ΣOMMIT: SUstainable Management of soil Organic Matter to MItigate Trade-offs between C sequestration and nitrous oxide, methane and nitrate losses

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WP1: Coordination and management

- The ΣOMMIT project evaluates **trade-offs and synergies** between soil C sequestration, nitrous oxide, methane and nitrate losses as affected by **soil management options** aimed at increasing soil C storage.
- The integrated and interdisciplinary approach will address the main **pedo-climatic conditions** and farming systems in Europe.

General objective: to assess:

- **what** (nature and quality of OM inputs),
- **how much** (quantity of OM inputs),
- **how** (application method of OM inputs),
- **when** and **where** (pedo-climatic conditions) soil management practices applied in mineral soil agro-ecosystems **increase soil C sequestration** while **mitigating** the **trade-offs** with soil N_2O and CH_4 **fluxes** and **N losses.**

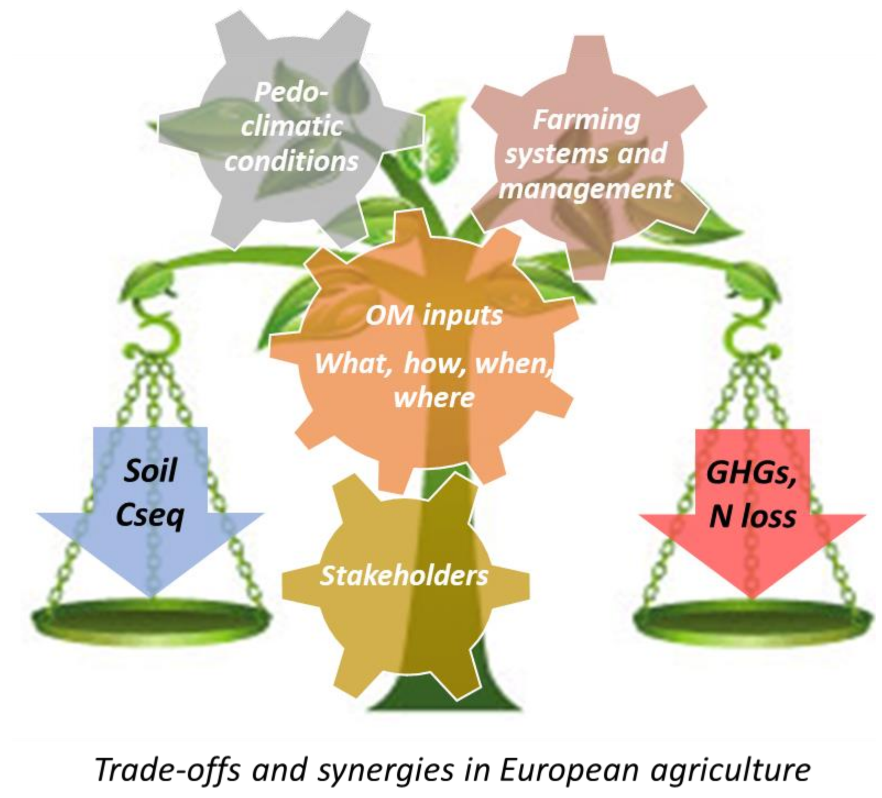


Figure 1. Schematic representation of the concept "trade-off" between soil carbon sequestration and the greenhouse gas emissions with four main regulating aspects.

WP2: Research synthesis and meta-analysis

Soil management strategy	SOC change		N_2O emission mitigation		CH_4 emission mitigation	N leaching	
Tillage management	no-tillage	non-inversion tillage	?		?	?	
Cropping systems	ROT; LEG; ORG; CONS		CONS; CC; CC incorpor-ated into the soil; CG; CF	CONS; ORG; PER	ORG; AGF; CG; CF	CC; LEG; ORG	
Water Management					?		
Fertilization and OM input – *Crop residues*					N/A		
Fertilization and OM input – *Cover crops*	non-legume	legume	non-legume	legume	N/A	non-legume	legume
Fertilization and OM input – *Livestock manure, slurry and compost*			?		N/A	N/A	
Fertilization and OM input – *Biochar*							
Fertilization and OM input – *Liming*					N/A		

