Temperate silvopastoral systems promote nitrification stability in the context of climate change: a case study in Brittany, France

Romane Mettauer, Mathieu Emily, Olivier Godinot and Edith le Cadre

Institut Agro Rennes Angers

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Stability of what to what?

Silvopastoral system: agroforestry system that combines trees with pastures on the same field (Burgress and Rosati, 2018)

→ Has gain attention as a way to increase the stability, i.e. resistance and resilience, of the agroecosystems to the climate change (IPCC, 2022)

→ One of the main expected ecosystem services: the regulation of the N losses (Valatin et al., 2022)

Yet, there is still much to explore on the regulation of N losses by silvopastoral systems (Kim and Isaac, 2020)

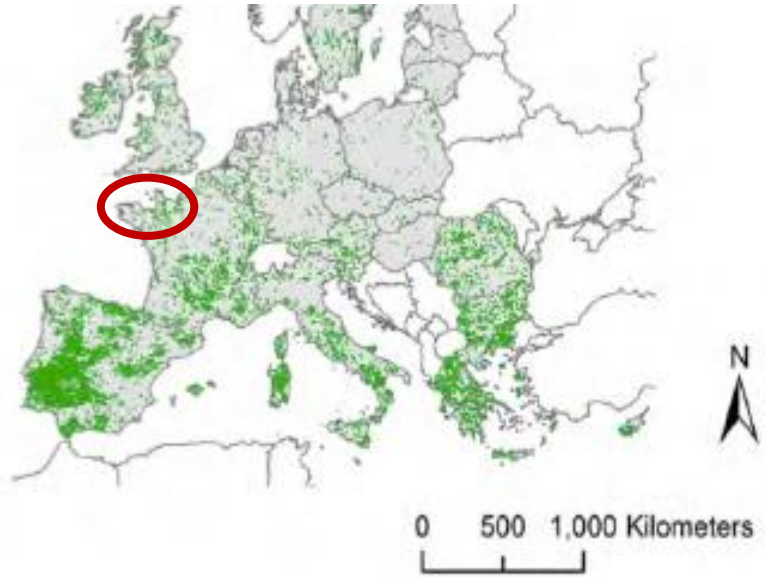
Understudied processes:
Nitrification and denitrification

Understudied conditions:
Extreme weather events, especially flooding

To what extent do temperate silvopastoral systems contribute to the stability of nitrification under flooding events?

Case study

Silvopastoral agroforestry in the Brittany region (France)



Agroforestry in Europe (den Herder et al, 2017)

In the Brittany region (France) : Two co-existing forms of silvopastoral systems in this region

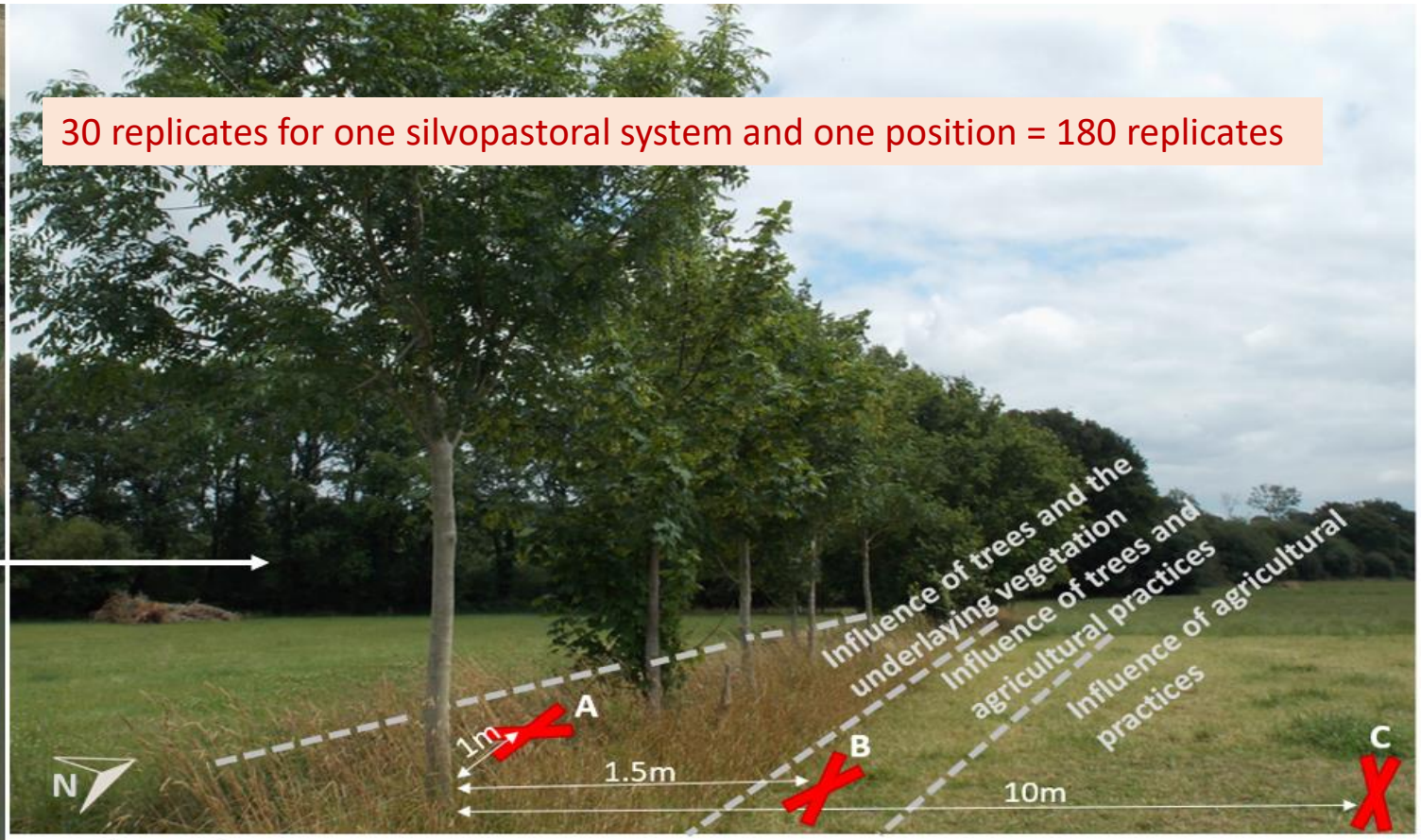
Bocage hedgerows = trees alignments bordering the fields

