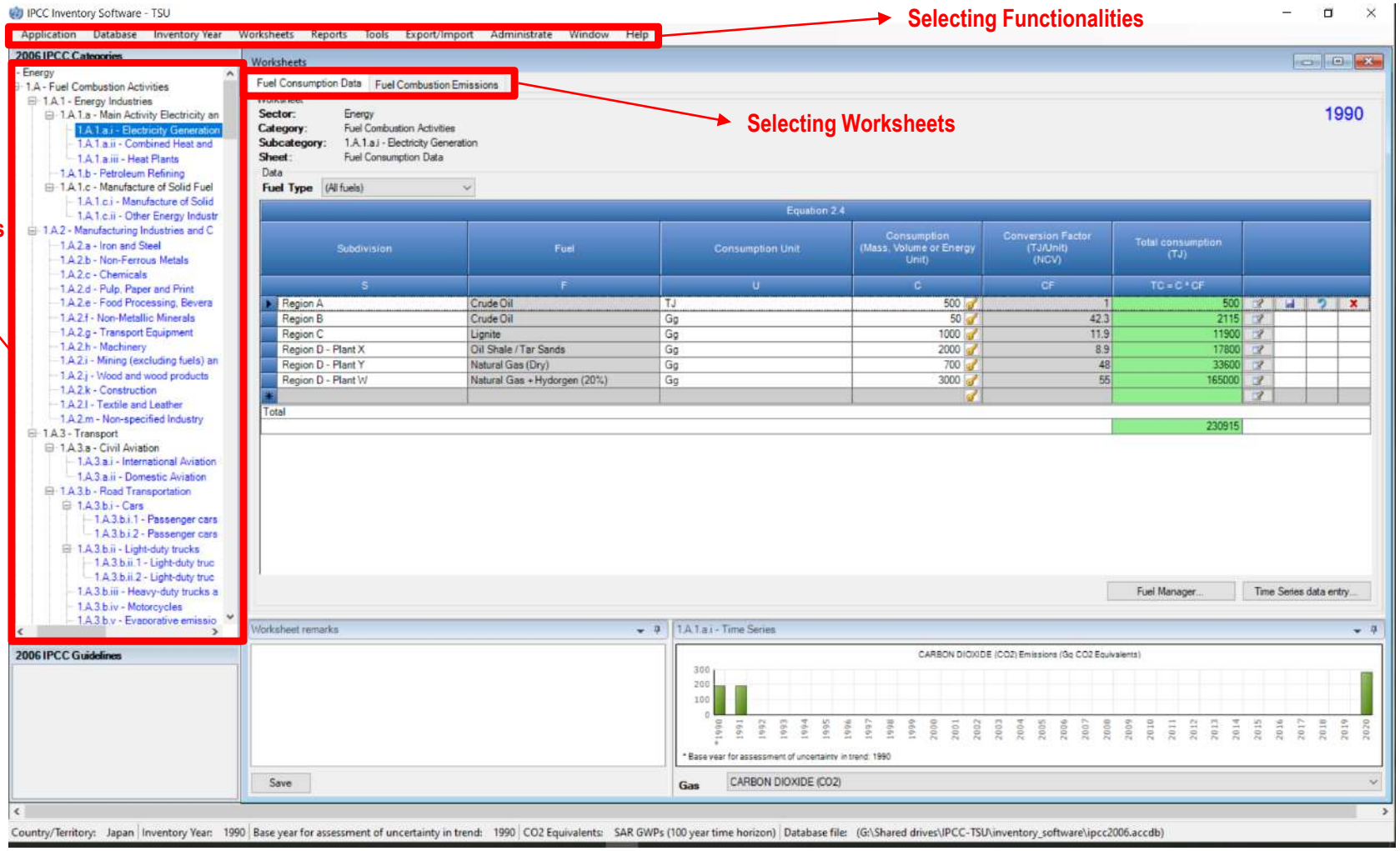
# IPCC Inventory Software

- New version 2.83 released at UNFCCC COP27
- A single tool:
  - ✓ with full capacity for all IPCC methodological Tiers and Approaches for source/sink GHG estimates
  - ✓ For preparing GHG estimates at national and/or subnational (including tracking of results of specific activities)
  - ✓ for storing and archiving the entire National GHG Inventory
  - ✓ For providing with verification of country-specific methods through comparison with IPCC methods
- Interoperability with UNFCCC reporting tool for CRT under implementation

# Ongoing work

- **Paris Agreement requirements**
  - ✓ AR5 GWP100
  - ✓ Indirect $CO_2$ emissions
  - ✓ (memo item) Indirect $N_2O$ emissions
  - ✓ Interoperability with UNFCCC reporting tool for CRTs (5/CMA.3)
- **Other**
  - ✓ Notation Keys
  - ✓ Time series export/import
  - ✓ Supporting tools

# The Software




- Free to use
- Comes in 2 separate packages for installation, *64-bit vs 32-bit*

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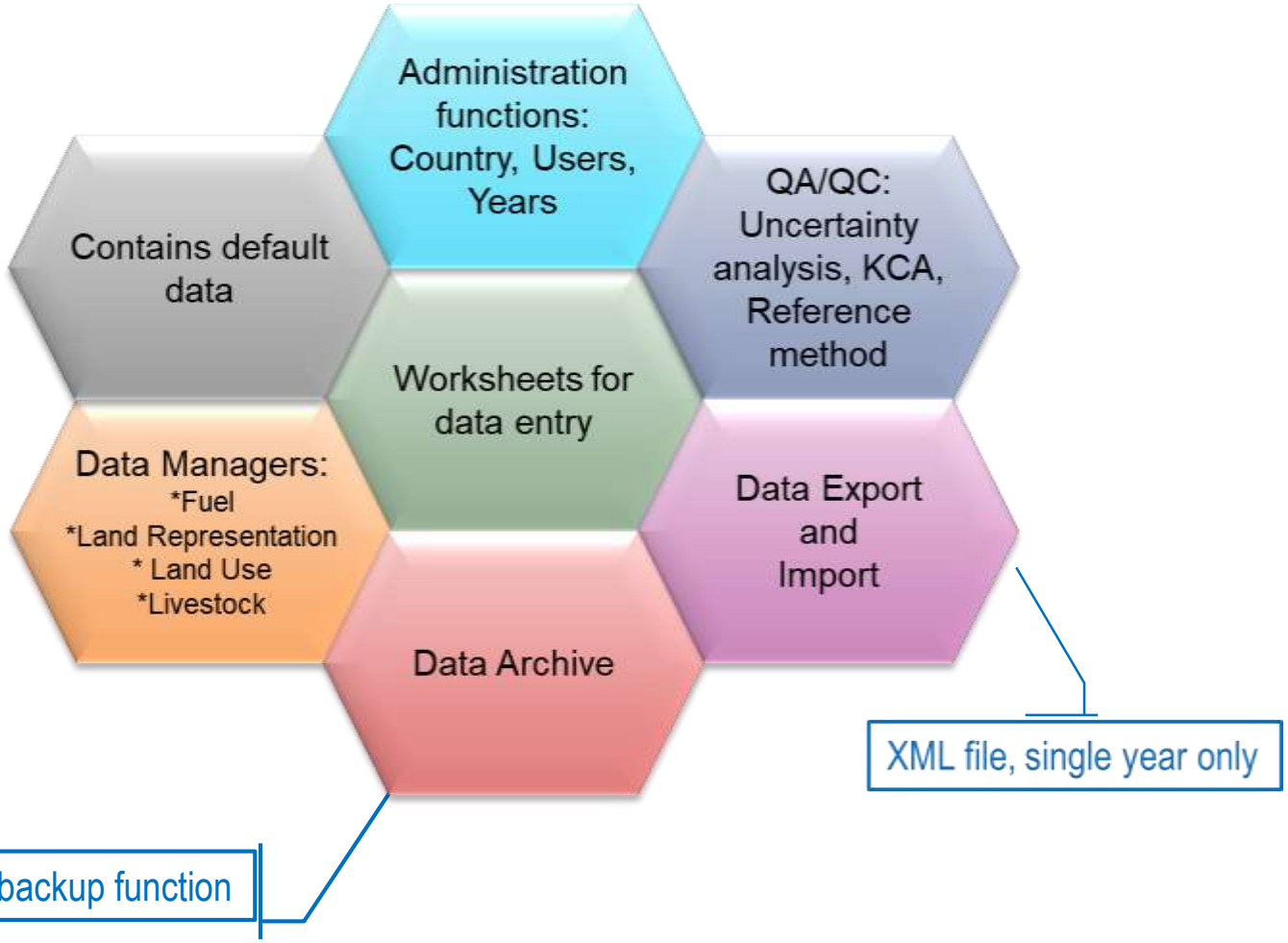
# Software Functions




- MSAccess *(ACE OLEDB 12)* for WindowsOS
- Microsoft .NET Framework 4.6.2

# Case Study for Eq 2.25 (SOM in mineral soils)

- **Case study area: 1,000 ha**
- **3 land use subdivisions:**
  A. Cropland, annual, intensive
  B. Cropland, perennial, agroforestry – pepper
  C. Forest land, managed, restoration AB (AC10)
- **Time series 1999-2020, 3 land use changes identified:**
  - ✓ In 1999, A. covers 600 ha and B. 400 ha
  - ✓ In 2000, 100 ha of A. are converted to B.
  - ✓ In 2010, 100 ha of A. are converted to B.
  - ✓ In 2020, 100 ha of B. are converted to C.
  - ✓ 2010 and 2020 changes occur on a land subject to a dedicated activity
- **Three different land representations approaches(1, 2, 3)**
  - ✓ Approach 1 *-no land use change identification-*
  - ✓ Approach 2 *-land use change identification-*
  - ✓ Approach 3 *-land use change identification and tracking across time-*

# Case Study for SOM in mineral soils

Case study on Eq. 2.25 (SOM in mineral soils)

| *category* | Cropland | | Cropland | | Forest land | |
|---|---|---|---|---|---|---|
| *subcategory* | annual | | perennial | | managed | |
| *subdivision* | intensive | | agroforestry - pepper | | restoration AB (AC10) | |
| | *tot area* | *change area* | *tot area* | *change area* | *tot area* | *change area* |
| Year | *ha* | | *ha* | | *ha* | |
| 1999 | 600 | --- | 400 | --- | --- | --- |
| 2000 | 500 | -100 → | 500 | `+100 | --- | --- |
| 2010 | 400 | -100 → | 500 | `+100 | --- | --- |
| 2020 | 400 | --- | 400 | -100 → | 100 | `+100 |

Two additional areas are included in this presentations to test the application to SOM of the Stock Different methods and to estimate CH4 emissions from created wetlands in inland wetland mineral soils

+ 500 ha of Cropland with created wetlands inland mineral soils *(lotus cultivation)*
+ 500 ha of Cropland in rotation system *(2-year annual + 8-year fallow)* to which the SD approach is applied

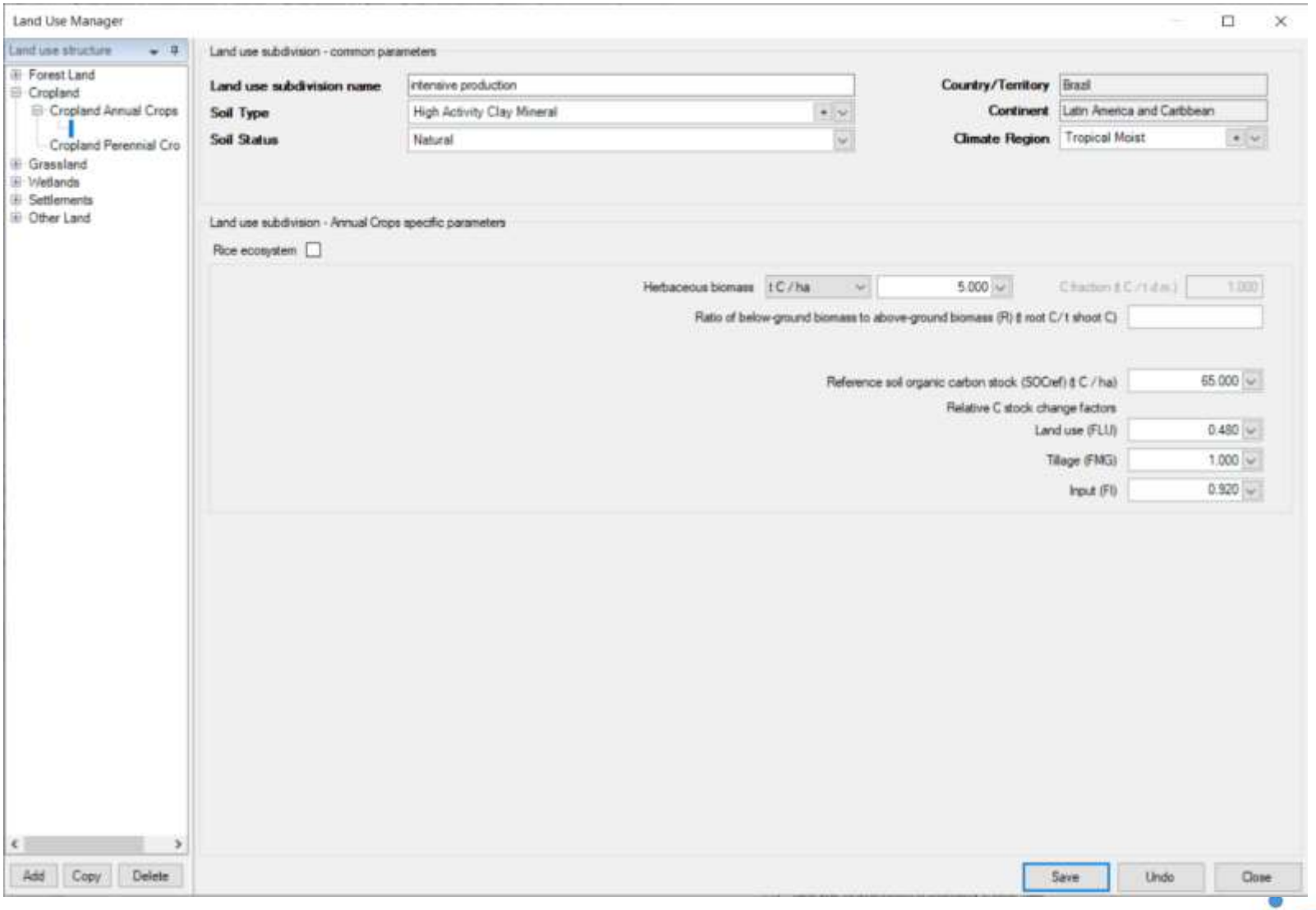
# SOC Change estimates

- **Land Use Manager (subdivisions' setting)**
- **Land Representation Manager (input of activity data)**
- **Mineral soil SOC change**
  - Equation 2.25
    - ✓ *(Formulation A)*
    - ✓ *(Formulation B)*
  - *[Stock Difference Method]*
- **Direct $N_2O$ emissions from managed soils**
- **Indirect $N_2O$ emissions from managed soils**
- ***[$CH_4$ emissions from rewetted/created wetlands inland mineral soils]***

# Land Use Manager (LUM)

- **First step when preparing a GHG inventory for land-related sources/sinks**
- **Input subdivisions to the 12 main land subcategories are to be input here**
  *[managed Forest land, unmanaged Forest land, annual Cropland, perennial Cropland , managed Grassland, unmanaged Grassland, managed Wetlands, unmanaged Wetlands, Settlements (Treed), Settlements (Other), managed Other land, unmanaged Other land]*
- **Describe as subdivisions, each and every different use/management of land in the area inventoried, further stratified by climate zone and soil type**
- **Parameters to be input are category specific and are used by the software to estimate at Tier 1 or 2**
- **There are not limits to the number of subdivisions that can be input**

