CHAPTER 13.

# Land management $CO_2$ removals

*This chapter provides requirements and guidance on accounting for removals from carbon stock changes due to land management activities across agricultural land uses, from both a scope 1 and scope 3 perspective.*

## 13.1 Overview

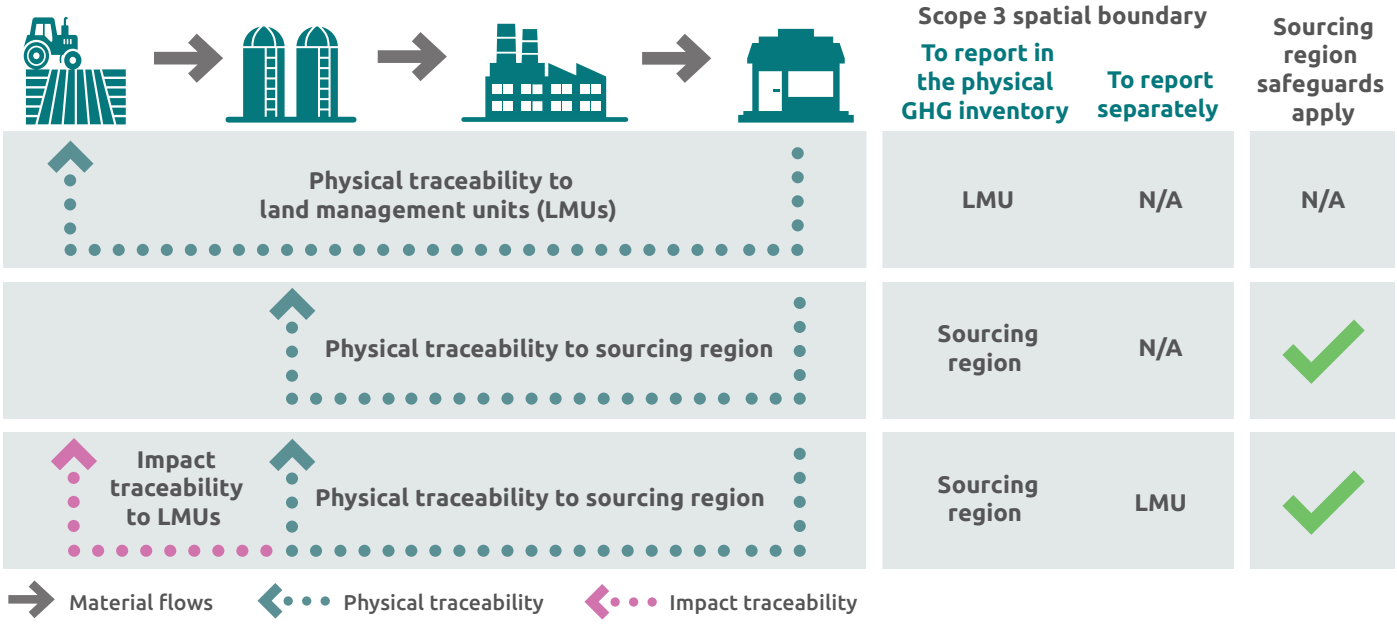
Land management $CO_2$ removals are net $CO_2$ removals resulting from net increases to carbon stored in land-based carbon pools (biomass, dead organic matter, and soil carbon pools) due to ongoing land management practices. All land management $CO_2$ removals are from biological sinks.

Accounting for agricultural land management $CO_2$ removals is subject to the $CO_2$ removal requirements provided in Chapter 12. Additionally, the following requirements must be met:

- Land management $CO_2$ removals are calculated using a stock-change accounting approach. Companies are required to estimate the net land carbon stock change for all required carbon pools. GHG inventories are designed to account only for direct anthropogenic impacts on land carbon stocks. All changes in land carbon stocks on existing productive agricultural land are considered anthropogenic (Requirement 19.LMR).
- Companies downstream from production (e.g., food processors, consumer goods companies, or retailers) must meet a certain level of traceability to identify the specific lands where carbon is stored (Figure 13.1, and Requirement 20.LMR).
    - Traceability to the LMU-level is not always possible due to information availability or supply chain time and space dynamics. Removals can be accounted for at the sourcing region level, provided that appropriate safeguards are met to ensure accuracy and mitigate double counting risks (see "sourcing region safeguards" in specific cases of Requirement 20.LMR below).
- Accounting for land management $CO_2$ removals requires data specific to the land carbon pools where the $CO_2$ is stored, either through regular measurements, calibrated modeling, or hybrid approaches (see Requirement 21.LMR).
- To ensure removed $CO_2$ remains stored, companies must have an ongoing monitoring plan to detect any future losses of stored carbon that may return to the atmosphere (see Requirement 23.LMR).

When land use change results in removals, companies first account for gross land use change emissions associated with any carbon stock decreases due to land use change following Requirement 10, and then may separately account for any annual land management $CO_2$ removals due to carbon stock increases of the subsequent land use in the year they occur.

**Figure 13.1 Removals with traceability to the sourcing region vs. the land management unit**




# 13.2 Requirements

## 13.2.1 Accounting requirements

*Note: Refer to Chapter 12 for general removals requirements.*

**REQUIREMENT 19.LMR:**

***Land management $CO_2$ removals accounting***

If companies account for and report land management $CO_2$ removals on productive agricultural lands in their GHG inventory, they **shall** meet the following requirements:

- **Accounting approach**: Companies **shall** account for and report land management $CO_2$ removals based on annual or annualized net land carbon stock gains occurring in the reporting year using stock-change accounting methods.
  - Companies **may** account for cropland carbon stock changes using monitoring frequencies at timescales that reflect the relevant crop rotation or crop cultivation cycle, if data quality requirements are met (see Requirement 21.LMR). See Section 9.4.3 in the Guidance for additional details.
- **Spatial boundaries**: Companies **shall** account for net land carbon stock changes from land management activities on all agricultural land in their scope 1 spatial boundary. Scope 3 land management $CO_2$ removals **shall** only be quantified using a sourcing region, land management unit or harvested area scope 3 spatial boundary.
  - See Requirement 5 and Requirement 14 to define the scope 1 and scope 3 spatial boundaries.
  - See Requirement 20.LMR for traceability requirements.

- **Carbon pools and land uses**: Companies **shall** account for the net land carbon stock change (rather than assuming no carbon stock change) for the carbon pools required in Requirement 14.
- **Anthropogenic impacts on agricultural land**: All changes in land carbon stocks on productive agricultural land in the reporting year are considered anthropogenic. Companies **shall** fully account for all net land carbon stock changes on all agricultural lands in the reporting year, including changes due to degradation and carbon stock losses from fires, storms, and other natural disturbances.

### REQUIREMENT 20.LMR:
### *Scope 3 land management $CO_2$ removals (LMR) traceability and sourcing region safeguards*

If companies account for and report scope 3 land management $CO_2$ removals on productive agricultural lands in their physical GHG inventory, they **shall** meet the following requirements:

- **Spatial boundary**: Companies **shall** define a sourcing region, land management unit, or harvested area scope 3 spatial boundary, which requires one of the following levels of traceability:
  - physical traceability to the LMU(s) where the carbon is stored;
  - physical traceability to the sourcing region where the carbon is stored; or
  - physical traceability to the sourcing region, and impact traceability to the LMU(s) where the carbon is stored (subject to Requirement 8).
- **Sourcing region traceability**: For companies defining physical traceability to a sourcing region, they **shall** establish physical traceability to the first point of aggregation or first processing facility in the sourcing region, or multiple first points of aggregation or processing facilities in close proximity that have overlapping sourcing areas to determine a single sourcing region covering the total area for all facilities.

