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# Does fresh organic matter addition to an industrial soil have an impact on soil structure and on PAHs distribution?

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# Context

- End of industrial activities associated to coal exploitation
- Huge areas of **wasteland**



Homécourt coking plant 60's



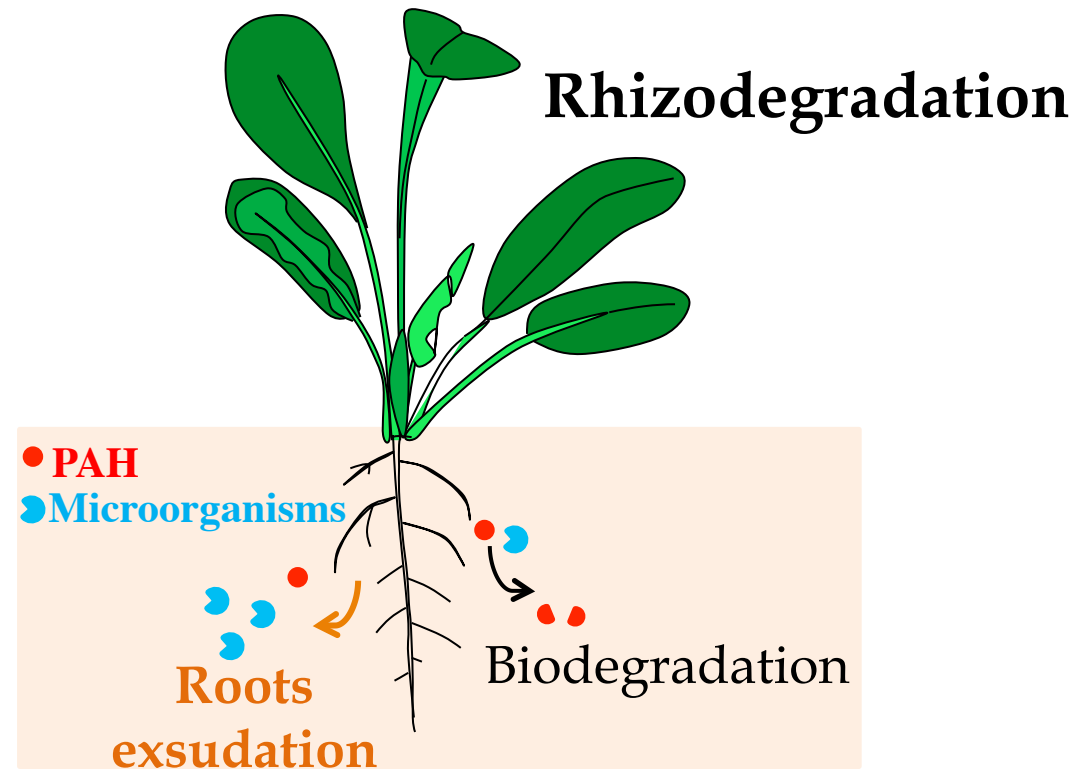
Homécourt coking plant 90's

- Persistent organic pollutant contamination
  - PAHs (polycyclic aromatic hydrocarbons)
- Toxic and carcinogenic compounds occur in all environmental compartments

➡ **necessity of remediation treatment**

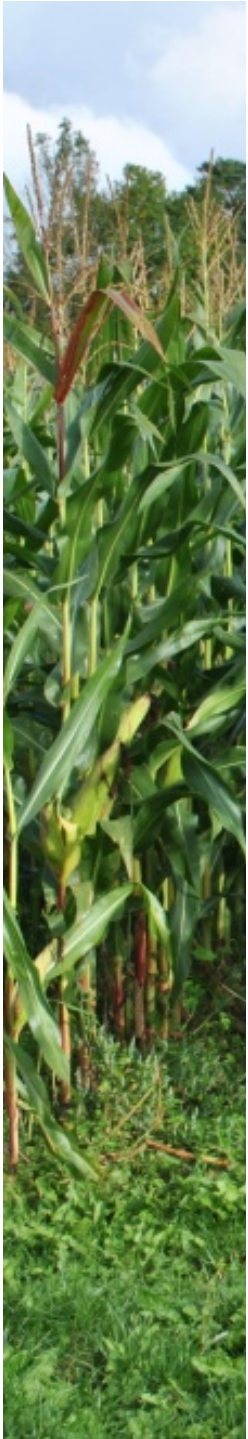
# Context

○ Among treatments: **plant-assisted remediation**



○ numerous benefits

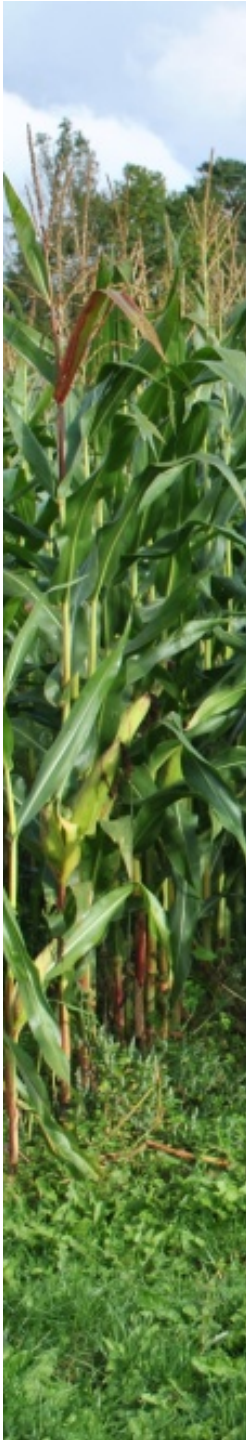
- Increased biological activity
- Soil aeration
- Surfactant release
- Biomass production



# Context

- Low PAH availability limits the treatment efficiency
- **net benefit** over several years of culture (including plant death and litter incorporation) on PAH availability and degradation is **not demonstrated**
- Objectives: assess **the effects of natural C input**
  - on the **soil structure**
  - consequences on the **PAH distribution, repartition and availability**

⇒ **lab and field scales**



# General approach

○ Case study of a former coking plant soil

TOC (g kg <sup>-1</sup> )	EOM (g kg <sup>-1</sup> )	Σ 16PAHs (mg kg <sup>-1</sup> )	PAHs availability (mg kg <sup>-1</sup> )
72	9.2 (13% of the TOC)	1025 (11% of the EOM)	17.8 (1.7 % of 16PAH)

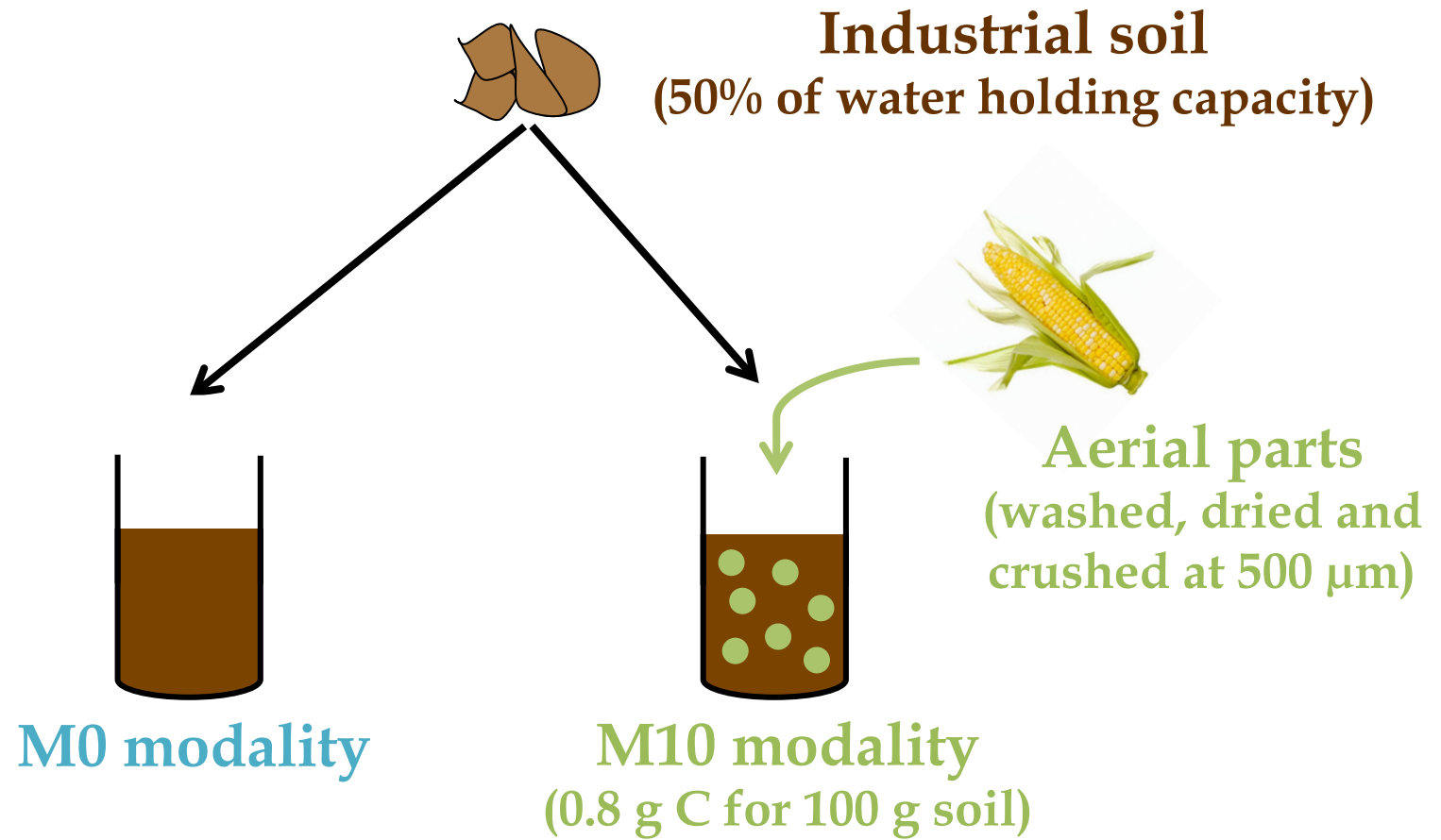
○ Combined **agronomic, isotopic and organic geochemistry** approaches and tools