Alley-cropping agroforestry = trees rows planted within the fields

Measuring nitrification stability

Soil sampling: two neighboring plots with similar soils and management

30 replicates for one silvopastoral system and one position = 180 replicates

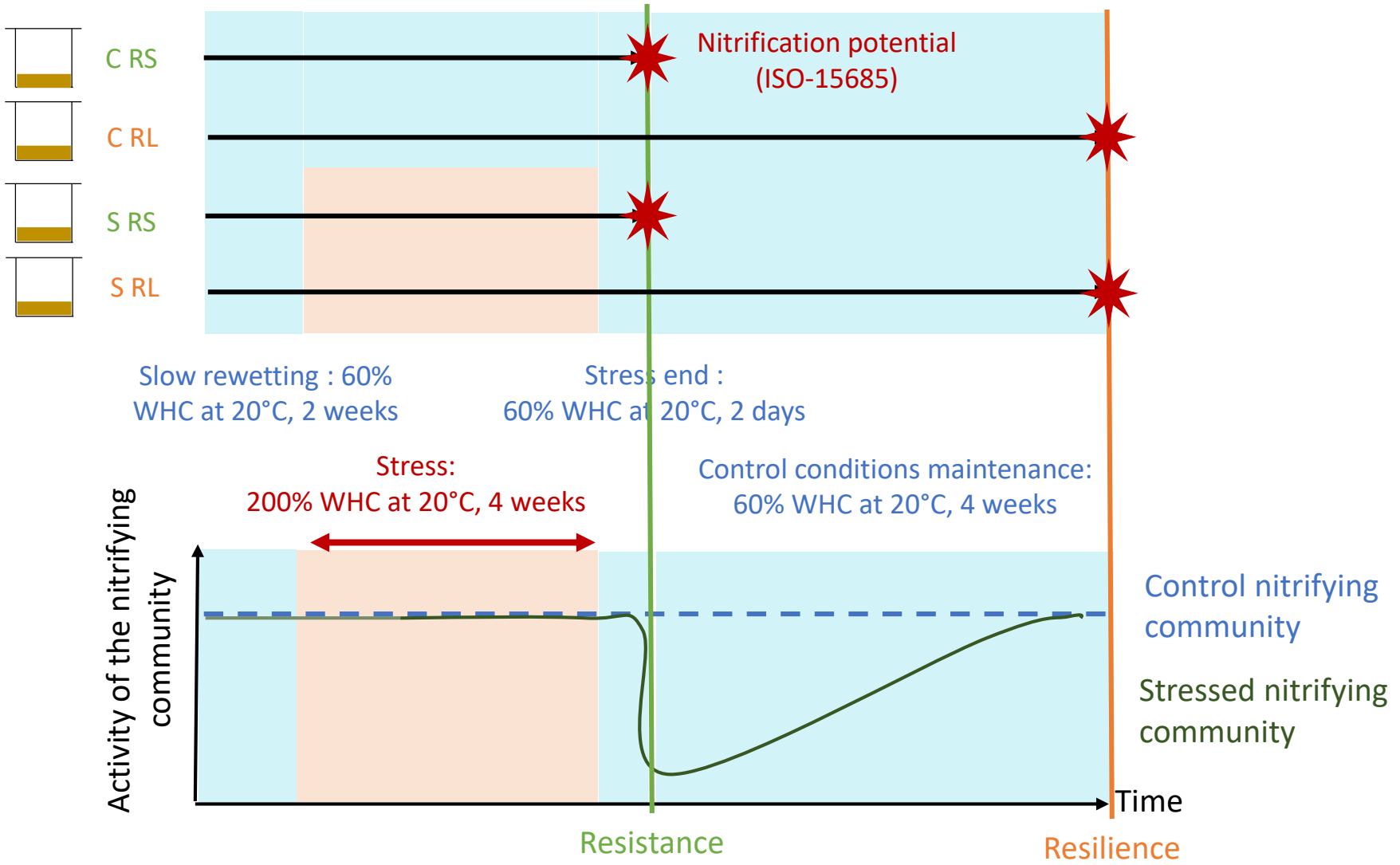


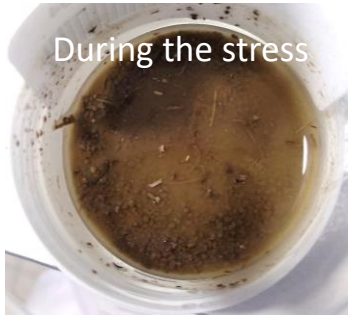
Legend:

- Localization of the study site (47°45'36.3"N 1°54'54.0"W)
- Position of the trees studied
- Plot with alley cropping agroforestry
- Plot with one hedgerow
- Positions of the sampling points