## Specific cases

### REQUIREMENT 20.1.LMR:
### *Sourcing region safeguards*

If companies only have traceability to a sourcing region, they **shall** ensure the following safeguards are met to report land management $CO_2$ removals:

- **Same spatial boundary for emissions and removals**: To satisfy this safeguard, companies are required to follow Requirement 5 (“same boundary across accounting categories”).
- **Attributable productive lands**: To satisfy this safeguard, companies are required to follow Requirement 6. The sourcing radius from the first point of aggregation or first processing facility (or multiple first collection points in close proximity that have overlapping sourcing areas used to determine a single sourcing region covering the total area for all facilities), or other methods used to determine the sourcing region boundary **should** be spatially explicit and reflect documented raw material transport distances to the first point of aggregation.
- **Same allocation method**: Companies are required to follow Requirement 9 (“same allocation methods across metrics”); see the *Guidance* for details.
- **Capturing variability**: Sampling or inventory approaches for direct measurements of net carbon stock changes in sourcing regions or data used to calibrate remote sensing–based or model-based approaches

**shall** be based on a sampling scheme and sufficient sample size that is representative of the variation due to both natural factors (e.g., climate, vegetation, soil type, topography, etc.) and management factors (e.g., plantation forest age classes, prescribed fire management, cropping systems, tillage practices, etc.) throughout all attributable productive lands included in the sourcing region.

- **Conservative assumptions**: To satisfy this safeguard, companies are required to follow the reporting requirements in Section 12.2.2; see the *Guidance* for details.
- **Avoiding double counting**: To satisfy this safeguard, companies are required to follow Requirement 22; see the *Guidance* for details. For an example of how to implement this requirement, see "right to report" option in Section 13.3 below.
- **Reversal accounting**: To satisfy this safeguard, companies are required to follow Requirement 23; see the *Guidance* for details.
- **Separate reporting by spatial scale**: If a company has different levels of traceability for different products and both LMU-level and sourcing region–level spatial boundaries are used to account for land management $CO_2$ removals, the removals accounted for at each spatial scale **shall** be reported separately.
- **Transparency of claims**: Companies **shall** disclose information on the data and spatial boundaries used to determine the sourcing region boundary and estimate land management $CO_2$ removals within the sourcing region.

## REQUIREMENT 21.LMR:
## *Data quality for land management $CO_2$ removals*

If companies account for and report land management $CO_2$ removals on productive agricultural lands in their GHG inventory, they **shall** meet the following requirements:

- **Data specific to sinks and pools**: Companies **shall** account for and report land management net $CO_2$ removals only if the net carbon stock changes are accounted for using empirical data specific to the land carbon pools where the carbon is stored in the reporting company's operations or value chain.
- **Sampling**: Companies **shall** resample using consistent methods at least every five years to estimate carbon stock changes using measurement-based approaches or to calibrate model-based or remote sensing–based approaches.

*Note: **Requirement 22** appears in Chapter 12; Requirement 22 is a general removals requirement that applies to accounting for both land management $CO_2$ removals and $CO_2$ removals with geologic storage.*

**REQUIREMENT 23.LMR:**

### *Permanence for land management $CO_2$ removals*

If companies account for and report land management $CO_2$ removals in their GHG inventory, they **shall** adhere to the permanence principle by meeting the following requirements:

- **Ongoing storage monitoring**: Companies **shall** account for and report land management net $CO_2$ removals only if ongoing storage monitoring is documented in a land management plan or monitoring plan and implemented to ensure carbon remains stored in the landscape, and they can detect losses of stored carbon in relevant land-based carbon pools.
- **Losses of stored carbon**: Companies **shall** account for and report net land carbon stock losses of previously reported land management net $CO_2$ removals in the year the losses occur, as either:
  - "Land management net biogenic $CO_2$ emissions," if the carbon pools are within the inventory boundary in the reporting year; or
  - "Reversals of land management $CO_2$ removals," if the carbon pools are no longer within the inventory boundary in the reporting year.

If companies lose the ability to monitor land carbon stocks associated with previously reported removals or if the monitoring plan is not renewed, companies **shall** assume previously reported removals are emitted and report reversals from land-based storage.

## *13.2.2 Reporting requirements*

### *Reporting requirements for land management $CO_2$ removals*

If companies account for and report "land management $CO_2$ removals" in their physical GHG inventory, they **shall** disclose the following information in their GHG report:

- **Spatial boundary**: The selected scope 3 spatial boundary for land management $CO_2$ removals and verifiable evidence justifying how the boundary aligns with the "recommended considerations to determine the level of traceability and the scope 3 spatial boundary" in Section 5.3.
  - **Demonstrate improvement**: Evidence that demonstrates improvement over time towards the most appropriate scope 3 spatial boundary and level of traceability for the given production system, and any planned improvements.
  - **Proximate and adjacent non-productive lands**: If companies define a land management unit scope 3 spatial boundary and choose to include proximate and adjacent non-productive lands within that boundary (see Requirement 7), they **shall** provide evidence that demonstrates the requirements are met.
- **Carbon pools and land uses**: The specific land carbon pools included in their analysis of net carbon stock changes, including when "no carbon stock change" is assumed for a particular carbon pool and land use.
- **Sourcing region safeguards**: If applicable, a description of how each of the sourcing region safeguards was met, including necessary data and supporting information.
- **Sampling**: Description of sampling methods and frequency of resampling.

## 13.3 Recommendations and options

### Ongoing storage monitoring plan

The monitoring plan **should** include spatial boundaries; methods used to estimate carbon stock changes; the sampling approach to achieve representative estimates of land carbon stock changes, land carbon pools included; frequency of monitoring and resampling; and data quality control procedures.

The monitoring plan **should** be documented in one of the following resources:

- The land management plan for a given LMU or sourcing region.
- A monitoring plan or program developed by the reporting company, supply chain coalition, or third-party with relevant expertise.

### "Right to report"

A documented "right to report" is one approach companies **may** apply to account for and report scope 3 removals from a particular LMU or to consistently track scope 3 emissions from a given LMU over time. This approach may help prevent double counting with GHG credits when setting targets; help prevent double counting with other companies at the same tiers of the value chain; ensure free, prior, informed consent is provided by landowners or managers; and provide documentation of traceability.

- When establishing a "right to report," it is the landowner's or land manager's decision about:
  - Which GHG programs or systems (if any) the removals are accounted for; and
  - Whom within a given GHG program or system can account for the removals (e.g., downstream companies in the value chain of products they sell, GHG credit purchasers, etc.).
- To achieve the "right to report" to account for scope 3 emission reductions or removals from a particular LMU, the reporting company **should** have documented consent from the landowner, land manager, or their proxy. This includes those who represent the owner or land managers, such as—but not limited to—cooperatives, community-based organizations, and so on.
- The "right to report" **should** include the allocation method used to account for emissions, removals, and other metrics.
- Where the "right to report" is provided by the landowner or operator to a customer of its products or supply chain initiatives, that "right to report" **may** cascade through the supply chain (i.e., it can be double counted vertically across the different tiers from one shared value chain but not horizontally among the same tier from different value chains).
- The "right to report" documentation could provide evidence for impact traceability where downstream companies do not have physical traceability to an LMU or sourcing region, following Requirement 8.

