Carbon Action MRV: Agricultural Fields' Carbon Measurement, Reporting, and Verification System

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Why

- Companies and policymakers need a simple and reliable method to assess the carbon balance of agricultural fields.
- Accurate carbon assessments are essential for sustainability strategies, greenhouse gas inventories, and developing new climate and agricultural policies.
- Carbon Action, a regenerative farming initiative, has developed a carbon monitoring system to support this progress.

Our system

- Carbon Action MRV is a **scalable**, largely automated system to monitor agricultural fields' carbon balance (**Fig. 2**).
- It links satellite-based plant growth estimates with soil carbon calculations using the Yasso model.
- The system is **designed for large-scale applications**, analyzing hundreds or thousands of fields.
- **Carbon Action MRV system explained in a video:**

Specifications

- **Open science**: Transparent, fully documented, supports third-party verification
- **Designed for international use**: Relies on EU Copernicus Programme's satellite data, accessed via the Finnish Meteorological Institute's Arctic Space Center
- **Scientific validation**: Uses the Yasso soil model, which is widely used in Earth system modeling and national greenhouse gas inventories, meeting the UNFCCC and IPCC standards

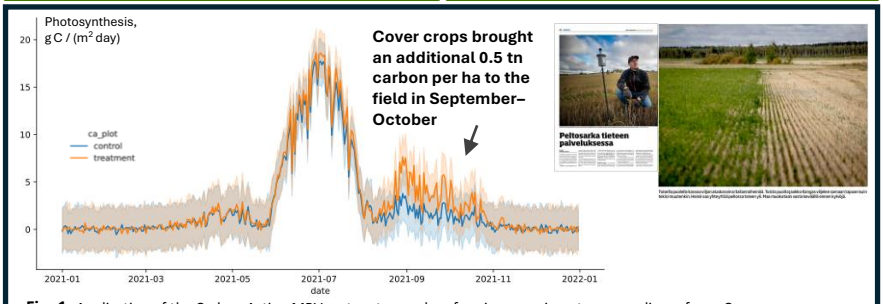

Fig. 1. Application of the Carbon Action MRV system to a carbon farming experiment on an ordinary farm. Cover crops increased soil carbon input by approximately 0.5 tons per hectare in September and October compared to the no-cover-crop control, representing about 10% of the annual input.

How it works

Biomass

- Daily plant growth and photosynthesis are derived from satellite chlorophyll data and weather sunlight data.
- These estimations are calibrated using eddy covariance stations, which continuously measure carbon dioxide fluxes between agricultural fields and the atmosphere (**Fig. 2a**).
- Biomass is calculated daily from accumulated photosynthesis production.
- Carbon input to soil is calculated annually from the accumulated biomass, harvested yield, and organic fertilizer additions (**Fig. 2b**).

Soil carbon

- Soil carbon stocks and annual changes are tracked using the Yasso model, which refines the estimates with soil carbon measurements.
- The Yasso model has been developed from global soil carbon and litter decomposition datasets and has been tested extensively in diverse ecosystems.

IT system

- The system is integrated into the Finnish Meteorological Institute's IT framework, supporting large-scale applications, like weather services.

Field Observatory

- The system is linked to the Field Observatory, an online platform providing real-time data from study sites (**Fig. 2a**).

Way forward

- Carbon Action is **continuously developing** the MRV system by expanding research and testing applications in international and national projects (**Fig. 1**).
- **Industry pilots**: Collaborating with food companies to test supply chain usability.
- **Policy support**: Assisting in national greenhouse gas inventory development and result-based farmer subsidy schemes.
- The Carbon Action MRV system offers a **science-based carbon estimation service for national and international stakeholders**.

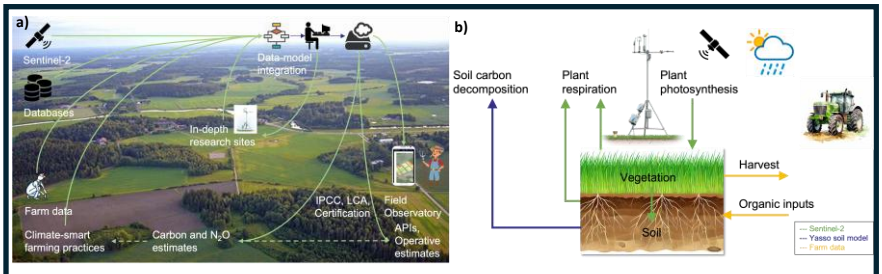

Fig. 2. a) Carbon Action MRV system for monitoring the carbon balance of agricultural fields. **b)** The system estimates biomass growth using Sentinel-2 satellite chlorophyll data and weather-based sunlight (photosynthetically active radiation, PAR) data, simulates soil carbon with the Yasso model, and incorporates farm data on harvested yield and organic inputs.

Links and references

www.bsag.fi/en/carbon-action-en/
www.fieldobservatory.org
www.fmi.fi/en/yasso

Vira et al. 2025. Preprint. https://doi.org/10.22541/essoar.173712580.08052217/v1
Nevalainen et al. 2022. https://doi.org/10.5194/gi-11-93-2022
Karhu et al. 2012. https://doi.org/10.1016/j.geoderma.2012.06.007

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