# Land Use Manager (LUM) – *annual cropland*

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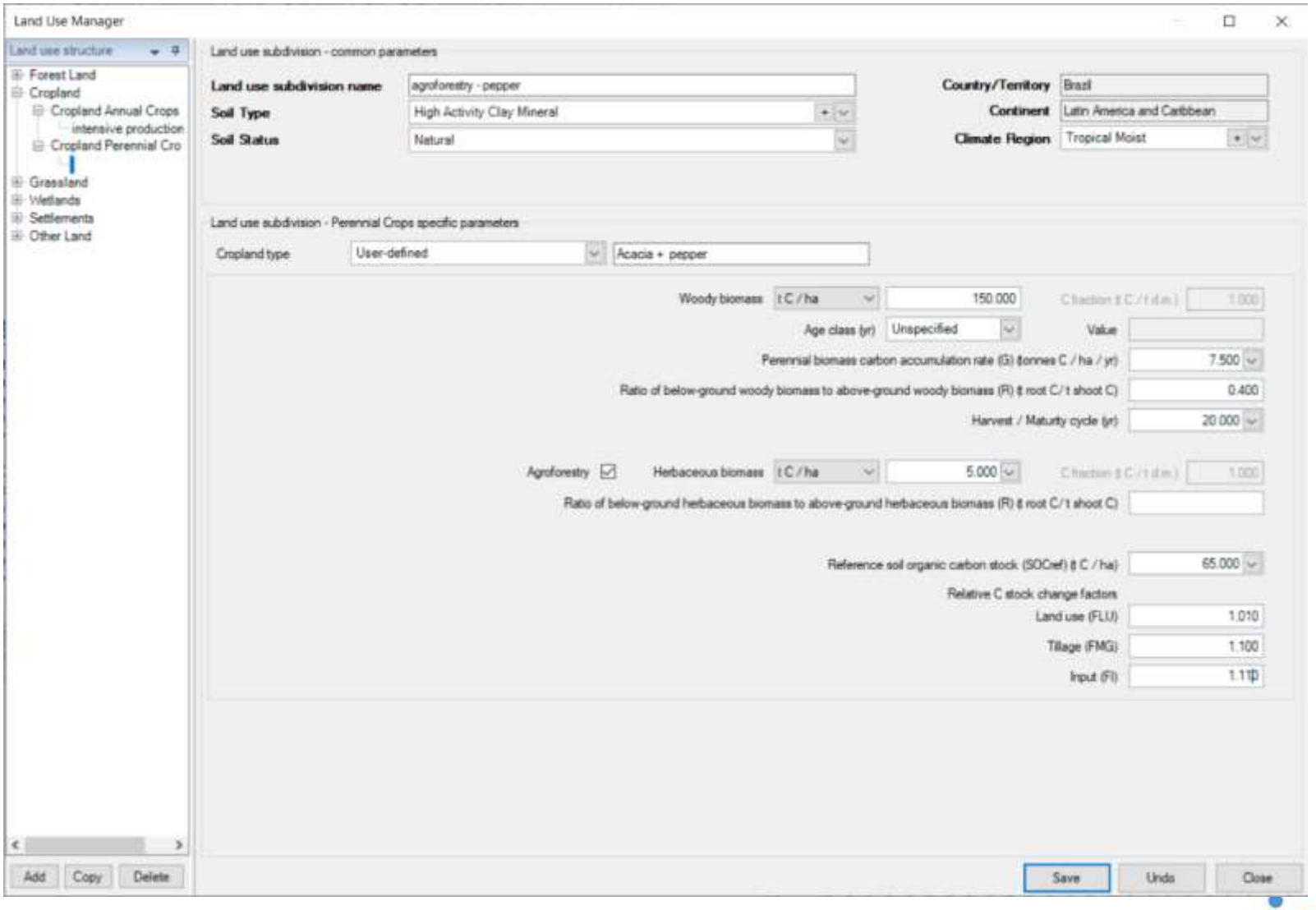
# Land Use Manager (LUM) – *perennial cropland*

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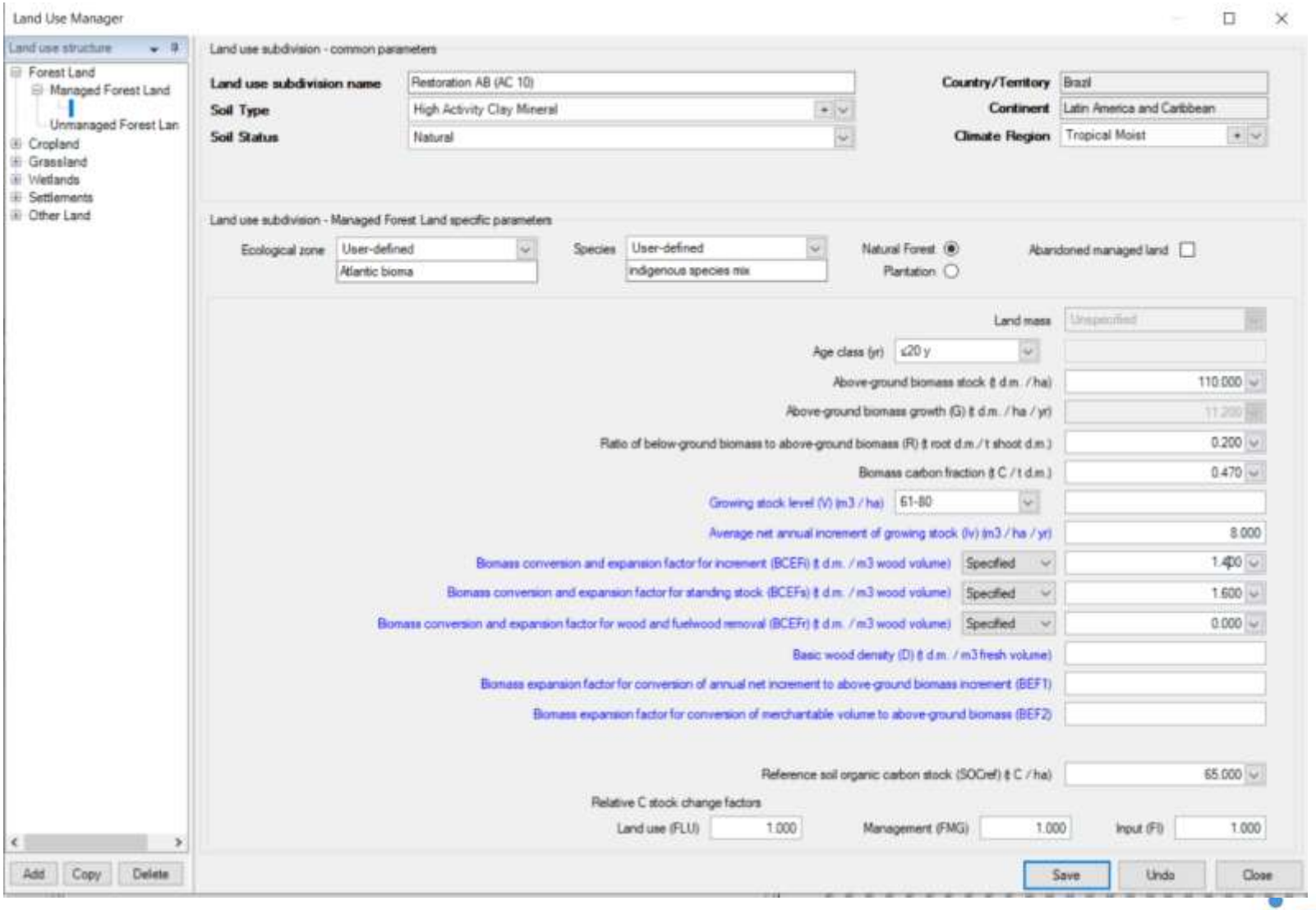
# Land Use Manager (LUM) – *forest land*

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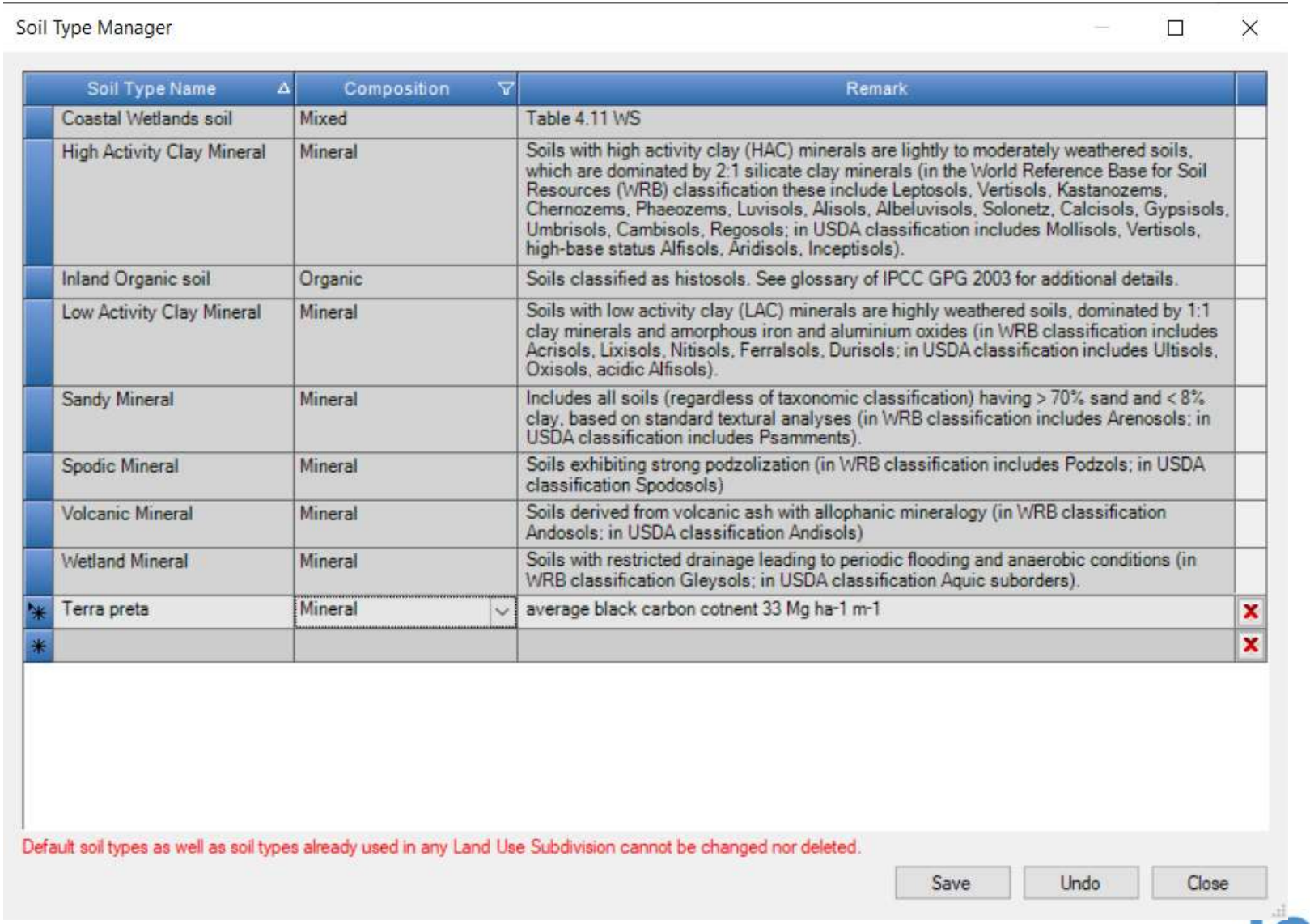
# LUM – Soil Type Manager



# LUM – Climate Region Manager

Climate Region Manager

| Climate domain | Climate Region | Remark |
|---|---|---|
| Tropical | Tropical Dry | Mean Annual Temperature >18°C and ≤7 days of frost/year; Elevation <1,000m; Mean Annual Precipitation ≤1,000mm |
| | Tropical Moist | Mean Annual Temperature >18°C and ≤7 days of frost/year; Elevation <1,000m; Mean Annual Precipitation ≤2,000mm |
| | Tropical Montane Dry | Mean Annual Temperature >18°C and ≤7 days of frost/year; Elevation ≥1,000m; Mean Annual Precipitation ≤1,000mm |
| | Tropical Montane Moist | Mean Annual Temperature >18°C and ≤7 days of frost/year; Elevation ≥1,000m; Mean Annual Precipitation >1,000mm |
| | Tropical Wet | Mean Annual Temperature >18°C and ≤7 days of frost/year; Elevation <1,000m; Mean Annual Precipitation >2,000mm |
| Subtropical (Mediterranean) | Warm Temperate Dry | Mean Annual Temperature >10°C and ≤18°C; Mean Annual Precipitation lower than Potential Evapo-Transpiration |
| | Warm Temperate Moist | Mean Annual Temperature >10°C and ≤18°C; Mean Annual Precipitation higher than Potential Evapo-Transpiration |
| Temperate | Cool Temperate Dry | Mean Annual Temperature >0°C and ≤10°C; Mean Annual Precipitation lower than Potential Evapo-Transpiration |
| | Cool Temperate Moist | Mean Annual Temperature >0°C and ≤10°C; Mean Annual Precipitation higher than Potential Evapo-Transpiration |
| Boreal | Boreal Dry | Mean Annual Temperature ≤0°C; Each Month Mean Tempearature ≥10°C; Mean Annual Precipitation lower than Potential Evapo-Transpiration |
| | Boreal Moist | Mean Annual Temperature ≤0°C; Each Month Mean Tempearature ≥10°C; Mean Annual Precipitation higher than Potential Evapo-Transpiration |
| Polar | Polar Dry | Mean Annual Temperature ≤0°C; Each Month Mean Tempearature <10°C; Mean Annual Precipitation lower than Potential Evapo-Transpiration |
| | Polar Moist | Mean Annual Temperature ≤0°C; Each Month Mean Tempearature <10°C; Mean Annual Precipitation higher than Potential Evapo-Transpiration |
| Tropical | eastern amazonia climate | mean annual precipiattion > 2,500 mm; mean annual temperature 31 C |
| | | |

Default climate regions as well as climate regions already used in any Land Use Subdivision cannot be changed nor deleted.

Save Undo Close

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# Land Representation approaches

**Approach I - 1,000 ha**

| Unit | Year | Land use | | | Area |
|---|---|---|---|---|---|
| | | category | subcategory | subdivision | ha |
| 1 | 1999 | Cropland | Annual | Soybean intensive | 600 ha |
| | 2000 - 2009 | | | | 500 ha |
| | 2010-2020 | | | | 400 ha |
| 2 | 1999 | Cropland | Perennial | Agroforestry - pepper | 400 ha |
| | 2000 - 2009 | | | | 500 ha |
| | 2010 - 2019 | | | | 600 ha |
| | 2020 | | | | 500 ha |
| --- | 1999 - 2019 | Forest land | Managed | Restoration AB (AC10) | --- |
| 3 | 2020 | | | | 100 ha |

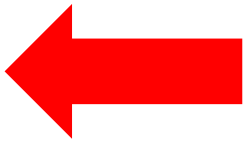
**Approach II - 1,000 ha**

| Unit | Year | Land use | | | Area |
|---|---|---|---|---|---|
| | | category | subcategory | subdivision | ha |
| 1 | 1999 | Cropland | Annual | Soybean intensive | 600 ha |
| | 2000-2009 | | | | 500 ha |
| | 2010-2020 | | | | 400 ha |
| 2.1 | 1999-2019 | Cropland | Perennial | Agroforestry - pepper | 400 ha |
| *[2.2]* | 2020 | | | | |
| 2.2 | 2000-2019 | Cropland | Perennial | Agroforestry - pepper | 100 ha |
| *[2.1]* | 2020 | | | | --- |
| 2.3 | 2010-2019 | Cropland | Perennial | Agroforestry - pepper | 100 ha |
| 3 | 2020 | Forest land | Managed | Restoration AB (AC10) | |

**Approach III - 1,000 ha**

| Unit | Year | Land use | | | Area |
|---|---|---|---|---|---|
| | | category | subcategory | subdivision | ha |
| --- | 1999 | Cropland | Perennial | Agroforestry - pepper | --- |
| 0 | 2000-2019 | | | | 100 ha |
| *[3]* | 2020 | | | | --- |
| 1 | 1999 | Cropland | Annual | Soybean intensive | 600 ha |
| | 2020-2009 | | | | 500 ha |
| | 2010-2020 | | | | 400 ha |
| 2 | 1999-2009 | Cropland | Annual | Soybean intensive | 100 ha |
| | 2010-2019 | Cropland | Perennial | Agroforestry - pepper | |
| | 2020 | Forest land | Managed | Restoration AB (AC10) | |
| 3 | 1999 - 2019 | Cropland | Perennial | Agroforestry - pepper | 400 ha |
| *[0]* | 2020 | | | | 500 ha |

- Units of ***Land remaining*** in blue
- Units of ***Land under conversion*** in orange



