Annual Science Days , 06 June 2024

EOM4soil , Best management practices - Multicriteria evaluation system for external organic matter use and elaboration of practical guidelines for end-users

Assessing agronomic and environmental impacts of external organic matter amendments in diverse agricultural practices: a comprehensive study

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Plan

- Impact of organic materials fertilizer on farming systems
- Contribution to the multi-criteria evaluation of organic matter application effects
- Multicriteria predictive tool : PROLEG
- Location of case studies in Europe for simulation purposes
- Preliminary results
- Conclusion

Impact of organic materials fertilizer on farming systems

Closing **nutrient cycles**
Improving **soil fertility**
Mineral **fertilizer savings**
Increased **SOC storage**
Climate change mitigation
Nutrient balance improvement
Reduction in **GHG emissions**
Improved soil structure
….

Introduction of pathogens/**contaminants**
Nutrient losses
Potential **odor issues**
Risk of **leaching**
Management and monitoring need
Storage challenges
Handling and application difficulties
Potential for runoff **contamination**
…

Evaluation with the long-term experiment

- Time-intensive
- Unaddressed factor variability

Contribution to the multi-criteria evaluation of organic matter application effects

<u>Main objective :</u> To assess the agronomic and environmental performances of various scenarios involving EOM use in Europe.

⇒ Define a set of representative scenarios of using Organic Materials inputs (OMs) in agricultural systems across the EU, focusing on various pedoclimatic zones and types of arable crops.

⇒ Conduct a multicriteria assessment of OM utilization, aiming to comprehensively evaluate its impact and sustainability across socio-economic, environmental, and agronomic dimensions within **actual farming practices** (current and prospective), but not in experiment site.

⇒ Provide best management practices and practical guidelines for end-users of OMs

Multicriteria predictive tool : PROLEG

Florent Levavasseur, Sabine Houot. Predicting the short- and long-term effects of recycling organic wastes in cropping systems with the PROLEG tool. Soil Use and Management, 2023, 39 (1), pp.535-556. ⟨10.1111/sum.12856⟩. https://doi.org/10.1111/sum.12856


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Predicting the short- and long-term effects of recycling organic wastes in cropping systems with the PROLEG tool

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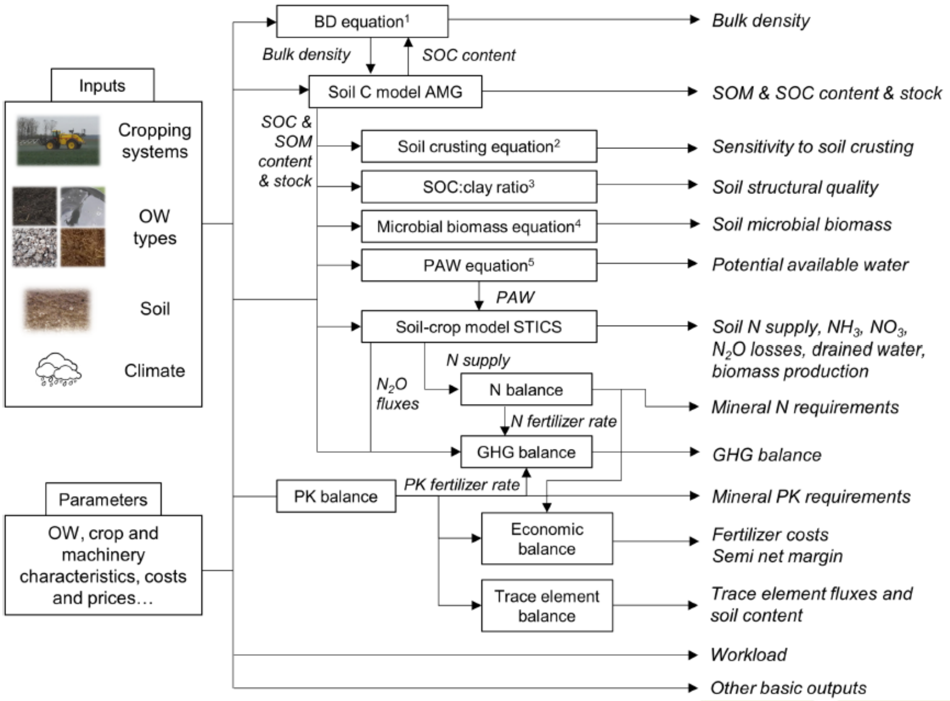
Abstract
Recycling organic wastes (OWs) in agriculture may increase soil organic carbon

Fig 1 : General structure of the PROLEG tool.