N/A: Not Assessed; no-tillage (zero-till); non-inversion tillage (minimum/ reduced tillage); legume; non-legume

Impact: Positive (green color), negative (red color), no difference (grey color)

positive | negative | neutral

Articles here:

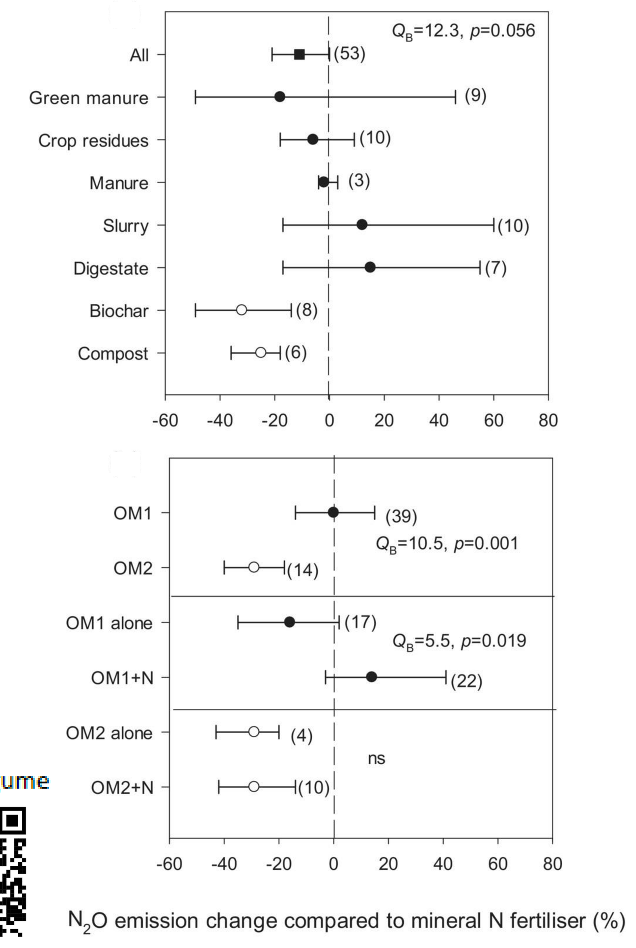


Figure 2. Summary of knowledge gap report (left) and sub-group analysis of organic matter input meta-analysis (right). OM1 is the grouping of compost and biochar and OM2 are the other organic materials.

- Synthesis of available literature to deliver a **knowledge gap** (white boxes in Figure 2) **report** .
- Meta-analysis with available data in European croplands**: compost and biochar** decreased the N_2O emissions, regardless of their application strategy whereas other organic materials did depend on their **application strategy**.
- **Manure, slurry and digestate** did not increase the N_2O emissions when applied **as substitute** of N fertilization but did increase the emissions when applied **on top** of the mineral N fertilization.

WP3: Targeted measurements LTEs*

*LTEs: Long term experiments

Targeted, novel measurements on key LTEs in the field and in the lab to:

- Evaluate the effects of **long-term application** of C input practices on the resilience of the soil to climate change, regarding greenhouse gas emissions with a **pedo-climatic gradient** considered..
- Increase our understanding on the microbial mechanisms involved in **N_2O and CH_4 fluxes in relation to C sequestration,** addressing soil management histories resulting in different SOM content and composition.

In the lab:

- Focus on C inputs in **cropland**
- Undisturbed **soil cores**
- **Laser-based spectrometers** for gas analysis

Figure 3. Gradient of C:N ratios: slurry, solid manure, compost, crop residues, and biochar.

