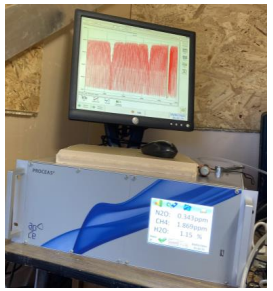
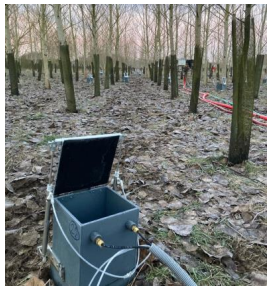
Does alley cropping agroforestry with nitrogen-fixing species mitigate greenhouse gas emissions?

Caroline Plain, Nicolas Marron, Séverine Piutti, Erwin Dallé, Abdoulaye Ndiaye, Daniel Epron

Abstract number: 226-Pm7w-1811

5th World Congress on Agroforestry
Quebec city – July 17-20, 2022

Context


Land use change and agriculture = 24% GHG and ~ 40% by 2050

Agroforestry ➔ CH_4 and N_2O emissions?

How?

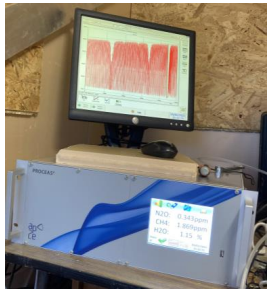
Alter soil water content, light intensity reaching the soil, temperature, organic matter quality and quantity, etc.

Nitrogen-fixing plants ➔ CH_4 and N_2O emissions?

How?

Modify the form and the amount of nitrogen available for microbes and thus increase nitrification/denitrification processes

Objectives





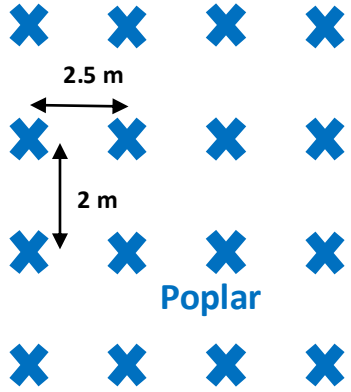
To determine the influence on net N_2O and CH_4 fluxes:

- ❖ of land use (agroforestry systems, grass- or clover-ley systems or forest plantations)
- ❖ and the presence of N-fixing species (trees or crops)

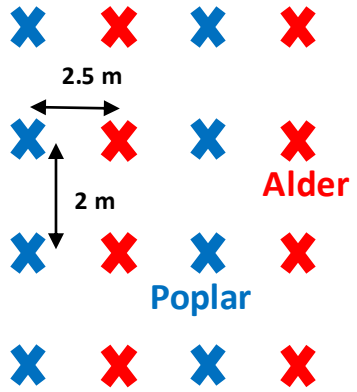
Materials and Methods

➢ Site

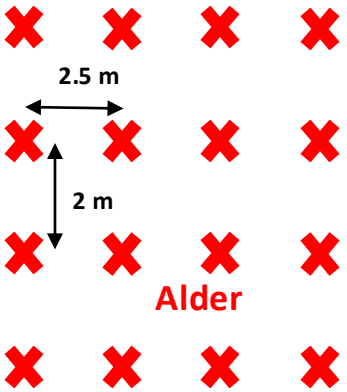
- Location NE of France
- Precipitations: 950 mm
- Mean annual temperature: 8.5°C



Monoculture plot



Forest mixture plot



Monoculture plot

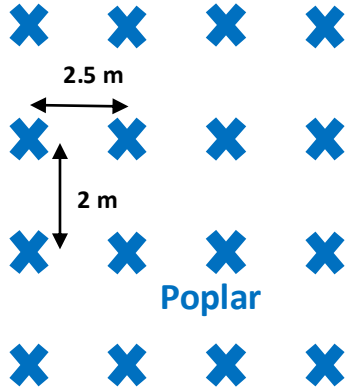
- 3 ha installed in 2014
- 3 blocks

- GHG fluxes measurements only in the 1st block
- 7 treatments (3 forest plots

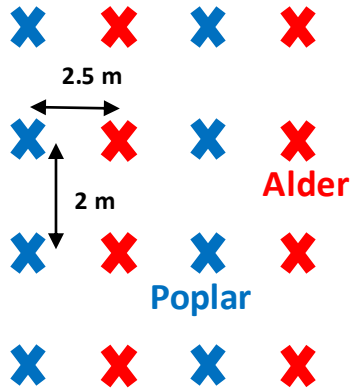
Materials and Methods

➢ Site

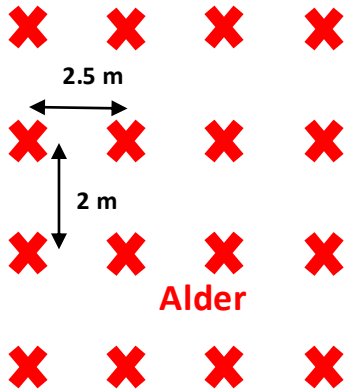
- Location NE of France
- Precipitations: 950 mm
- Mean annual temperature: 8.5°C