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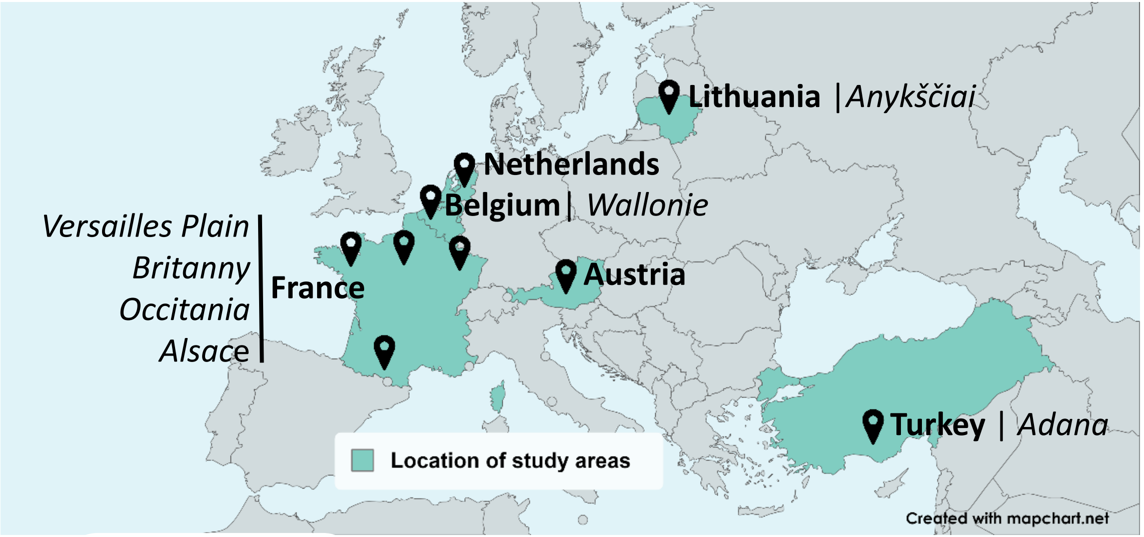
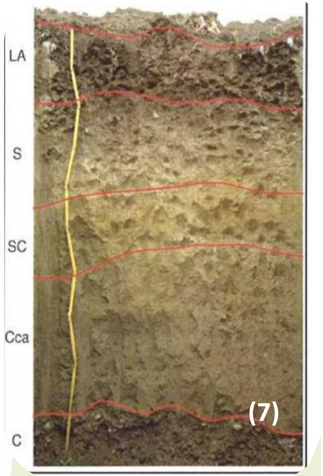
Location of case studies in Europe for simulation purposes

Fig 2 : Map of intervention area in Europe





(1) Bruehl Farm in Eckwersheim (Alsace)
(2) Composting sewage sludge (Paris)
(3) The Quimper methanizer (Britanny)
(4) Sunflower field in Lauragais (Occitany)
(5) Beets and wheats fields in Wallonia
(6) Rapeseed fields in Versailles plain
(7) Deep grey Hardt soil in Alsace
(8) Red Hardt superficial limestone soil in Alsace

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Diversity in application methods of organic materials

- Applied in **main crops** or **cover crops**.
- Application rates, **from 5 to 50 tonnes/ha**
- **With or without incorporation** of fertilizers after spreading
- **One or several types** of organic matter in the same cropping system
- **Same types** of organic matter applied differently in **different regions**, on **different crops**