- granulodensimetric fractionation (water stable soil aggregates)
- <sup>13</sup>C and <sup>14</sup>C measurements
- OM characterization at molecular scale

○ Two scales: **lab** and **field**



# Lab scale: maize incubation



○ Incubation in the **dark** and at **20°C**

○ 6 durations of incubation: **0, 3, 6, 9, 12, 15 months** with 4 replicates (statistical test: ANOVA)

# Field scale: lysimetric plots

○ **Experimental site:** French Scientific Interest Group – Industrial Wastelands ([www.gisfi.fr](http://www.gisfi.fr))

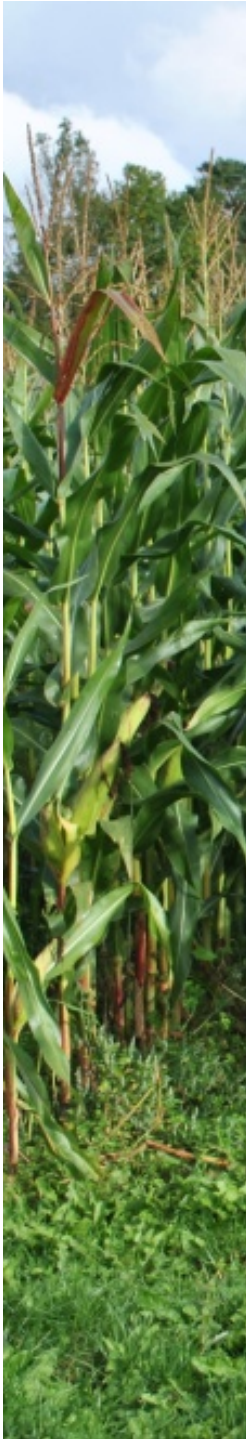


○ **Lysimeter plots** filled with the same industrial soil with two modalities: **bare soil and planted soil** (*Medicago sativa*) with 4 replicates



○ **Monitoring during 6 years**

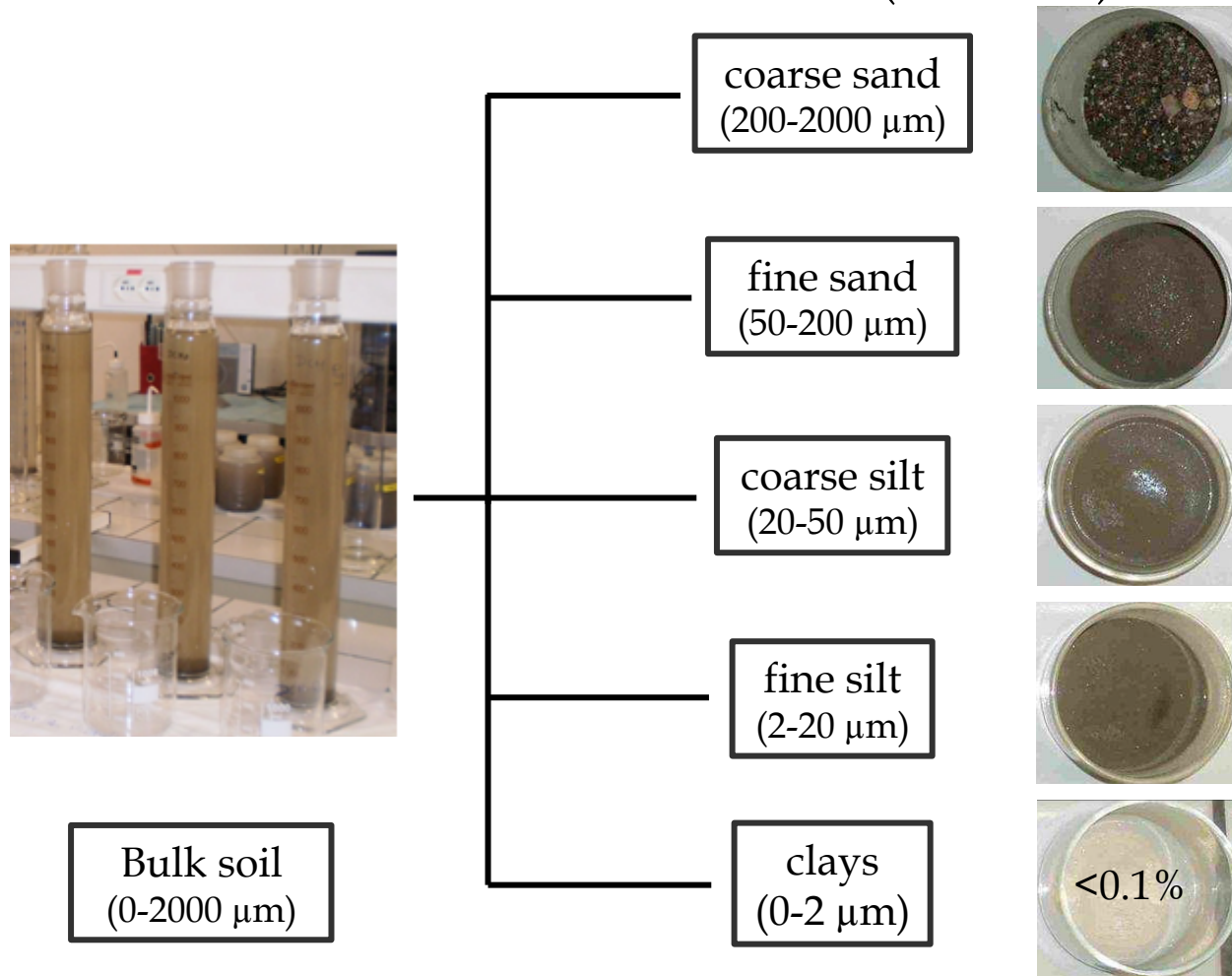
○ **Fresh carbon incorporation** was followed with the  $^{14}\text{C}$  activity



