MARVIC
MRV for carbon farming

Policy brief
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# Baselines
# Discussion note from the MARVIC consortium

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## 1. Approach for quantifying the standard performance of agricultural practices and processes

The recommendations below are a summary of the 'baseline chapter' of MARVIC D1.2[1].
This deliverable explores the different options for rules and guiding principles for carbon farming schemes, i.e., baselines, additionality, permanence, leakage and double counting. So far, the analysis mainly focused on soil organic carbon (SOC) and arable land. When drafting the recommendations below, we mainly had SOC and arable land in mind. During the MARVIC project, the analysis will be further updated to take into account other agricultural land uses (i.e., grasslands, agroforestry, managed peatlands) and integrated into the MARVIC Monitoring, Reporting and Verification (MRV) Framework (D1.5).

We have identified different options to calculate baselines. Figure 1 provides an overview of these options. The following definitions were applied:
**Baseline** = evolution of carbon stocks under business as usual (BAU) management practices;
**Specific baseline**: calculated using data specifically characterizing the farm or field engaged in the carbon farming project;
**Standardised baseline** (in many carbon farming (CF) schemes also called 'generic' baselines): calculated using data that represent average conditions;

**Static***: a baseline that is calculated only once, at the beginning of the project;
**Dynamic***: a baseline that is recalculated during the lifetime of project, or at the end – taking into account the actual conditions;
** Note that the terminology of 'static' and 'dynamic' will most probably be changed during the project and replaced by for example 'ex-ante' or 'ex-post' as we have noticed it creates confusion.*

The way baselines are determined could roughly be distinguished by '**scale** category', i.e., standardised baselines vs specific baselines, '**calculation method** category', i.e. measure-remeasure, and modelling and '**time** category', i.e., static or dynamic.

[1] Lanckriet, E., Ruau, C., De La Sayette, M., Jubera, R., Lorand, L., Xu, H., & Ruysschaert, G. (2024). Rules and guiding principles for the MRV framework (Deliverable 1.2 of MARVIC project, V1.0). (Dissemination level: confidential) – *we are considering to publish the Baseline ideas over the coming months and get more feedback from the scientific community.*

Figure 1 provides an overview of major options to calculate baselines based on these three categories.

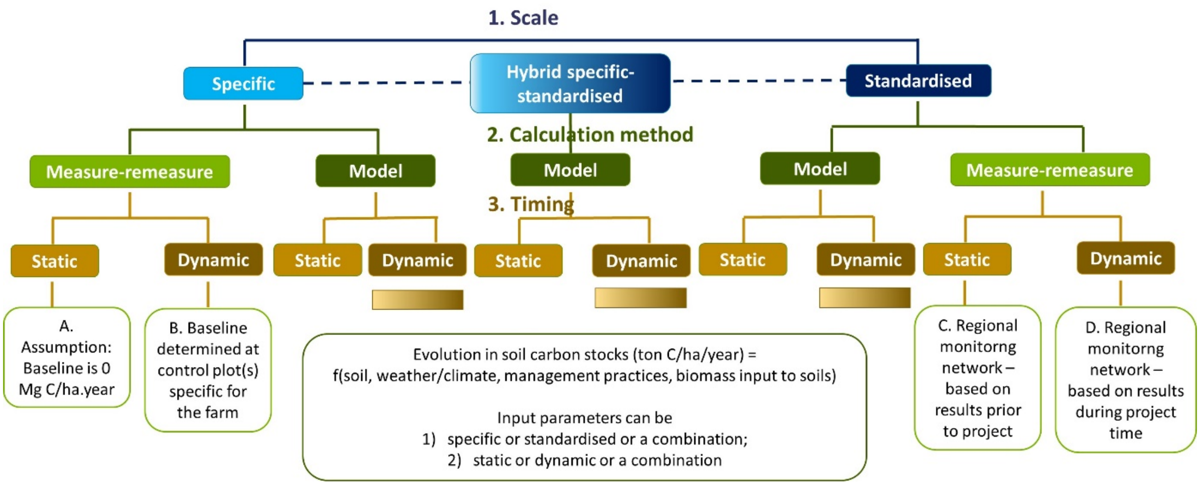


**Figure 1:** Different options for calculating baselines for carbon farming (derived from Lanckriet et al., 2024; MARVIC D1.2). The coloured bars under 'dynamic' indicate that with modelling some input parameters could be 'dynamic', others 'static'.

