Dynamic of soil microbial communities in response to long-term repeated organic or inorganic fertilizations

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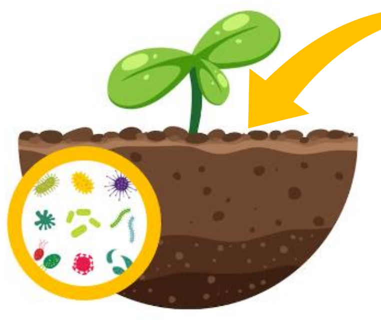
INTRODUCTION

Soil microbial communities

Essential role in soil functioning

- Organic matter renewal
- Nutrient recycling
- Soil structuring
- Pollution control
- Regulation/barrier to pathogens
- Plant productivity

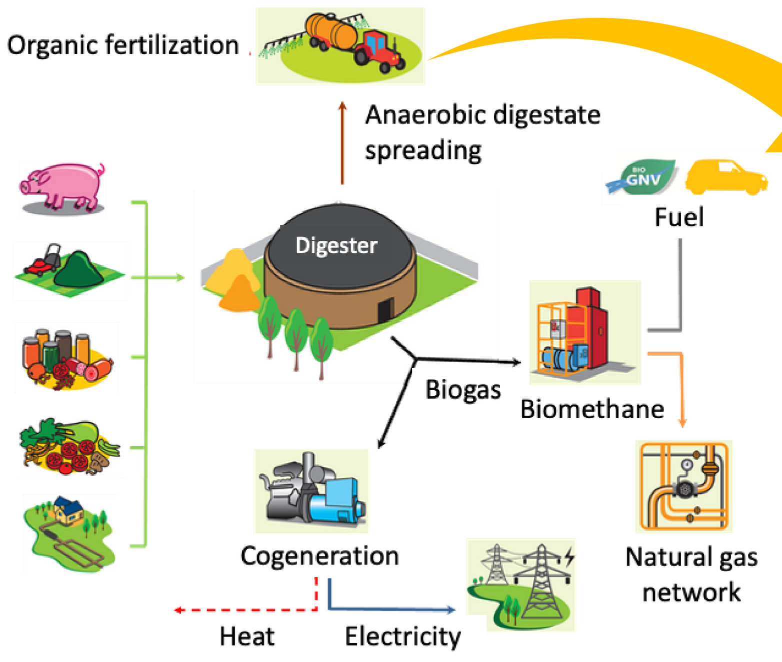


Fertilization

Inorganic / Organic

Could improve soil microbial quality and increase crop productivity

Anaerobic digestates as an organic fertilizer?



Their use at large scale in agricultural fields could represent an alternative to mineral fertilizers and a solution for organic matter recycling, looking for an agroecological transition and a reduction of environmental impacts of agriculture.

Few scientific data are available to assess the impact of digestates on the soil microbial communities.

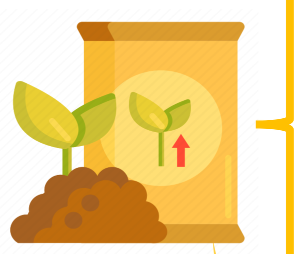
What is the impact, in the field, of repeated inputs of digestates on the soil microbial communities?

MATERIALS AND METHODS

SOERE-PRO: Long-term experimental site, to study the repeated application of organic waste products **(OWP)**

Randomized block
4 replicates per treatment
109m² each plot

Treatments



- **ON:** No fertilization
- **MIN:** Mineral fertilizer
- OWP:
  - **PS:** Pig slurry
  - **PS-DIG:** Pig slurry anaerobic digestate
  - **CM:** Cattle manure

Treatments	Mean dose raw product applied per year
ON	0
MIN	100 kg N/ha
PS	32 t/ha
PS-DIG	33 t/ha
CM	25 t/ha

MIN, **PS**, and **DIG-PS** were applied once every year, and **CM** once every two years

Mean chemical properties of OWP applied from 2012 to 2021

OWP	% DM	C org	N tot	NH_4	pH	ISMO
PS	7,2%	380 g/kg sec	5,3 g/kg PB	3,92 g/kg PB	8,48	49,3
PS-DIG	6%	345 g/kg sec	5 g/kg PB	3,88 g/kg PB	9	54,7
CM	26%	360 g/kg sec	6,3 g/kg PB	1,3 g/kg PB	9,36	58,8