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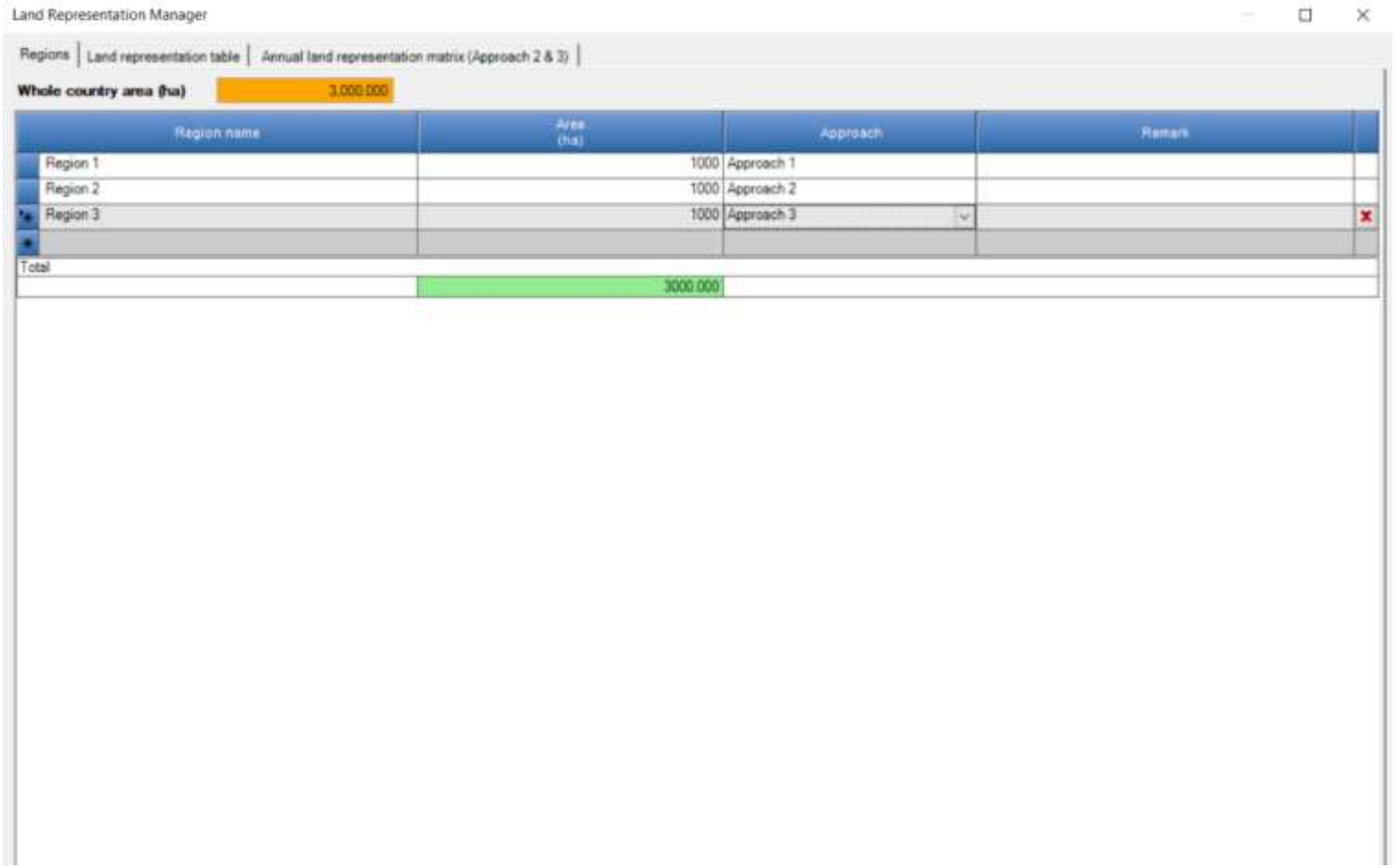
# Land Representation Manager (LRM)

- **Allows to use any of the three IPCC approaches**:
  - ✓ Approach 1 *-no land use change identification-*
  - ✓ Approach 2 *-land use change identification-*
  - ✓ Approach 3 *-land use change identification and tracking across time-*

- **Ensures consistency of land representation** *-including through fully spatially explicit tracking of units of land-*

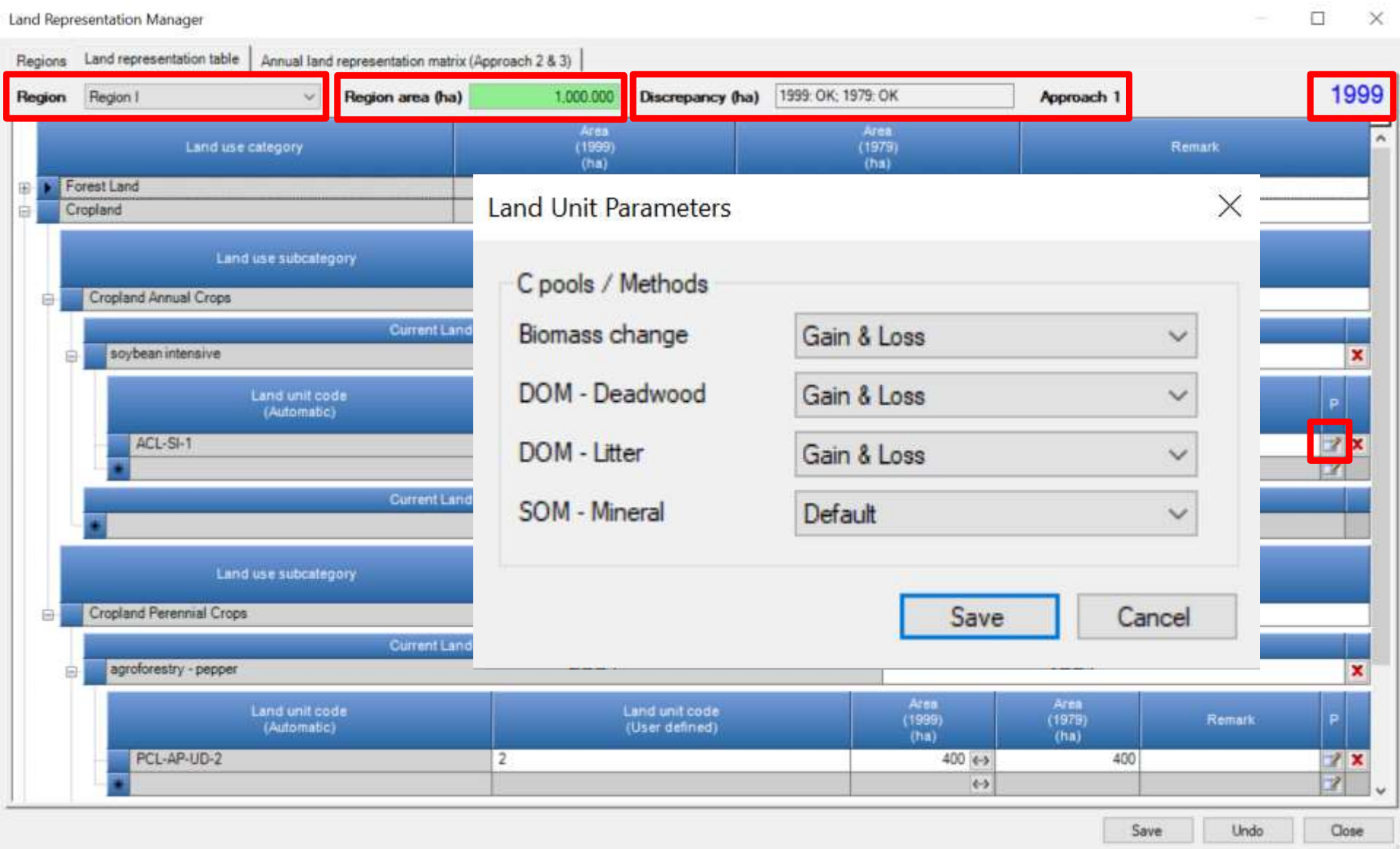
Unit of land, an area homogenous per
- ✓ physical conditions *-climate/vegetation zone and soil type-* and
- ✓ current and historical socio-economic functions **-***land use & management type-*

# LRM – Regions Tab

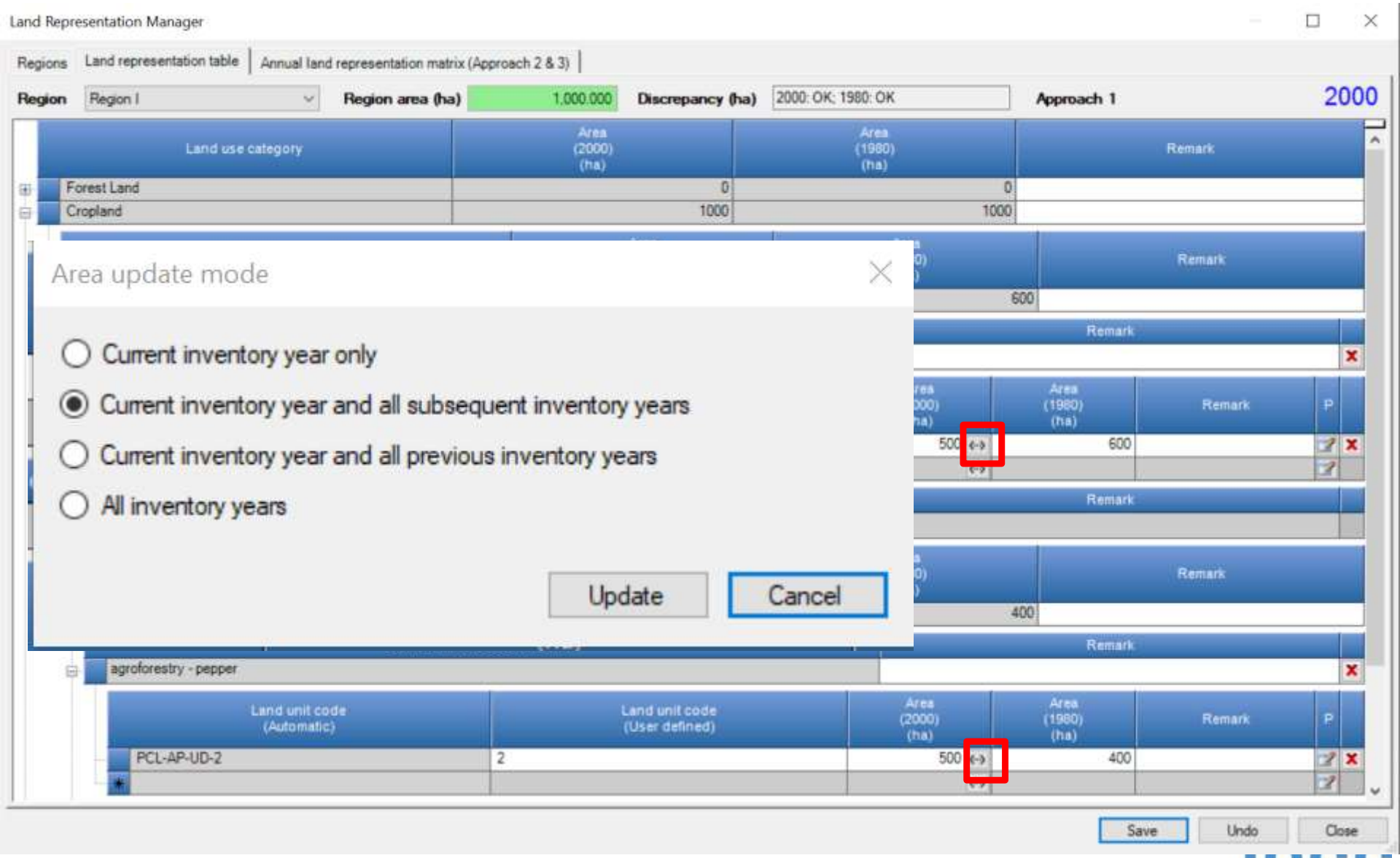



- ✓ A country can be represented in a single set of National data or in a number of Regions
- ✓ For each Region the land representation approach is to be selected

# LRM – Land Representation Tab [1999] [Appr. 1]



# LRM – Land Representation Tab [2000] [Appr. 1]



# LRM – Land Representation Tab [2010] [Appr. 1]

# LRM – Land Representation Tab [2020] [Appr. 1]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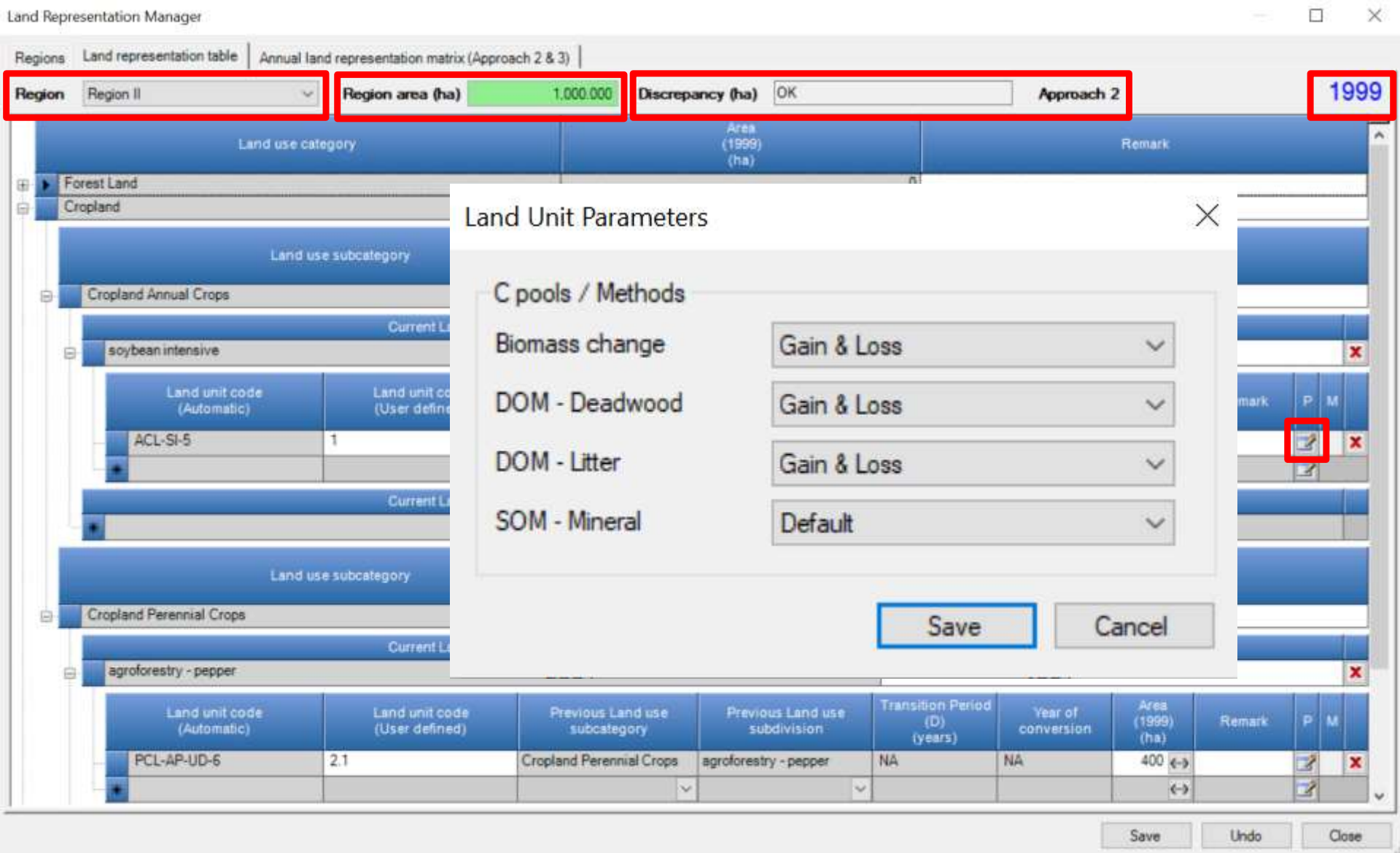
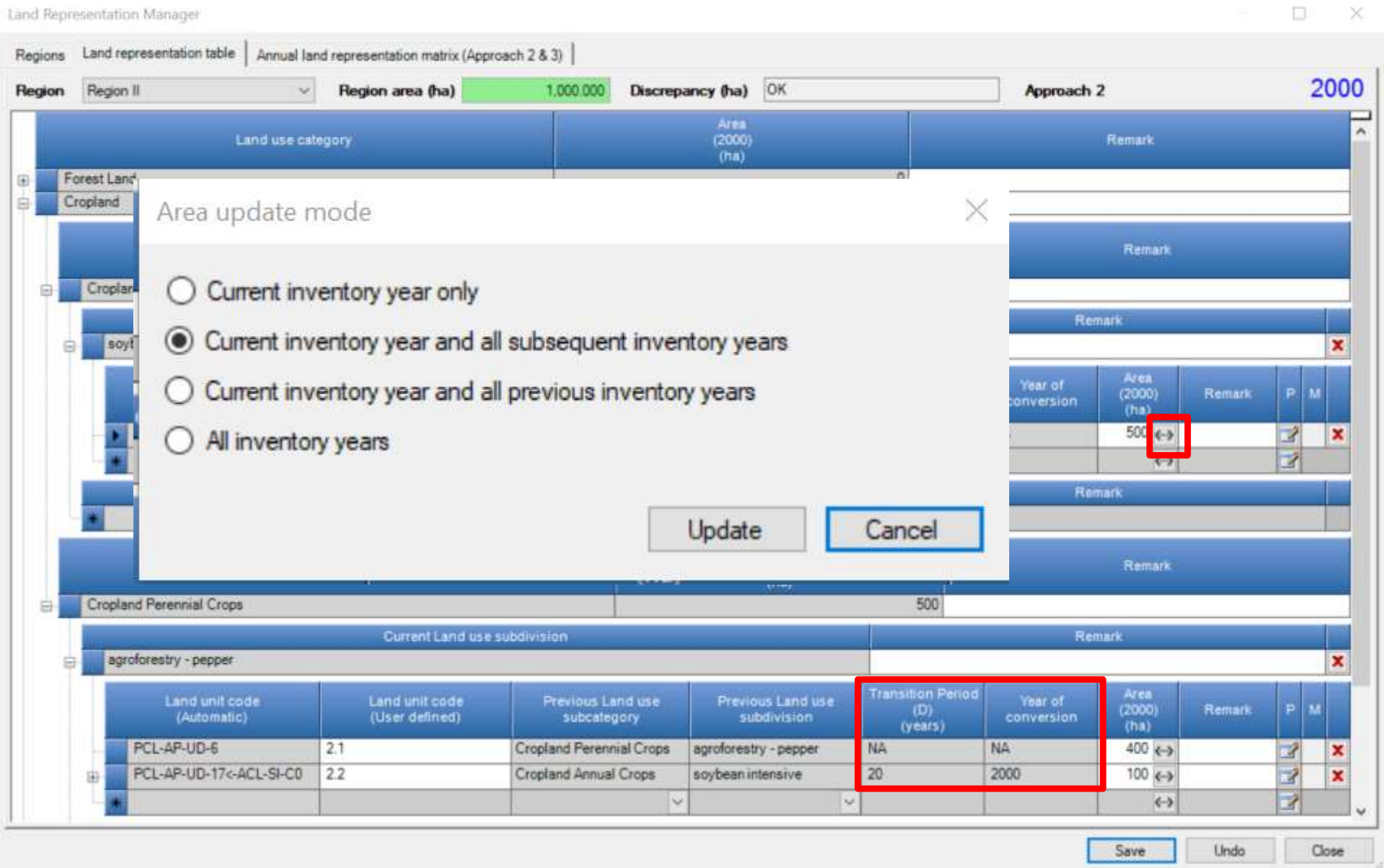
# LRM – Land Representation Tab [1999] [Appr. 2]