Measuring nitrification stability

Stability = Resistance + Resilience



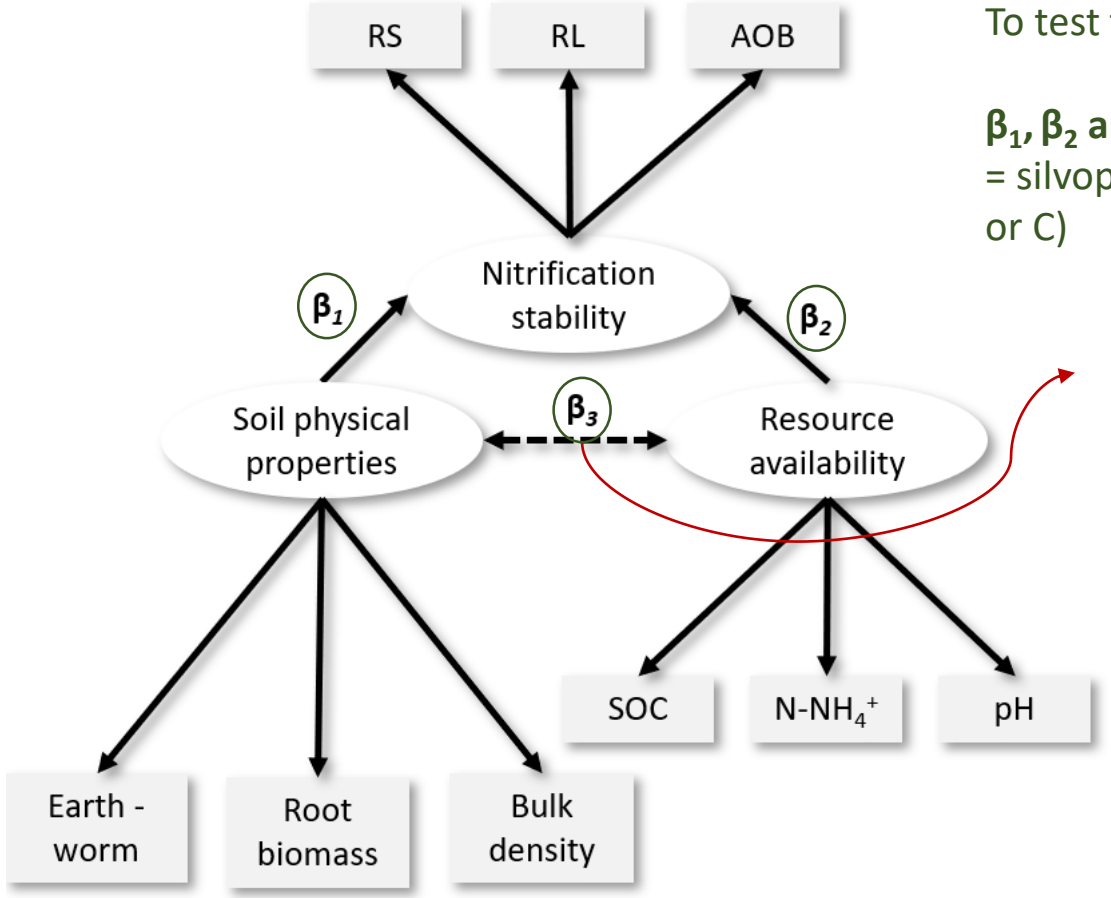


Exploring causal relations

Multigroup Latent Structural Equation Modeling (ML-SEM) (Fan et al., 2016)

SEM: enables to test direct and indirect effets of pre-assumed