Topsoil horizon properties at the beginning of the trial: clay: 14,2%, silt: 70,8%, sand: 15%

Soil sampling every year

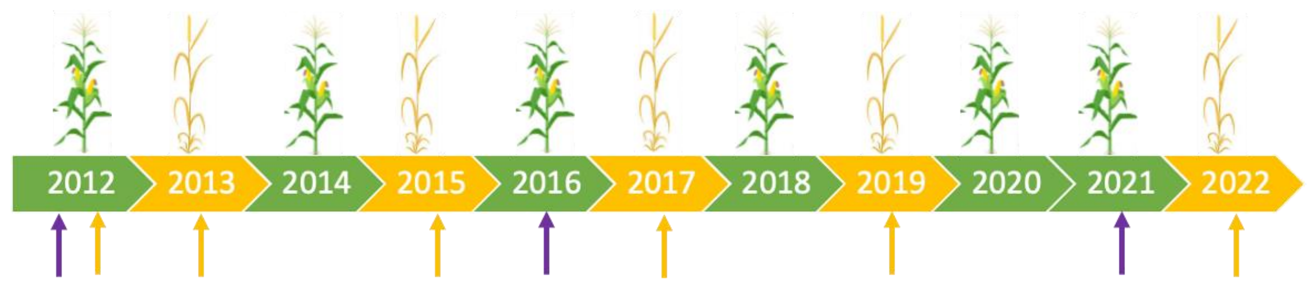
Horizon 0-25cm

11 months after last treatment application

Soil sample → **Physicochemical analysis**; **Metabarcoding** → Soil microbial quality indicators

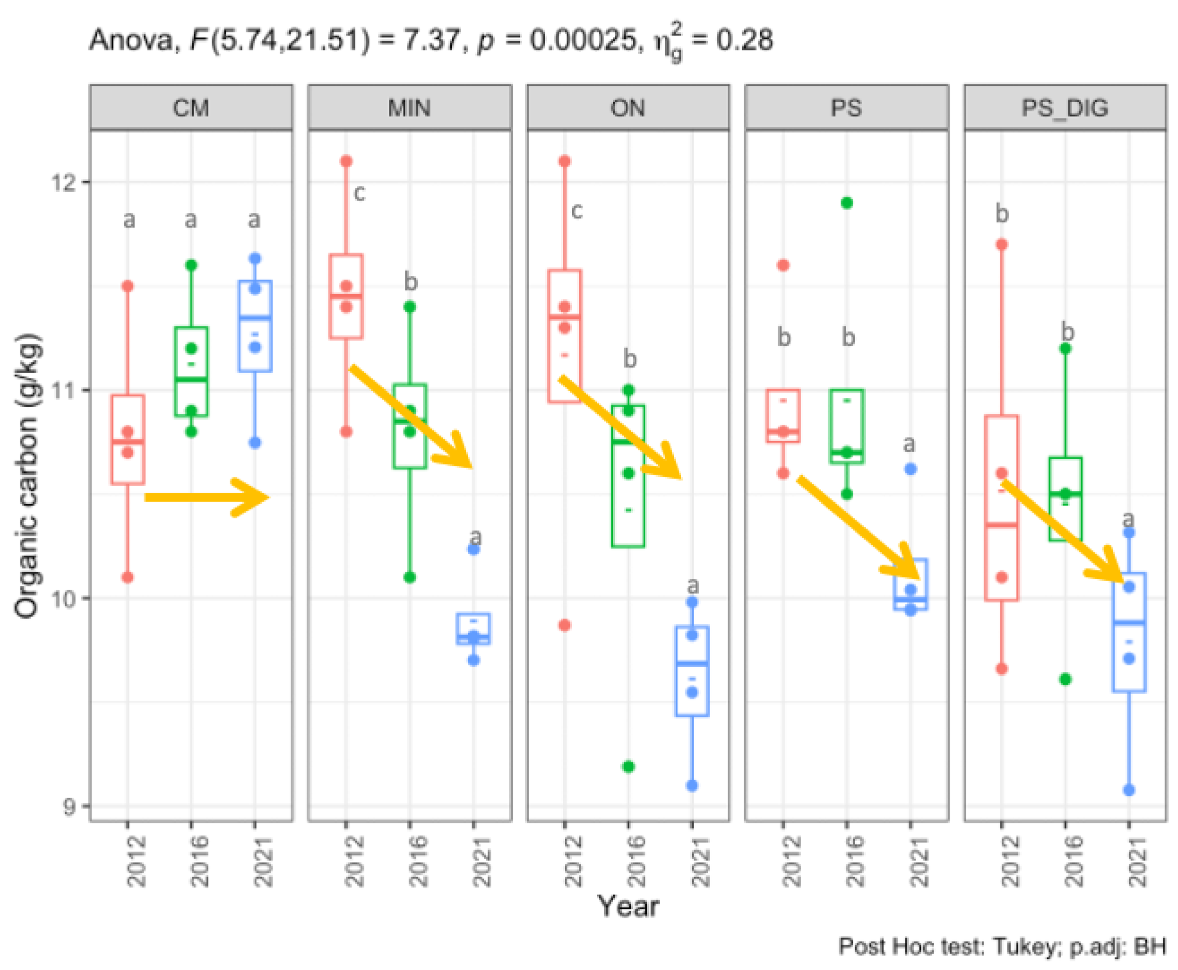
All molecular analyses performed in 2022