SOC dynamics are mainly dependent on four major categories of driving factors, i.e., soil conditions, weather/climate, management practices (all decisions farmers take) and biomass input to soils. Biomass input to soils is in its turn also dependent on soil conditions, weather/climate, management practices. When using a SOC model, we can choose to have a mix of an specific and standardised input parameters. Likewise, when opting for a modelled dynamic baseline, some input parameters might be static, others dynamic.

What baseline option should be chosen depends on different **criteria**, such as: what farmers prefer to incentivise, the choices made regarding the definition of additionality, the calculation method of the project line (e.g., chosen model, assimilation with Earth Observation (EO) data (yes/no)).

**Our general recommendations (for arable):**

1. To use a hybrid specific-standardised approach with an SOC model using **'specific' soil data** (e.g., clay content, initial SOC) and **'standardised' management'**.

2. To use for the quantification of the baseline the **same quantification method** as for the project line a.o., same model, same method to estimate biomass inputs (e.g., EO or not).

» Using the soil-specific data and the same quantification method for baseline and project line requires that only standardised management is provided to carbon farming schemes and not baseline values (if some freedom is given to the schemes regarding the quantification method for project lines).

**1. Hybrid specific-standardised approach with SOC model using 'specific' soil data and 'standardised' management**

The reason is that soil characteristics (e.g., clay and initial SOC content) influence the carbon removal result of the carbon farming management practices (see Figure 2 as an example). First movers, for example, might have higher SOC stocks than the average in the region, and might as a result sequester less carbon as maintaining high SOC stocks requires already high SOC inputs. When a baseline is calculated with the soil characteristics of the field where the CF practices are applied, the first mover will always do better than the standard management in the region. When using average soil characteristics, this is not guaranteed, which might cause frustration and a feeling of injustice.

As maintaining high carbon stocks (regardless of the reason of these high stocks) usually requires better management than average, calculating baselines with soil-specific

