Climate MRV for Africa – Phase 2
Development of National GHG Inventory Croplands

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Cropland

- Cropland includes arable and tillable land, rice fields, and agroforestry systems where the vegetation structure falls below the thresholds used for the Forest Land category, and is not expected to exceed those thresholds at a later time. Cropland includes all annual and perennial crops as well as temporary fallow land (i.e.,
- land set at rest for one or several years before being cultivated again). Annual crops include cereals, oils seeds,
- vegetables, root crops and forages. Perennial crops include trees and shrubs, in combination with herbaceous
- crops (e.g., agroforestry) or as orchards, vineyards and plantations such as cocoa, coffee, tea, oil palm, coconut,
- rubber trees, and bananas, except where these lands meet the criteria for categorisation as Forest Land. Arable
- land which is normally used for cultivation of annual crops but which is temporarily used for forage crops or
- grazing as part of an annual crop-pasture rotation (mixed system) is included under cropland.





Relevant carbon pools for cropland

Biomass

- Above-ground biomass
- Below-ground biomass

Dead Organic Matter

Dead wood

Litter

Soil (soil organic mater)

Carbon storage

- The amount of carbon stored in and emitted or removed from permanent cropland depends on crop type, management practices, and soil and climate variables.

Cropland-calculation steps

- **Step 1:** Estimate annual loss of biomass due to conversion.
- **Step 2:** Estimate quantity of carbon released from fraction of biomass burned *on-site*.
- **Step 3:** Estimate quantity of carbon released from fraction of biomass burned *off-site*.
- **Step 4:** Estimate carbon released from decay of above-ground biomass.
- **Step 5:** Estimate total annual CO_2 release from burning and decay of biomass, resulting from forest and grassland conversion

Sources of Activity Data

AD factors	Tier 1	Tier 2	Tier 3
Area converted annually	FAO: Tropical Forests Assessment Report	National data on area conversion at disaggregated level If no national data use data from FAO: Tropical Forests Assesment	Ministry responsible for land resources Satelite or remote sensing
Average area converted (10-year average)			

Examples of cropland sub-categories

TABLE 5.4
EXAMPLES OF PERENNIAL CROPLAND SUB-CATEGORIES WHICH A COUNTRY MAY HAVE

Broad sub-categories	Specific Sub-categories
Fruit orchards	Mango, Citrus, Apple
Plantation crops	Rubber, Coconut, Oil, palm, Coffee, Cacao
Agroforestry systems	Hedgerow cropping (alley cropping), Improved fallow, Multi-storey systems, Home gardens, Boundary planting, Windbreaks

Source of Emission Factors

EF	Tier 1	Tier 2	Tier 3
Aboveground biomass before and after conversion	IPCC 2006 EFDB	National/regional scientific literature EFDB IPCC 2006	Data from national forest Inventory at finer scales according to forest/grassland categories Ecological/ silvicultural studies in different categories
Fraction of biomass burnt on-site and off-site			National forest inventory data Biomass consumption data according to forest/grassland categories
Fraction of biomass oxidised	Default value	Default value	National forest inventories
Carbon fraction of biomass	Default value	Default value	Published data at species level
Fraction of biomass left to decay	Default value	Default value	National forest inventory

Biomass

- The default method is to multiply the area of perennial woody cropland by a net estimate of biomass accumulation from growth and subtract losses associated with harvest or gathering or disturbance (according to Equation 2.7 in Chapter 2). Losses are estimated by multiplying a carbon stock value by the area of cropland on which perennial woody crops are harvested.

Biomass

- In accordance with the IPCC 2006 GL, carbon stock changes in biomass are only estimated for perennial woody crops (the biomass of annual crops is assumed to be in equilibrium). Perennial biomass can be found in orchards and vineyards.

Biomass

Carbon stock change of biomass (ΔCBiom) might be estimated applying Equation 2.15 of the IPCC 2006 GL:

$$\Delta CBiom = \Delta CG + \Delta C_{Conversion} - \Delta C_{loss}$$

Where:

- ΔCBiom = annual change in carbon stocks of biomass, tonnes C yr-1
- ΔCG = annual increase in carbon stocks due to biomass growth, tonnes C yr-1
- ΔCL = annual decrease in carbon stocks due to biomass loss, tonnes C yr-1
- ΔCConversion = annual carbon loss due to converting perennials to other land use, tones C yr-1.

The estimation should be done separately for orchards and vineyards, and separately for growth and losses, and for losses due to conversions where perennials are converted to annual croplands or other land use.