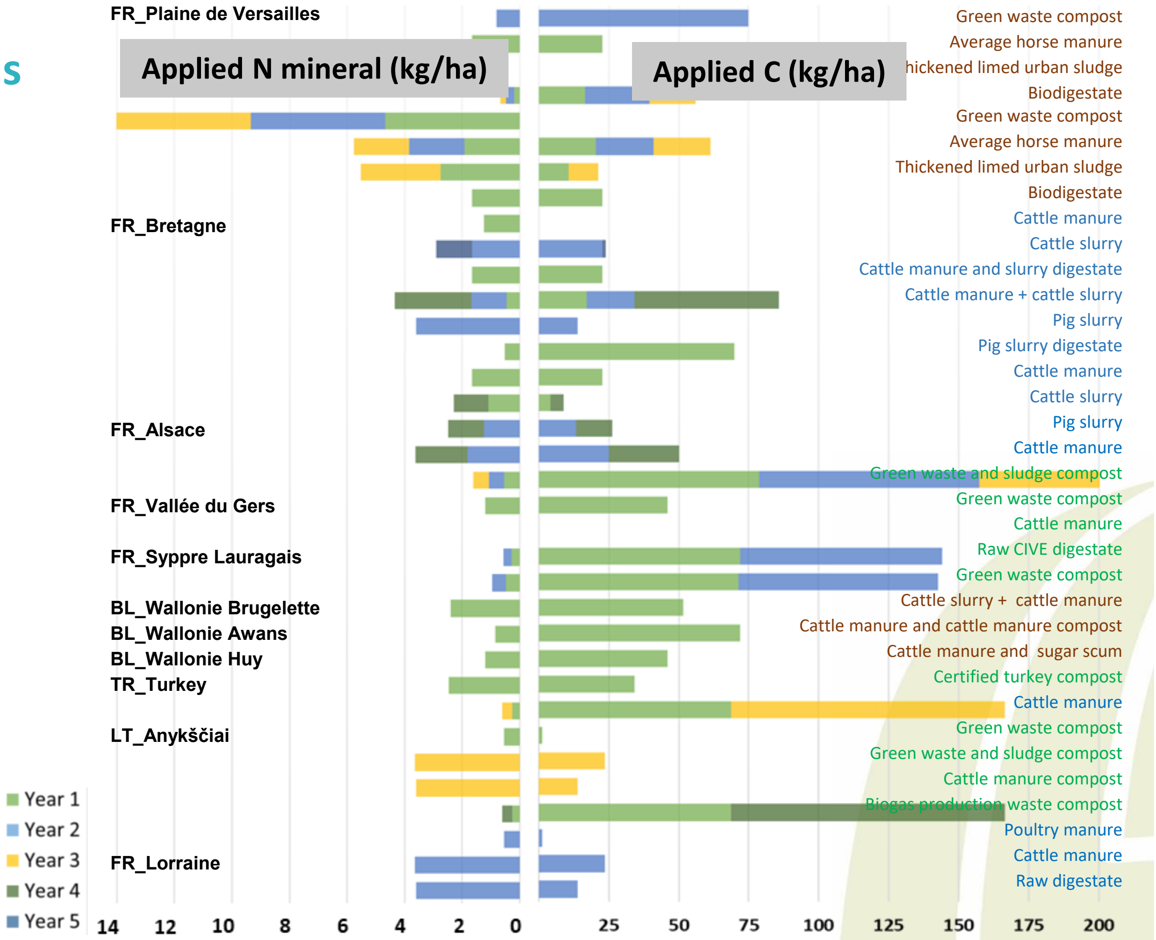


Fig 3 : Quantity of mineral nitrogen and carbon applied to the fields of major crops in different cropping systems

Case study : preliminary results

Municipality of Brugelette – Wallonie Belgium

Scenario 1	Mineral fertilizer	Min
Scenario 2	Mineral fertilizer + Cattle slurry & cattle manure	**Min + M**

Versailles plain – Paris France

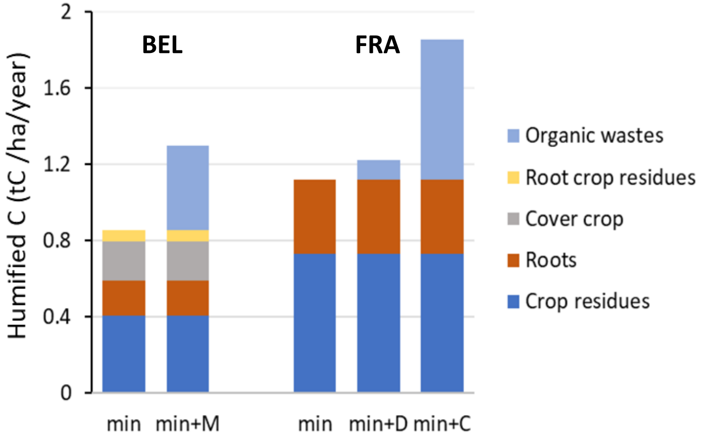
Scenario 3	Mineral fertilizer	**Min**
Scenario 4	Mineral fertilizer + Biowaste digestate	**Min + D**
Scenario 5	Mineral fertilizer + green waste/ biowaste compost	**Min + C**