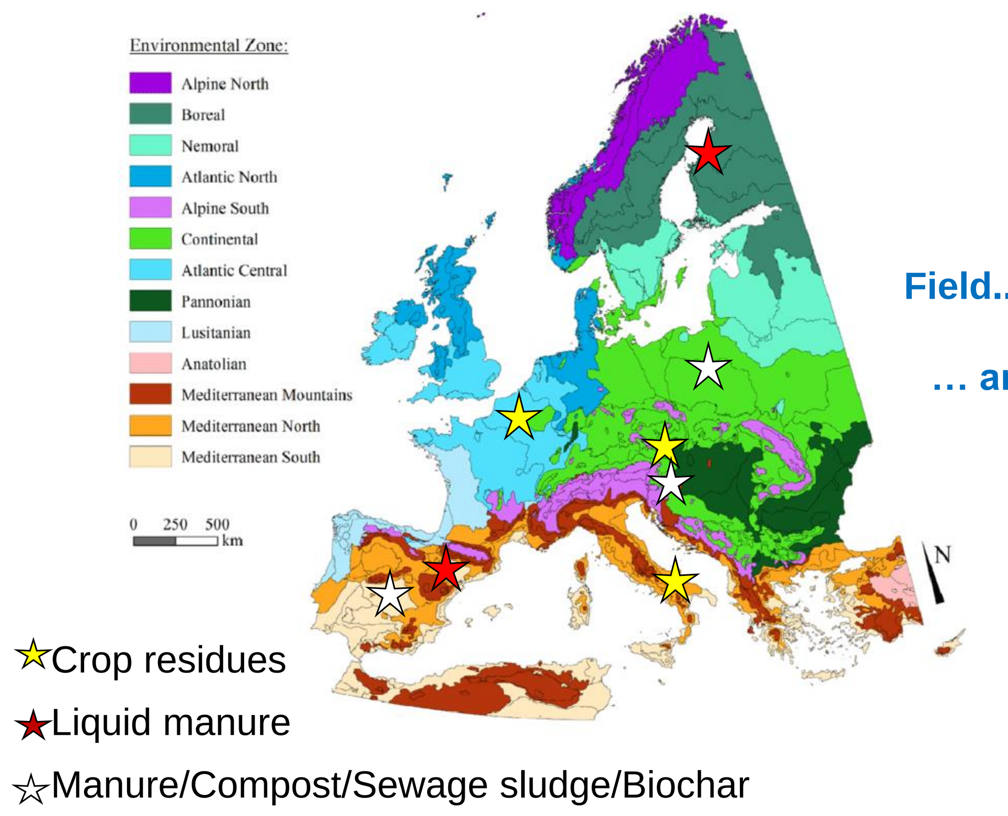


Figure 4. Location of long-term experiments on the environmental stratification of Europe. Adapted from Metzger et al. (2005). Glob. Ecol. Biogeogr. https://doi.org/10.1111/j.1466-822X.2005.00190.x

Figure 5. Field gas measurements (top) and lab gas measurements (middle) with soil cores (bottom).

WP4: Modelling and simulation experiments

N_2O treatments comparison (STICS model) in a long-term field experiment with automated chambers

		Treatment
T1	CONV	CONventional management
T2	RT	Reduced Tillage
T3	RT-RR	Reduced Tillage and Residues Removal
T4	RN	Reduced Nitrogen
T5	RN-LEG	Reduced Nitrogen and LEGuminous crops
T6	RR-PER	Residues Removal and PERennial crops
T7	ORG	ORGanic Agriculture
T8	ORG-A	ORGanic Agriculture with Alfalfa