- **Microbial molecular biomass** – Amount of ADN
- **Microbial diversity** – 16S and 18S gene sequencing

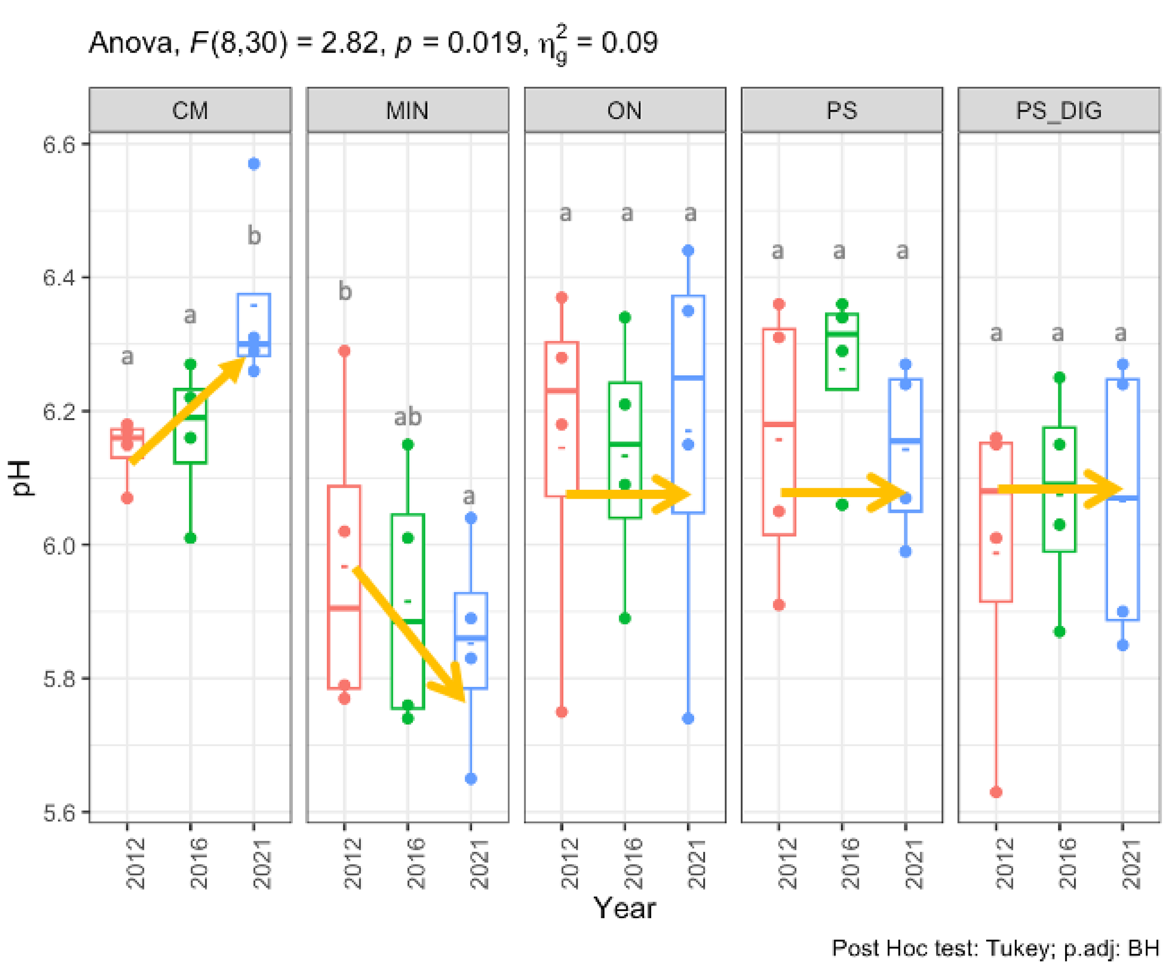


RESULTS

Physicochemical soil parameters