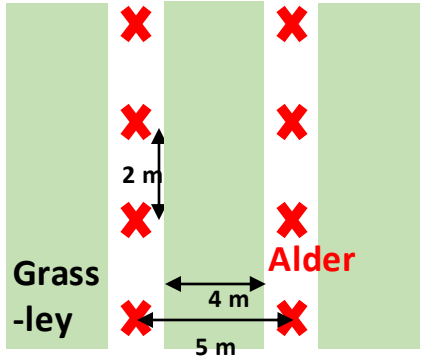
Monoculture plot



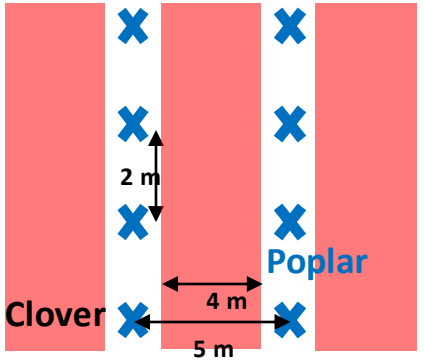
Forest mixture plot



Monoculture plot



Agroforestry plot



Agroforestry plot

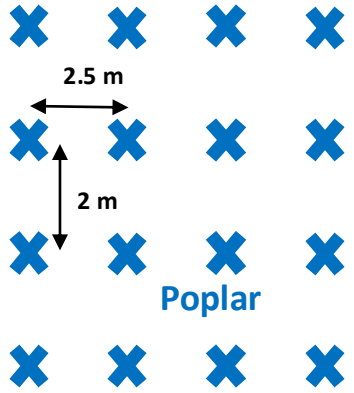
- 3 ha installed in 2014
- 3 blocks

- GHG fluxes measurements only in the 1st block
- 7 treatments (3 forest plots / 2 agroforestry plots

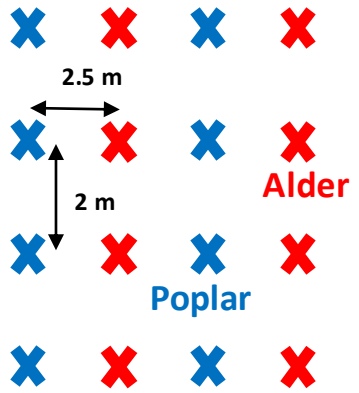
Materials and Methods

➢ Site

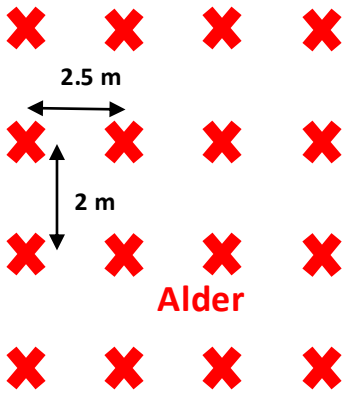
- Location NE of France
- Precipitations: 950 mm
- Mean annual temperature: 8.5°C