# 13.4 Guidance for requirements and recommendations

This section provides additional guidance on accounting for and reporting land management $CO_2$ removals on agricultural land. Accounting for and reporting removals in this *Standard* is optional. This *Standard* is based on a stock change accounting approach that quantifies the net $CO_2$ flux; therefore, throughout the text, the term "$CO_2$ removals" is used to describe *net* $CO_2$ removals. If a company chooses to report land management $CO_2$ removals, it must calculate removals using a stock change accounting approach and meet the other requirements set forth in Chapters 12 and 13. Chapter 12 provides general removals accounting requirements, and Chapter 13 sets forth requirements that are specific to land management $CO_2$ removals.

Under the stock change accounting approach, land management $CO_2$ removals on agricultural land are synonymous with enhanced carbon storage in land-based carbon pools (i.e., where the carbon is derived from atmospheric $CO_2$). Net increases in carbon stocks in the system (i.e., total net increases across all land-based carbon pools) are used to estimate net $CO_2$ removals from the atmosphere. Net decreases in carbon stocks in the system are used to estimate net $CO_2$ emissions to the atmosphere and are accounted for as "land management net biogenic $CO_2$ emissions" (see Chapter 9).

Guidance for calculating land management $CO_2$ removals is provided in Section 13.5. This *Standard* also recommends that *gross* $CO_2$ removals are reported for transparency separately under the "gross $CO_2$ fluxes" accounting category, separately from the physical GHG inventory. Section 13.5.4 provides accounting and calculation guidance for companies that report "gross biogenic land $CO_2$ removals."

## 13.4.1 Traceability and sourcing region safeguards

As set forth in Requirement 20.LMR, if a company chooses to account for and report scope 3 land management $CO_2$ removals on agricultural land, the company must account for and report scope 3 removals only if the reporting company has established physical traceability throughout the full $CO_2$ removals pathway, including to the sink (where $CO_2$ is transferred from the atmosphere to non-atmospheric pools), to the carbon pools where the carbon is stored, and to any intermediate processes if relevant. For example, a company that purchases cocoa could utilize a mass balance chain of custody model to demonstrate the traceability of the cocoa they purchase through the value chain back to a specific cocoa plantation or a set of cocoa plantations producing such cocoa.

As set forth in Requirement 20.LMR, when accounting for land management $CO_2$ removals on agricultural land, to satisfy the general traceability requirement in Chapter 20, a company must establish the following:

- physical traceability to the LMU(s) where the carbon is stored (e.g., traceability to a specific farm, plantation, or ranch; or set of farms, plantations, or ranches); or
- physical traceability to the sourcing region where the carbon is stored (e.g., traceability to a first point of collection or aggregation for a given crop, to which all croplands producing that crop within a given sourcing radius supply); or
- physical traceability to the sourcing region, and impact traceability to the LMU(s) where the carbon is stored (subject to Requirement 8).

Table 13.1 describes the different types and levels of traceability required to satisfy Requirement 20.LMR, and the corresponding scope 3 spatial boundary, applicability of the sourcing region safeguards, and how to report scope 3 land management $CO_2$ removals. For requirements and guidance on defining the scope 3 spatial boundary (i.e., lands within the LMU or attributable productive lands within a sourcing region), see Requirements 6–8 and corresponding guidance in Chapter 5. If a company only has physical traceability to a sourcing region, sourcing region safeguards must be met, as set forth in Requirement 20.1.LMR.

**Table 13.1 Scope 3 land management $CO_2$ removals requirements by type and level of traceability**

| Type(s) of traceability | Level of traceability | Spatial boundary | Sourcing region safeguards | Reporting requirements |
|---|---|---|---|---|
| **Physical traceability** | Known land management unit(s) of origin where the carbon is stored | Land management unit | NA | Report as scope 3 land management $CO_2$ removals within the physical GHG inventory |
| | Known first point of aggregation or first processing facility | Sourcing region | Satisfy all sourcing region safeguards (see "sourcing region safeguards" below) | Report as scope 3 land management $CO_2$ removals within the physical GHG inventory |
| **Physical traceability and impact traceability** | Physical traceability to the sourcing region; and<br>Impact traceability to the land management unit(s) where the carbon is stored | Land management unit | Satisfy all sourcing region safeguards (see "sourcing region safeguards" below) | Report separately outside the physical GHG inventory (see Requirement 8) |

## Sourcing region safeguards

If a company chooses to account for and report land management $CO_2$ removals but can only establish physical traceability to a sourcing region, Requirement 20.1.LMR sets forth nine safeguards that the company must follow. Some of these safeguards build on a broader requirement and specify how that requirement must be implemented when a company sets a sourcing region scope 3 spatial boundary to account for land management $CO_2$ removals. The guidance below provides additional guidance for how the safeguards in Requirement 20.1.LMR are met:

- **Same spatial boundary for emissions and removals**: To satisfy this safeguard, companies are required to follow Requirement 5 (see "Same boundaries across accounting categories"): Companies **shall** apply the same scope 3 spatial boundary to account for all land emissions, removals, and other accounting categories in their inventory, for a given volume of a given product (e.g., the same attributable productive land in the sourcing region producing that crop or animal product) or other specific scope 3 activity (e.g., the same leased lands or investment properties).
- **Attributable productive lands**: To satisfy this safeguard, companies are required to follow Requirement 6: Companies that set a sourcing region-level scope 3 spatial boundary **shall** account for emissions, removals, and other metrics only on attributable productive agricultural lands in the sourcing region boundary. Specifically:
  - The sourcing region scope 3 spatial boundary **shall** only include attributable productive lands (see Requirement 6) that contributed to producing crops, animal products, or other agricultural products relevant to the reporting company. For additional guidance on determining attributable productive lands, see Chapter 5.
- **Same allocation method**: To satisfy this safeguard, companies are required to follow Requirement 9 (see "Same allocation methods across metrics"): The same allocation method **shall** be applied for emissions, removals, and other metrics within a given spatial boundary. Specifically:
  - Companies **shall** allocate carbon stock changes in the sourcing region to all materials using the same allocation method across the relevant attributable productive lands in the sourcing region, using the allocation decision tree,[1] based on the annual share of relevant material outputs produced within the

sourcing region. For example, if a company sources corn from a region with croplands that apply a corn-soy rotation and uses an economic allocation approach to allocate removals on relevant farmlands to the corn they purchase, they must also use economic allocation to allocate emissions on such farmlands.

Companies are also required to follow Requirement 22 (see "No over-allocating removals"): The sum of the allocated removals from an LMU, sourcing region, or technological $CO_2$ removal operation **shall** not exceed 100 percent of the removals occurring on the LMU, or sourcing region, or technological $CO_2$ removal operation in the reporting year. For example, a company sourcing both corn and soy from the above example must not allocate removals to corn using physical allocation and soy using economic allocation methods, as this applies two different allocation methods and has the potential to allocate more removals than are occurring in the sourcing region. Similarly, certification programs operating in such regions need to ensure that chain of custody systems, particularly mass balance programs, apply allocation methods in a way that prevents overallocation of removals to certified volumes.