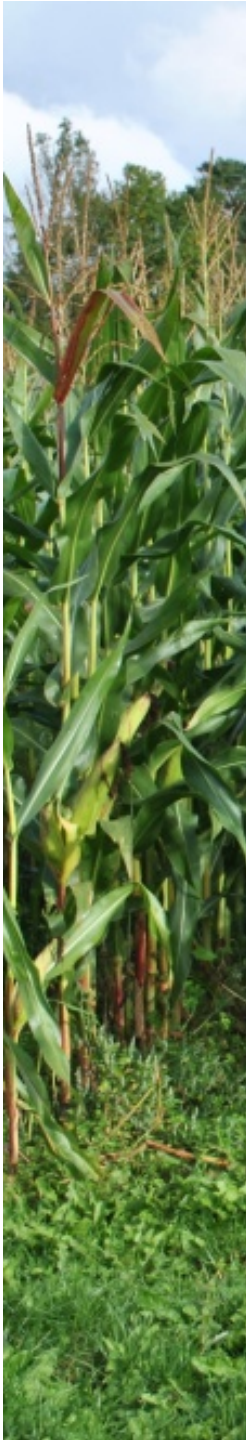


# Biomass and soil structure

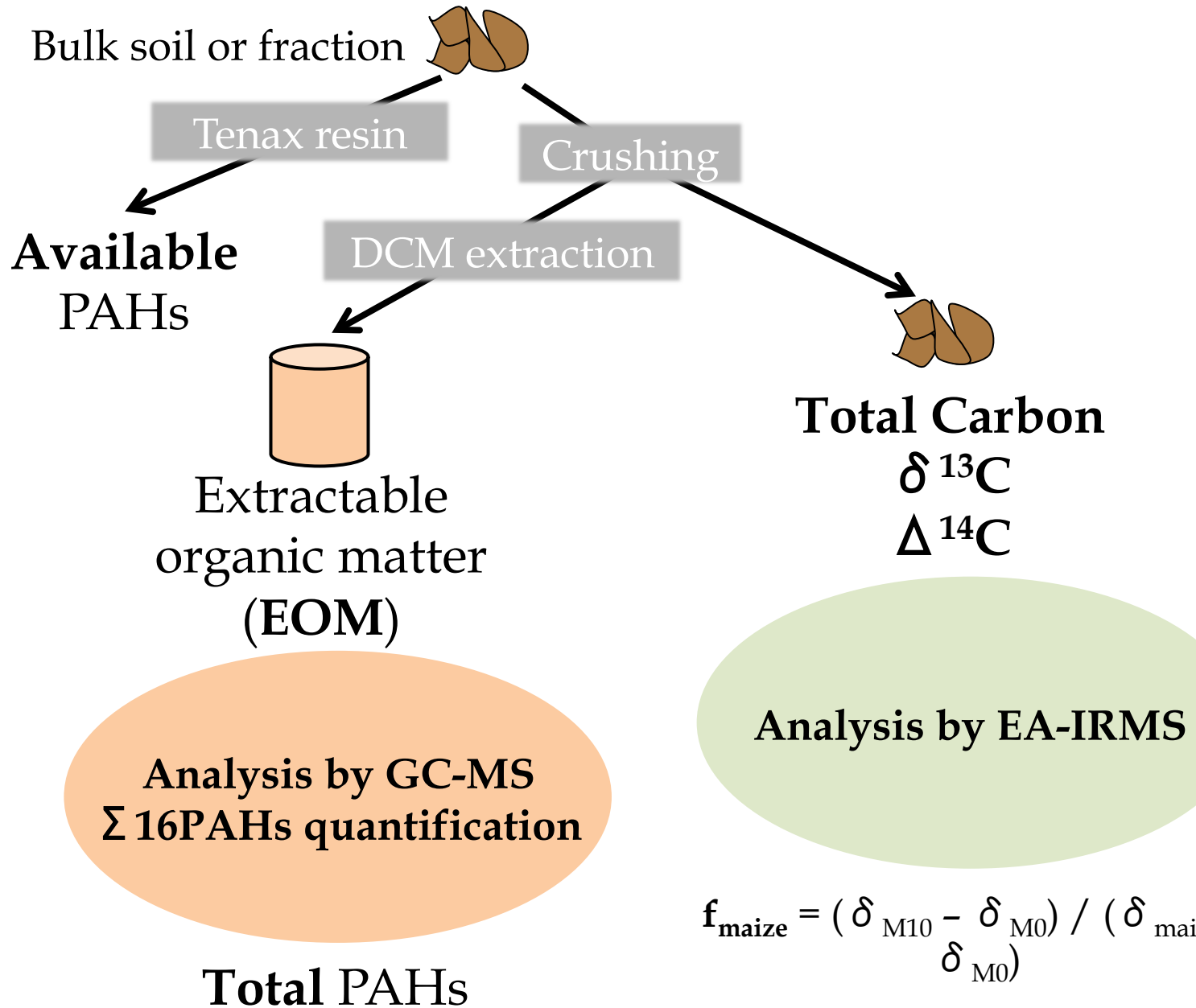
- Fumigation-extraction: to estimate the **microbial biomass**
- Water granulodensimetric fractionation: **soil structure** without OM or carbonate removal ( $\neq$  texture)