Monoculture plot

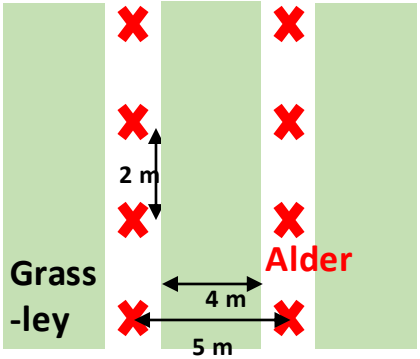


Forest mixture plot

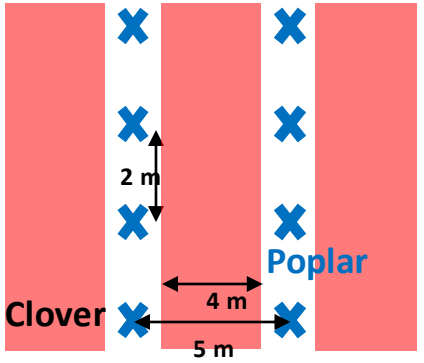


Monoculture plot

- 3 ha installed in 2014
- 3 blocks

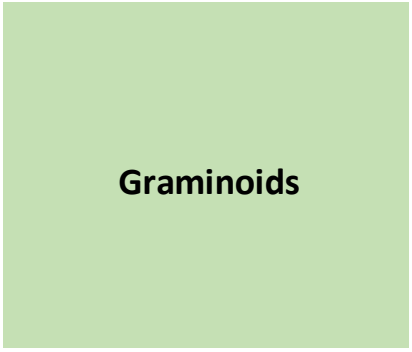


Agroforestry plot

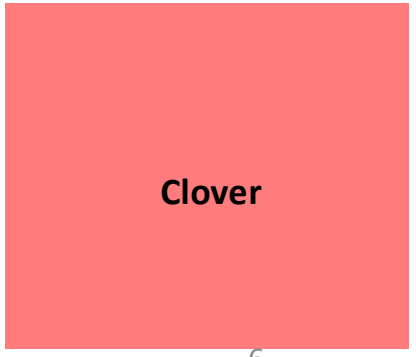


Agroforestry plot

- GHG fluxes measurements only in the 1st block
- 7 treatments (3 forest plots / 2 agroforestry plots / 2 crop plots)