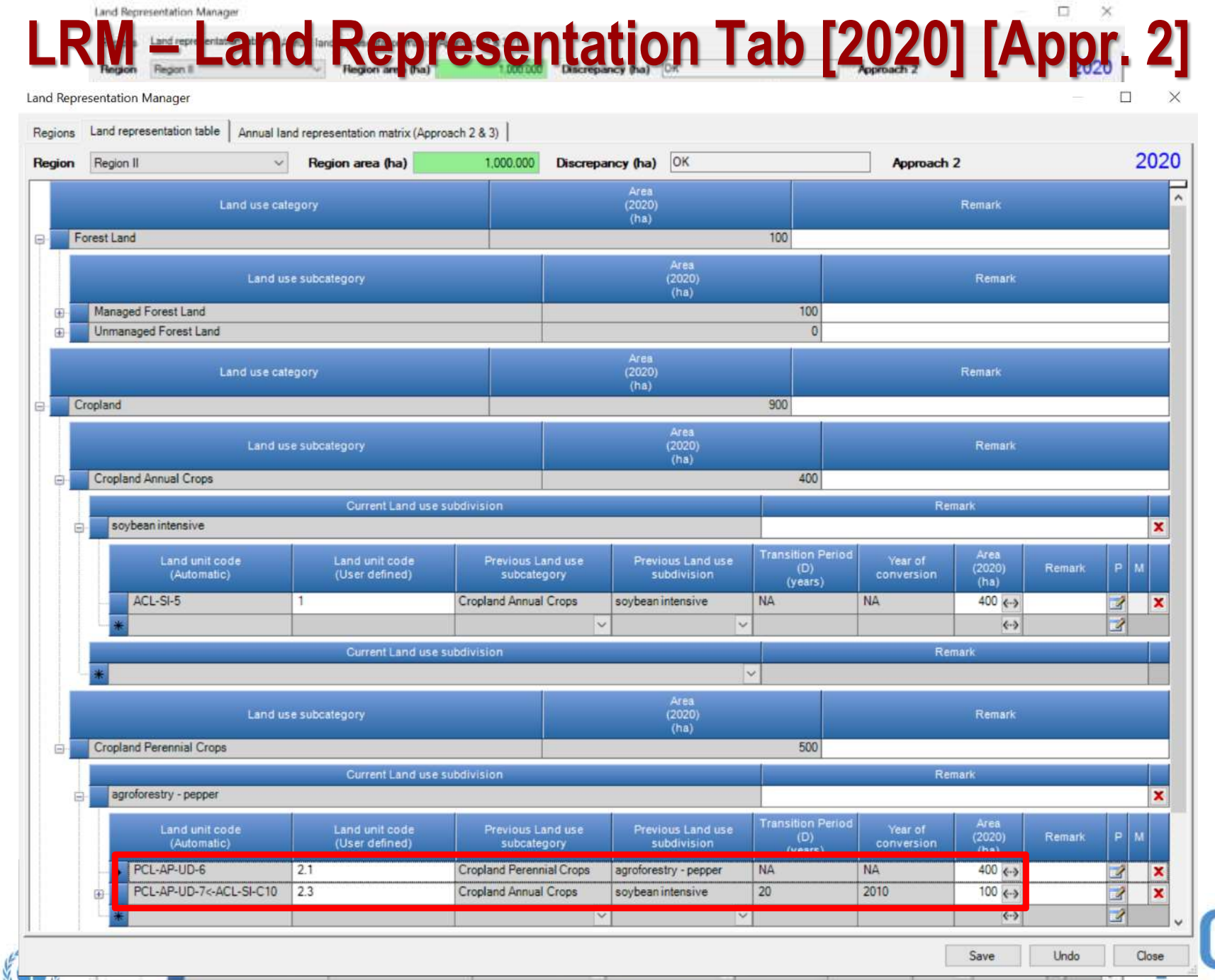


# LRM – Land Representation Tab [2000] [Appr. 2]



# LRM – Land Representation Tab [2010] [Appr. 2]

# LRM – Land Representation Tab [2020] [Appr. 2]

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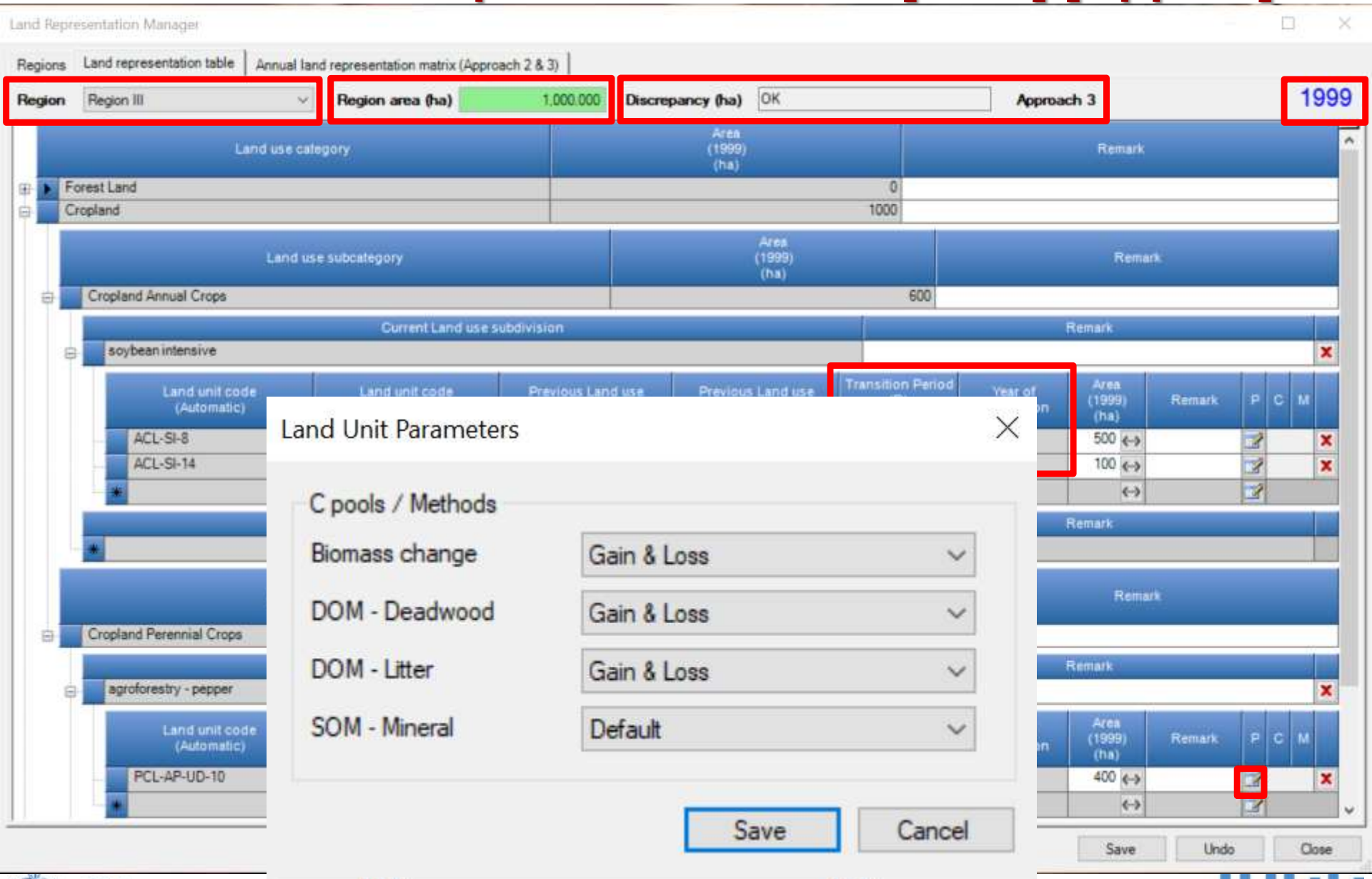
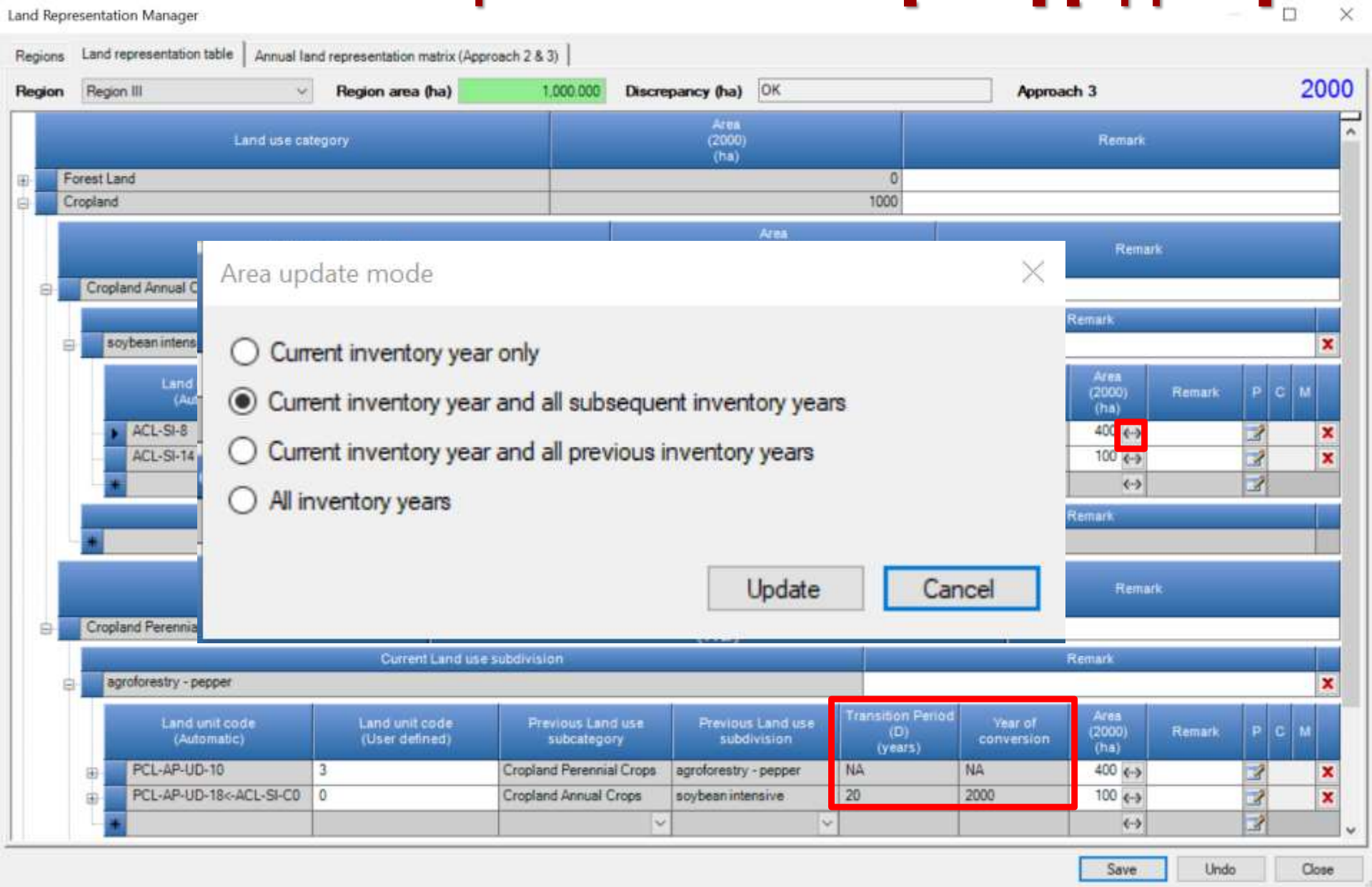
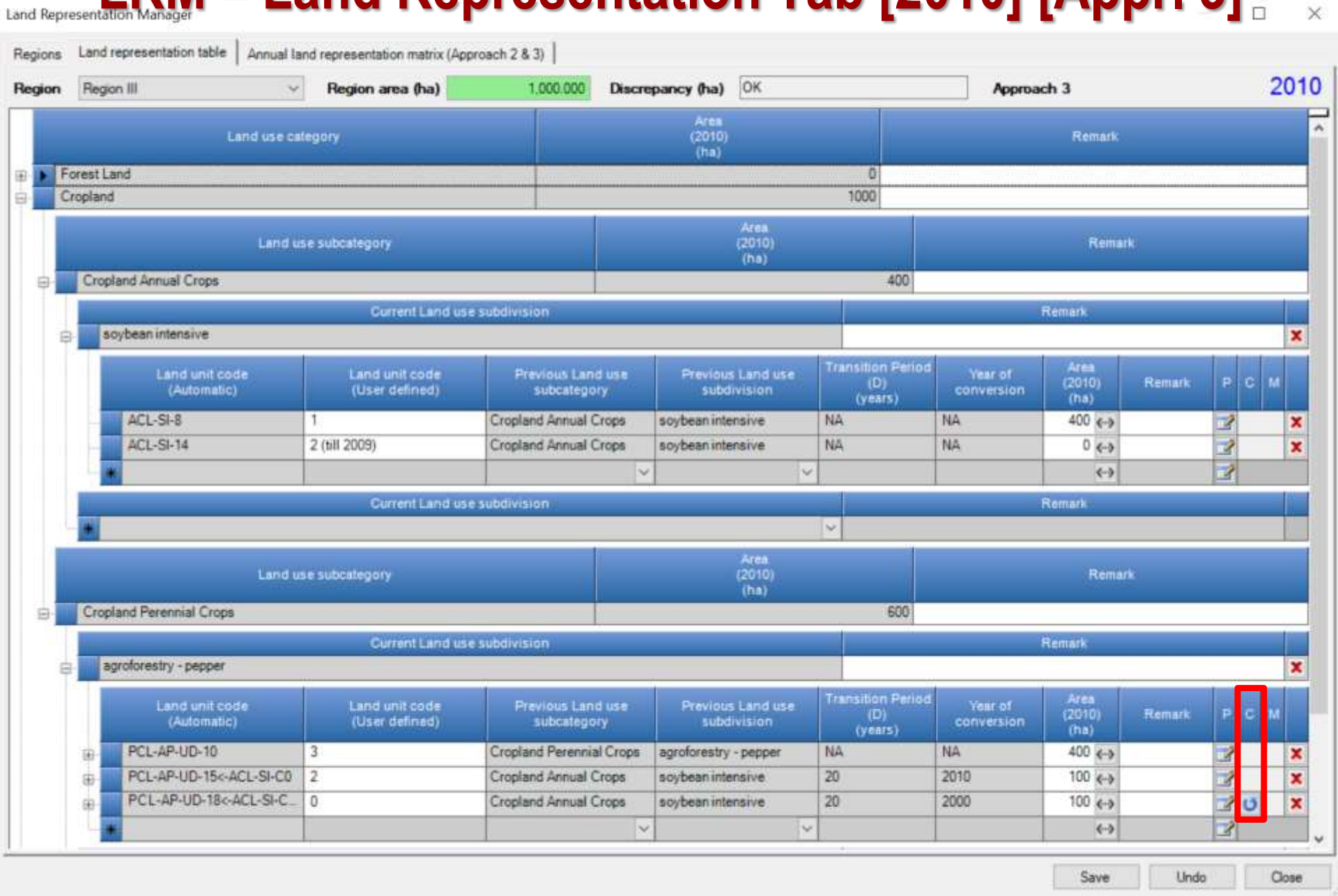
# LRM – Land Representation Tab [1999] [Appr. 3]