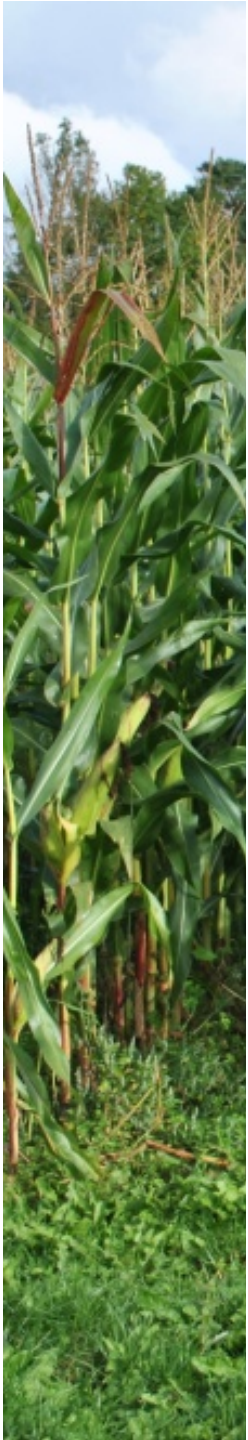






# EOM and C analysis

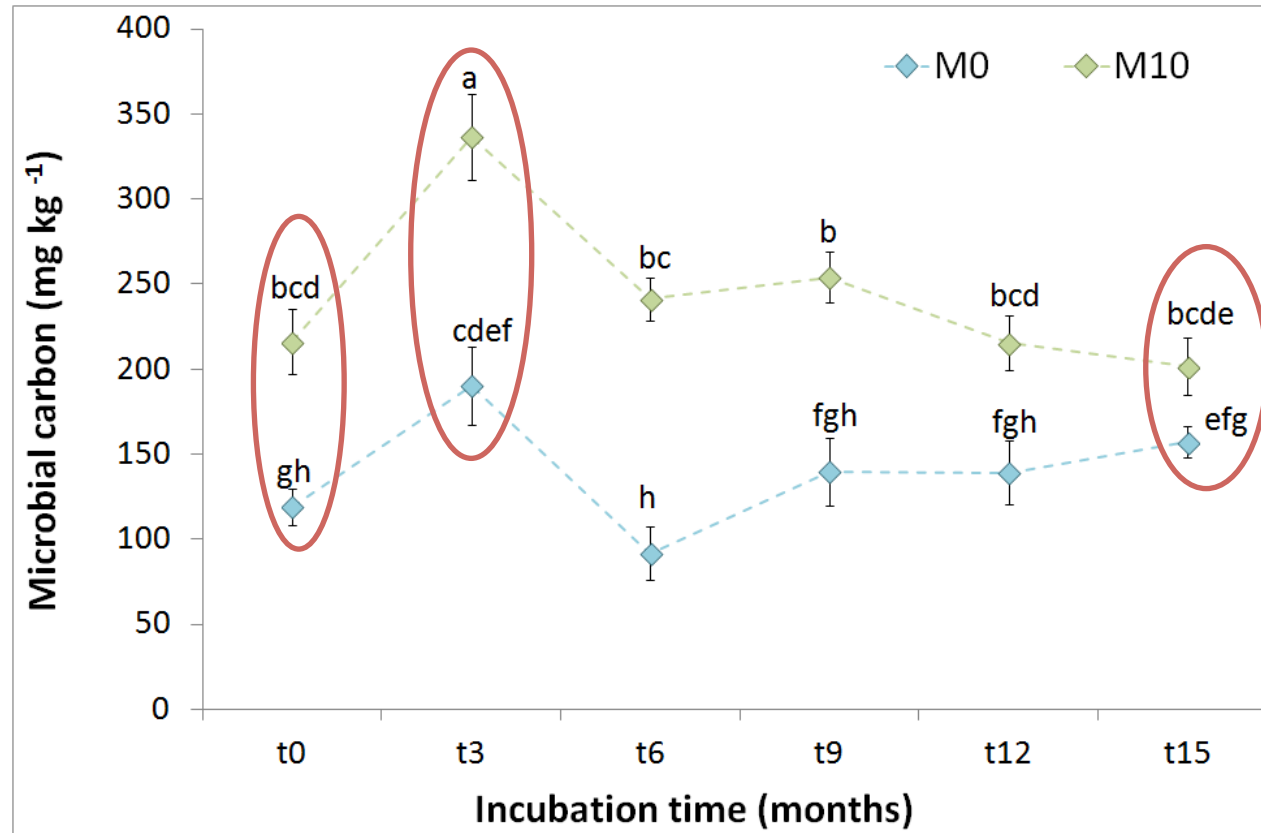




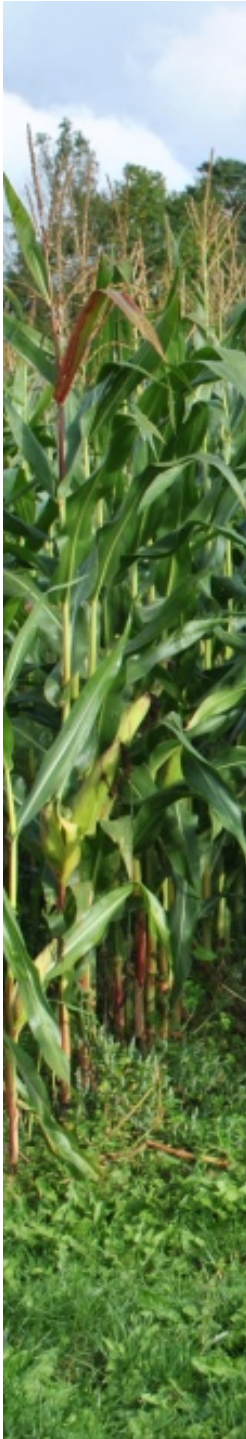
# Results

## Lab experiment

# Microbial biomass evolution

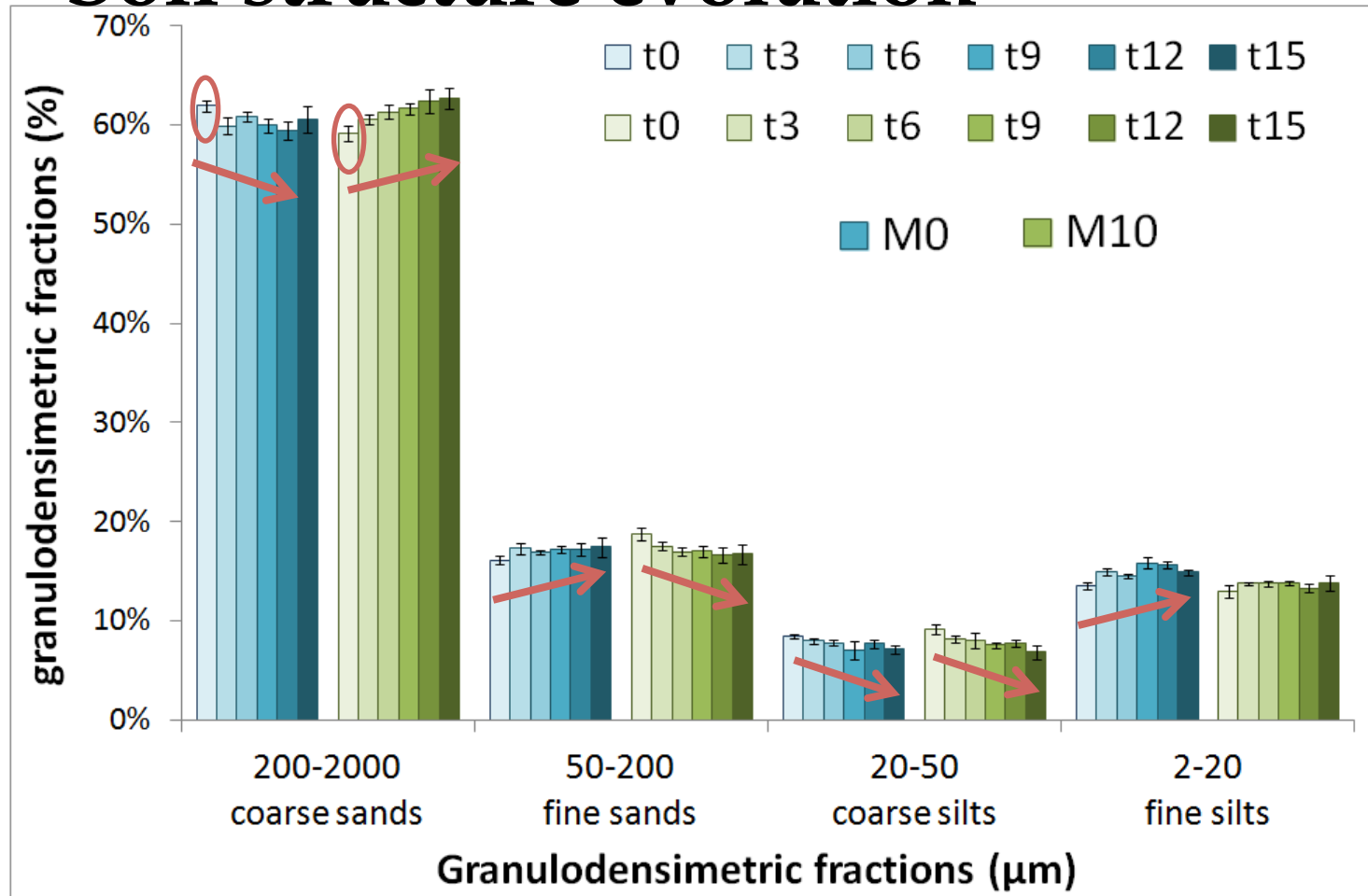


- More microorganisms in M10 modality
- Priming effect at t<sub>3</sub> (optimal conditions of incubation and fresh OM impact for M10)
- M10 reach M0 after 15 months

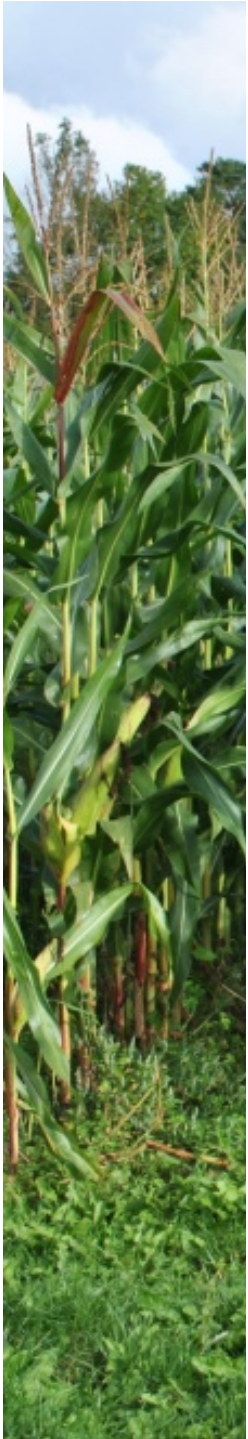




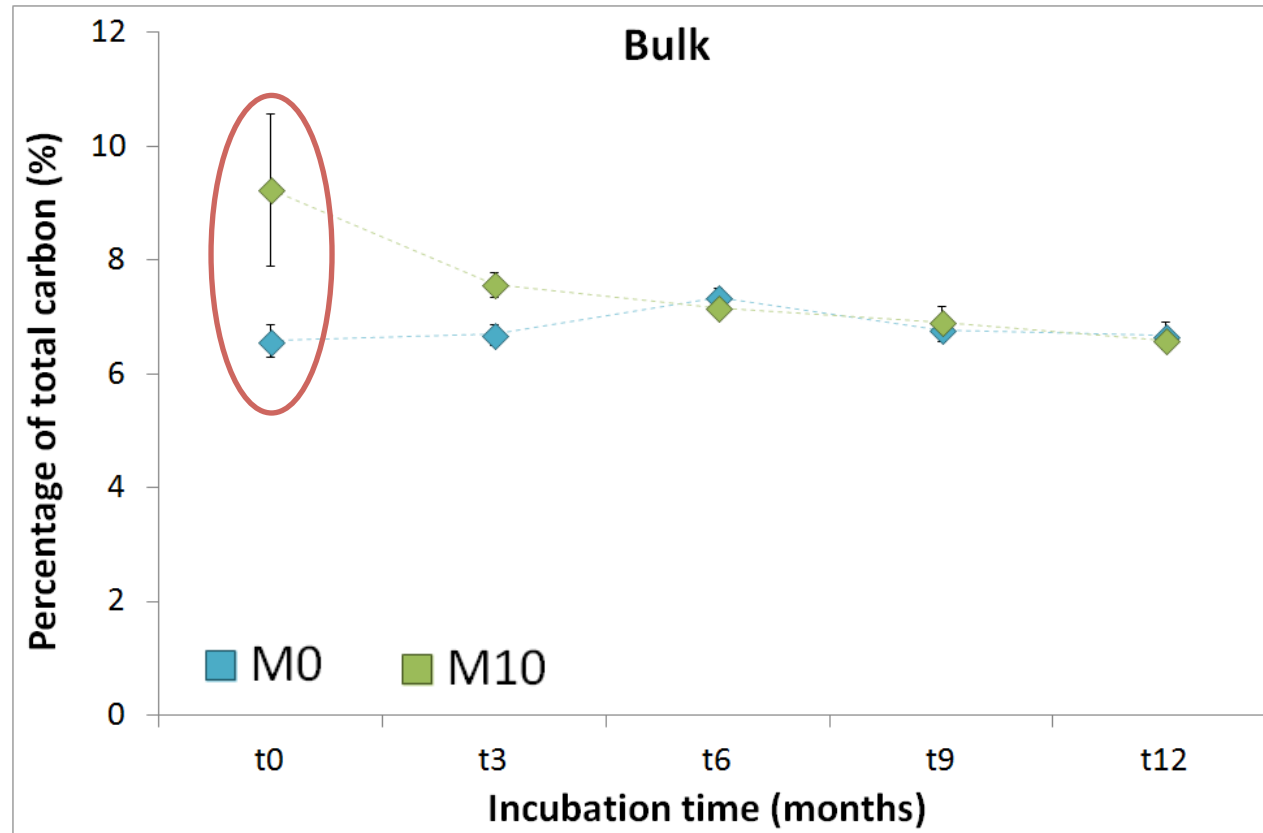
# Soil structure evolution



- **Heterogeneity** between both modalities
- **Disaggregation trend** for M0 modality
- **Aggregation trend** for M10 modality