Crop plot



Crop plot

Materials and Methods

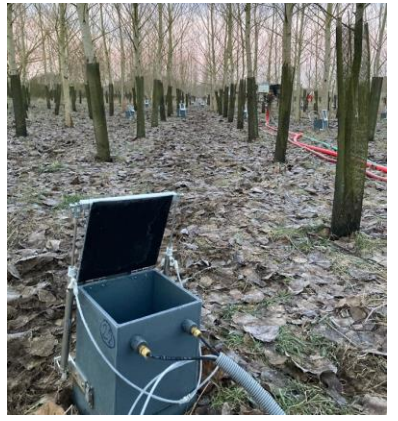


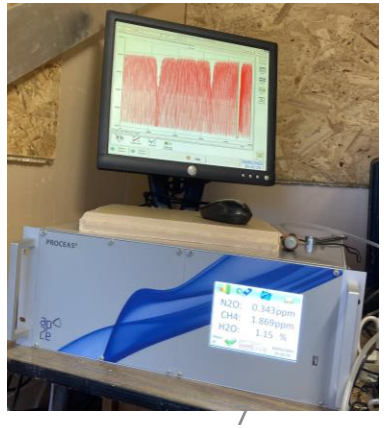

- GHG measurements recorded in 2021

  6 automatic chambers / treatments connected to a laser spectrometer

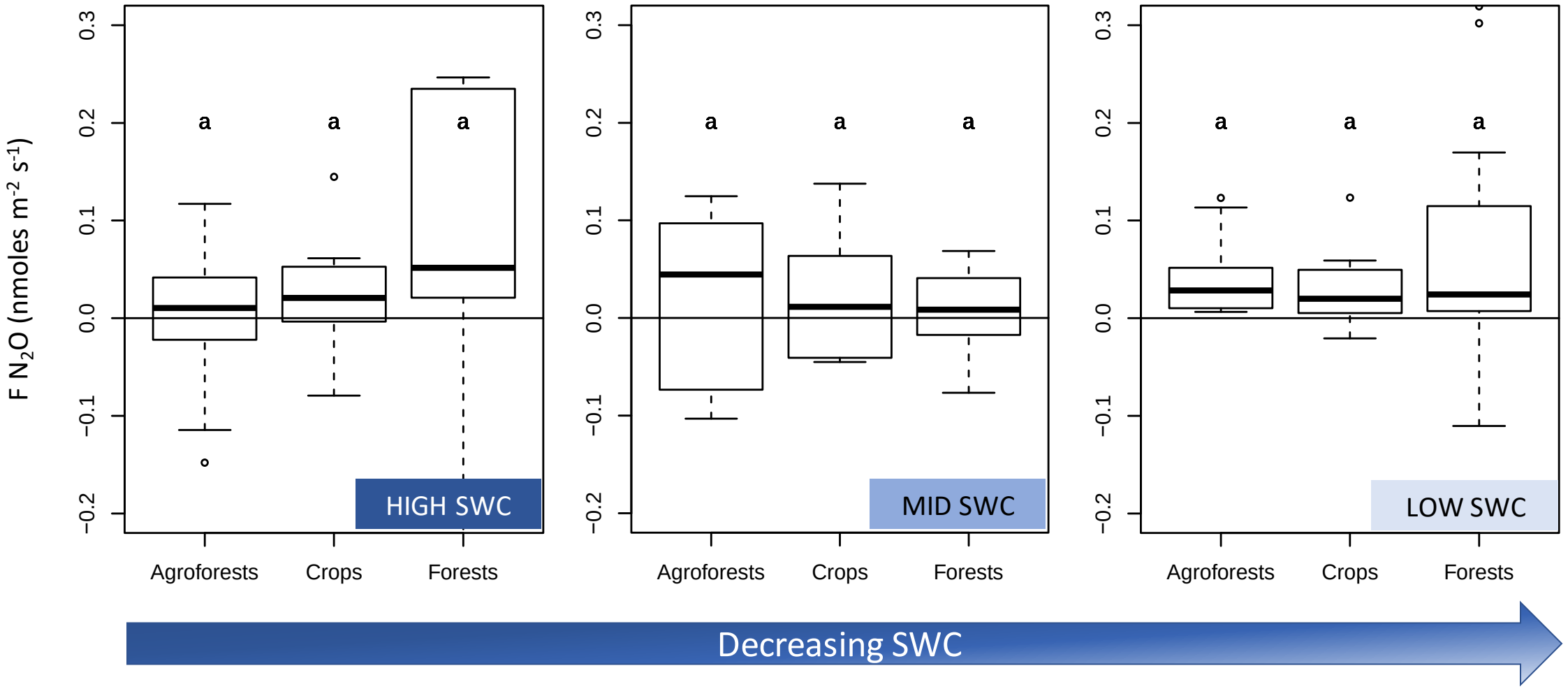
  (CH_4, N_2O by AP2E spectrometer)

- Meteorological measurements (SWC CS650 Campbell sci.)
- NH_4 and NO_3+NO_2 extracted on soil cores with KCl and analyzed with skalar (San+)