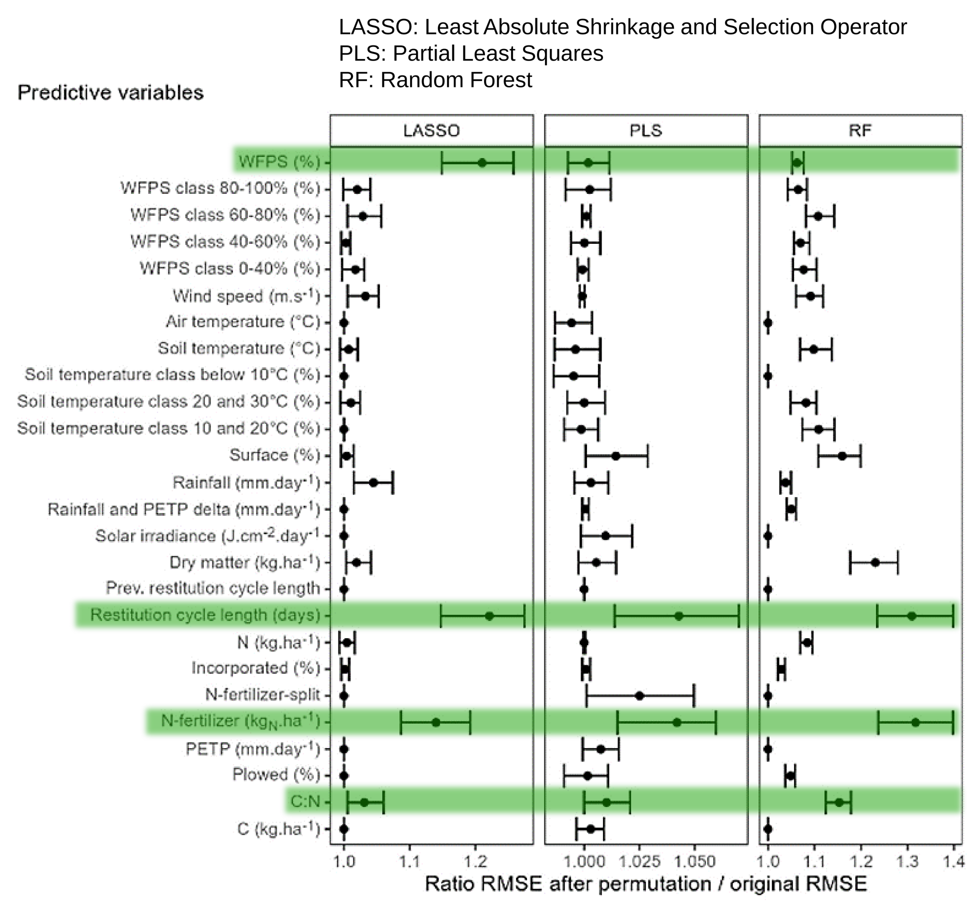


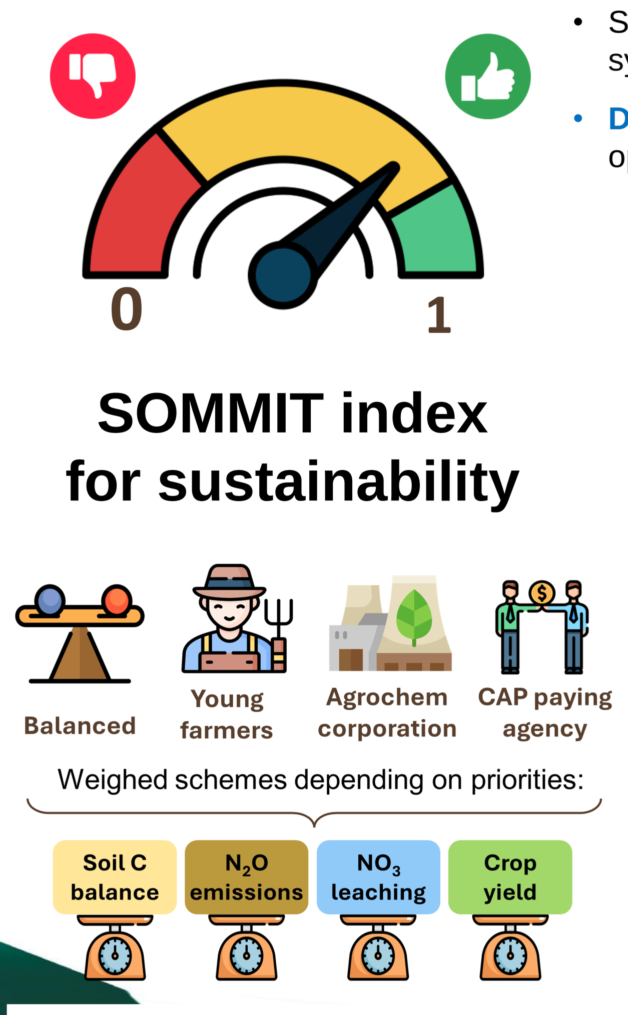
Figure 6. Field treatments used for the N_2O modeling exercise (left) and resulting predictive variables and their respective performance in the STICS model (right).