Case studies	Type	Horizon	Thickness (cm)	% Clay	% Silt	% Sand	% CaCO3	pH	% SOM	C/N
Brugelette	***Deep***	H1	25	15	77	8	0	7	2.4	10
	luvisol	H2	25	20	73	7	0	7.2	1	
		H3	50	27	68	5	0	7.5	0.5	
		H4	45	20	73	7	0	8	0.1	
Versailles plain	***Shallow***	H1	20	20	60	20	45	8.5	3.5	9.5
	calcisol	H2	35	20	0	20				

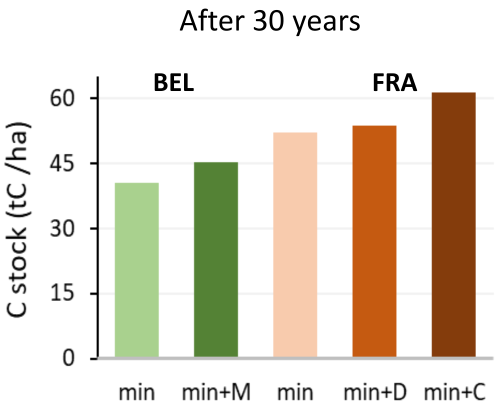
Case study : preliminary results

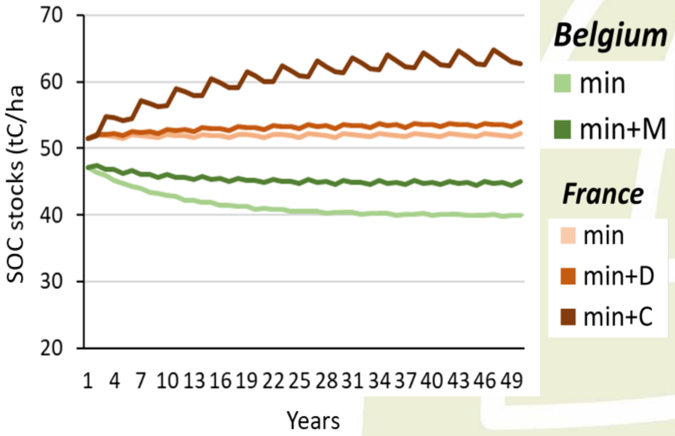
Humified C input and SOC stocks

- Increase in humified C input through the application of cattle manure and green waste compost.
- Slight increase in humified C input through the application of biowaste digestate



- Significant increase in SOC stocks after 30 years of compost application.
- Carbon destocking in the Belgian scenario, after the high initial carbon stock