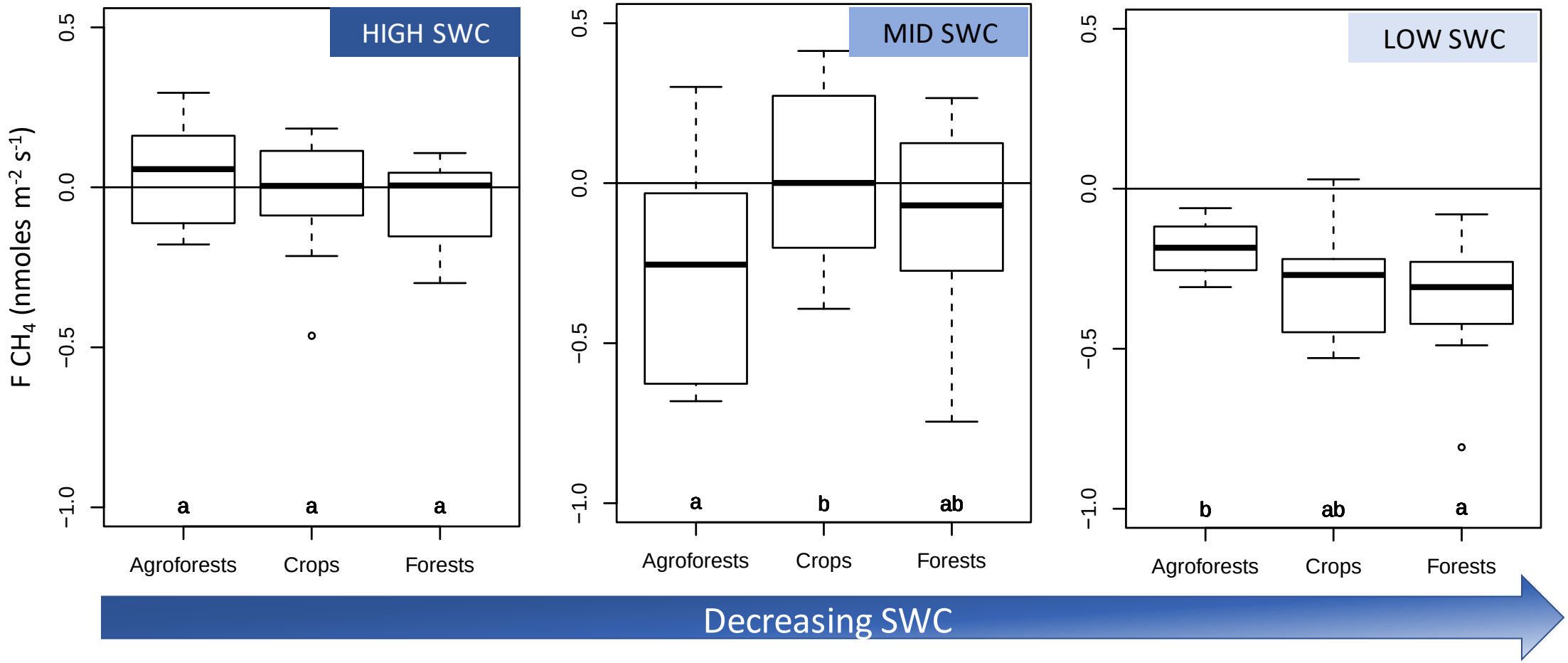


N_2O emissions between treatments at different SWC



For N_2O: No significant differences between treatments whatever the SWC

CH_4 emissions between treatments at different SWC