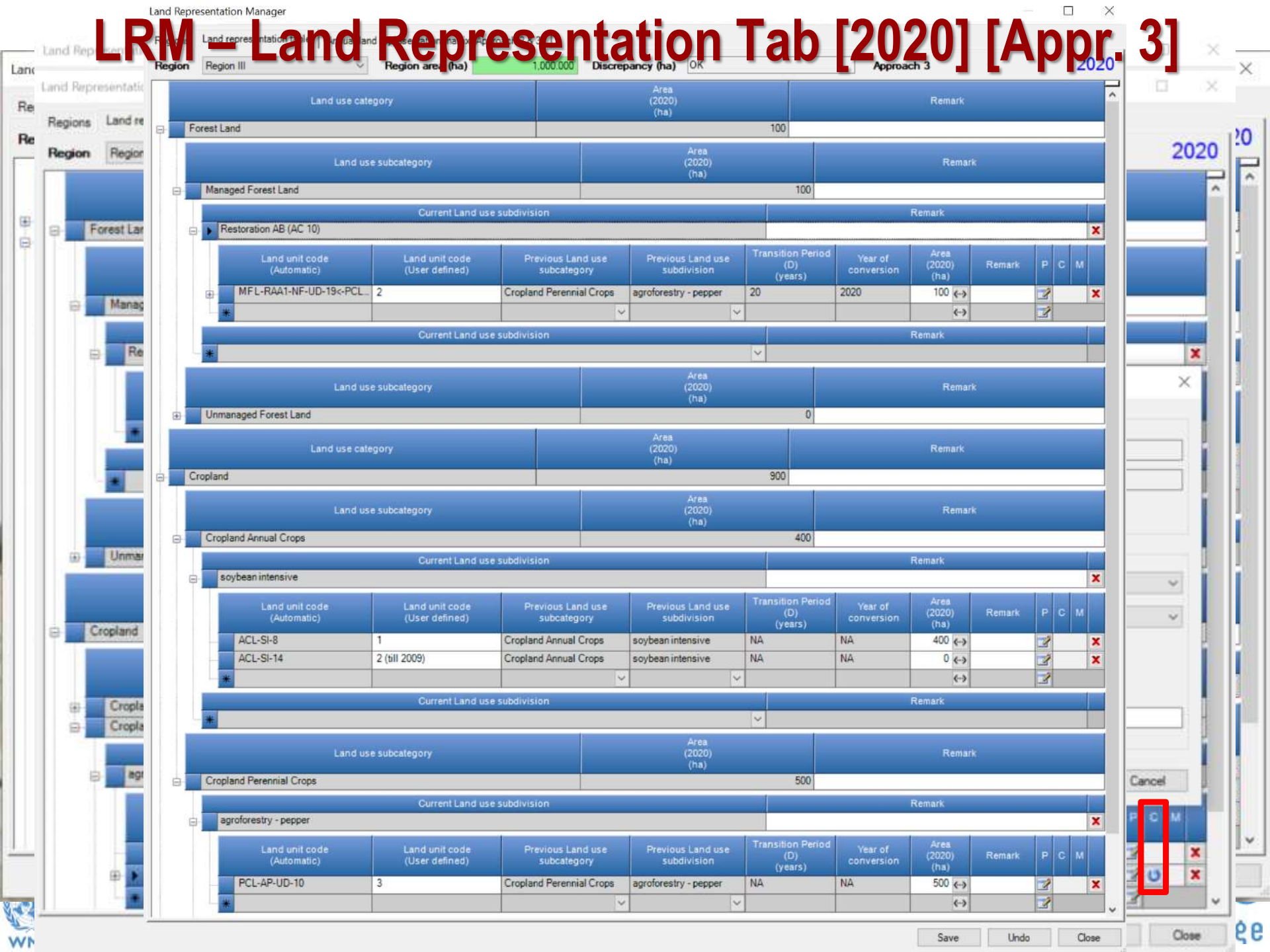
# LRM – Land Representation Tab [2000] [Appr. 3]



# LRM – Land Representation Tab [2010] [Appr. 3]



# LRM – Land Representation Tab [2020] [Appr. 3]



# Annual land representation matrix – 2010 [Appr. 2&3]

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

**Region** Region II **Region area (ha)** 1,000.000 **Approach 2** 2000

| Initial | | Forest Land | | Cropland | | Grassland | | Wetlands | | Settlements | | Other Land | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Final | | Managed Forest Land | Unmanaged Forest Land | Cropland Annual Crops | Cropland Perennial Crops | Managed Grassland | Unmanaged Grassland | Managed Wetlands | Unmanaged Wetlands | Settlements (Treed) | Settlements (Other) | Managed Other Land | Unmanaged Other Land | Final Area (ha) | Net change (ha) |
| Forest Land | Managed Forest Land | | | | | | | | | | | | | 0 | 0 |
| | Unmanaged Forest Land | | | | | | | | | | | | | 0 | 0 |
| Cropland | Cropland Annual Crops | | | 500 | | | | | | | | | | 500 | -100 |
| | Cropland Perennial Crops | | | 100 | 400 | | | | | | | | | 500 | 100 |
| Grassland | Managed Grassland | | | | | | | | | | | | | 0 | 0 |
| | Unmanaged Grassland | | | | | | | | | | | | | 0 | 0 |
| Wetlands | Managed Wetlands | | | | | | | | | | | | | 0 | 0 |
| | Unmanaged Wetlands | | | | | | | | | | | | | 0 | 0 |
| Settlements | Settlements (Treed) | | | | | | | | | | | | | 0 | 0 |
| | Settlements (Other) | | | | | | | | | | | | | 0 | 0 |
| Other Land | Managed Other Land | | | | | | | | | | | | | 0 | 0 |
| | Unmanaged Other Land | | | | | | | | | | | | | 0 | 0 |
| | Initial Area (ha) | 0 | 0 | 600 | 400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1000 | 0 |

No data Input - for verification only (not exportable yet)

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# Annual land representation matrix – 2010 [Appr. 2&3]

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

**Region** Region II **Region area (ha)** 1,000.000 **Approach 2** **2010**

| Final | | Initial: Forest Land – Managed Forest Land | Forest Land – Unmanaged Forest Land | Cropland – Cropland Annual Crops | Cropland – Cropland Perennial Crops | Grassland – Managed Grassland | Grassland – Unmanaged Grassland | Wetlands – Managed Wetlands | Wetlands – Unmanaged Wetlands | Settlements – Settlements (Treed) | Settlements – Settlements (Other) | Other Land – Managed Other Land | Other Land – Unmanaged Other Land | Final Area (ha) | Net change (ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Forest Land | Managed Forest Land | | | | | | | | | | | | | 0 | 0 |
| | Unmanaged Forest Land | | | | | | | | | | | | | 0 | 0 |
| Cropland | Cropland Annual Crops | | | 400 | | | | | | | | | | 400 | -100 |
| | Cropland Perennial Crops | | | 100 | 500 | | | | | | | | | 600 | 100 |
| Grassland | Managed Grassland | | | | | | | | | | | | | 0 | 0 |
| | Unmanaged Grassland | | | | | | | | | | | | | 0 | 0 |
| Wetlands | Managed Wetlands | | | | | | | | | | | | | 0 | 0 |
| | Unmanaged Wetlands | | | | | | | | | | | | | 0 | 0 |
| Settlements | Settlements (Treed) | | | | | | | | | | | | | 0 | 0 |
| | Settlements (Other) | | | | | | | | | | | | | 0 | 0 |
| Other Land | Managed Other Land | | | | | | | | | | | | | 0 | 0 |
| | Unmanaged Other Land | | | | | | | | | | | | | 0 | 0 |
| | Initial Area (ha) | 0 | 0 | 500 | 500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1000 | 0 |

No data Input - for verification only (not exportable yet)

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# Annual land representation matrix – 2020 [Appr. 2/3]

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

**Region** Region III **Region area (ha)** 1,000.000 **Approach 3** **2020**

| Initial | | Forest Land | | Cropland | | Grassland | | Wetlands | | Settlements | | Other Land | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Final | | Managed Forest Land | Unmanaged Forest Land | Cropland Annual Crops | Cropland Perennial Crops | Managed Grassland | Unmanaged Grassland | Managed Wetlands | Unmanaged Wetlands | Settlements (Treed) | Settlements (Other) | Managed Other Land | Unmanaged Other Land | Final Area (ha) | Net change (ha) |
| Forest Land | Managed Forest Land | | | | 100 | | | | | | | | | 100 | 100 |
| | Unmanaged Forest Land | | | | | | | | | | | | | 0 | 0 |
| Cropland | Cropland Annual Crops | | | 400 | | | | | | | | | | 400 | 0 |
| | Cropland Perennial Crops | | | | 500 | | | | | | | | | 500 | -100 |
| Grassland | Managed Grassland | | | | | | | | | | | | | 0 | 0 |
| | Unmanaged Grassland | | | | | | | | | | | | | 0 | 0 |
| Wetlands | Managed Wetlands | | | | | | | | | | | | | 0 | 0 |
| | Unmanaged Wetlands | | | | | | | | | | | | | 0 | 0 |
| Settlements | Settlements (Treed) | | | | | | | | | | | | | 0 | 0 |
| | Settlements (Other) | | | | | | | | | | | | | 0 | 0 |
| Other Land | Managed Other Land | | | | | | | | | | | | | 0 | 0 |
| | Unmanaged Other Land | | | | | | | | | | | | | 0 | 0 |
| | Initial Area (ha) | 0 | 0 | 400 | 600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1000 | 0 |

No data Input - for verification only (not exportable yet)

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# Mineral soil SOC change – Equation 2.25

**BOX 2.1 (UPDATED)**
**ALTERNATIVE FORMULATIONS OF EQUATION 2.25 FOR APPROACH 1 ACTIVITY DATA VERSUS APPROACH 2 OR 3 ACTIVITY DATA WITH TRANSITION MATRICES**

Two alternative formulations are possible for Equation 2.25 depending on the Approach used to collect activity data, including

**Formulation A (Approach 1 for Activity Data Collection)**

$$\Delta C_{Mineral} = \frac{\left[\sum_{c,s,i}\left(SOC_{REF_{c,s,i}} \bullet F_{LU_{c,s,i}} \bullet F_{MG_{c,s,i}} \bullet F_{I_{c,s,i}} \bullet A_{c,s,i}\right)\right]_0 - \left[\sum_{c,s,i}\left(SOC_{REF_{c,s,i}} \bullet F_{LU_{c,s,i}} \bullet F_{MG_{c,s,i}} \bullet F_{I_{c,s,i}} \bullet A_{c,s,i}\right)\right]_{(0-T)}}{D}$$

**Formulation B (Approaches 2 and 3 for Activity Data Collection)**

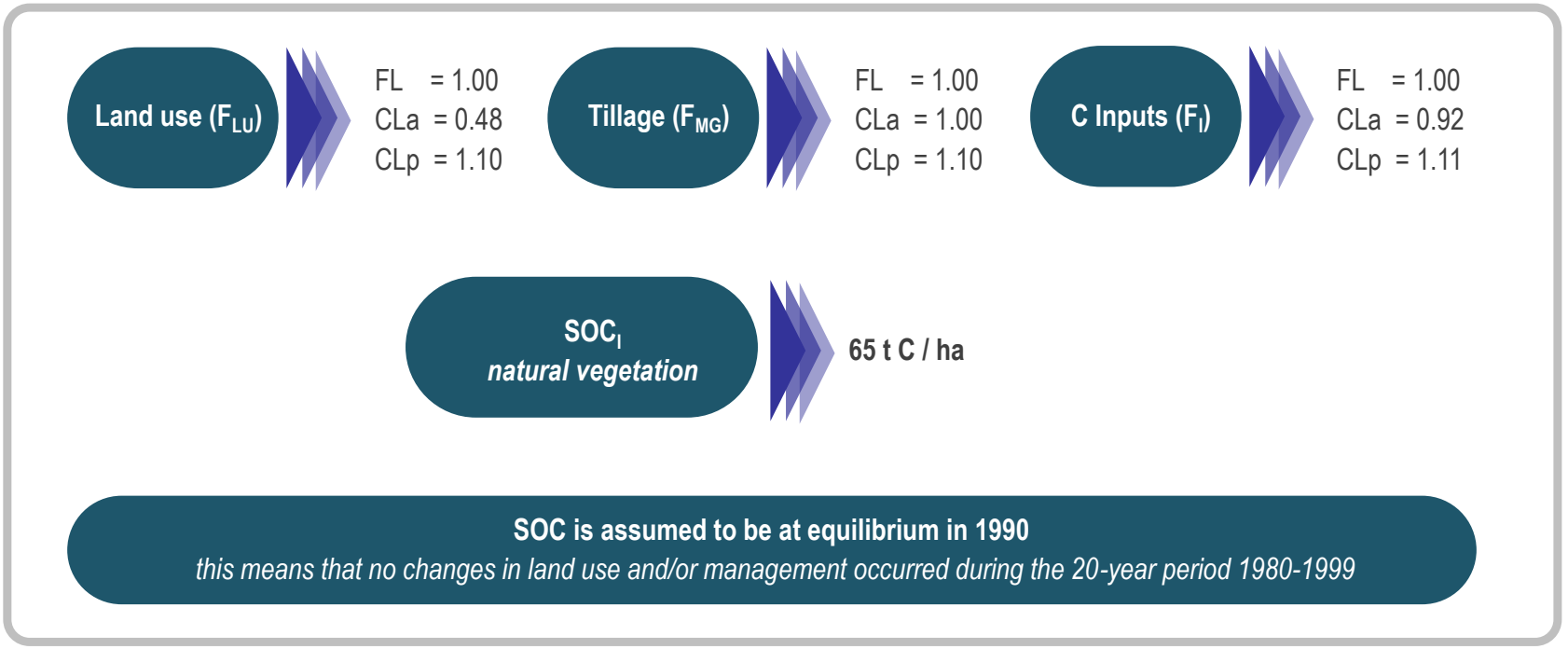
$$\Delta C_{Mineral} = \frac{\sum_{c,s,p}\left[\left\{\left(SOC_{REF_{c,s,p}} \bullet F_{LU_{c,s,p}} \bullet F_{MG_{c,s,p}} \bullet F_{I_{c,s,p}}\right)_0 - \left(SOC_{REF_{c,s,p}} \bullet F_{LU_{c,s,p}} \bullet F_{MG_{c,s,p}} \bullet F_{I_{c,s,p}}\right)_{(0-T)}\right\} \bullet A_{c,s,p}\right]}{D}$$

Where:

$p$ = a parcel of land representing an individual unit of area over which the inventory calculations are performed.