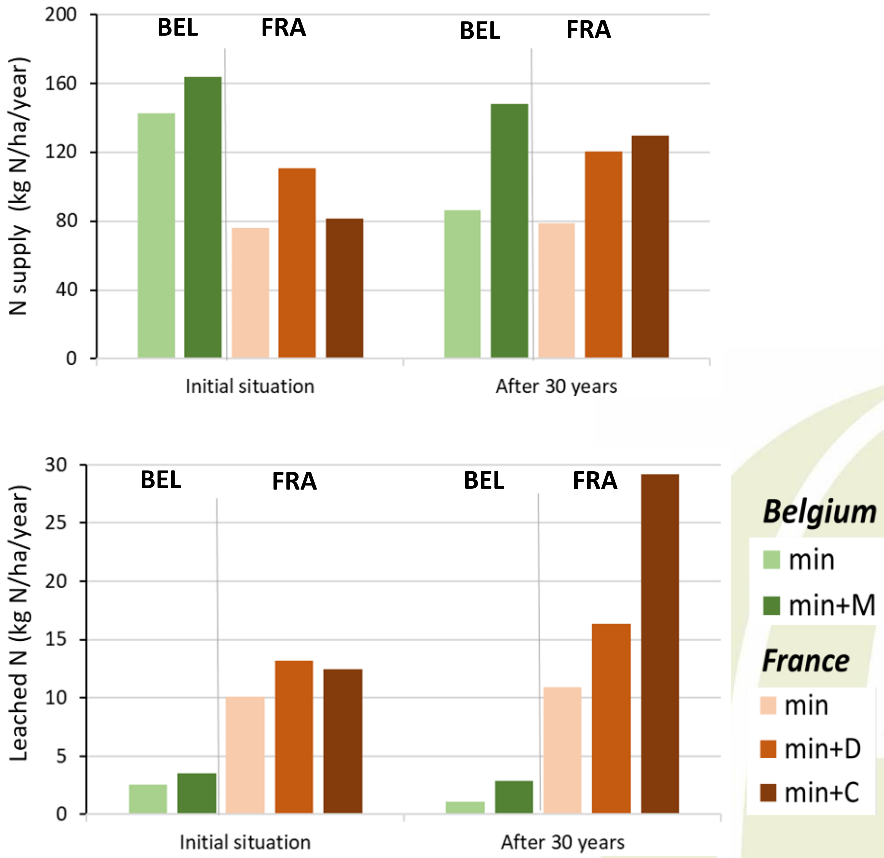




Case study : preliminary results

Soil N supply and N losses

- Significant decrease in long-term N supply in Belgium with mineral fertilizer.
- Soil N supply significantly increases after repeated compost applications.
- After 30 years, the increase in SOM and subsequent soil N mineralization resulted in an increase in N leaching, both with compost and digestate applications.



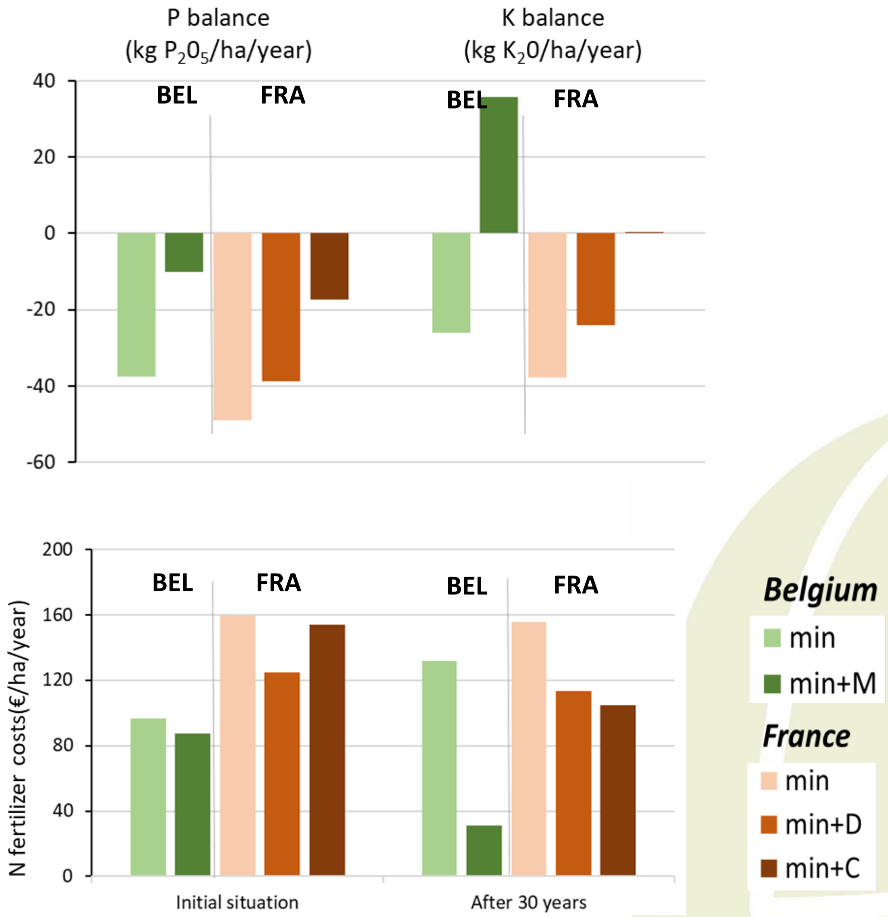
Case study : preliminary results

PK balance

- Initial decrease in PK requirements observed in both regions with all organic materials.
- An excess of K with cattle manure and slurry in Belgium after 30 years.