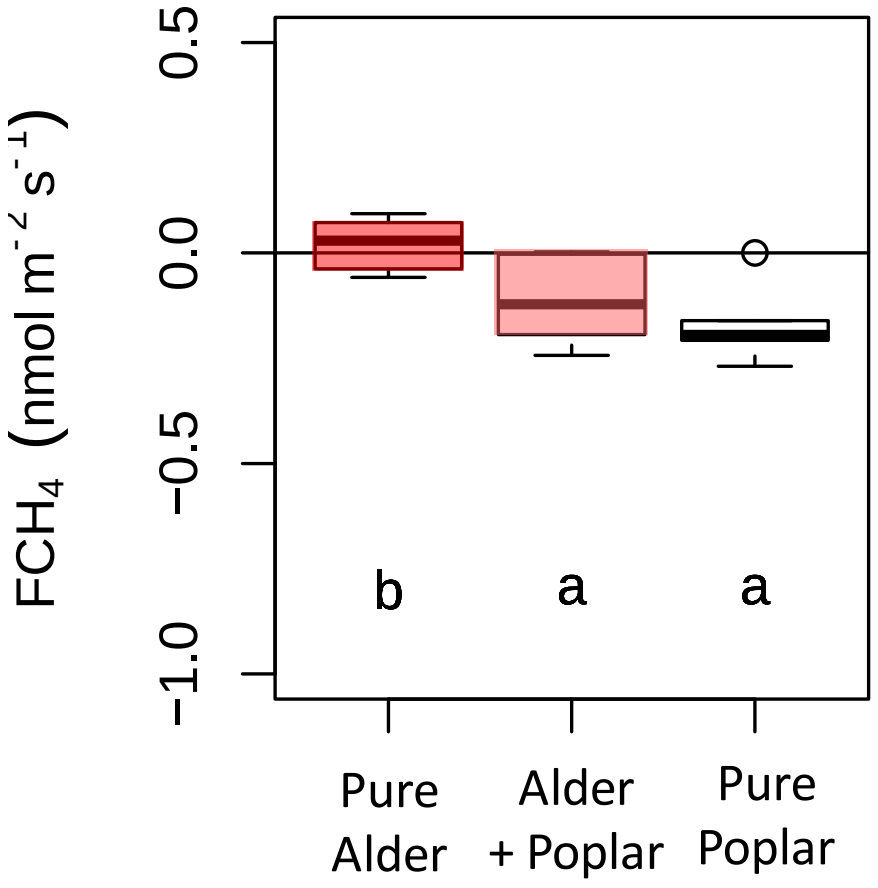


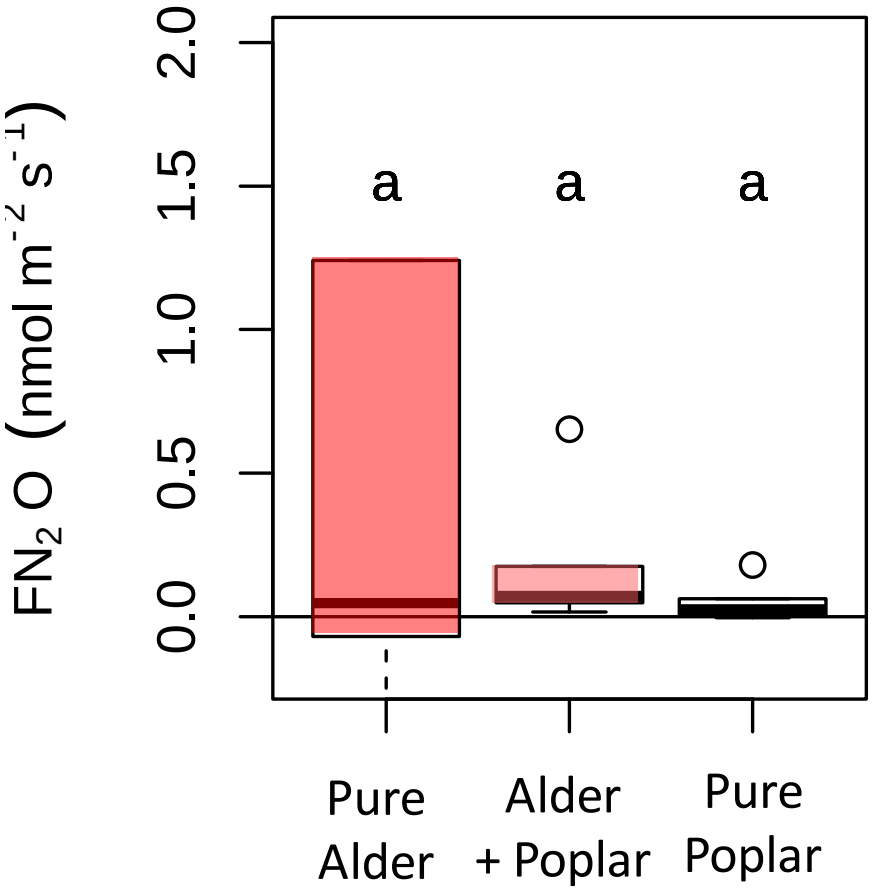
For CH_4: During the entire monitoring period and at high SWC, no significant differences between treatments. But 2021 was a wet year.