Between the 2 formulations, the software applies that associated with the approach for land representation selected for the Region to which the unit of land belongs

# Equation 2.25 – Stock-Change Factors



# Equation 2.25 – Formulation A

$$\Delta C_{Mineral} = \frac{\left(SOC_{0\_GHGI} - SOC_{(0-T)\_GHGI}\right)}{D}$$

$$= \frac{\left[\sum_{c,s,i,}\left(SOC_{REF_{c,s}} \cdot F_{LU_{c,i}} \cdot F_{MG_{c,i}} \cdot F_{I_{c,i}} \cdot A_{c,s,i}\right)\right]_0 - \left[\sum_{c,s,i,}\left(SOC_{REF_{c,s}} \cdot F_{LU_{c,i}} \cdot F_{MG_{c,i}} \cdot F_{I_{c,i}} \cdot A_{c,s,i}\right)\right]_{(0-D)}}{D}$$

**Where, "D"** is the **transition period** *(IPCC default is 20 years)*, and **"c"** *(climate)*, **"s"** *(soil)*, **"i"** *(management system)* **correspond to the variables, in each land use category/subcategory, according to which the estimate is stratified/disaggregated**

According to such variables, **SOC at equilibrium,** in any inventory year, for each stratum (unit of land) ***c,s,i***, is calculated as:

- $\left(\mathrm{SOC_{REF_{c,s}}} \cdot \mathrm{F_{LU_{c,i}}} \cdot \mathrm{F_{MG_{c,i}}} \cdot \mathrm{F_{I_{c,i}}} \cdot \mathrm{A_{c,s,i}}\right)_0$

*i.e. the combination of current land uses and management systems of practices in the current inventory year "0" (t C)*

- $\left(\mathrm{SOC_{REF_{c,s}}} \cdot \mathrm{F_{LU_{c,i}}} \cdot \mathrm{F_{MG_{c,i}}} \cdot \mathrm{F_{I_{c,i}}} \cdot \mathrm{A_{c,s,i}}\right)_{(0-D)}$

*i.e. the combination of land uses and management systems of practices of D years before the current inventory year (t C)*

# Equation 2.25 – Formulation A (2000)

| Year | 1999 | | | 2000 | | | 2010 | | | 2020 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Category | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp |
| Land unit | Area (ha) | | | | | | | | | | | |
| 1 | 0 | 600 | 0 | 0 | 500 | 0 | 0 | 400 | 0 | 0 | 400 | 0 |
| 2 | 0 | 0 | 400 | 0 | 0 | 500 | 0 | 0 | 600 | 0 | 0 | 500 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| $SOC_0$ tC | 0 | 17,222 | 32,063 | 0 | 14,352 | 40,079 | 0 | 11,482 | 48,095 | 6,500 | 11,482 | 40,079 |
| $SOC_{0-T}$ tC | 0 | 17,222 | 32,063 | 0 | 17,222 | 32,063 | 0 | 17,222 | 32,063 | 0 | 14,352 | 40,079 |
| $\Delta C$ tC $yr^{-1}$ | 0.000 | 0.000 | 0.000 | 0.000 | -143.520 | 400.793 | 0.000 | -287.040 | 801.587 | 325.000 | -143.520 | 0.000 |

Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

Worksheet

**Sector:** Agriculture, Forestry and Other Land Use
**Category:** Cropland
**Subcategory:** 3.B.2.a - Cropland Remaining Cropland
**Sheet:** SOC Changes in mineral soils - Approach 1 (Information item)

2000

Data

**Region** Region I - **Approach 1**

| Land use category | | | Equation 2.25 - A | | |
|---|---|---|---|---|---|
| Land unit code | Land use during reporting year | | Soil organic carbon stock in mineral soils in year 2000 (tonnes C / ha) | Soil organic carbon stock in mineral soils in year 1980 (tonnes C / ha) | Annual change in carbon stocks in mineral soils (tonnes C / yr) |
| | | | SOC(2000) | SOC(1980) | ΔCmineral = ((SOC(2000) - SOC(1980)) / 20 |
| 1 | Cropland Annual C... | soybean intensive | 14352 | 17222.4 | -143.52 |
| 2 | Cropland Perennial... | agroforestry - pepper | 40079.325 | 32063.46 | 400.79325 |
| Total | | | 54431.325 | 49285.86 | 257.27325 |

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# Equation 2.25 – Formulation A (2010)

| Year | 1999 | | | 2000 | | | 2010 | | | 2020 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Category | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp |
| Land unit | Area (ha) | | | | | | | | | | | |
| 1 | 0 | 600 | 0 | 0 | 500 | 0 | 0 | 400 | 0 | 0 | 400 | 0 |
| 2 | 0 | 0 | 400 | 0 | 0 | 500 | 0 | 0 | 600 | 0 | 0 | 500 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| $SOC_0$ tC | 0 | 17,222 | 32,063 | 0 | 14,352 | 40,079 | 0 | 11,482 | 48,095 | 6,500 | 11,482 | 40,079 |
| $SOC_{0\text{-}T}$ tC | 0 | 17,222 | 32,063 | 0 | 17,222 | 32,063 | 0 | 17,222 | 32,063 | 0 | 14,352 | 40,079 |
| $\Delta C$ tC $yr^{-1}$ | 0.000 | 0.000 | 0.000 | 0.000 | -143.520 | 400.793 | 0.000 | -287.040 | 801.587 | 325.000 | -143.520 | 0.000 |

Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

Worksheet

**Sector:** Agriculture, Forestry and Other Land Use
**Category:** Cropland
**Subcategory:** 3.B.2.a - Cropland Remaining Cropland
**Sheet:** SOC Changes in mineral soils - Approach 1 (Information item)

2010

Data

**Region** Region I - **Approach 1**

| Land use category | | | Equation 2.25 - A | | |
|---|---|---|---|---|---|
| Land unit code | Land use during reporting year | | Soil organic carbon stock in mineral soils in year 2010 (tonnes C / ha) | Soil organic carbon stock in mineral soils in year 1990 (tonnes C / ha) | Annual change in carbon stocks in mineral soils (tonnes C / yr) |
| | | | SOC(2010) | SOC(1990) | ΔCmineral = ((SOC(2010) - SOC(1990)) / 20 |
| 1 | Cropland Annual C... | soybean intensive | 11481.6 | 17222.4 | -287.04 |
| 2 | Cropland Perennial... | agroforestry - pepper | 48095.19 | 32063.46 | 801.5865 |
| Total | | | 59576.79 | 49285.86 | 514.5465 |

Land Use Manager | Land Representation Manager | Uncertainties

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# Equation 2.25 – Formulation A (2020)

| Year | 1999 | | | 2000 | | | 2010 | | | 2020 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Category | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp |
| Land unit | Area (ha) | | | | | | | | | | | |
| 1 | 0 | 600 | 0 | 0 | 500 | 0 | 0 | 400 | 0 | 0 | 400 | 0 |
| 2 | 0 | 0 | 400 | 0 | 0 | 500 | 0 | 0 | 600 | 0 | 0 | 500 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| $SOC_0$ tC | 0 | 17,222 | 32,063 | 0 | 14,352 | 40,079 | 0 | 11,482 | 48,095 | 6,500 | 11,482 | 40,079 |
| $SOC_{0\text{-}T}$ tC | 0 | 17,222 | 32,063 | 0 | 17,222 | 32,063 | 0 | 17,222 | 32,063 | 0 | 14,352 | 40,079 |
| $\Delta C$ tC $yr^{-1}$ | 0.000 | 0.000 | 0.000 | 0.000 | -143.520 | 400.793 | 0.000 | -287.040 | 801.587 | 325.000 | -143.520 | 0.000 |

Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

Worksheet

**Sector:** Agriculture, Forestry and Other Land Use

**Category:** Cropland

**Subcategory:** 3.B.2.a - Cropland Remaining Cropland

**Sheet:** SOC Changes in mineral soils - Approach 1 (Information item)

2020

Data

**Region** Region I - **Approach 1**

| Land use category | | | Equation 2.25 - A | | |
|---|---|---|---|---|---|
| Land unit code | Land use during reporting year | | Soil organic carbon stock in mineral soils in year 2020 (tonnes C / ha) | Soil organic carbon stock in mineral soils in year 2000 (tonnes C / ha) | Annual change in carbon stocks in mineral soils (tonnes C / yr) |
| | | | SOC(2020) | SOC(2000) | ΔCmineral = ((SOC(2020) - SOC(2000)) / 20 |
| 1 | Cropland Annual C... | soybean intensive | 11481.6 | 14352 | -143.52 |
| 2 | Cropland Perennial... | agroforestry - pepper | 40079.325 | 40079.325 | 0 |
| Total | | | 51560.925 | 54431.325 | -143.52 |

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# Equation 2.25 – Formulation B – Approach 2

$$\Delta C_{Mineral} = \frac{\left(SOC_{0\_GHGI} - SOC_{(0-T)\_GHGI}\right)}{T}$$

$$= \frac{\sum_{c,s,i,p}\left\{\left[\left(SOC_{REF_{c,s,p}} \bullet F_{LU_{c,i,p}} \bullet F_{MG_{c,i,p}} \bullet F_{I_{c,i,p}}\right)_0 - \left(SOC_{REF_{c,s,p}} \bullet F_{LU_{c,i,p}} \bullet F_{MG_{c,i,p}} \bullet F_{I_{c,i,p}}\right)_T\right] \bullet A_{c,s,i,p}\right\}}{D}$$

**Where, "D"** is the **transition period** *(IPCC default is 20 years)*, and **"c"** *(climate)*, **"s"** *(soil)*, **"i"** *(management system)* **correspond to the variables, in each land use category/subcategory, according to which the estimate is stratified/disaggregated**

According to such variables, **SOC at equilibrium,** in any inventory year, for each stratum (unit of land) ***c,s,i***, is calculated as:

- $\left(\mathrm{SOC}_{\mathrm{REF}_{c,s}} \bullet \mathrm{F}_{\mathrm{LU}_{c,i}} \bullet \mathrm{F}_{\mathrm{MG}_{c,i}} \bullet \mathrm{F}_{\mathrm{I}_{c,i}} \bullet \mathrm{A}_{c,s,i}\right)_0$

*i.e. the combination of current land uses and management systems of practices in the current inventory year "0" (t C)*

- $\left(\mathrm{SOC}_{\mathrm{REF}_{c,s}} \bullet \mathrm{F}_{\mathrm{LU}_{c,i}} \bullet \mathrm{F}_{\mathrm{MG}_{c,i}} \bullet \mathrm{F}_{\mathrm{I}_{c,i}} \bullet \mathrm{A}_{c,s,i}\right)_{(0-D)}$

*i.e. the combination of land uses and management systems of practices of in the latest year "T" before the conversion (t C)*

# Equation 2.25 – Formulation B - A2 (2000)

| Year | 1999 | | | 2000 | | | 2010 | | | 2020 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Category | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp |
| Land unit | Area (ha) | | | | | | | | | | | |
| 1 | 0 | 600 | 0 | 0 | 500 | 0 | 0 | 400 | 0 | 0 | 400 | 0 |
| 2.1 | 0 | 0 | 400 | 0 | 0 | 400 | 0 | 0 | 400 | 0 | 0 | 400 |
| 2.2 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 0 |
| 2.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 100 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| $SOC_0$ tC | | | | | | 8,016 | | | 16,032 | 6,500 | | 8,016 |
| $SOC_{0-T}$ tC | | | | | | 2,870 | | | 5,741 | 8,016 | | 2,870 |
| $\Delta C$ tC $yr^{-1}$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 257.273 | 0.000 | 0.000 | 514.547 | -75.793 | 0.000 | 257.273 |

Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

Worksheet

**Sector:** Agriculture, Forestry and Other Land Use
**Category:** Cropland
**Subcategory:** 3.B.2.a - Cropland Remaining Cropland
**Sheet:** Annual net C stock change in soil organic matter of mineral soils - Approach 2 and Approach 3 (Default method)

2000

Data

**Region** Region II - **Approach 2**

| Land use category | | | Equation 2.25 - B | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Area (ha) | Reference carbon stock for the climate and soil combination (tonnes C / ha) | Time dependence of stock change factors (D) or number of years over a single inventory time | Stock change factor for land-use system for the subdivision in the current inventory year (-) | Stock change factor for management regime for the subdivision in the current inventory year (-) | Stock change factor for C input for the subdivision in the current inventory year (-) | Soil organic carbon stock in mineral soils at equilibrium for the current subdivision (tonnes C / ha) | Stock change factor for land-use system at conversion (-) | Stock change factor for management regime at conversion (-) | Stock change factor for C input at conversion (-) | Soil organic carbon stock in mineral soils for the subdivision at conversion (tonnes C / ha) | Annual change in carbon stocks in mineral soils (tonnes C / yr) | |
| Land unit code | Initial land use | Land use during reporting year | National statistics or international data sources | Tables 2.3 / 5.2 WS | Default value is 20 | National statistics or international data sources | National statistics or international data sources | National statistics or international data sources | SOC(0) = SOCref * Flu(0) * Fmg(0) * Fi (0) | IPCC defaults or country-specific | IPCC defaults or country-specific | IPCC defaults or country-specific | SOC(c) = SOCref * Flu(c) * Fmg(c) * Fi (c) | ΔCmineral = ((SOC (0) - SOC(c)) * A) / D | |
| | | | A | SOCref | D | Flu(0) | Fmg(0) | Fi(0) | SOC(0) | Flu(c) | Fmg(c) | Fi(c) | SOC(c) | | |
| 2.2 | Cropland... soybean... | Cropland... agrofores... | 100 | 65 | 20 | 1.01 | 1.1 | 1.11 | 80.15865 | 0.48 | 1 | 0.92 | 28.704 | 257.27325 | |
| Total | | | 100 | | | | | | | | | | | 257.27325 | |

# Equation 2.25 – Formulation B - A2 (2010)

| Year | 1999 | | | 2000 | | | 2010 | | | 2020 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Category | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp |
| Land unit | Area (ha) | | | | | | | | | | | |
| 1 | 0 | 600 | 0 | 0 | 500 | 0 | 0 | 400 | 0 | 0 | 400 | 0 |
| 2.1 | 0 | 0 | 400 | 0 | 0 | 400 | 0 | 0 | 400 | 0 | 0 | 400 |
| 2.2 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 0 |
| 2.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 100 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| $SOC_0$ tC | | | | | | 8,016 | | | 16,032 | 6,500 | | 8,016 |
| $SOC_{0-T}$ tC | | | | | | 2,870 | | | 5,741 | 8,016 | | 2,870 |
| $\Delta C$ tC $yr^{-1}$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 257.273 | 0.000 | 0.000 | 514.547 | -75.793 | 0.000 | 257.273 |

Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

Worksheet

**Sector:** Agriculture, Forestry and Other Land Use

**Category:** Cropland

**Subcategory:** 3.B.2.a - Cropland Remaining Cropland

**Sheet:** Annual net C stock change in soil organic matter of mineral soils - Approach 2 and Approach 3 (Default method)

2010

Data

**Region** Region II - **Approach 2**

| Land use category | | | Equation 2.25 - B | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Area (ha) | Reference carbon stock for the climate and soil combination (tonnes C / ha) | Time dependence of stock change factors (D) or number of years over a single inventory time | Stock change factor for land-use system for the subdivision in the current inventory year (-) | Stock change factor for management regime for the subdivision in the current inventory year (-) | Stock change factor for C input for the subdivision in the current inventory year (-) | Soil organic carbon stock in mineral soils at equilibrium for the current subdivision (tonnes C / ha) | Stock change factor for land-use system at conversion (-) | Stock change factor for management regime at conversion (-) | Stock change factor for C input at conversion (-) | Soil organic carbon stock in mineral soils for the subdivision at conversion (tonnes C / ha) | Annual change in carbon stocks in mineral soils (tonnes C / yr) |
| Land unit code | Initial land use | Land use during reporting year | National statistics or international data sources | Tables 2.3 / 5.2 WS | Default value is 20 | National statistics or international data sources | National statistics or international data sources | National statistics or international data sources | $SOC(0) = SOCref * Flu(0) * Fmg(0) * Fi$ (0) | IPCC defaults or country-specific | IPCC defaults or country-specific | IPCC defaults or country-specific | $SOC(c) = SOCref * Flu(c) * Fmg(c) * Fi$ (c) | $\Delta Cmineral = ((SOC(0) - SOC(c)) * A) / D$ |
| | | | A | SOCref | D | Flu(0) | Fmg(0) | Fi(0) | SOC(0) | Flu(c) | Fmg(c) | Fi(c) | SOC(c) | ΔCmineral |
| 2.3 | Cropland... | soybean... | Cropland... | agrofores... | 100 | 65 | 20 | 1.01 | 1.1 | 1.11 | 80.15865 | 0.48 | 1 | 0.92 | 29.704 | 257.27325 |
| 2.2 | | soybean... | | agrofores... | 100 | 65 | 20 | 1.01 | 1.1 | 1.11 | 80.15865 | 0.48 | 1 | 0.92 | 29.704 | 257.27325 |
| Total | | | 200 | | | | | | | | | | | 514.5465 |