- **Capturing variability**: For further guidance on sampling design, see Section 13.4.2 and Sections 9.5.3.1–9.5.3.4.
- **Conservative assumptions**: To satisfy this safeguard, companies are required to follow Requirement 21 (see "Uncertainty"): Companies **shall** provide quantitative uncertainty estimates for removals, including the removal value, the uncertainty range for the estimated removal value based on a specified confidence level, and justification of how the removal value does not overestimate removals. Specifically:
  - Companies **shall** use conservative estimates of carbon stock changes within the uncertainty range to estimate removals at a sourcing region level. For example, companies may select a conservative estimate lower than both the mean or median value in the uncertainty range or apply an uncertainty deduction to justify a removals value (see Section 12.4.3 for details).
- **Avoiding double counting**: To satisfy this safeguard, companies are required to follow Requirement 22 (see "Avoid double counting"): If companies account for and report removals in their GHG inventory, they **shall** not double count scope 3 removals from the same LMU, sourcing region, or technological $CO_2$ removal operation with other companies at the same or similar tiers of the value chain that source from or sell to that land management system or operation. Specifically:
  - Companies **shall** prevent the double counting of removals by ensuring that the attributable productive lands included in the sourcing region scope 3 spatial boundary when accounting for land management $CO_2$ removals attributed to a given volume of agricultural products are not also included in an overlapping land management unit scope 3 spatial boundary when accounting for removals attributed to other volumes of agricultural products within the reporting company's own value chain or in another company's value chain (i.e., annual carbon stock increases on one given land area must not be included in both a sourcing region scope 3 spatial boundary and an LMU scope 3 spatial boundary for two separate volumes of agricultural products with different levels of traceability). Note that where agricultural products are produced in sourcing regions where typical land management practices involve multi-output systems (e.g., crop rotations or intercropping), such productive agricultural lands can be attributed to multiple agricultural products, following the "same allocation method" safeguard above.
- **Reversal accounting**: To satisfy this safeguard, companies are required to follow Requirement 23 (see "Losses of stored carbon"): Companies **shall** account for and report net carbon stock losses of previously reported removals in the year the losses occur, as either net $CO_2$ emissions, if the carbon pools are within the inventory boundary in the reporting year, or reversals, if the carbon pools are no longer in the inventory boundary in the reporting year. Emissions or reversals from losses of stored carbon shall be allocated using the same methods as used in previous inventories, where the removals were reported. Specifically:

- Companies that previously reported removals at the sourcing region level **shall** continue to account for annual net carbon stock changes across all attributable productive lands in the sourcing region, and if annual net carbon stock decreases occur, report them as emissions (if they continue to source from that region) or reversals associated with net carbon stock losses of previously reported removals (if they no longer source from that region).

- **Separate reporting by spatial scale**: Companies **shall** satisfy the relevant safeguard set forth in Requirement 20.1.LMR, in addition to satisfying the disaggregated reporting specified in Requirement 31.
- **Transparency of claims**: Companies **shall** satisfy the relevant safeguard set forth in Requirement 20.1.LMR, in addition to satisfying the reporting requirements in Section 6.2.2.

### "Right to report" to avoid double counting

When a company has physical traceability to a sourcing region, and sets a corresponding scope 3 spatial boundary to account for land management $CO_2$ removals, there is a risk that attributable productive lands included within the sourcing region spatial boundary will also be included in an LMU-level scope 3 spatial boundary by a different reporting company (e.g., a different company that has physical traceability to an LMU or set of LMUs that are included in the attributable productive lands within the reporting company's own sourcing region scope 3 spatial boundary). If both companies in this situation account for and report land management $CO_2$ removals within their respective scope 3 spatial boundaries for all crops produced on such lands, this situation would lead to the double counting of removals, in violation of Requirement 22.

For example, Company A sources corn and has physical traceability to a Sourcing Region A that includes all attributable productive lands that produce corn in that sourcing region. Company B also sources corn and has physical traceability to LMU B, which produces the corn that Company B sources. If LMU B is within the attributable productive lands of Sourcing Region A, the double counting of removals could occur between the inventories of these two companies.

As set forth in Section 13.3, a documented "right to report" is one approach companies may apply to avoid the double counting of removals in situations like the example above. A right to report can also be used to avoid double counting with GHG credits, ensure free prior informed consent is provided by landowners or managers (see the recommendation in Section 5.3), and to provide documentation of traceability.

## *13.4.2 Data quality for land management $CO_2$ removals*

### Empirical data requirement and secondary data to support calculations

Empirical data on net land carbon stock changes should consist of direct measurements, through sampling-based approaches or inventories, of the carbon stocks within the company's operations or value chain, or direct measurements to calibrate model-based or remote sensing-based approaches (see Section 6.4.4.3 for general guidance on model calibration). For example, to quantify soil carbon stock changes due to agricultural management practices, a company could develop a soil sampling protocol to estimate soil carbon stock changes in the relevant croplands over time, or a soil carbon sampling protocol used to calibrate biogeochemical models representative of the relevant cropping systems.

Empirical data does not need to be generated by the reporting company: it may be gathered by the company directly, provided by a third party, or obtained in collaboration with value chain partners. Global average data on carbon stocks for a given climate type, ecological zone, and soil type (i.e., IPCC Tier 1 default carbon stock and stock change factors) are not sufficient to meet the empirical data requirement in Requirement 21.

To support land carbon stock change estimates, some average or proxy data that was not gathered from specific activities within a company's operations or value chain, but that is representative of such activities, may be used to support the calculations of net land carbon stock change estimates. Such secondary data should be representative of lands in the spatial boundary and drawn from peer-reviewed scientific literature, government statistics, or reports published by international institutions (e.g., FAO, CGIAR, UNEP, WRI) confirming the estimated value and associated uncertainty over multiple studies. The parameters in the following list are some examples of the types of parameters that may be based on secondary data representative of lands in the spatial boundary when calculating land carbon stocks or land carbon stock changes:

- Root-to-shoot ratios to estimate below-ground biomass based on above-ground biomass
- Wood density to estimate biomass from volume measurements
- Biomass, dead wood, or litter carbon content to estimate the mass of C from biomass
- Biomass conversion and expansion factors to estimate biomass from merchantable growing stock volume measurements

For example, carbon stock changes in perennial monoculture systems (e.g., oil palm plantations or orchards) may be estimated using activity data on the amount of carbon stock losses (e.g., pruning or replanting) and the total area experiencing a disturbance event, empirical data on growth rates (either measured directly or based on models calibrated using data specific to the crop system), and average data on the wood densities, root-to-shoot ratios, and carbon content of biomass representative of the woody perennial crop.

## Sampling design for empirical data collection and model calibration

As set forth in Requirement 21.LMR, companies must resample using consistent methods at least every five years to estimate carbon stock changes using measurement-based approaches or to calibrate model-based or remote sensing-based approaches.

The first step in establishing a resampling protocol using measurement-based approaches is to determine where to collect samples. For scope 1 accounting, companies should generate a sampling approach that is representative and inclusive of all lands included in their operational boundary. For scope 3 accounting, sampling points can be used to parameterize and verify model-based estimates (though model training and evaluation should rely on separate datasets).

Best practice sampling protocols will vary depending on the land use and carbon pool. In general, a set of lands should be sampled that represents the major soil types, climate, and production systems within a company's supply chain. For further guidance on measurement-based calculation approaches and guidance for collecting field data across land-based carbon pools, see Sections 9.5.3.2–9.5.3.4. Because of the cost associated with field (e.g., soil) measurements, companies should collaborate across the supply chain to coordinate measurements where scope 3 portfolios overlap between companies.

## Uncertainty

As set forth in Requirement 21, all companies that report removals, including land management net $CO_2$ removals, must also report quantitative uncertainty estimates for those removals. Companies must provide quantitative uncertainty estimates for removals, including the removal value, the uncertainty range for the estimated removal value based on a specified confidence level, and justification of how the removal value does not overestimate removals.

If companies choose to report removals, they are recommended to only report removals that are statistically significant based on the disclosed confidence level and uncertainty range. Where the probability density function of the net land carbon stock change contains a value of zero or negative values for probabilities greater than or equal to the significance level, such land carbon stock increases are not significant and should not be reported as land management net $CO_2$ removals.