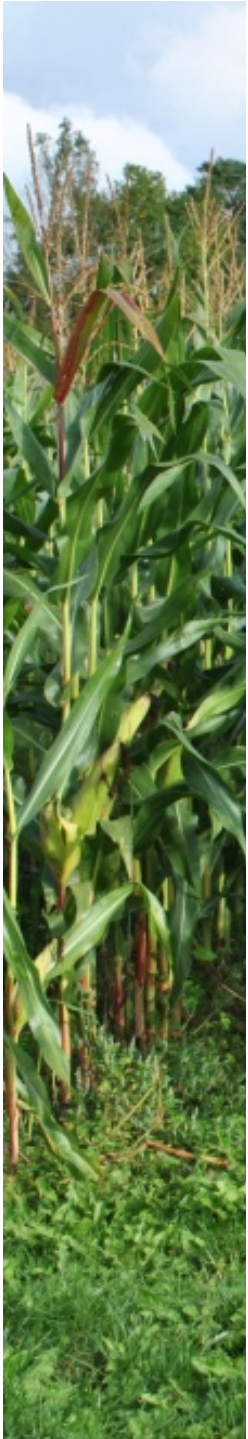
# Total carbon content evolution (in bulk)



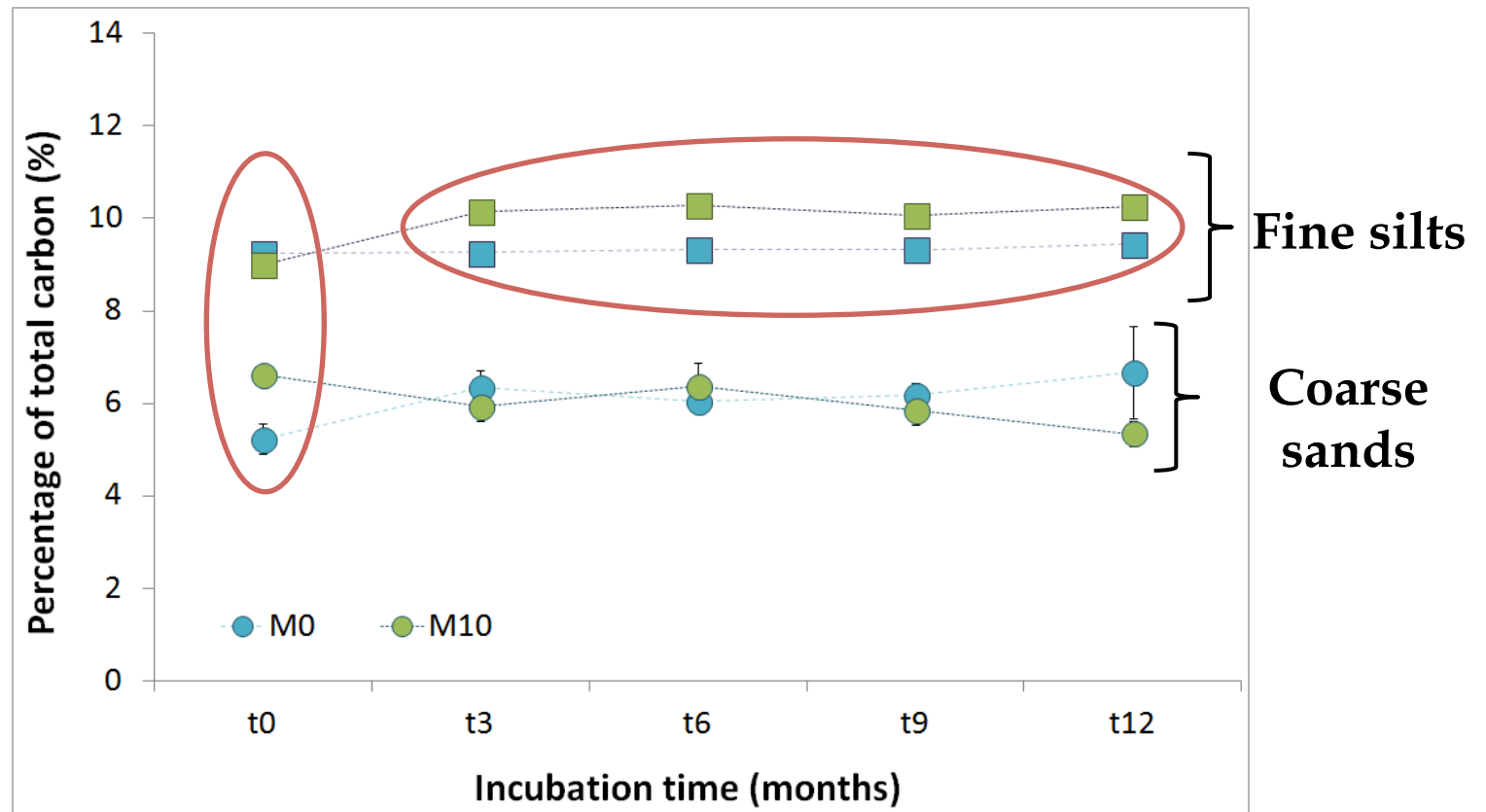
○TC higher in M10 due to maize addition in bulk

○TC in M0: stable in bulk

○TC decreases in M10 to reach M0 at  $t_6$



# Total carbon content evolution (in fractions)



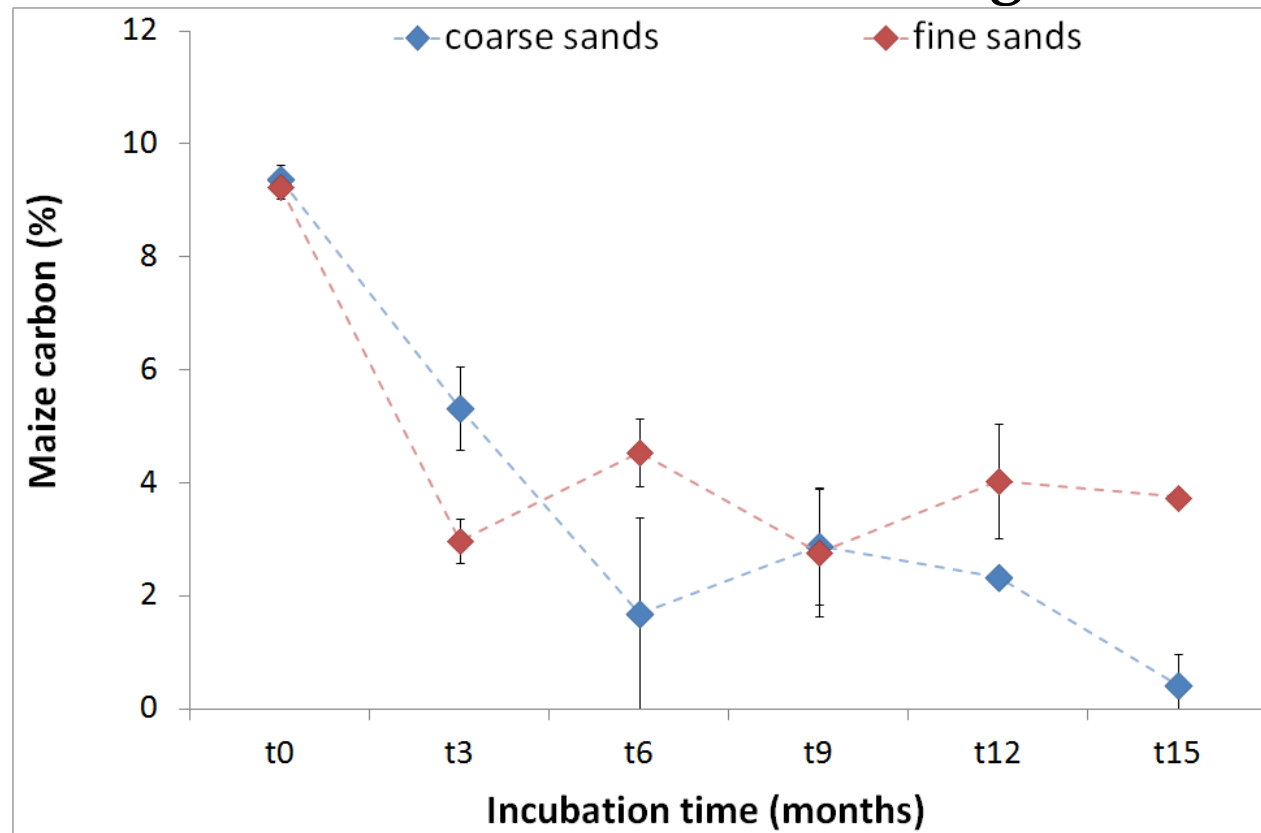
○M0: stable whatever the fractions

○M10:

- Initial incorporation in the sands (coarse and fine)
- After 3 months, accumulation in fine silts