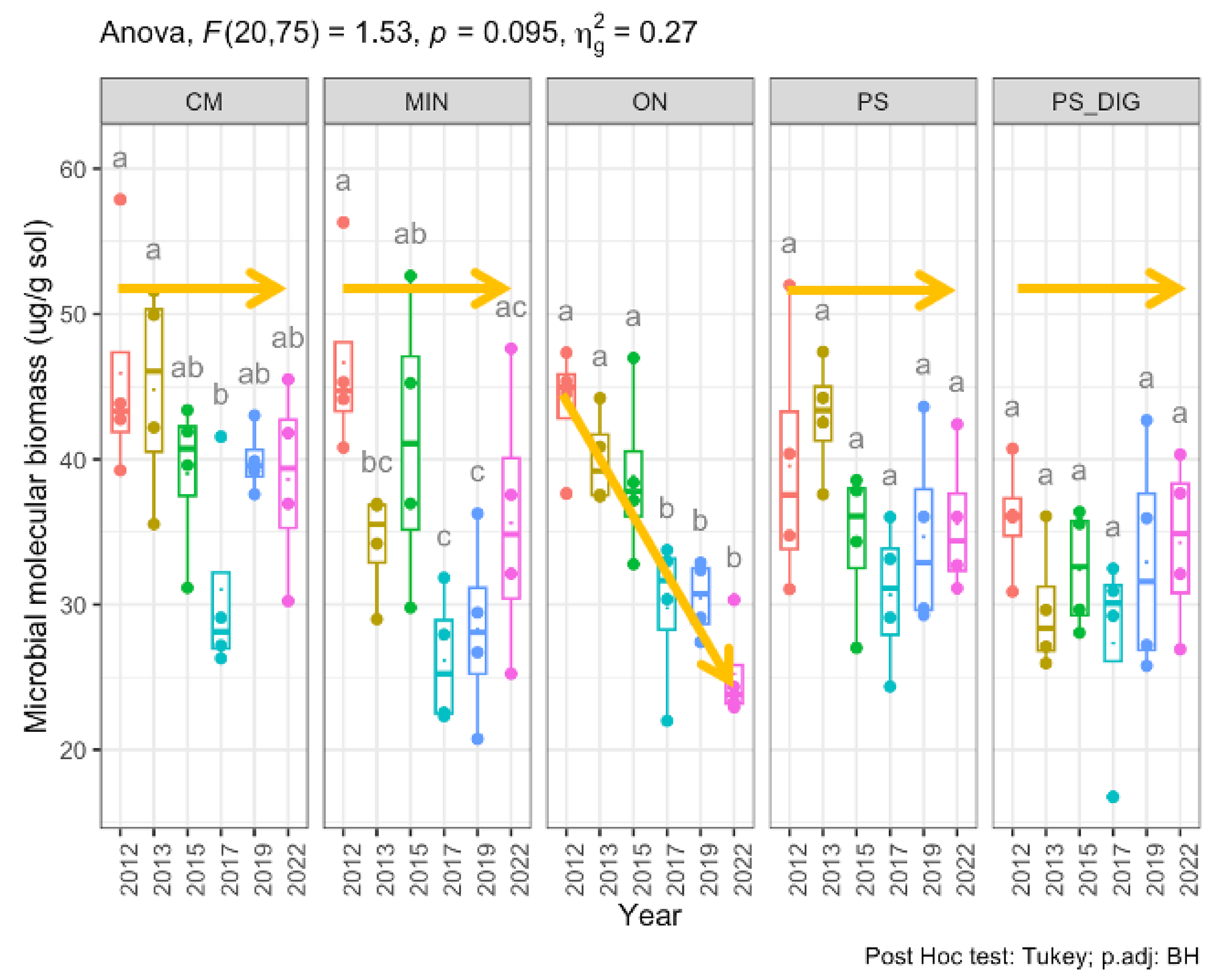


The only plots that did not show a **significant decrease in soil organic carbon** were those fertilized with CM.