### *Case Study: Indigo Ag—Land management removals requirements*

Indigo Ag (Indigo) is an agricultural technology company that acts as a project developer and measurement, reporting, and verification (MRV) partner for both carbon offset and scope 3 programs. In this capacity, Indigo works with companies to design land management programs that reduce emissions and enhance soil organic carbon removals for raw commodities in their supply chains.

#### PROGRAM DESIGN

Each scope 3 program consists of a defined set of agricultural fields that collectively supply a known volume of product, representing all or a portion of that product purchased by a company in a given year. Within the program boundary, Indigo supports physical traceability to the field-level through a site- or group-level mass balance approach applied within a single sourcing region and country, consistent with GHG Protocol guidance.

#### DATA COLLECTION & MODEL CALIBRATION

Indigo collects agricultural management data, including crop type, tillage methods, and fertilizer application, directly from participating farmers or agribusiness partners. These empirical data are specific to the lands where carbon is stored in the company's value chain (Requirement 21.LMR).

Secondary data sources, including government datasets, remote sensing data, and peer-reviewed literature, are used in combination with field boundaries to gather meteorological information, inform model inputs, and support model validation (Requirement 21.LMR).

Representative soil data are used to calibrate Indigo's model-based quantification approach at least every five years (Requirement 21.LMR). Soil data may come from direct sampling, research partnerships, or peer reviewed literature, provided the data are representative of the relevant soils, crops, geographies, and management practices for which removals are reported. Where soil samples are taken, cores are collected to a depth of 30 cm and analyzed for carbon concentration, pH, and bulk density. In years and fields where soil samples are not collected, soil attributes are derived using publicly available datasets relevant to the field boundaries.

#### MODELING & QUANTIFICATION

Indigo quantifies soil organic carbon (SOC) stock changes using DayCent-CR, a peer-reviewed[a] Tier 3 biogeochemical model that is calibrated and validated using representative empirical soil datasets. DayCent-CR ingests field-specific management data (described above) to model program outcomes at the point-level (see figure below).

SOC stock change is quantified over the cultivation cycle of the purchased crop. This cycle begins immediately after the harvest of the prior cash crop and ends with the harvest of the crop purchased in the reporting year, allowing Indigo to quantify net emissions and removals associated with the crop-specific production cycle.

Modeled results are produced at the field or management-zone level and then aggregated across the program boundary. If SOC stock increases within the program boundary over the cultivation cycle, the net carbon stock change is reported as a land management $CO_2$ removal.

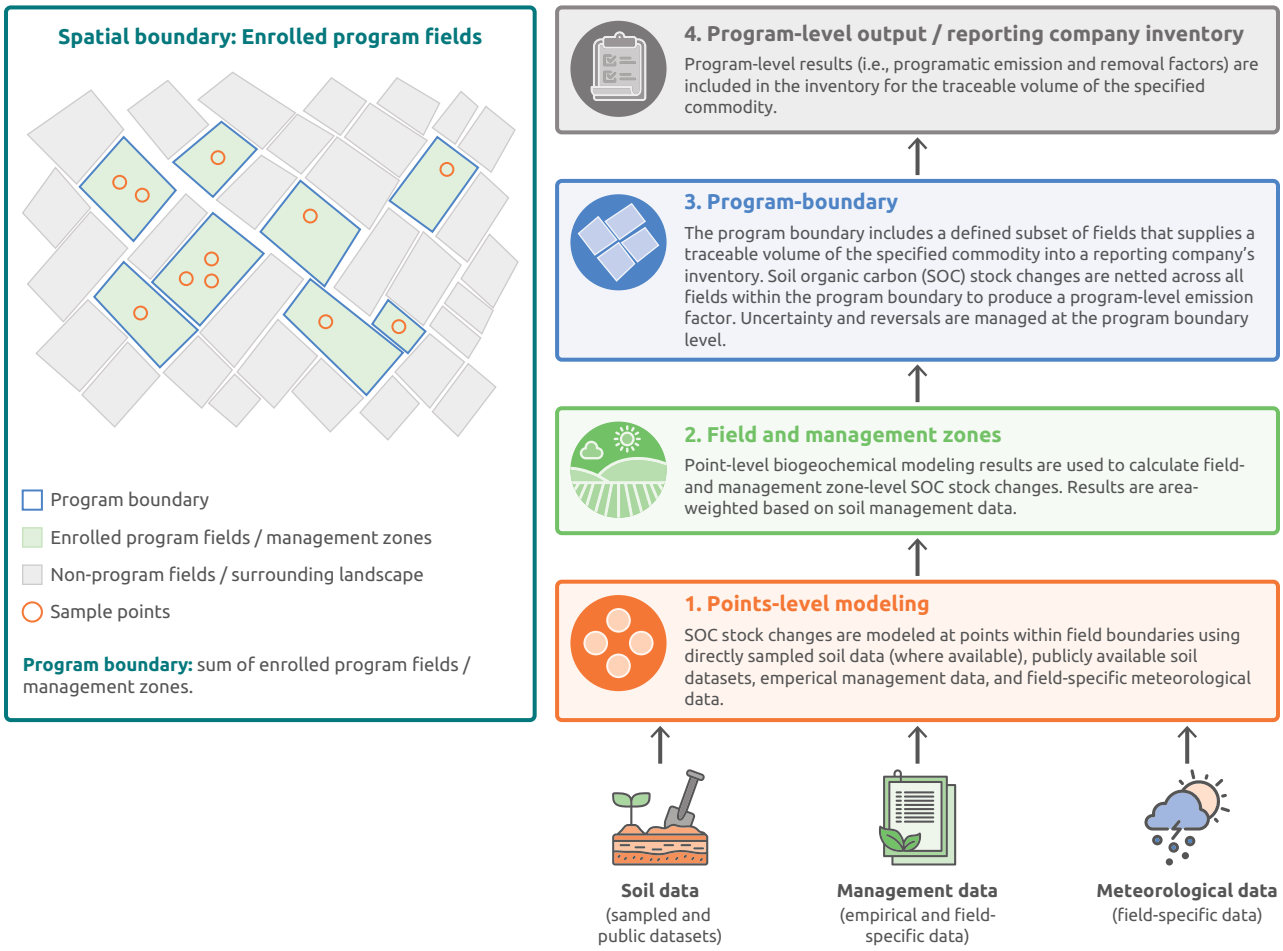
#### RESULTS & UNCERTAINTY

Indigo provides program-level emission or removal factors for the procured commodity, reflecting the volume weighted average outcome across all fields in the program boundary. Aggregating field-level results at the program level reduces uncertainty and the influence of field-level variability, providing a more decision-useful estimate for Scope 3 reporting.

## *Case Study: Indigo Ag—Land management removals requirements (cont.)*

To support inventory-ready removals, Indigo can provide quantitative uncertainty estimates for SOC removals in line with Requirement 21. The assessment integrates model prediction error and uncertainty associated with the underlying calibration and sampling data, supporting conservative reporting and helping avoid overestimation of removals.