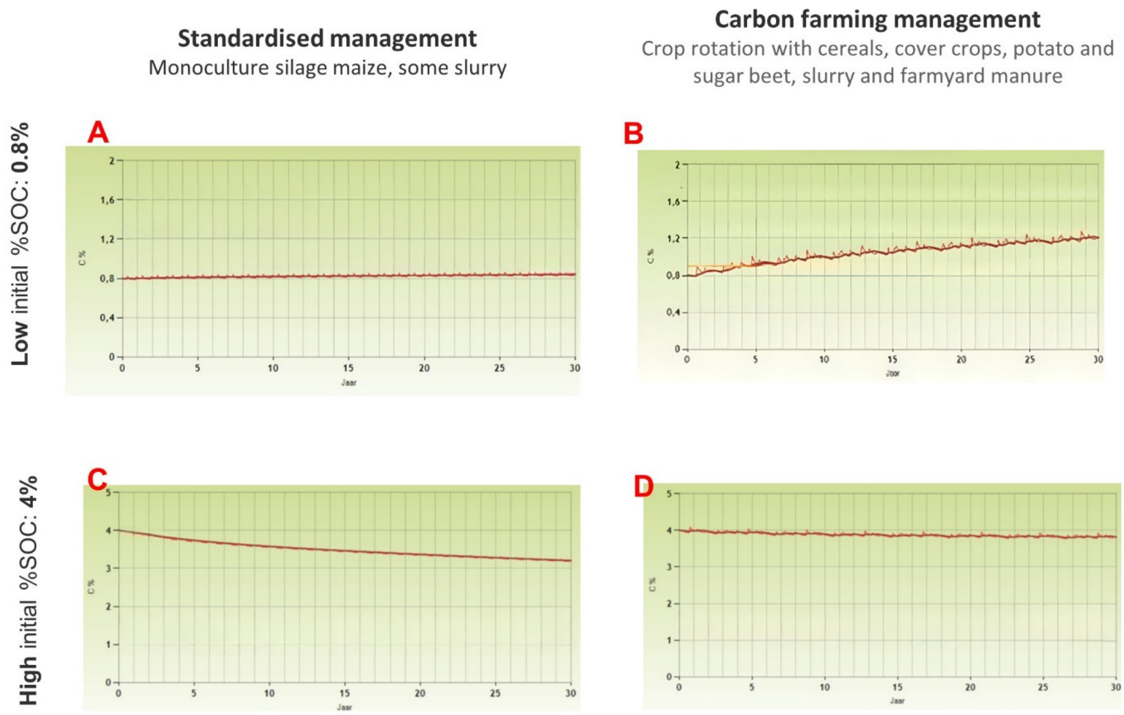


**Figure 2.** Simulation with a RothC-based model of carbon contents under standard management practices (maize monoculture; left) and under carbon farming management practices (crop rotation with cereals, cover crops, farmyard manure, right). At the top the SOC evolution is shown when starting from a low initial SOC and at the bottom starting from a high initial SOC. When using the same initial SOC (A vs B or C vs D), carbon farming management will always be incentivised, as opposed to using the average SOC for the baseline, when A might be compared with D or C with B (Lanckriet et al., 2024 MARVIC D1.2).

information guarantees also that management that is resulting in maintaining high carbon stocks can be incentivised.

The approach of calculating baselines with 'specific' soil data implies that a baseline will be parcel specific and thus needs to be calculated parcel-specific by parcel (or per unit of 'homogeneous land'). This also requires good soil data, which could result from initial soil sampling at parcel level or improved soil maps. This might seem to be a disadvantage but this information is required anyway for quantifying project lines.

## 2. Baselines should be calculated with the same quantification method as the project line

When using the same input parameters different models will result in different SOC simulations. Therefore, the project line and baseline should be calculated with the **same model** (that is locally validated and calibrated if needed).

**Biomass carbon inputs to soils** (roots, exudates, aboveground biomass residues) are an important driver for SOC. There are several approaches to assess these inputs, such as using fixed average values per crop type, using yield statistics for a region (accounting for the average year effect), using farm-specific yield data (often not available for non-cash crops) or using Earth Observation (e.g. Agri-carbonEO[2]. Using EO has the advantage of capturing spatial variability within and between fields of aboveground biomass, as well as effects between years, e.g., due to extreme weather events such as drought and flooding which causes a decrease in photosynthetic activity and the capacity of plants to capture $CO_2$ from the air and transmit carbon to the soil.

Due to extreme weather events, carbon sequestration could be less than anticipated by farm management. When detailed approaches such as EO are used to quantify the project line, the same should be done for

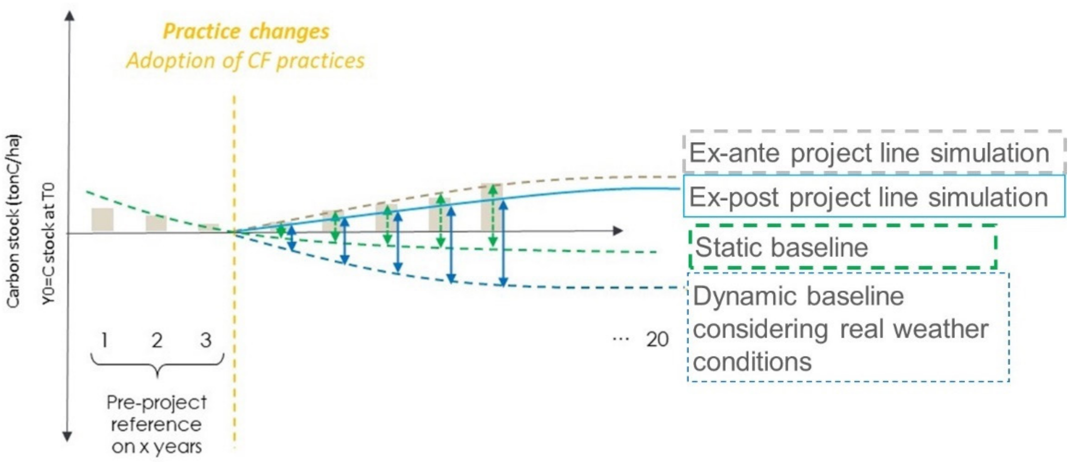


**Figure 3**: Illustration of the impact of dynamic baselines using real weather conditions (and biomass carbon input to soil) (Lanckriet et al., 2024 MARVIC D1.2).

[2] https://www.cesbio.cnrs.fr/agricarboneo/agricarbon-eo/

the baseline, as also under business as usual or standard management there would be an impact of these extreme weather events on SOC dynamics, as illustrated in Figure 3. EO could be used to quantify average biomass carbon inputs to soils for a given region (or farm type or cropping system) in the years preceding the start of the project (static baseline) or during the years of the project (dynamic baseline). The latter has the advantage that actual conditions were taken into account both for the baseline and for the project line.