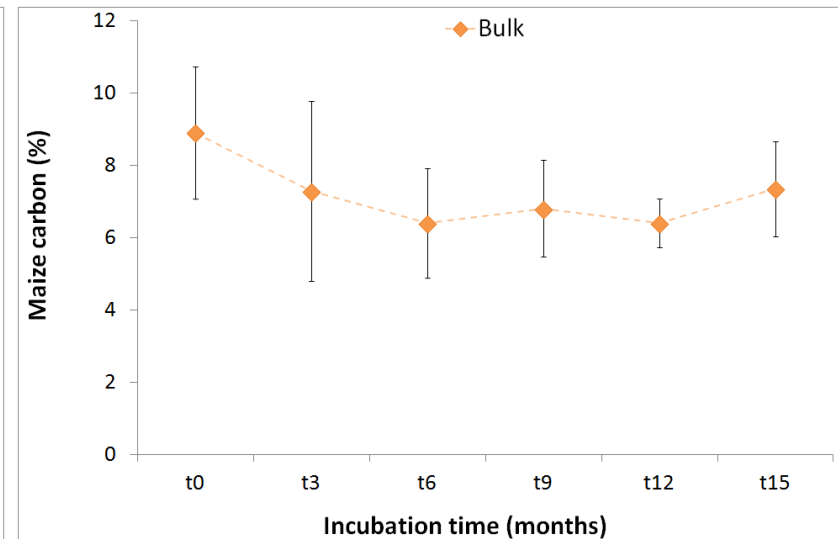
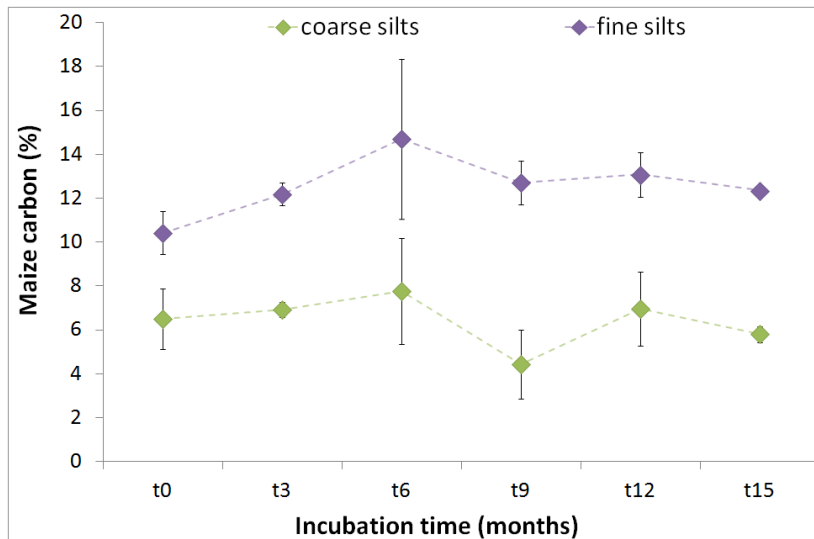
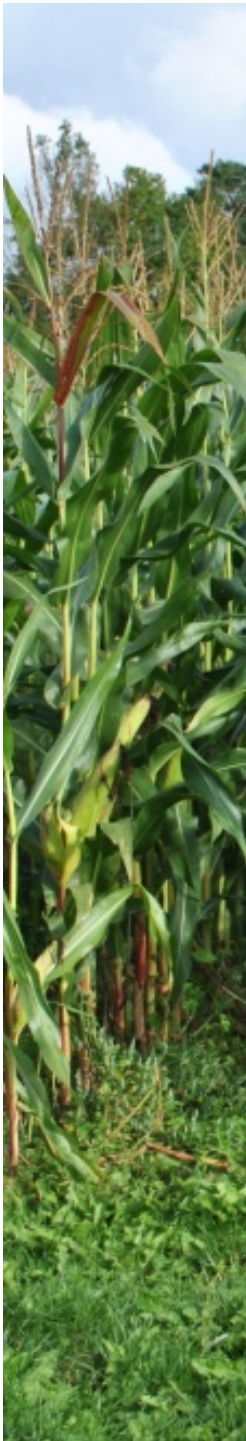


# Maize carbon: $^{13}\text{C}$ and mixing model (M10 modality)



○ Sands (coarse and fine): C from maize is **rapidly degraded**

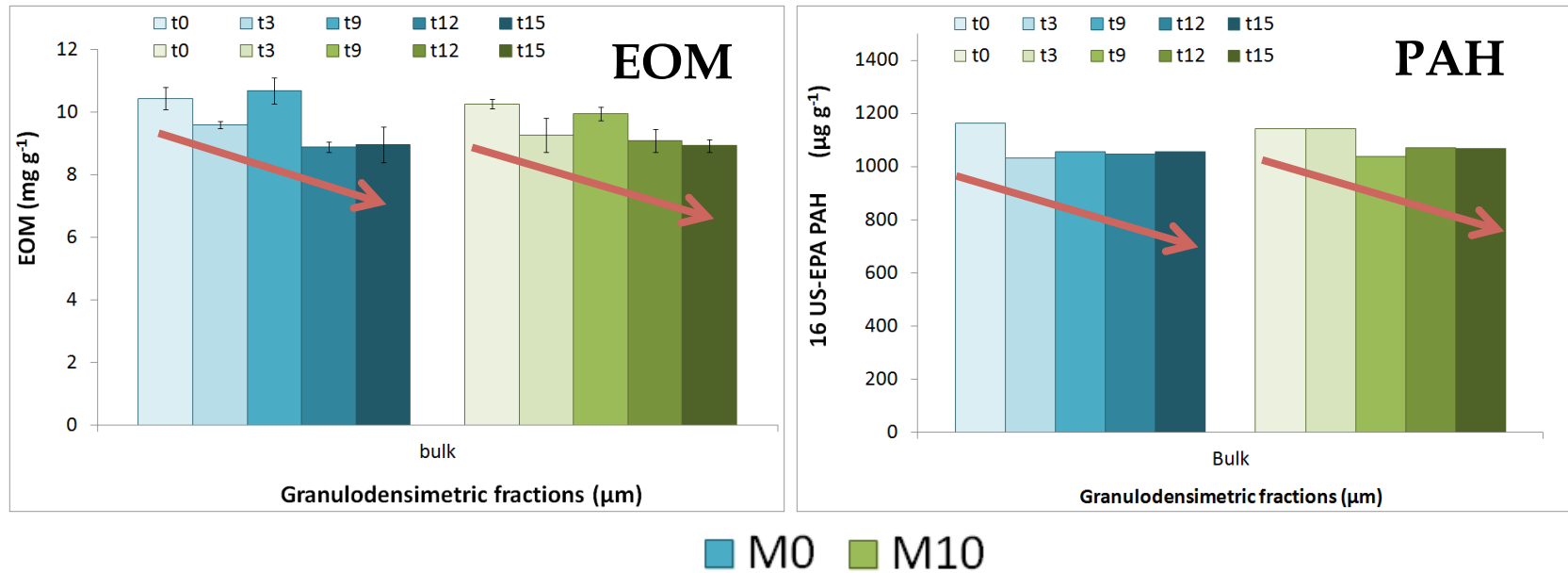
# Maize carbon: $^{13}\text{C}$ and mixing model (M10 modality)



- **Silts: Stabilization and accumulation** of fresh carbon
- **Fine silts: higher amount** of C deriving from the maize
- **Bulk: Proportion of C coming from the maize stable** with a trend to decrease



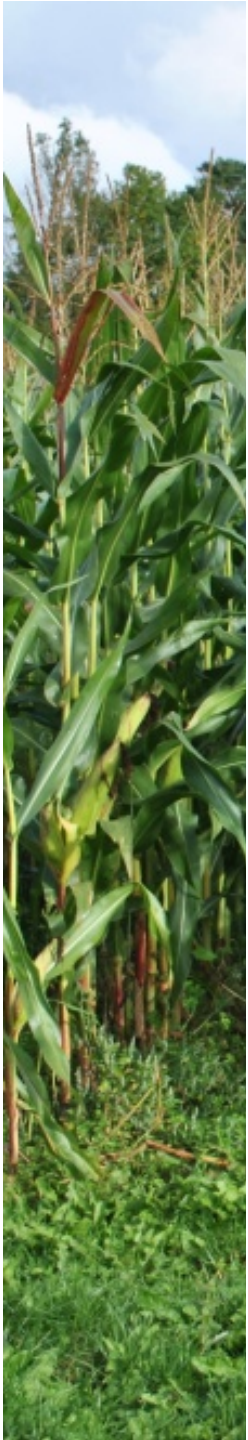
# EOM and Total PAH (in bulk)