N Fertilizer costs

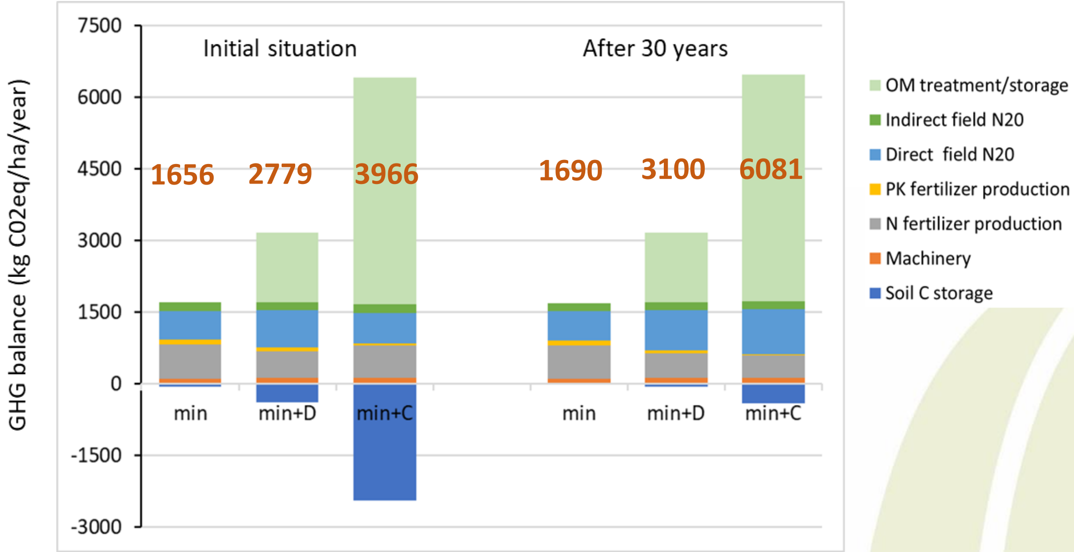
- Slight decrease in N fertilizer-related costs in the first year due to the application of cattle manure and cattle slurry.
- Reduction in N fertilizer-related costs observed after 30 years following the repeated application of all organic materials.



Case study : preliminary results

GHG balance with OM treatment and storage in Versailles plain (FRA)

- Significant increase of GHG balances for both compost and digestate scenarios compared to the mineral fertilizer scenario from the start; and after 30 years.



Conclusion :

PROLEG tools consider the GHG emissions and SOC storage related to diverse OM production and storage

- A large diversity of OM (Organic Matter) can be simulated.
- Trade-offs between positive and negative effects can be identified.
- Assessment of SOC (Soil Organic Carbon) storage following different OM applications in various fields.
- Ability to assess how the GHG (Greenhouse Gas) balance of cropping systems is modified in both the short and long term after repeated OM applications.
- Advantage for farmers: estimate soil fertility of their fields and achieve nutrient saving

Ongoing and future work

- Simulation of all case types
- Comparison of results
- Identification of drivers of the simulated effects.

Conclusion :

Practical implications for end-users:

- *Diversity of EOM use in Europe:* Highlighting variations in EOM types, application rates, and crops benefiting from EOM application.
- *Diverse effects of EOM:* Emphasizing the variability in EOM effects based on usage diversity, soil types, and climate conditions.
- *Variability in EOM impact*: Recognizing the inability to generalize EOM effects due to significant variability.
- *Trade-offs:* Balancing positive effects (carbon storage, nutrient supply) with negative impacts (nitrogen losses, increased GHG emissions in certain contexts).
- *Recommendations for recycling waste in agriculture:* Suggesting optimal recycling methods like composting and anaerobic digestion for waste management in agriculture.

Thank you for your attention!