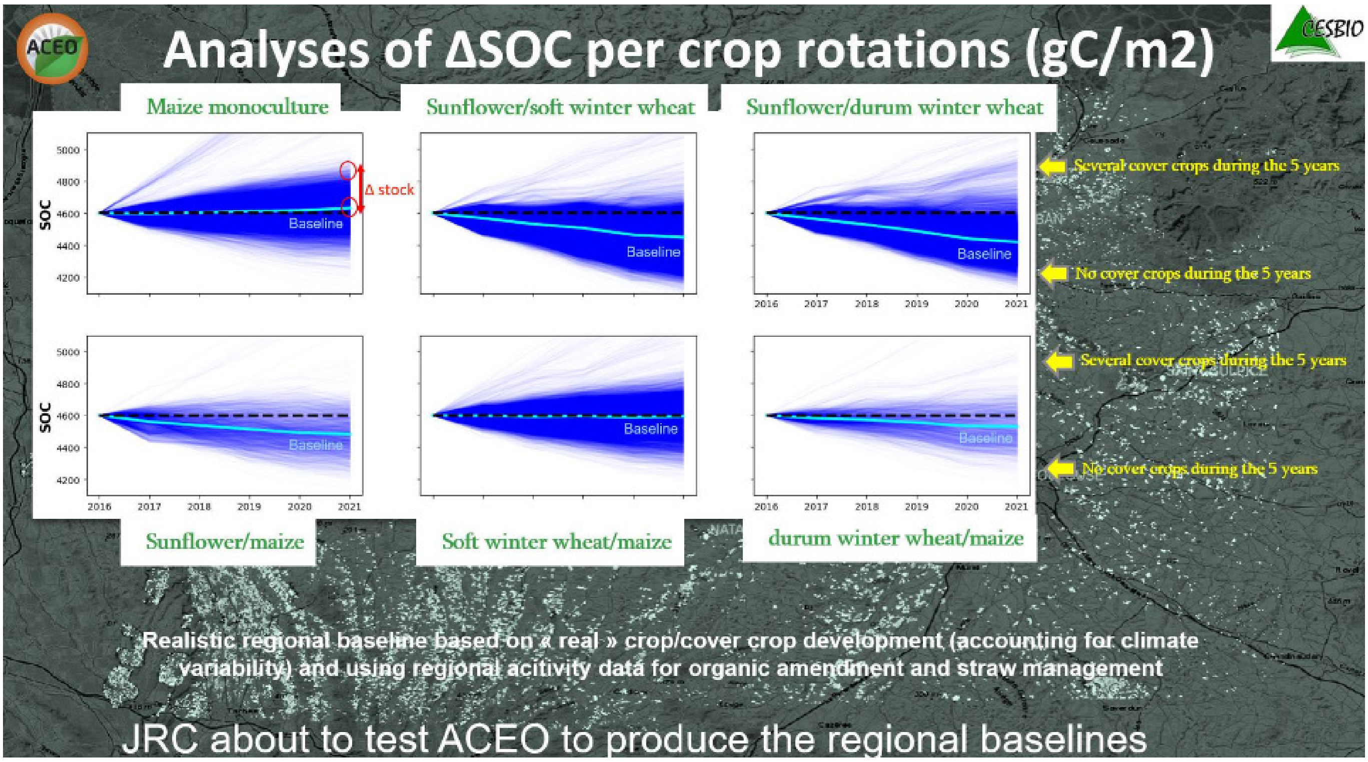


**Figure 4**: Example of baselines quantified with (cover) crop carbon inputs determined with EO (slide of INRAE/Cesbio).

Figure 4 illustrates how baselines could be calculated using crop carbon input to soils derived from EO. In Figure 4, this is done per crop rotation, but the same calculation could be done for a certain region or farm type in a region.

<u>**3. Pros and cons of other baseline options**</u>

- **Specific baseline measure-remeasure (static):** this approach assumes that the baseline is 0 ton C/ha.year, but in reality soils are not in a steady state and are emitting or sequestering carbon under a business as usual scenario;

- **Specific baseline measure-remeasure (dynamic):** the advantage is that the non-steady state character of the baseline can be captured and that actual (weather) conditions are the same as under the project. It requires control plots where

BAU practices are maintained (time consuming and costly);

- **Standardised baseline measure-remeasure:** this requires a soil carbon monitoring network for which emission factors per land use type/soil type are calculated. This approach has the same disadvantages as the described above, i.e., that it does not account for differences between average soil conditions and the specific soil conditions of a project.