- **Simulation** of long-term agro-ecological system in France responses to contrasting **management options**. Conventional management means: inversion tillage, residue incorporation, standard N fertilization, not organic..
- For the three methods, **N fertilization and C:N ratio** from the incorporated **crop residues** where the most important variables associated with the N_2O emissions together with the **duration** of the modelling (restitution cycle).

WP5: Trade-offs and synergies synthesis

Article here:

- Synthesizing system **using fuzzy logic**, that uses a 0 to 1 scale to measure how sustainable a system is, rather than saying it is totally bad or good.
- **Downloadable interactive dashboard**: Each scenario is based on several management options and pedoclimatic conditions.



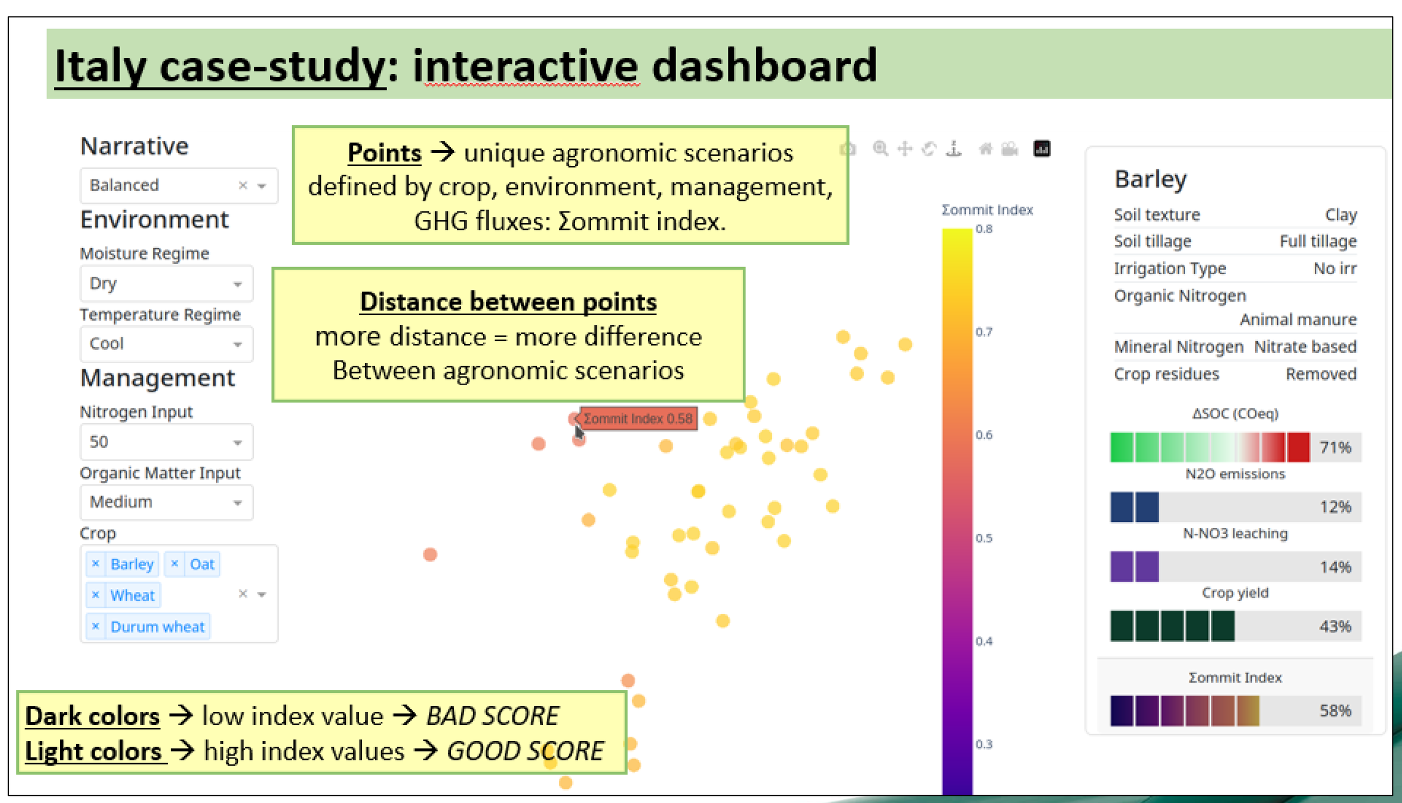


Figure 7. Left: SOMMIT index for sustainability based on fuzzy logic of different scenarios and four indicators (soil C balance, N_2O emissions, nitrate leaching and crop yield). Right: Screenshot of the interactive dashboard for a specific case study in Italy and balanced narrative for the SOMMIT index.