***Empirical data, representative soil data, and model outputs are integrated across spatial scales to estimate net soil organic carbon stock changes within the program boundary***




### CONCLUSION

This case study demonstrates a practical pathway for scope 3 land management removals accounting. By aggregating outcomes at the program level and managing soil data, model calibration, and monitoring centrally, Indigo helps companies reduce uncertainty and operationalize removals requirements while maintaining the data quality, transparency, and conservativeness needed for GHG Protocol–aligned reporting.[b]

*Notes*: a. For additional detail see Brummitt et al. 2024. Disclaimer: The GHG Protocol has not reviewed and is not endorsing resources shared outside of this text box; b. Additional information on Indigo Ag's approach to agricultural emissions and removals quantification, including solutions for removals at all stages in a company's sustainability journey, is available at Indigo Ag.

## 13.4.3 Permanence for land management $CO_2$ removals

### Ongoing storage monitoring plan

Land managers, supply chain partners, or other entities developing a monitoring plan to account for and report land management $CO_2$ removals should specify the following information in their monitoring plan:

- **Spatial boundaries:** A description of the productive land and any non-productive lands included in the LMU-level spatial boundary or attributable productive lands included in the sourcing region spatial boundary that will be monitored.
- **Methods used to estimate carbon stock changes:** A description of the method (Stock-Difference or Gain-Loss) and of the calculation approach (factor-based, model-based, remote sensing-based, measurement-based, or hybrid approach). This description should include information about the relevant parameters that are quantified within the calculation approach.
- **Sampling approach to achieve a representative estimate of land carbon stock changes:** A description of the sampling design and protocol used to operationalize the monitoring approach (for further guidance on sampling approaches, see Sections 13.4.2 and 9.5.3.1–9.5.3.4).
- **Land carbon pools included:** A list of the carbon pools (biomass, dead organic matter, and soil) that are monitored directly (e.g., via a measurement-based approach) and indirectly (e.g., based on model- or remote-sensing-based approaches).

- **Frequency of monitoring and resampling:** A description of how often monitoring will occur (e.g., resampling frequency), and how often data and models will be recalibrated to estimate annualized carbon stock changes and to identify and report carbon stock losses.
- **Data quality control procedures:** A description of the methods used to quantify uncertainty and to resolve errors (e.g., in instrument calibration).

For example, a company could develop a land management plan, including an ongoing storage monitoring plan, as follows: A group of downstream companies in a given supply chain could work with farms implementing regenerative agriculture practices to develop a monitoring plan that includes soil carbon sampling on a five-year basis across a range of farms enrolled in a given program. A monitoring plan could include a description of the set of farms included in the spatial boundary that will be monitored, a description of the measurement-based approach and sampling design and protocol (e.g., sampling frequency and stratification by soil type), and procedures to quantify and reduce uncertainty.

Additional guidance for implementing an ongoing storage monitoring plan by scope is provided below:

- **Scope 1 land management $CO_2$ removals**: As set forth in Requirement 23.LMR, ongoing monitoring is required for land-based carbon pools associated with previously reported removals on lands owned or controlled by the reporting company. Ongoing monitoring of scope 1 land management $CO_2$ removals may be conducted by the reporting company or a third party (e.g., supply chain coalition or aggregator) in accordance with the guidance on accounting for annual carbon stock changes provided in Chapters 9 and 13. Such monitoring must be able to detect relevant carbon stock losses.
- **Scope 3 land management $CO_2$ removals**: Ongoing monitoring is required for all land-based carbon pools associated with previously reported removals on all LMUs, or attributable productive lands within sourcing regions, in the value chain of the reporting company. As set forth in Requirement 23, ongoing monitoring is required for all carbon pools associated with previously reported land management $CO_2$ removals, whether or not those carbon pools are part of the inventory boundary in the reporting year.

  Ongoing monitoring of scope 3 land management $CO_2$ removals may be conducted through data sharing agreements with the entity (or entities) that owns or controls the relevant LMUs or attributable productive lands within the sourcing region, directly by the reporting companies through agreements with the land manager(s), or by a third party (e.g., supply chain coalition or aggregator) in accordance with the guidance on accounting for annual carbon stock changes provided in Chapters 9 and 13. Such monitoring must be able to detect relevant carbon stock losses.

Options to help ensure ongoing storage monitoring in dynamic supply chains can include:

- Use of satellite imaging or other remote sensing approaches
- Applying a sourcing region-level scope 3 spatial boundary to account for net land carbon stock changes, in order to better ensure consistent spatial boundaries over time with changing suppliers
- If applying an LMU-level scope 3 spatial boundary, monitoring land management activities across relevant LMUs at a programmatic level to consistently detect land management practice changes through standardized methods (e.g., through collecting management data from relevant farms or using remote sensing tools)
- Working with supply chain partnerships or new third-party programs to build ongoing storage monitoring systems for specific products and geographies
- Developing contracts with suppliers or supply chain coalitions that specify data sharing agreements to enable ongoing storage monitoring

## Losses of stored carbon

As set forth in Requirement 23.LMR, companies must account for and report net land carbon stock losses of previously reported land management net $CO_2$ removals in the year the losses occur, as either:

1. **Land management net biogenic $CO_2$ emissions**, if the carbon pools are part of the GHG inventory boundary in the reporting year; or
2. **Reversals of land management $CO_2$ removals**, if the carbon pools are no longer in the GHG inventory boundary in the reporting year.

If companies lose the ability to monitor land carbon stocks associated with previously reported removals, companies must assume previously reported removals are emitted and report reversals of land management $CO_2$ removals.

For example, a food manufacturing company could account for scope 3 land management $CO_2$ removals associated with the agricultural products they purchased in 2020, based on the net carbon stock change across all land carbon pools on the relevant productive agricultural lands in 2020. If ongoing monitoring later reveals net decreases in the same land-based carbon stocks on land remaining in the company's inventory boundary in 2021, the company accounts for and reports such losses as scope 3 land management net biogenic $CO_2$ emissions in 2021. If the land-based carbon stocks were on land outside the company's inventory boundary, the company accounts for and reports such losses as reversals.

Additional guidance for reversals accounting by scope is provided below.

- **Scope 1 land management $CO_2$ removals**: When a company loses the ability to monitor land carbon stocks associated with previously reported scope 1 land management $CO_2$ removals, they are required to account for reversals in accordance with Requirement 23.LMR. If a company sells land where scope 1 land management net $CO_2$ removals were previously reported, base year recalculation may lead to factoring out previously reported emissions and removals associated with such lands, and reversals accounting is not required in such cases. For further guidance on base year recalculation, see Section 17.4.3.
- **Scope 3 land management $CO_2$ removals**: When a company loses the ability to monitor land carbon stocks associated with previously reported scope 3 land management $CO_2$ removals (e.g., a company changes sourcing regions and no longer has access to monitoring data from suppliers), they must account for reversals in accordance with Requirement 23.LMR. Companies that change suppliers and/or sourcing regions do not need to account for reversals if they can continue to monitor net carbon stock changes associated with previously reported removals. This can be achieved through agreements with producers (see the "right to report" option in Section 13.3), enrolling in scope 3 programs with policies to ensure ongoing storage monitoring with participating producers, or through remote sensing tools.