Biomass growth and loss

Carbon stock changes due to growth and loss might be estimated using Equation 2.7 of the IPCC 2006 GL:

$$\Delta C_{Biom} = \Delta C_G - \Delta C_L$$

Both orchards and vineyards are assumed to be grown in 30 year-long rotations. During the rotation, the plantations are assumed to have a linear increase of biomass (i.e., ΔCG), whereas they are assumed to lose all their biomass (i.e., ΔCL) in the year when they are regenerate.

Biomass growth and loss

The estimation of ΔCG might be done using Equation 2.9 of the IPCC 2006 GL:

$$\Delta CG = A_{perennials} * G_{TOTAL} * CF$$

- where
- $A_{perennials}$ = area of orchards and vineyards, respectively (taken e.g. from the statistics) in the inventory year, ha (all areas included that were perennials at the beginning of the inventory year),
- GTOTAL = county-specific net biomass accumulation rate, and
- CF = carbon fraction (the default value of 0.5 tC t biomass-1 might be used).

Biomass growth and loss

The annual decrease in carbon stocks from biomass loss due to regenerating perennials might be estimated using Equation 2.16 of the IPCC 2006 GL:

$$\Delta CL = Aperennials * B_{Before} * CF$$

where

- B_{Before} = biomass of the regenerated orchard or vineyard at the age of 30 years, t biomass, and is equal to GTOTAL (tC ha-1 yr-1) * 30 (years). (Since all biomass is considered loss during the regeneration, the "fraction of biomass lost in disturbance" term, or fd, in the equation is taken to be equal to 1.)

Below ground biomass in perennial vegetation

- The default assumption is that there is no change in below ground biomass of annuals plantations in agricultural systems. Default values for below ground biomass for agricultural systems are not available.

Dead Organic Metter

- Applying Tier 1 method the dead wood and litter stock are not present in croplands or are at equilibrium as in agroforestry systems and orchards. → No need to estimate the carbon changes for these pools
- In Tier 2 and 3 allow for calculations in dead wood and litter carbon due to management practices.

Mineral Soil

EQUATION 2.25
ANNUAL CHANGE IN ORGANIC CARBON STOCKS IN MINERAL SOILS

$$\Delta C_{Mineral} = \frac{(SOC_0 - SOC_{(0-T)})}{D}$$

$$SOC = \sum_{c,s,i} \left(SOC_{REF_{c,s,i}} \bullet F_{LU_{c,s,i}} \bullet F_{MG_{c,s,i}} \bullet F_{I_{c,s,i}} \bullet A_{c,s,i} \right)$$

(Note: T is used in place of D in this equation if T is ≥ 20 years, see note below)

Where:

$\Delta C_{Mineral}$ = annual change in carbon stocks in mineral soils, tonnes C yr^{-1}

SOC_0 = soil organic carbon stock in the last year of an inventory time period, tonnes C

$SOC_{(0-T)}$ = soil organic carbon stock at the beginning of the inventory time period, tonnes C

SOC_0 and $SOC_{(0-T)}$ are calculated using the SOC equation in the box where the reference carbon stocks and stock change factors are assigned according to the land-use and management activities and corresponding areas at each of the points in time (time = 0 and time = 0-T)

T = number of years over a single inventory time period, yr

D = Time dependence of stock change factors which is the default time period for transition between equilibrium SOC values, yr. Commonly 20 years, but depends on assumptions made in computing the factors F_{LU}, F_{MG} and F_I. If T exceeds D, use the value for T to obtain an annual rate of change over the inventory time period (0-T years).

c = represents the climate zones, *s* the soil types, and *i* the set of management systems that are present in a country.

SOC_{REF} = the reference carbon stock, tonnes C ha^{-1} (Table 2.3)

F_{LU} = stock change factor for land-use systems or sub-system for a particular land-use, dimensionless

[Note: F_{ND} is substituted for F_{LU} in forest soil C calculation to estimate the influence of natural disturbance regimes.

F_{MG} = stock change factor for management regime, dimensionless

F_I = stock change factor for input of organic matter, dimensionless

A = land area of the stratum being estimated, ha. All land in the stratum should have common biophysical conditions (i.e., climate and soil type) and management history over the inventory time period to be treated together for analytical purposes.

Organic soil

EQUATION 2.26
ANNUAL CARBON LOSS FROM DRAINED ORGANIC SOILS (CO_2)

$$L_{Organic} = \sum_{c} (A \bullet EF)_c$$

Where:

$L_{Organic}$ = annual carbon loss from drained organic soils, tonnes C yr^{-1}

A = land area of drained organic soils in climate type *c*, ha

Note: A is the same area (F_{os}) used to estimate N_2O emissions in Chapter 11, Equations 11.1 and 11.2

EF = emission factor for climate type *c*, tonnes C ha^{-1} yr^{-1}

Thank you!

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