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# Equation 2.25 – Formulation B - A2 (2020)

| Year | 1999 | | | 2000 | | | 2010 | | | 2020 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Category | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp |
| Land unit | Area (ha) | | | | | | | | | | | |
| 1 | 0 | 600 | 0 | 0 | 500 | 0 | 0 | 400 | 0 | 0 | 400 | 0 |
| 2.1 | 0 | 0 | 400 | 0 | 0 | 400 | 0 | 0 | 400 | 0 | 0 | 400 |
| 2.2 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 0 |
| 2.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 100 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| $SOC_0$ tC | | | | | | 8,016 | | | 16,032 | 6,500 | | 8,016 |
| $SOC_{0-T}$ tC | | | | | | 2,870 | | | 5,741 | 8,016 | | 2,870 |
| $\Delta C$ tC $yr^{-1}$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 257.273 | 0.000 | 0.000 | 514.547 | -75.793 | 0.000 | 257.273 |

Biomass increase (G&L 1/4) | Biomass loss (G&L 2/4) | Biomass loss (G&L 3/4) | Biomass loss (G&L 4/4) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

Worksheet
**Sector:** Agriculture, Forestry and Other Land Use
**Category:** Forest Land
**Subcategory:** 3.B.1.b.i - Cropland converted to Forest Land
**Sheet:** Annual net C stock change in soil organic matter of mineral soils - Approach 2 and Approach 3 (Default method)
Data

2020

**Region** Region II - **Approach 2**

| Land use category | | | Equation 2.25 - B | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Area (ha) | Reference carbon stock for the climate and soil combination (tonnes C / ha) | Time dependence of stock change factors (D) or number of years over a single inventory time period (T) (yr) | Stock change factor for land-use system for the subdivision in the current inventory year (-) | Stock change factor for management regime for the subdivision in the current inventory year (-) | Stock change factor for C input for the subdivision in the current inventory year (-) | Soil organic carbon stock in mineral soils at equilibrium for the current subdivision (tonnes C / ha) | Stock change factor for land-use system at conversion (-) | Stock change factor for management regime at conversion (-) | Stock change factor for C input at conversion (-) | Soil organic carbon stock in mineral soils for the subdivision at conversion (tonnes C / ha) | Annual change in carbon stocks in mineral soils (tonnes C / yr) |
| Land unit code | Initial land use | Land use during reporting year | National statistics or international data sources | Tables 2.3 / 6.2 WS | Default value is 20 | IPCC defaults or country-specific | IPCC defaults or country-specific | IPCC defaults or country-specific | SOC(0) = SOCref * Flu(0) * Fmg(0) * Fi (0) | IPCC defaults or country-specific | IPCC defaults or country-specific | IPCC defaults or country-specific | SOC(c) = SOCref * Flu(c) * Fmg(c) * Fi (c) | ΔCmineral = ((SOC (0) - SOC(c)) * A) / D |
| | | | A | SOCref | D | Flu(0) | Fmg(0) | Fi(0) | SOC(0) | Flu(c) | Fmg(c) | Fi(c) | SOC(c) | ΔCmineral |
| 3 | Cropland.. | agrofores.. Manage.. Restorati.. | 100 | 65 | 20 | 1 | 1 | 1 | 65 | 1.01 | 1.1 | 1.11 | 80.15865 | -75.79325 |
| Total | | | 100 | | | | | | | | | | | -75.79325 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Land unit code | Initial land use | Land use during reporting year | National statistics or international data sources | Tables 2.3 / 5.2 WS | Default value is 20 | National statistics or international data sources | National statistics or international data sources | National statistics or international data sources | SOC(0) = SOCref * Flu(0) * Fmg(0) * Fi (0) | IPCC defaults or country-specific | IPCC defaults or country-specific | IPCC defaults or country-specific | SOC(c) = SOCref * Flu(c) * Fmg(c) * Fi (c) | ΔCmineral = ((SOC (0) - SOC(c)) * A) / D |
| | | | A | SOCref | D | Flu(0) | Fmg(0) | Fi(0) | SOC(0) | Flu(c) | Fmg(c) | Fi(c) | SOC(c) | ΔCmineral |
| 2.3 | Cropland.. | soybean.. Cropland.. agrofores.. | 100 | 65 | 20 | 1.01 | 1.1 | 1.11 | 80.15865 | 0.48 | 1 | 0.92 | 28.704 | 257.27325 |
| Total | | | 100 | | | | | | | | | | | 257.27325 |

# Equation 2.25 – Formulation B – Approach 3

$$\Delta C_{Mineral} = \frac{\left(SOC_{0\_GHGI} - SOC_{(0-T)\_GHGI}\right)}{T}$$

$$= \frac{\sum_{c,s,i,p}\left\{\left[\left(SOC_{REF_{c,s,p}} \bullet F_{LU_{c,i,p}} \bullet F_{MG_{c,i,p}} \bullet F_{I_{c,i,p}}\right)_0 - SOC_{@conversion_{c,s,i,p}}\right] \bullet A_{c,s,i,p}\right\}}{D}$$

**Where, "D"** is the **transition period** *(IPCC default is 20 years)*, and **"c"** *(climate)*, **"s"** *(soil)*, **"i"** *(management system)* **correspond to the variables, in each land use category/subcategory, according to which the estimate is stratified/disaggregated**

According to such variables, **SOC at equilibrium,** in any inventory year, for each stratum (unit of land) ***c,s,i***, is calculated as:

- $\left(\mathrm{SOC_{REF_{c,s}}} \bullet \mathrm{F_{LU_{c,i}}} \bullet \mathrm{F_{MG_{c,i}}} \bullet \mathrm{F_{I_{c,i}}} \bullet \mathrm{A_{c,s,i}}\right)_0$

*i.e. the combination of current land uses and management systems of practices in the current inventory year "0" (t C)*

While the SOC just before the conversion ($SOC_{@conversion}$) of the unit land is not calculated as SOC at equilibrium of the combination of land uses and management systems of practices of in the latest year "T" before the conversion (t C). $SOC_{@conversion}$ is the actual SOC of the unit of land in the latest year "T" before the conversion (t C)

# Equation 2.25 – Formulation B – A3 (2000)

| Year | 1999 | | | 2000 | | | 2010 | | | 2020 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Category | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp |
| Land unit | Area (ha) | | | | | | | | | | | |
| 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 0 |
| 1 | 0 | 600 | 0 | 0 | 500 | 0 | 0 | 400 | 0 | 0 | 400 | 0 |
| 2 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 100 | 0 | 0 |
| 3 | 0 | 0 | 400 | 0 | 0 | 400 | 0 | 0 | 400 | 0 | 0 | 500 |
| $SOC_0$ tC | | | | | | 8,016 | | | 16,032 | 6,500 | | 0 |
| $SOC_{0-T}$ tC | | | | | | 2,870 | | | 5,741 | 5,443 | | 0 |
| $\Delta C$ tC $yr^{-1}$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 257.273 | 0.000 | 0.000 | 514.547 | 52.843 | 0.000 | 0.000 |

Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

Worksheet

**Sector:** Agriculture, Forestry and Other Land Use

**Category:** Cropland

**Subcategory:** 3.B.2.a - Cropland Remaining Cropland

**Sheet:** Annual net C stock change in soil organic matter of mineral soils - Approach 2 and Approach 3 (Default method)

2000

Data

**Region** Region III - **Approach 3**

| Land use category | | | Equation 2.25 - B | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Land unit code | Initial land use | Land use during reporting year | Area (ha) | Reference carbon stock for the climate and soil combination (tonnes C / ha) | Time dependence of stock change factors (D) or number of years over a single inventory time period (T) (yr) | Stock change factor for land-use system for the subdivision in the current inventory year (-) | Stock change factor for management regime for the subdivision in the current inventory year (-) | Stock change factor for C input for the subdivision in the current inventory year (-) | Soil organic carbon stock in mineral soils at equilibrium for the current subdivision (tonnes C / ha) | Soil organic carbon stock in mineral soils for the subdivision at conversion (tonnes C / ha) | Annual change in carbon stocks in mineral soils (tonnes C / yr) |
| | | | National statistics or international data sources | Tables 2.3 / 6.2 WS | Default value is 20 | National statistics or international data sources | National statistics or international data sources | National statistics or international data sources | SOC(0) = SOCref * Flu (0) * Fmg(0) * Fi(0) | | ΔCmineral = ((SOC(0) - SOC(c)) * A ) / D |
| | | | A | SOCref | D | Flu(0) | Fmg(0) | Fi(0) | SOC(0) | SOC(c) | ΔCmineral |
| 0 | Cropland An.. soybean int.. | Cropland Pe.. agroforestry.. | 100 | 65 | 20 | 1.01 | 1.1 | 1.11 | 80.15865 | 28.704 | 257.27325 |
| Total | | | 100 | | | | | | | | 257.27325 |

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# Equation 2.25 – Formulation B – A3 (2010)

| Year | 1999 | | | 2000 | | | 2010 | | | 2020 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Category | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp |
| Land unit | Area (ha) | | | | | | | | | | | |
| 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 0 |
| 1 | 0 | 600 | 0 | 0 | 500 | 0 | 0 | 400 | 0 | 0 | 400 | 0 |
| 2 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 100 | 0 | 0 |
| 3 | 0 | 0 | 400 | 0 | 0 | 400 | 0 | 0 | 400 | 0 | 0 | 500 |
| $SOC_0$ tC | | | | | | 8,016 | | | 16,032 | 6,500 | | 0 |
| $SOC_{0\text{-}T}$ tC | | | | | | 2,870 | | | 5,741 | 5,443 | | 0 |
| $\Delta C$ tC $yr^{-1}$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 257.273 | 0.000 | 0.000 | 514.547 | 52.843 | 0.000 | 0.000 |

Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained | SOM Organic Rewetted

Worksheet

**Sector:** Agriculture, Forestry and Other Land Use

**Category:** Cropland

**Subcategory:** 3.B.2.a - Cropland Remaining Cropland

**Sheet:** Annual net C stock change in soil organic matter of mineral soils - Approach 2 and Approach 3 (Default method)

2010

Data

**Region** Region III - **Approach 3**

| Land use category | | | | | Equation 2.25 - B | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Area (ha) | Reference carbon stock for the climate and soil combination (tonnes C / ha) | Time dependence of stock change factors (D) or number of years over a single inventory time period (T) (yr) | Stock change factor for land-use system for the subdivision in the current inventory year (-) | Stock change factor for management regime for the subdivision in the current inventory year (-) | Stock change factor for C input for the subdivision in the current inventory year (-) | Soil organic carbon stock in mineral soils at equilibrium for the current subdivision (tonnes C / ha) | Soil organic carbon stock in mineral soils for the subdivision at conversion (tonnes C / ha) | Annual change in carbon stocks in mineral soils (tonnes C / yr) | |
| Land unit code | Initial land use | | Land use during reporting year | | National statistics or international data sources | Tables 2.3 / 5.2 WS | Default value is 20 | National statistics or international data sources | National statistics or international data sources | National statistics or international data sources | SOC(0) = SOCref * Flu (0) * Fmg(0) * Fi(0) | | ΔCmineral = ((SOC(0) - SOC(c)) * A ) / D | |
| | | | | | A | SOCref | D | Flu(0) | Fmg(0) | Fi(0) | SOC(0) | SOC(c) | ΔCmineral | |
| 0 | Cropland An... | soybean int... | Cropland Pe... | agroforestry... | 100 | 65 | 20 | 1.01 | 1.1 | 1.11 | 80.15865 | 28.704 | 257.27325 | |
| 2 | | soybean int... | | agroforestry... | 100 | 65 | 20 | 1.01 | 1.1 | 1.11 | 80.15865 | 28.704 | 257.27325 | |
| Total | | | | | 200 | | | | | | | | 514.5465 | |

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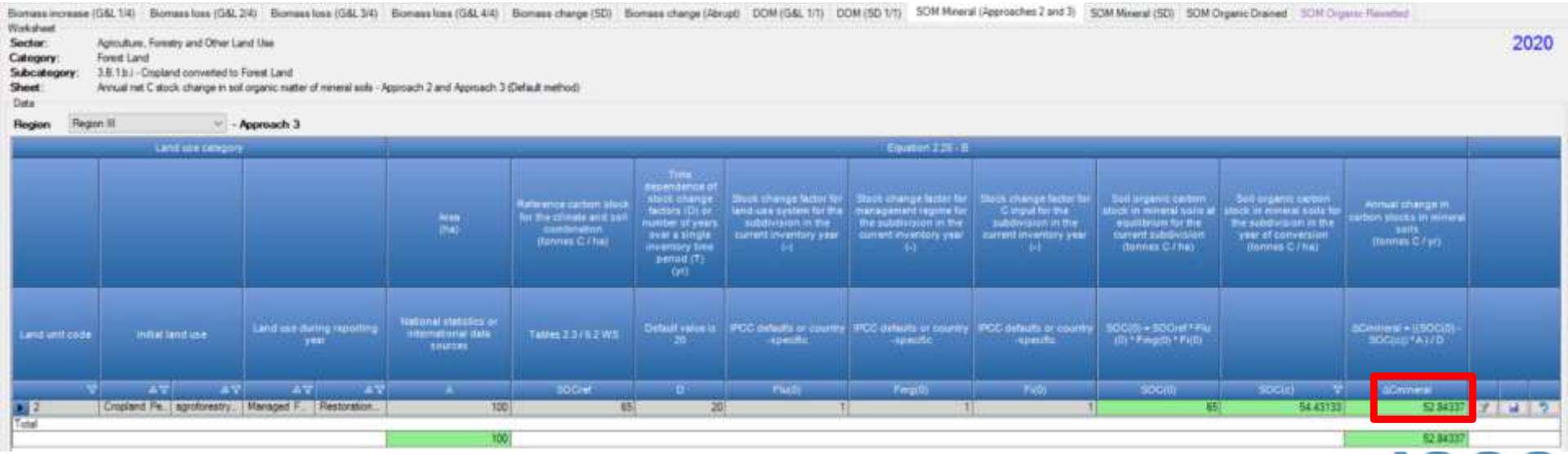
# Equation 2.25 – Formulation B – A3 (2020)

| Year | 1999 | | | 2000 | | | 2010 | | | 2020 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Category | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp | F | CLa | CLp |
| Land unit | Area (ha) | | | | | | | | | | | |
| 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 0 |
| 1 | 0 | 600 | 0 | 0 | 500 | 0 | 0 | 400 | 0 | 0 | 400 | 0 |
| 2 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 100 | 0 | 0 |
| 3 | 0 | 0 | 400 | 0 | 0 | 400 | 0 | 0 | 400 | 0 | 0 | 500 |
| $SOC_0$ tC | | | | | | 8,016 | | | 16,032 | 6,500 | | 0 |
| $SOC_{0-T}$ tC | | | | | | 2,870 | | | 5,741 | 5,443 | | 0 |
| $\Delta C$ tC $yr^{-1}$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 257.273 | 0.000 | 0.000 | 514.547 | 52.843 | 0.000 | 0.000 |

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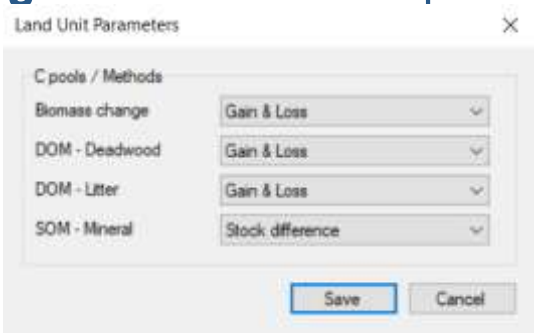
# Stock-Difference Method

Can be selected in the **Land Representation Manager** for each C pool (biomass/DOM/SOM) of each unit of land