Significant **acidification of the soil** in the **MIN** fertilized plots. **CM** application significantly **increase the soil pH** over time. Soil **pH** remained **stable for ON, PS and PS-DIG** over 10 years

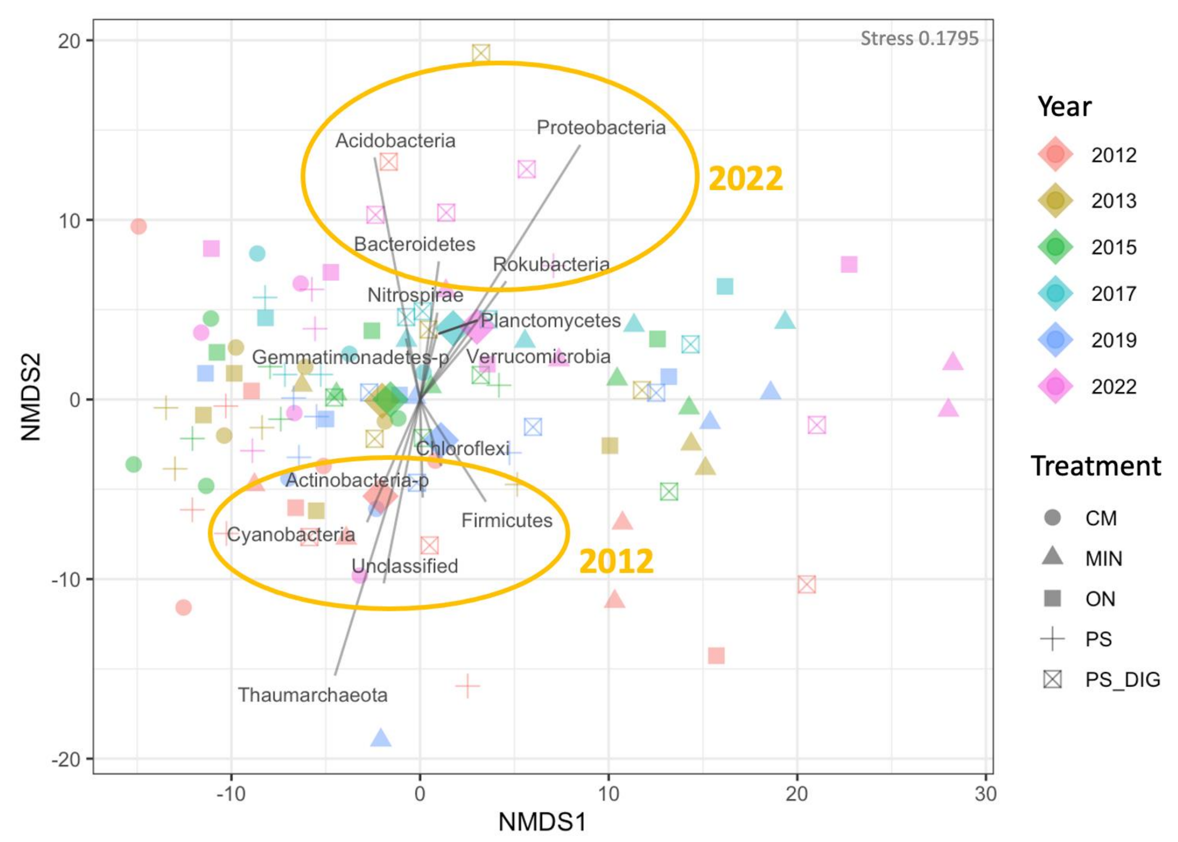
Soil microbial molecular biomass



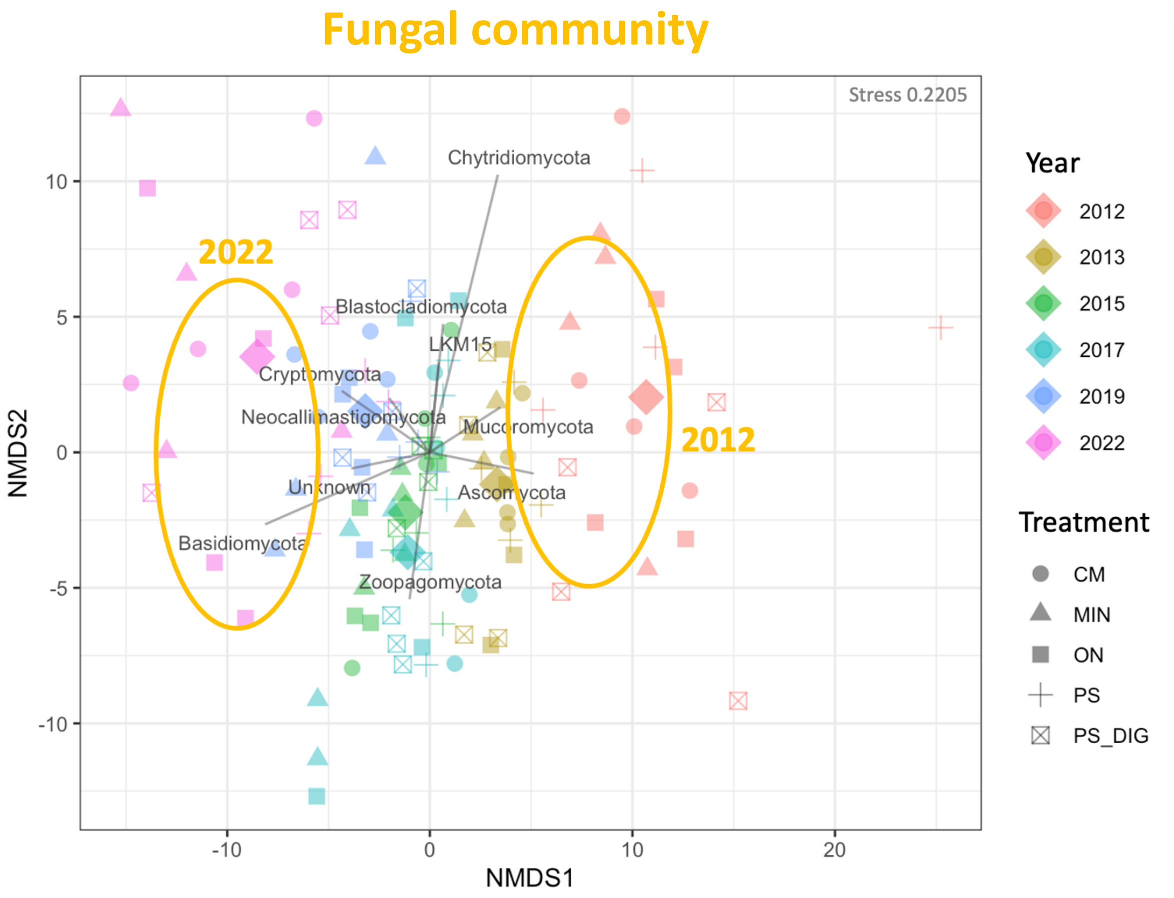
Soil microbial molecular biomass remained stable over 10 years for all treatments except the unfertilized plots **(ON)** where **a significant decrease was observed (58% less between 2012 and 2022).**

Structure of soil microbial communities

Prokaryotic community



Fungal community



NMDS : Non-metric multidimensional scaling from OUT-based Robust-Aitchison dissimilarity distance

The prokaryotic community structure highlighted **changes over time depending on the treatment**.
A time-dependent effect was also observed in the fungal community structure, however the discrimination between different treatments seemed less pronounced than observed for the prokaryotic communities.

CONCLUSIONS

- ✓ Repeated applications of organic and inorganic fertilizer products induced lasting modifications of the soil's chemical properties. These changes vary from one treatment to another.
- ✓ Regardless of the type of fertilization (organic or inorganic), the dynamic of soil molecular microbial biomass was stable over time.
- ✓ The soil microbial community structure showed lasting modifications with a significant temporal gradient that varies according to the treatment. These modifications stimulated *Proteobacteria*, known to prefer nutrient-rich environments and involved in the degradation of complex organic compounds, and *Basidiomycota*, an important group of soil fungal decomposers.
- ✓ After 10 years of repeated inputs, the digestate has globally the same effect on soil microbial community than other fertilizers (organic or mineral).

⚠ *Soil physico-chemical results → What about soil microbiology in the following years?*

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