Methane Sink : Forest > Agroforestry plantation at low SWC

Agroforestry > Crops plantation at mid-SWC

Influence of forest plantations on GHG emissions

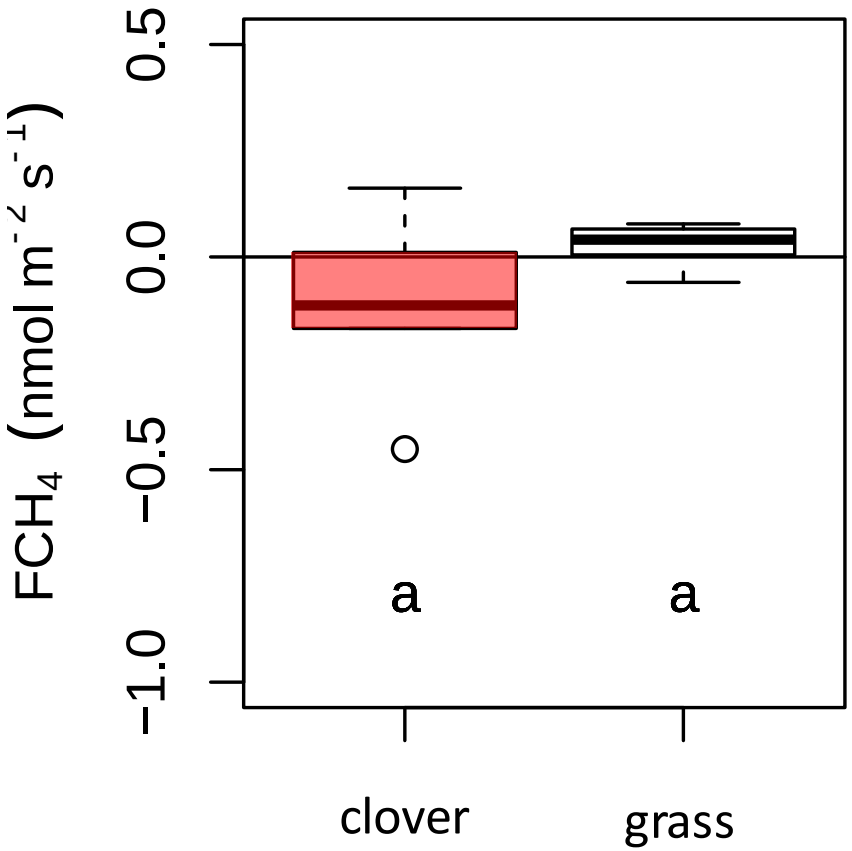


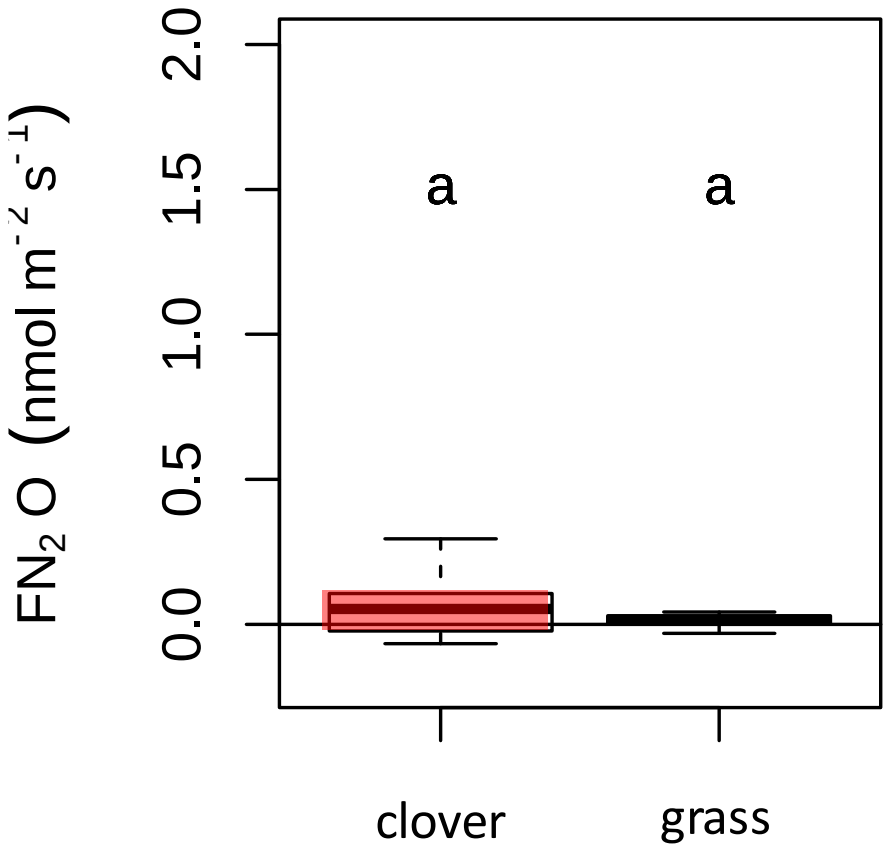


<u>FCH_4 differences: Pure alder emitted CH_4 and Alder+Poplar or pure poplar were methane sinks</u>

Not explained by mineral N content (no significant differences between treatments)

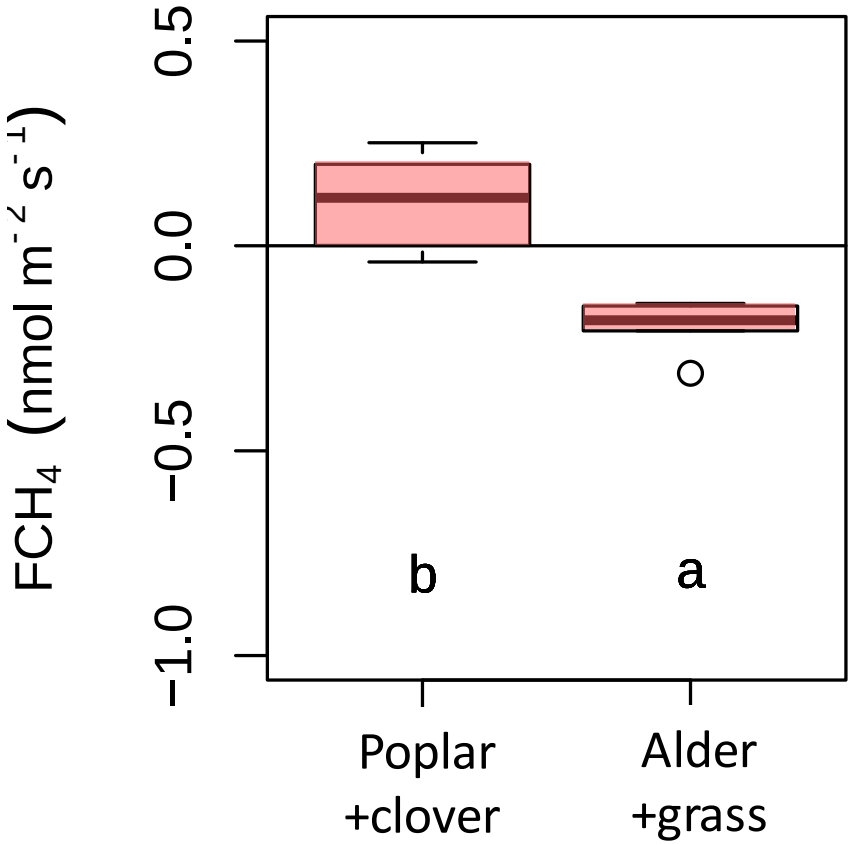
Influence of crop species on GHG emissions