- **Specific baselines (modelled or with control plots)** have the advantage is that technical additionality is assured (but not necessarily financial additionality or average practice additionality). This approach also ensures that famers with less sustainable management practices in the past can be incentivised (low hanging fruit); in contrast, when standard management is used, the barrier might be too large as they first have to bridge the gap to this standard management.

## 2. Boundaries to define "comparable practices and processes in similar social, economic, environmental, technological and regulatory circumstances"

The issue of boundaries is a critical topic that requires further discussion within the MARVIC consortium. This is essential to ensure that comparable practices and processes are accurately defined and appropriately applied across different regions. There is a notable diversity of opinions within the consortium, reflecting the varied farming conditions across regions.

- **Regional variability and dominant farm types:** In regions with dominant farm types and crops, some advocate for setting standard management per crop type or rotation. This approach is straightforward and ensures consistency within a specific crop type. However, regions with a high heterogeneity of (mixed) farm types and cropping systems would suggest to set a standardised management per farm type or land use (e.g., arable, grasslands). Benchmarking per farm type has the advantage to encourage best management practices within that type without favouring one over another. The disadvantage is that this approach may not adequately address mixed-activity farms, which are common in some regions.

- **Other crops as carbon farming practice:** Within a given land use or farm type, a carbon farming practice could be to include more crops in the rotation that provide higher carbon inputs into the soil, or that are harvested earlier so that cover crops can be sown earlier, leading to higher cover crop biomass, or that are sown later providing the potential for longer cover crop growth in spring (extended destruction).

- **Calculating average carbon inputs:** An option could be to calculate the average carbon inputs from (cover) crops to the soil per parcel (for arable land) within a given region or farm type. This would involve setting this as a characteristic for 'standard' management, regardless of the (cover) crop types grown (as opposed to select the 'standard' crops in a region and calculate biomass input for those crops as the standard).

- **Defining boundaries and regional considerations:** The boundaries – whether based on crop type, farm type or land use - and the size of the region to consider will depend on specific situations. The boundaries likely need to be defined by the Member States (MS). It is crucial to carefully investigate the impact of boundary choices on individual farms. This includes considering economic, social and environmental factors to ensure that the chosen boundaries are fair and effective.

- **Leakage:** The risk for leakage should also be very carefully investigated, when boundaries are not set per crop type, there could be a shift in crops that are more favourable for carbon farming targets, leading to a potential risk of leakage.

One way to overcome this could be, just like in whole farm Life Cycle Assesment (LCA) analysis, to calculate carbon sequestration per unit of protein or other nutritional values.

## 3. At which level should the different variables be defined? i.e, farm, pixel level, etc.

This issue is not broadly discussed in the MARVIC consortium yet, although we agree that this is very important to define.

In practice, some variables will be determined at the pixel, field, farm level or regional level. For instance:

- Data derived from EO technologies, such as satellite imagery, that are typically determined per pixel;
- Soil maps that can be polygons or pixels;
- Application of organic amendments that is determined per farm or pixel (in case of sensors on machines), or regional statistics.

The level of quantification will depend on the availability of data in a given context, which varies across Europe. In practice, for the project lines, sometimes some fields are grouped or clustered to simplify the approach.

Rather than defining the level of quantification universally, it should be defined **at what level the accuracy should be calculated and verified.** This depends on the purpose of the MRV:

- **Off-setting (field level).** For carbon offset projects, accuracy is often verified at the field level to ensure precise accounting of carbon removals and emissions.
- **In-setting (farm level or field level).** Carbon removals will need to be allocated to certain crops, just like is done for LCA of products at the farm. However, challenges arise when fields used by a farm vary from year to year. We notice a shift towards the field level, with the last version of the international standards demanding field level MRV when possible.

- **LULUCF (regional/national level).** For reporting under the Land Use, Land Use Change, and Forestry (LULUCF) Regulation, accuracy needs to be verified at the regional or national level. This approach aligns with broader policy goals and targets.

For carbon farming, we can question if verification of the accuracy of the quantification method should be performed at the field level or rather at the regional level, allowing some overestimation at one field and some underestimation at another field. While this might cause some injustice between farmers, the main goal for carbon farming is to reach LULUCF targets, which are determined at the regional or country level.