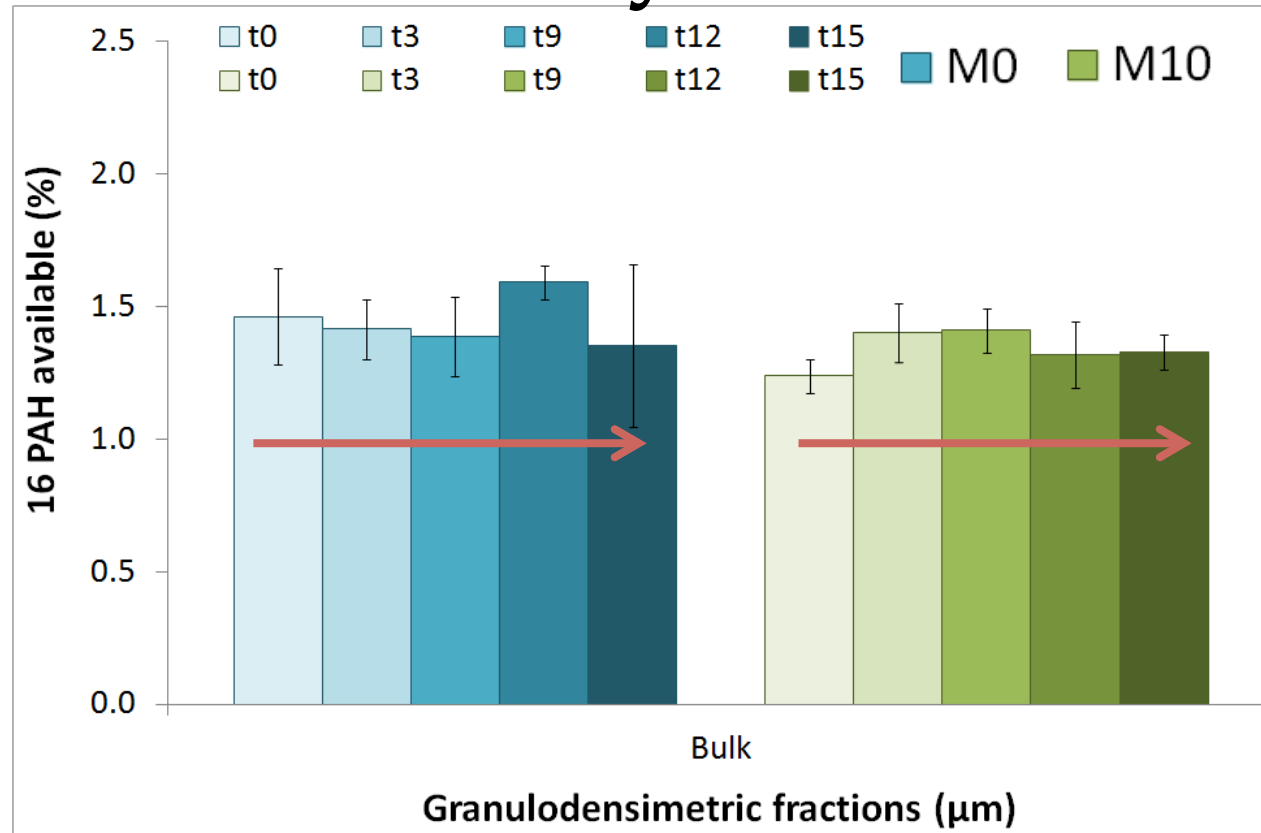
○ EOM decrease showing anthropogenic C degradation (only significant in fine silts)

○ No difference between M0 and M10

○ 10% of PAH degradation

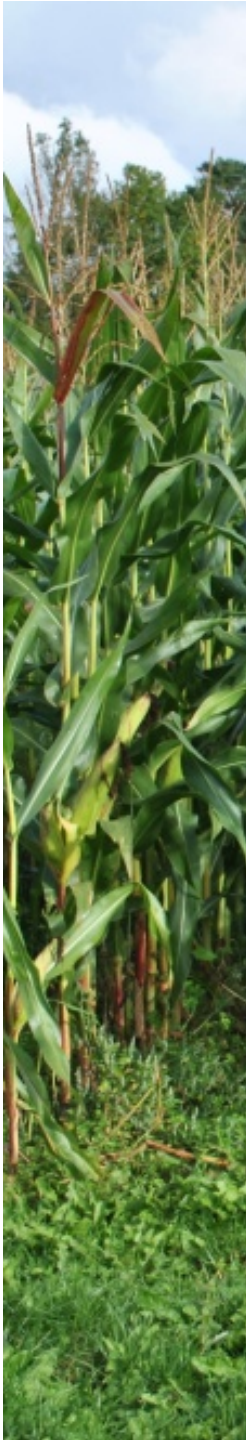


# PAH availability (in bulk)



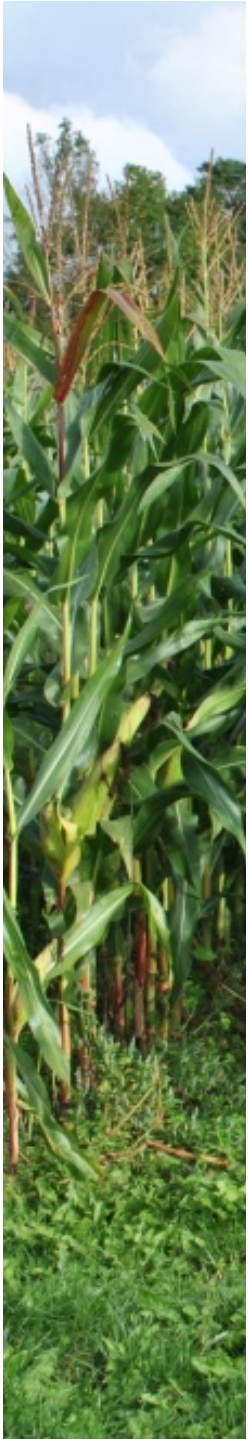
○PAH availability:

- stable in the bulk soil
- similar behavior in fractions



# **Results**

## **Field experiment**



# Fresh carbon monitoring: $^{14}\text{C}$ activity

Percentage of modern carbon		
Fractions	Bare soil	Planted soil
Bulk	5.66	12.14

- **Small amount** of fresh carbon
- **Incorporation of fresh OM** when presence of plants