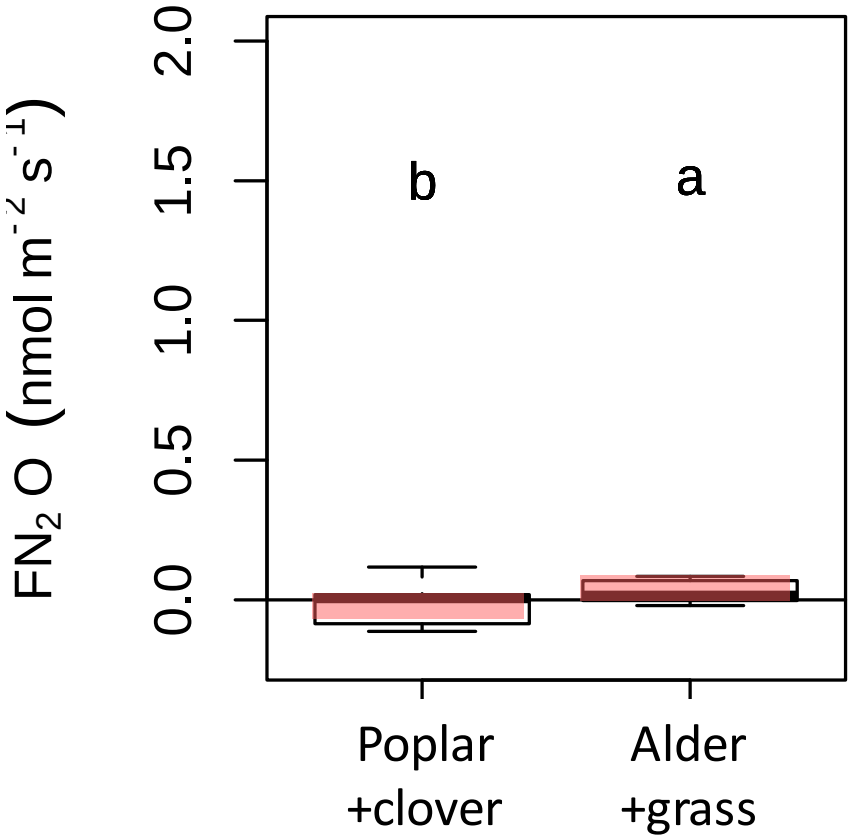




No fluxes differences even if NO_3 clover > NO_3 grass

Influence of agroforestry associations on GHG emissions





CH_4

Poplar+Clover emitted CH_4

Alder+Grass was CH_4 sink

N_2O

Alder+Grass emitted N_2O

Poplar+Clover was a N_2O sink

N contents were not significantly different

To conclude

✓ For both GHG: no significant differences between agroforestry, crops and forest plantations when considering the whole period of monitoring, for 2021 a wet year

- But at low SWC: forests were better methane sink than agroforestry
- At medium SWC: crops were better methane sink than agroforestry

✓Strong dependence of the results on the kind of association:

- For forest, best was pure poplar (CH_4 sink)
- For crops, no influence
- For agroforestry, Clover + Poplar was better in terms of N_2O emissions (sink) but was a methane source ; While the Grass + Alder association was a sink

Thank you!

For more information:
caroline.plain@univ-lorraine.fr

More information about the site:

- Poster 226-Ry6e-1411, Session: A1-2, Number: A11

- Poster 226-4UDw-1511, Session: A1-2, Number: A15

- Short video: 226-AaEw-1411

- Talk Wednesday: Session B2, Room 301A, 10.30 am

- Talk Wednesday: Session B2, Room 301A, 10.45 am