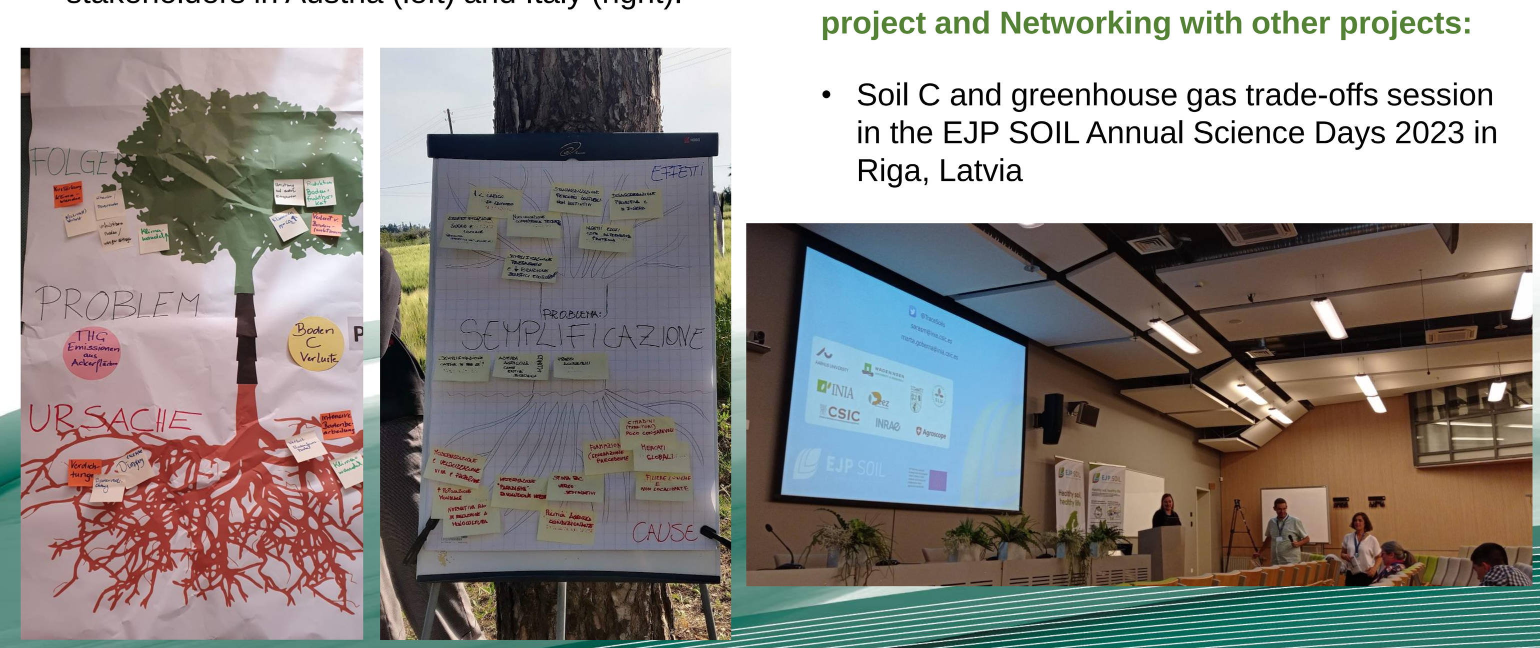
WP6: Communication and stakeholders involvement

Effective stakeholders' involvement:

- **Open dialog** on soil management strategies with stakeholders in Austria (left) and Italy (right).

Communication and Dissemination of the project and Networking with other projects:

- Soil C and greenhouse gas trade-offs session in the EJP SOIL Annual Science Days 2023 in Riga, Latvia



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