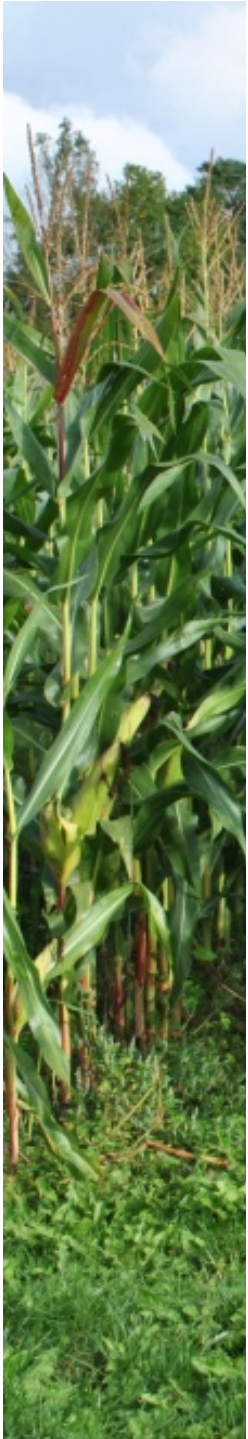


# Fresh carbon monitoring: $^{14}\text{C}$ activity

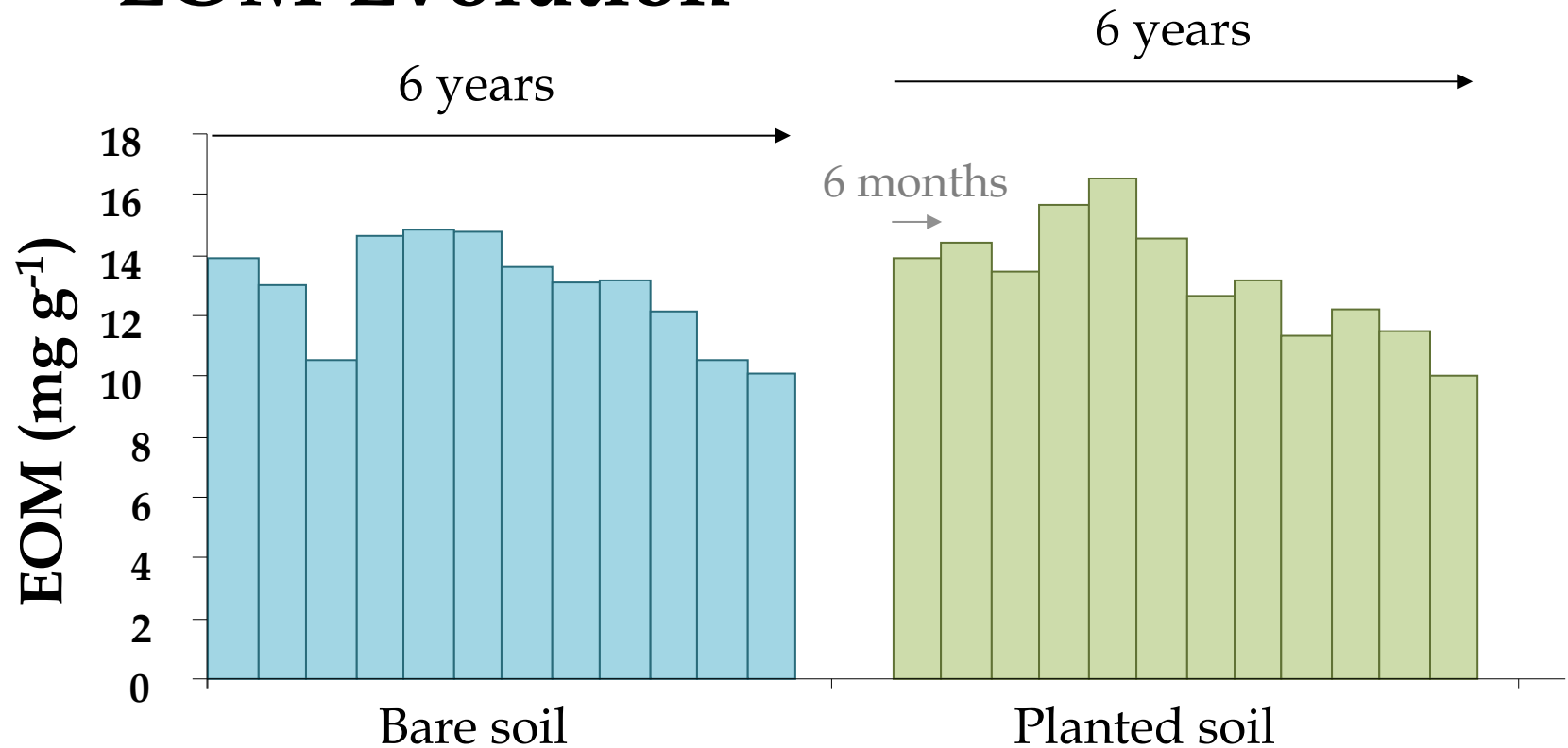
Fractions	Percentage of modern carbon	
	Bare soil	Planted soil
Bulk	5.66	12.14
Coarse sands	6.87	13.11
Fine sands	12.74	13.82
Coarse silts	11.28	11.24
Fine silts	17.53	33.44

- **Small amount** of fresh carbon
- **Incorporation of fresh OM** when presence of plants
- **Slight accumulation** in the coarse sands
- **Storage in the fine silts** even when the amount of fresh carbon is low

➡ **Compatible with the experiment at lab scale**

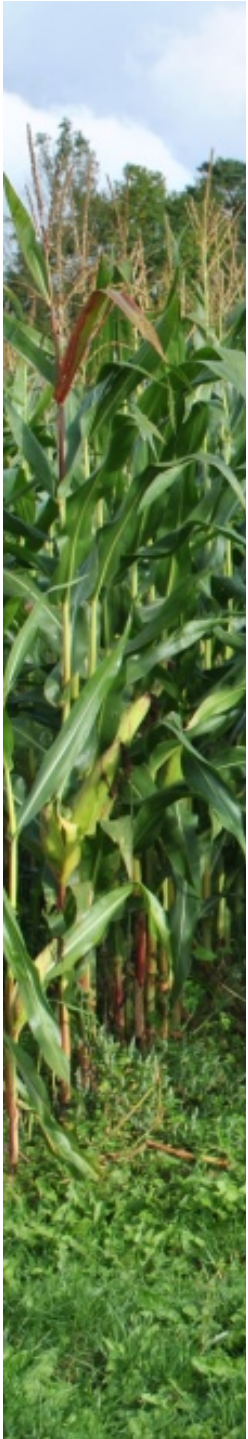


# EOM Evolution

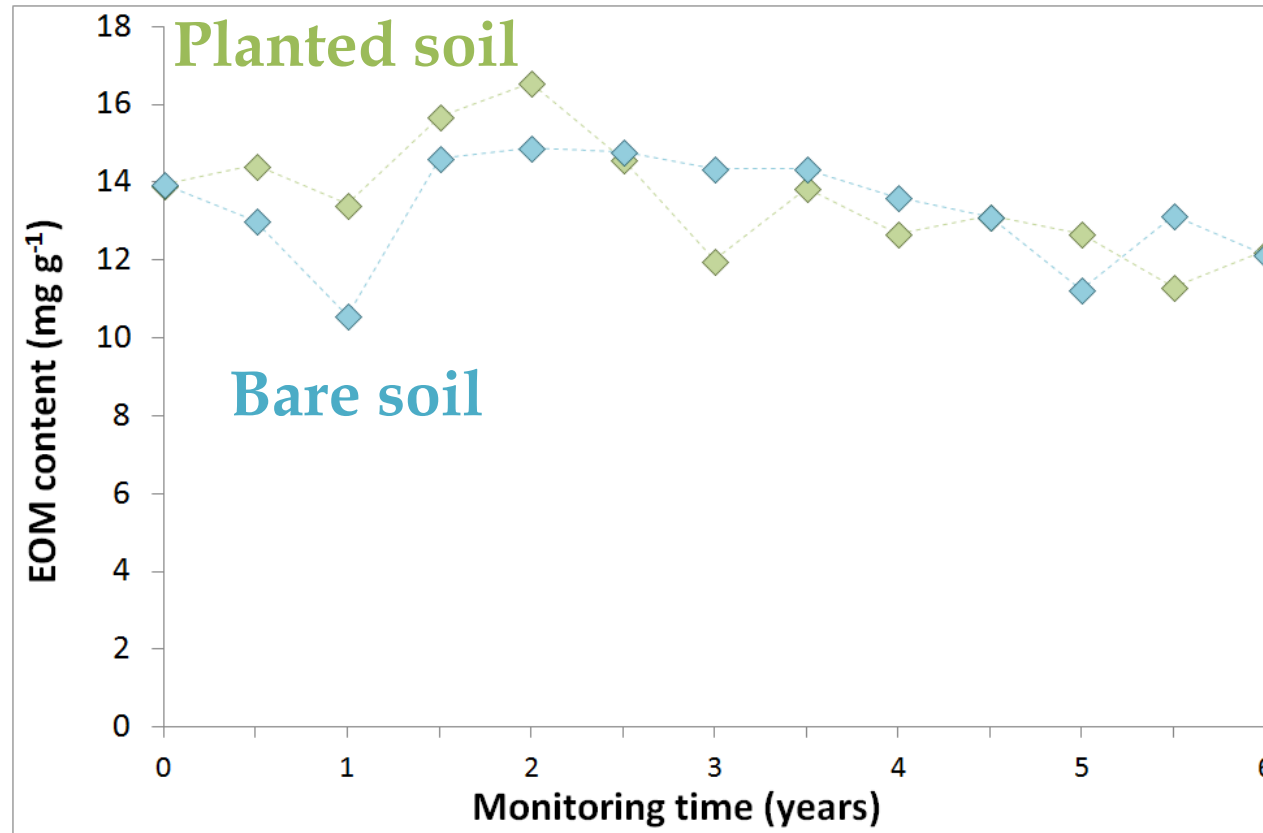


○ No difference between planted or bare soil

➔ Compatible with the experiment at lab scale



# EOM Evolution

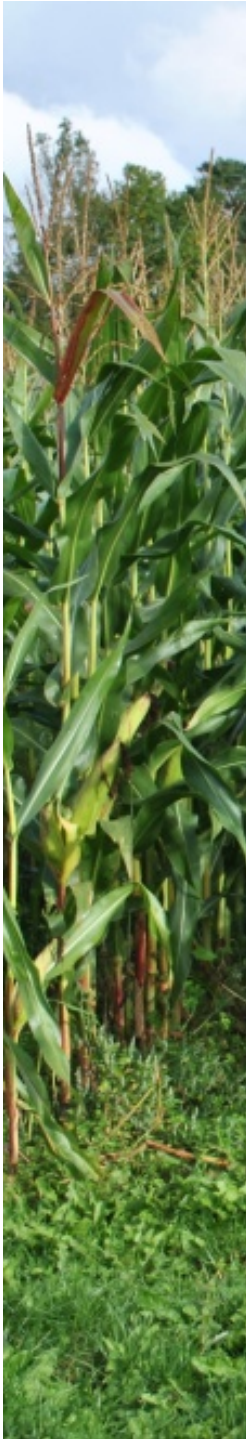


○ No difference between planted or bare soil

➔ Compatible with the experiment at lab scale

# Conclusion

- **Aggregation of the soil with fresh OM input**
  - **Stimulation of the microbial biomass**
  - **Fresh OM rapidly degraded in the sands and stored in the silts**
  - **No difference between M0 and M10 in a pollution point of view (EOM content, PAH concentration and PAH availability)**
  - **Field experiment confirm these conclusions**
- ➡ **Fresh OM is not a mobilizing agent for the pollution**





# Acknowledgments

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**Thank you for your attention**