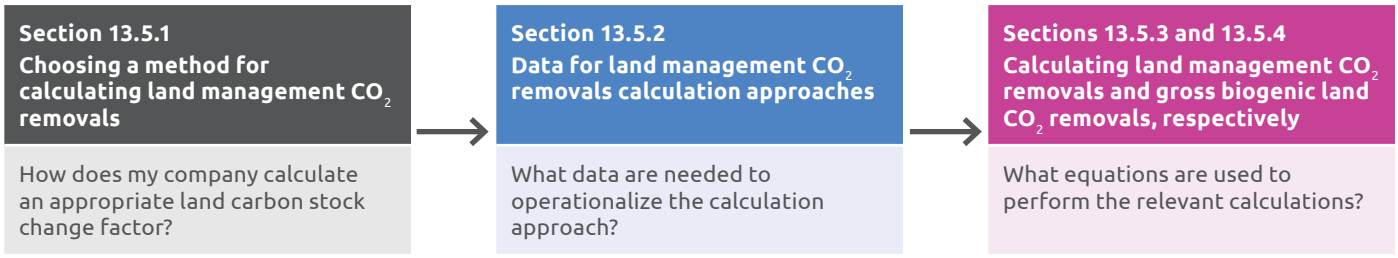
## 13.5 Calculating land management $CO_2$ removals

Figure 13.2 provides an overview of the calculation guidance in Section 13.5. Note that land management $CO_2$ removals are accounted for based on the net land carbon stock change; therefore, the calculation guidance in this chapter largely references the corresponding calculation guidance in Sections 9.5.3.2–9.5.3.4 in Chapter 9. These sections provide calculation guidance and methods for estimating carbon stock changes across specific land-based carbon pools, including:

- Biomass carbon stock changes (Section 9.5.3.2)
- Dead organic matter carbon stock changes (Section 9.5.3.3)
- Soil carbon stock changes (Section 9.5.3.4)

Section 13.5.4 provides calculation guidance for *gross* biogenic land $CO_2$ removals.

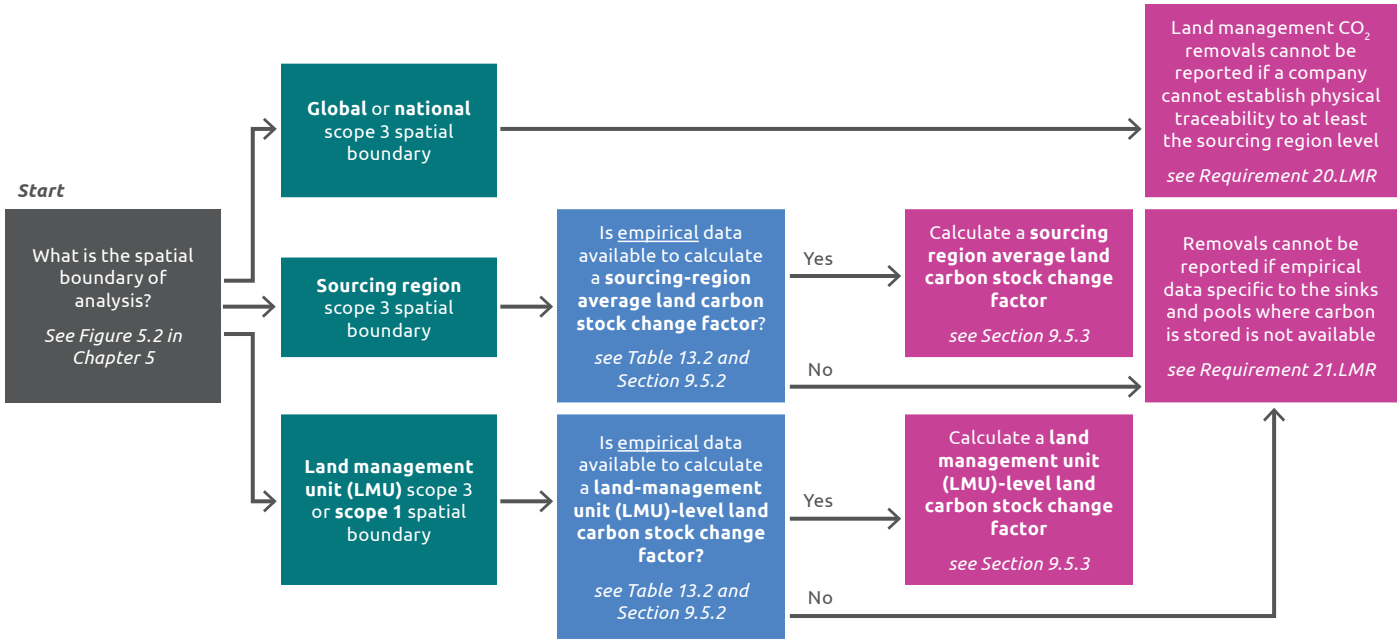
**Figure 13.2 Overview of Section 13.5**




### 13.5.1 Choosing a method for calculating land management $CO_2$ removals

Figure 13.3 provides a decision tree to assist companies in calculating a land carbon stock change factor to account for land management $CO_2$ removals.

**Figure 13.3** Decision tree for calculating land carbon stock changes to account for land management $CO_2$ removals




## 13.5.2 Data for land management $CO_2$ removals calculation approaches

Tables 13.2 and 13.3 provide an overview of the data needed to calculate a carbon stock change factor when accounting for land management $CO_2$ removals at a sourcing region- or LMU-level, respectively.

**Table 13.2** Data for calculating a sourcing region- or LMU-specific carbon stock change factor, when accounting for land management $CO_2$ removals

| Data | Description |
|---|---|
| **Empirical data specific to the sinks and pools where carbon is stored** | Empirical data on net carbon stock changes should consist of direct measurements, obtained through sampling-based approaches or inventories, of the carbon stocks within the company's operations or value chain, or direct measurements to calibrate model-based or remote sensing-based approaches (see Section 13.4.2 for additional guidance for land management $CO_2$ removals and Section 6.4.4.3 for general guidance on model calibration).<br>For example, to quantify soil carbon stock changes due to agricultural management practices, a company could develop a soil sampling protocol to collect data to estimate soil carbon stock changes on the relevant croplands over time or a soil carbon sampling protocol to collect data to calibrate biogeochemical models representative of relevant cropping systems.<br>Global average data on carbon stocks for a given climate type, ecological zone, and soil type are not sufficient to meet the empirical data requirement (i.e., IPCC Tier 1 default carbon stock and stock change factors). |
| **Some secondary data, as applicable** | To support carbon stock change estimates, some average or proxy data that was not gathered from specific activities within a company's operations or value chain, but that is representative of such activities, may be used to support the calculations of net carbon stock change estimates. Examples of average data that may be utilized include root-to-shoot ratios, wood density and carbon content, and biomass conversion and expansion factors. |

## 13.5.3 Calculating land management $CO_2$ removals

To calculate land management $CO_2$ removals, companies should follow the relevant calculation guidance for net land carbon stock changes in Chapter 9. Section 9.5.3 provides calculation guidance to calculate scope 1 and scope 3 net carbon stock changes (net positive or net negative) across all land-based carbon pools (Section 9.5.3.1), including biomass carbon stock change (Section 9.5.3.2), dead organic matter carbon stock change (Section 9.5.3.3), and soil carbon stock change (Section 9.5.3.4). Data and calculation methods for calculating net land carbon stocks used to account for land management $CO_2$ removals must meet the data quality criteria in Requirement 21 and Requirement 21.LMR (see Section 13.4.2 for details).

## 13.5.4 Calculating gross biogenic land $CO_2$ removals

Gross biogenic land $CO_2$ removals are calculated using flow accounting, based on the gross carbon flow from the atmosphere to storage within biomass carbon pools. Gross biogenic land $CO_2$ removals are largely the result of photosynthesis, where atmospheric $CO_2$ is converted to organic carbon in plant biomass through plant growth. For example, any annual growth in crops on croplands would be included when estimating gross biogenic land $CO_2$ removals, whereas the net biomass carbon stock change in most annual cropping systems is assumed to be zero (i.e., the carbon stock gains from biomass growth are equal to the carbon stock losses from harvesting and the decomposition of crop residues).