SOM Organic Rewetted

Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained

Worksheet

**Sector:** Agriculture, Forestry and Other Land Use

**Category:** Cropland

**Subcategory:** 3.B.2.a - Cropland Remaining Cropland

**Sheet:** Annual net C stock change in soil organic matter of mineral soils (Stock difference method)

2020

Data

**Region** Region IV - **Approach 2**

| Land use category | | | Equation 2.5 | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area (ha) | Soil organic carbon stock in mineral soils at time 0 (tonnes C / ha) | Soil organic carbon stock in mineral soils at time 0-T (tonnes C / ha) | Number of years over a single inventory time period (Year) | Annual change in carbon stocks in mineral soils (tonnes C / yr) | |
| Land unit code | Initial land use | Land use during reporting year | National statistics or international data sources | National statistics or international data sources | National statistics or international data sources | | ΔCmineral = ((SOC(0) - SOC(0-T)) / T | |
| | | | A | SOC(0) | SOC(0-T) | T | ΔCmineral | |
| Total | | | 0 | | | | 0 | |

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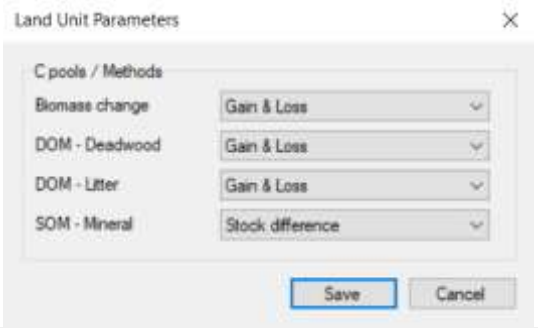
# Stock-Difference Method

Can be selected in the **Land Representation Manager** for each C pool (biomass/DOM/SOM) of each unit of land




SOM Organic Rewetted

Biomass change (G&L) | Biomass change (SD) | Biomass change (Abrupt) | DOM (G&L 1/1) | DOM (SD 1/1) | SOM Mineral (Approach 1 - Information item) | SOM Mineral (Approaches 2 and 3) | SOM Mineral (SD) | SOM Organic Drained

Worksheet

**Sector:** Agriculture, Forestry and Other Land Use

**Category:** Cropland

**Subcategory:** 3.B.2.a - Cropland Remaining Cropland

**Sheet:** Annual net C stock change in soil organic matter of mineral soils (Stock difference method)

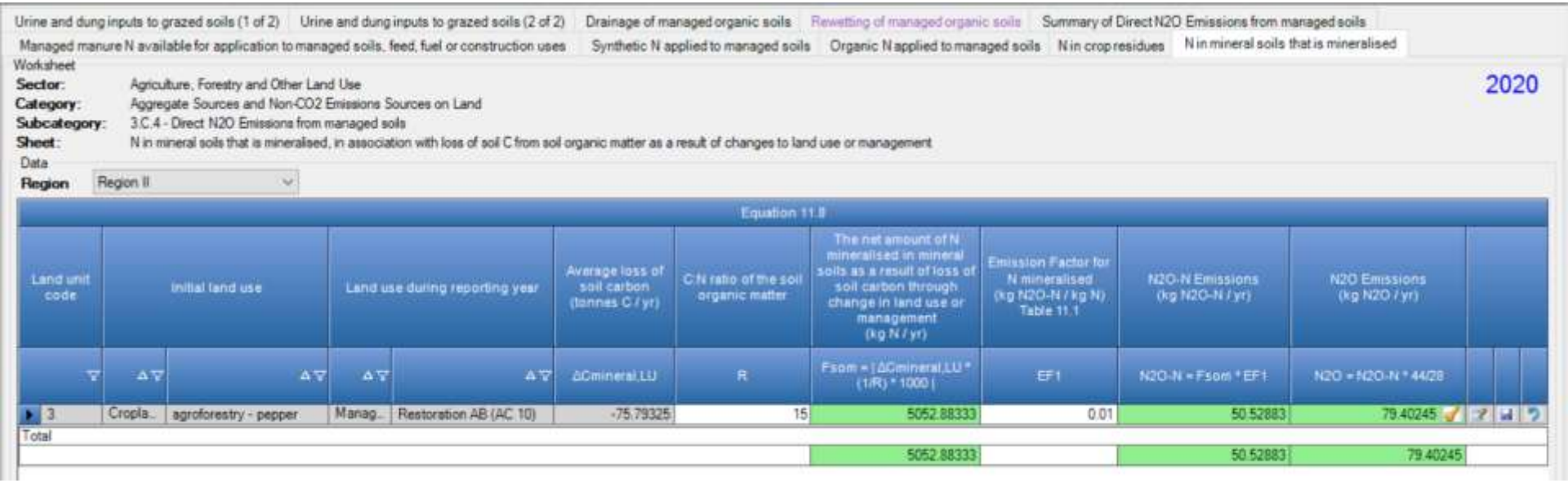
2020

Data

**Region** Region IV - **Approach 2**

| Land use category | | | Equation 2.5 | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area (ha) | Soil organic carbon stock in mineral soils at time 0 (tonnes C / ha) | Soil organic carbon stock in mineral soils at time 0-T (tonnes C / ha) | Number of years over a single inventory time period (Year) | Annual change in carbon stocks in mineral soils (tonnes C / yr) | |
| Land unit code | Initial land use | Land use during reporting year | National statistics or international data sources | National statistics or international data sources | National statistics or international data sources | | ΔCmineral = ((SOC(0) - SOC(0-T)) / T | |
| | | | A | SOC(0) | SOC(0-T) | T | ΔCmineral | |
| Total | | | 0 | | | | 0 | |

# Direct $N_2O$ emissions from managed soils



Urine and dung inputs to grazed soils (1 of 2) | Urine and dung inputs to grazed soils (2 of 2) | Drainage of managed organic soils | Rewetting of managed organic soils | Summary of Direct N2O Emissions from managed soils

Managed manure N available for application to managed soils, feed, fuel or construction uses | Synthetic N applied to managed soils | Organic N applied to managed soils | N in crop residues | N in mineral soils that is mineralised

Worksheet

**Sector:** Agriculture, Forestry and Other Land Use

**Category:** Aggregate Sources and Non-CO2 Emissions Sources on Land

**Subcategory:** 3.C.4 - Direct N2O Emissions from managed soils

**Sheet:** N in mineral soils that is mineralised, in association with loss of soil C from soil organic matter as a result of changes to land use or management

2020

Data

**Region** Region II

Equation 11.8

| Land unit code | Initial land use | | Land use during reporting year | | Average loss of soil carbon (tonnes C / yr) | C:N ratio of the soil organic matter | The net amount of N mineralised in mineral soils as a result of loss of soil carbon through change in land use or management (kg N / yr) | Emission Factor for N mineralised (kg N2O-N / kg N) Table 11.1 | N2O-N Emissions (kg N2O-N / yr) | N2O Emissions (kg N2O / yr) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ΔCmineral,LU | R | Fsom = \| ΔCmineral,LU * (1/R) * 1000 \| | EF1 | N2O-N = Fsom * EF1 | N2O = N2O-N * 44/28 | | | |
| 3 | Cropla.. | agroforestry - pepper | Manag.. | Restoration AB (AC 10) | -75.79325 | 15 | 5052.88333 | 0.01 | 50.52883 | 79.40245 | | | |
| Total | | | | | | | | | | | | | |
| | | | | | | | 5052.88333 | | 50.52883 | 79.40245 | | | |

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# Indirect $N_2O$ emissions from managed soils
## *leaching/runoff*

N2O from Atmospheric Deposition of N Volatilised from Managed Soils | N2O from N leaching/runoff from Managed Soils

Worksheet

**Sector:** Agriculture, Forestry and Other Land Use
**Category:** Aggregate Sources and Non-CO2 Emissions Sources on Land
**Subcategory:** 3.C.5 - Indirect N2O Emissions from managed soils
**Sheet:** N2O from N leaching/runoff from Managed Soils

2020

Data

**Region** Region II

| | | Equation 11.10 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Annual amount of synthetic fertilizer N applied to soils (kg N / yr) | Amount of animal manure, compost, sewage sludge and other organic N additions applied to soils (kg N / yr) | Amount of urine and dung N deposited by grazing animals (kg N / yr) | Amount of N in crop residues (above- and below-ground), including N-fixing crops, and from forage/pasture renewal, returned to soils (kg N / yr) | Amount of N mineralised in mineral soils associated with loss of soil C from SOM as a result of changes to land use or management (kg N / yr) | Amount of N mineralised in organic soils associated with loss of soil C from soil organic matter as a result of changes to land use or management (kg N / yr) | Fraction of all N added to/mineralised in managed soils that is lost through leaching and runoff (kg N / (kg of N additions)) | Emission factor for N2O emissions from N leaching and runoff (kg N2O-N/(kg N leaching/runoff)) | Amount of N2O–N produced from leaching and runoff of N additions to managed soils (kg N2O-N/yr) | N2O Emissions (kg N2O/yr) | |
| Land use category | Land use subdivision | | | | | | | Table 11.3 | Table 11.3 | N2O-N=(Fsn + Fon + Fprp + Fcr + Fsom + (N from Fos)) * FracLEACH-(H) * EF5 | N2O = N2O-N * (44/28) | |
| | | Fsn | Fon | Fprp | Fcr | Fsom | N from Fos | FracLEACH-(H) | EF5 | N2O-N | N2O | |
| Forest Land | Restoration AB (AC 10) | | | | | 5052.88333 | 0 | 0.3 | 0.0075 | 11.36899 | 17.86555 | |
| Total | | | | | | | | | | | | |
| | | 0 | 0 | 0 | 0 | 5052.88333 | 0 | | | 11.36899 | 17.86555 | |

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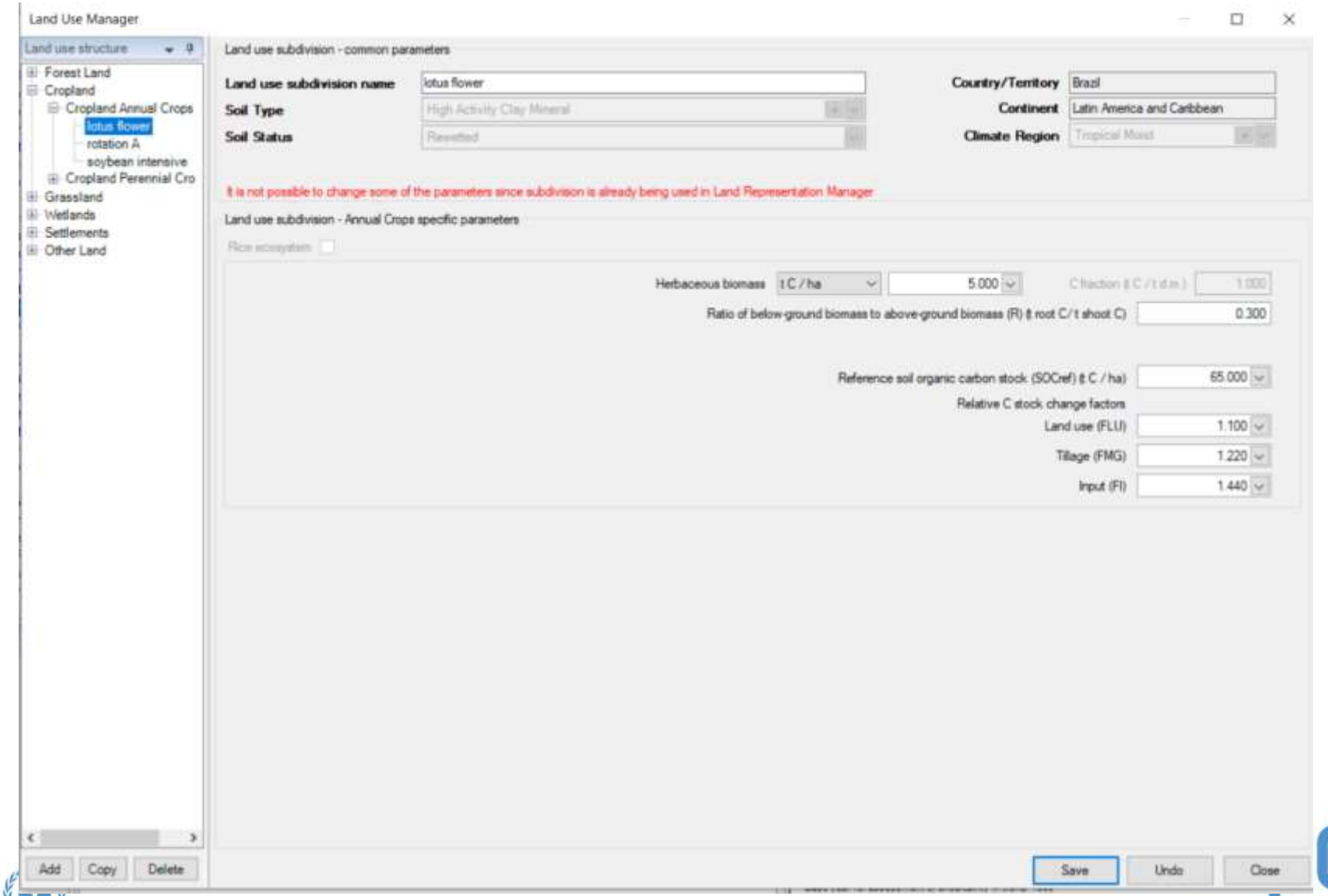
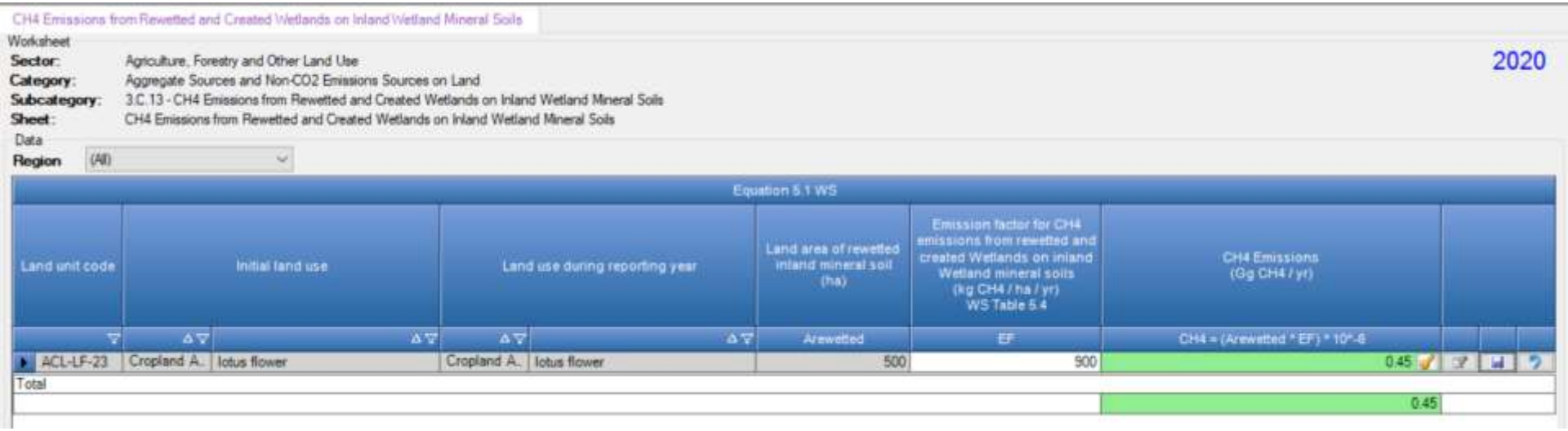
# $CH_4$ emissions from rewetted/created wetlands in inland mineral soils



# $CH_4$ emissions from rewetted/created wetlands in inland mineral soils



CH4 Emissions from Rewetted and Created Wetlands on Inland Wetland Mineral Soils

Worksheet

**Sector:** Agriculture, Forestry and Other Land Use

**Category:** Aggregate Sources and Non-CO2 Emissions Sources on Land

**Subcategory:** 3.C.13 - CH4 Emissions from Rewetted and Created Wetlands on Inland Wetland Mineral Soils

**Sheet:** CH4 Emissions from Rewetted and Created Wetlands on Inland Wetland Mineral Soils

2020

Data

**Region** (All)

| Equation 5.1 WS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Land unit code | Initial land use | | Land use during reporting year | | Land area of rewetted inland mineral soil (ha) | Emission factor for CH4 emissions from rewetted and created Wetlands on inland Wetland mineral soils (kg CH4 / ha / yr) WS Table 5.4 | CH4 Emissions (Gg CH4 / yr) |
| | | | | | Arewetted | EF | CH4 = (Arewetted * EF) * 10^-6 |
| ACL-LF-23 | Cropland A.. | lotus flower | Cropland A.. | lotus flower | 500 | 900 | 0.45 |
| Total | | | | | | | 0.45 |

*All elements sourced from the **2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands** are clearly identifiable because of the liliac color used.*

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# Thank you

https://www.ipcc-nggip.iges.or.jp/index.html

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