Gross $CO_2$ removals can be estimated by multiplying the annual increase in biomass carbon stocks on lands included in the relevant spatial boundary by negative 44/12 (to convert C to $CO_2$; see Equation 3.1). Biomass carbon stock gains can be represented by two distinct but related parameters, gross biogenic land $CO_2$ removals and annual biomass carbon stock increases:

- **Gross biogenic land $CO_2$ removals** are expressed in tonnes $CO_2$ per year and include all gross carbon transfers from the atmosphere to land-based carbon pools. Gross biogenic land $CO_2$ removal estimates are often based on proxy measurements of gross biomass carbon stock increases as opposed to direct measurement of $CO_2$ removals to land-based carbon pools. Companies estimate gross biogenic land $CO_2$ removals using data on all biomass carbon stock gains (i.e., both above-ground and below-ground biomass) that occur in land-based carbon pools due to plant growth, but not other transfers between land-based carbon pools, as these do not constitute a removal (i.e., they are not related to transfers of carbon from the atmosphere). For example, for maize cropping systems, this would include all growth associated with the maize plant during the year, but would not include increases to soil carbon stocks (e.g., due to changes to tillage practices).
- **Annual biomass carbon stock increases** are expressed in tonnes C per year and include all carbon stock gains within biomass carbon pools (i.e., both above-ground and below-ground biomass). This parameter is used in the Gain-Loss equation (see Equation 9.2) to quantify the annual net land carbon stock changes. Companies typically only estimate annual biomass carbon stock gains for woody perennial biomass, as any gains in herbaceous plant biomass are conservatively assumed to be lost in the same year, due to harvest, crop residue burning/consumption, or decomposition. If companies choose to account for such herbaceous carbon stock gains when applying

the Gain Loss equation, they must also account for herbaceous carbon stock losses. For example, in a typical maize cropping system, only carbon stock gains associated with woody perennial plants (e.g., trees planted as wind breaks) would be included in the estimate of annual biomass carbon stock increases. If companies choose to include any herbaceous biomass gains associated with the maize biomass when applying the Gain-Loss equation, they would also need to account for herbaceous carbon stock losses from harvest, crop residue burning/consumption, or transfers to the dead organic matter or soil carbon pool.

Companies quantify gross biogenic land $CO_2$ removals and/or annual biomass carbon stock increases based on the area of land in certain strata (e.g., ecological zone and climate domain) that remains in the same land-use category, multiplied by the annual average biomass growth for those strata. Equation 13.2 is used to estimate the annual average biomass growth, based on the average above-ground biomass growth and root-to-shoot ratios for specific vegetation types. Note, companies can also use the output of Equation 13.1 as an input for annual biomass carbon stock gains ($\Delta C\_G\_B_{l,a,y}$) in Equation 9.2 (Gain-Loss Method) when estimating the net land carbon stock change.

***Equation 13.1 Gross biogenic land $CO_2$ removals and annual biomass carbon stock increases***

$$CO2\_L\_GR_{l,a,y} = \left(A_{l,a,y} \times G\_T_{l,a,y} \times CF\right) \times \frac{44}{12}$$

$$\Delta C\_G\_B_{l,a,y} = A_{l,a,y} \times G\_T_{l,a,y} \times CF$$

| Description | | Unit | Source |
|---|---|---|---|
| $CO2\_L\_GR$ | Gross biogenic land $CO_2$ removals | tonnes $CO_2$ (year)$^{-1}$ | Calculated |
| $\Delta C\_G\_B_{l,a,y}$ | Annual biomass land carbon stock gains in land stratum *l*, in assessment area *a*, in year *y* | tonnes C (year)$^{-1}$ | Calculated |
| $A_{l,a,y}$ | Estimated area of land remaining in the same land use in land stratum *l*, in assessment area *a*, in year *y* | ha | User input |
| $G\_T_{l,a,y}$ | Average biomass growth above- and below-ground in land stratum *l*, in assessment area *a*, in the reporting year *y* | tonnes dry matter (ha)$^{-1}$ (year)$^{-1}$ | Equation 13.2 |
| $CF$ | Carbon fraction of dry matter | tonne C (tonne dry matter)$^{-1}$ | User input |
| $44/12$ | Conversion factor: C to $CO_2$ | | Constant |
| $a$ | Assessment area | | User input |
| $l$ | Land stratum | | User input |
| $y$ | Reporting year | | User input |

*Source*: Equation 2.9 in IPCC (2006), Volume 4: Section 2.3 ("Generic methodologies applicable to multiple land-use categories").

*Equation 13.2 Average annual biomass growth*

$$G\_T_{l,a,y} = \sum_{w} \left[ G_{w,l,a} \times (1 + R_w) \right]$$

| Description | | Unit | Source |
|---|---|---|---|
| $G\_T_{l,a,y}$ | Average biomass growth above and below-ground in land stratum *l*, in assessment area *a*, in the reporting year *y* | tonnes dry matter (ha)$^{-1}$ (year)$^{-1}$ | Calculated |
| $G_{w,l,a}$ | Average annual above-ground biomass growth for a specific woody vegetation type *w*, in land stratum *l*, in assessment area *a* | tonnes dry matter (ha)$^{-1}$ (year)$^{-1}$ | User input |
| $R_w$ | Ratio of below-ground biomass to above-ground biomass for a specific woody vegetation type *w* | tonne dry matter below-ground biomass (tonne dry matter above-ground biomass)$^{-1}$ | User input |
| $w$ | Vegetation type | | User input |
| $a$ | Assessment area | | User input |
| $l$ | Land stratum | | User input |
| $y$ | Reporting year | | User input |

*Source*: Equation 2.10 in IPCC (2006), Volume 4: Section 2.3 ("Generic methodologies applicable to multiple land-use categories"). See also section 5.2.1 in IPCC (2019a) for default factors.

When estimating gross biogenic land $CO_2$ removals default values for above-ground biomass growth and the ratio of below-ground biomass to above-ground biomass can be applied to estimate the average annual biomass growth. IPCC guidelines for national GHG inventories provide global Tier 1 estimates of average annual above-ground and below-ground biomass growth for specific vegetation types by land use (e.g., Section 5.2.1 in Volume 4 of the IPCC's *2019 Refinement* (IPCC 2019a) provides above- and below-ground accumulation rates in perennial woody crops in perennial cropland monocultures and agroforestry systems by climate domain or region, geographic region, and system). IPCC guidelines also provide root-to-shoot ratios (i.e., the ratio of below-ground biomass to above-ground biomass for a specific vegetation type) to estimate corresponding below-ground biomass growth.

Note that gross biogenic land $CO_2$ removals estimates based on IPCC global default values or proxy measurements of gross biomass growth, as opposed

to direct measurement of $CO_2$ uptake or gross primary productivity, do not meet the removals requirements to be used as an input in the Gain-Loss Method when accounting for net land carbon stock change and land management $CO_2$ removals.

For Tier 2 or 3 methods, quantifying annual average biomass growth is based on average biomass growth from country-level data, direct measurements, or calibrated model results. Companies may obtain Tier 2 data on above-ground and below-ground biomass accumulation rates from published literature or data used in relevant national GHG inventories. When Tier 3 methods are applied, companies may sample growth rates from repeated measurements in sample plots in accordance with measurement-based approaches or modeled growth rates based on calibrated model-based approaches (see Section 9.5.3.1 for general discussion of these calculation approaches).

## *Endnotes*

1 See "Scope 3 allocation recommendations" and "Agriculture sector allocation recommendations" in Section 6.3.

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