causal relations involving measurable (manifest) variables and conceptual (latent) variables

ML-SEM: tests similarities and dissimilarities between several groups of data



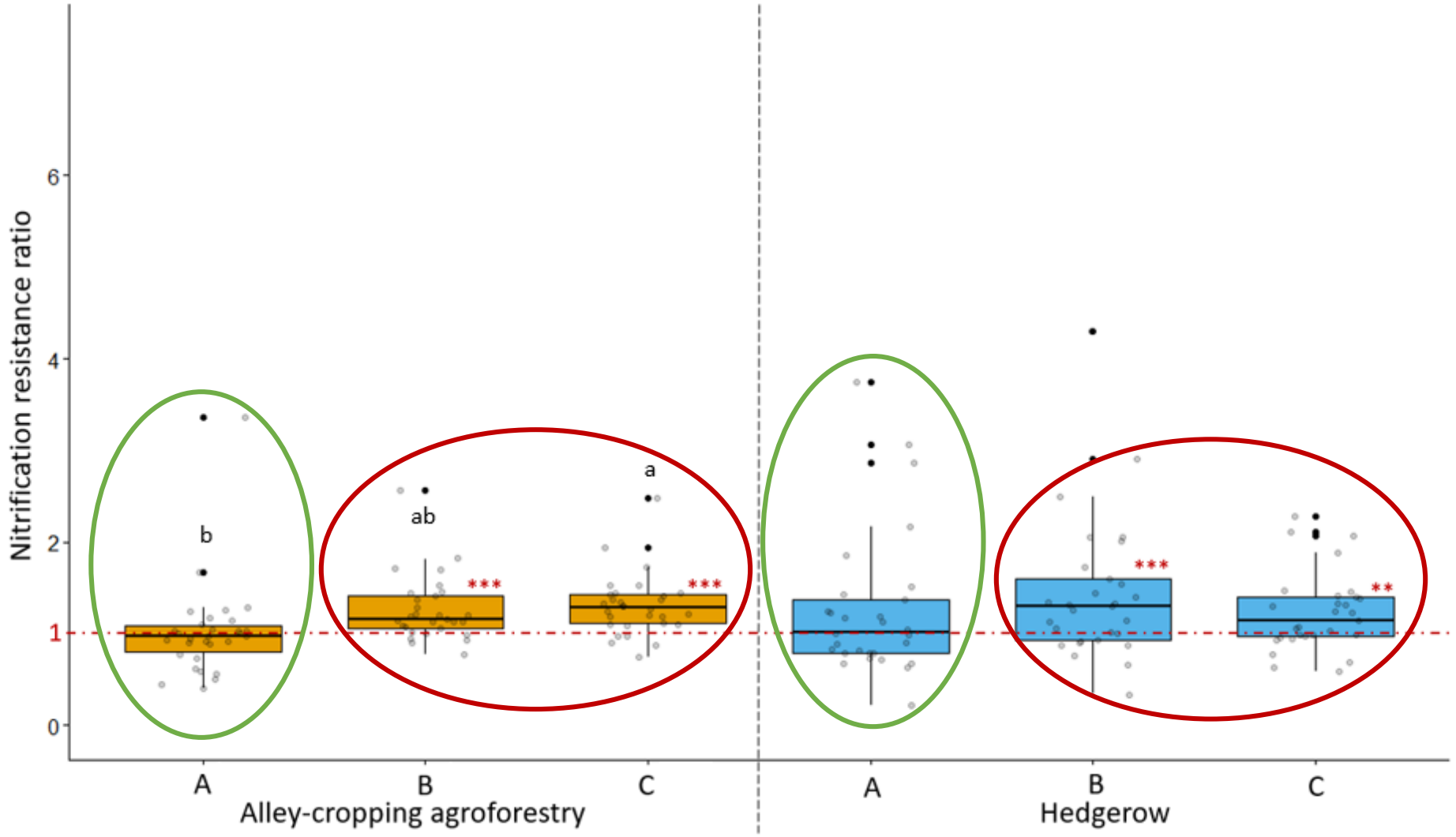
To test the similarities across the silvopastoral systems and positions:

β_1, β_2 and β_3 are estimated commonly for different groups of data : one group = silvopastoral system (hedgerow or alley cropping) x position to the trees (A, B or C)

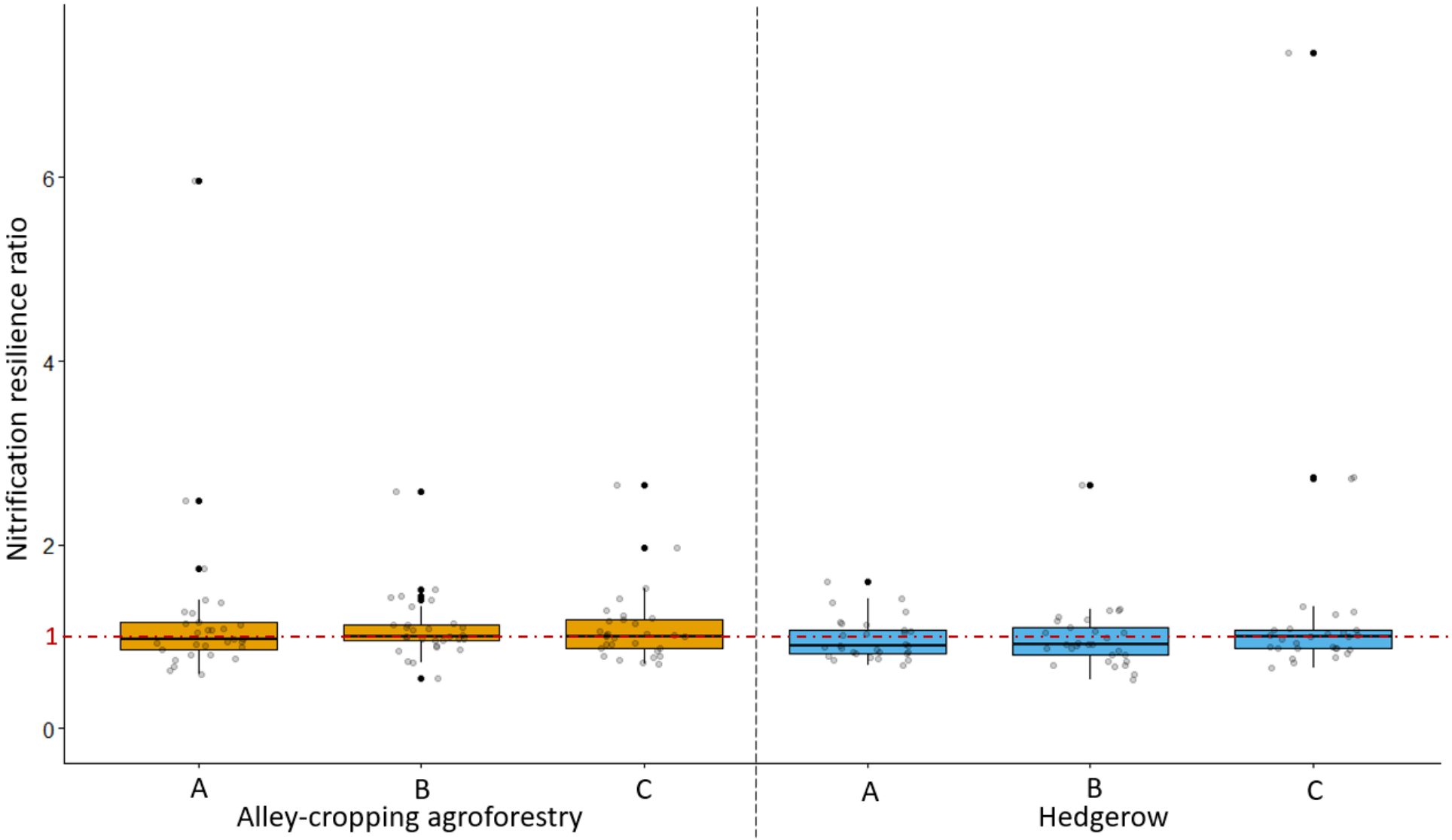
To test if feedback loops contribute to nitrification stability:

Model A: with β_3
Model A': without β_3

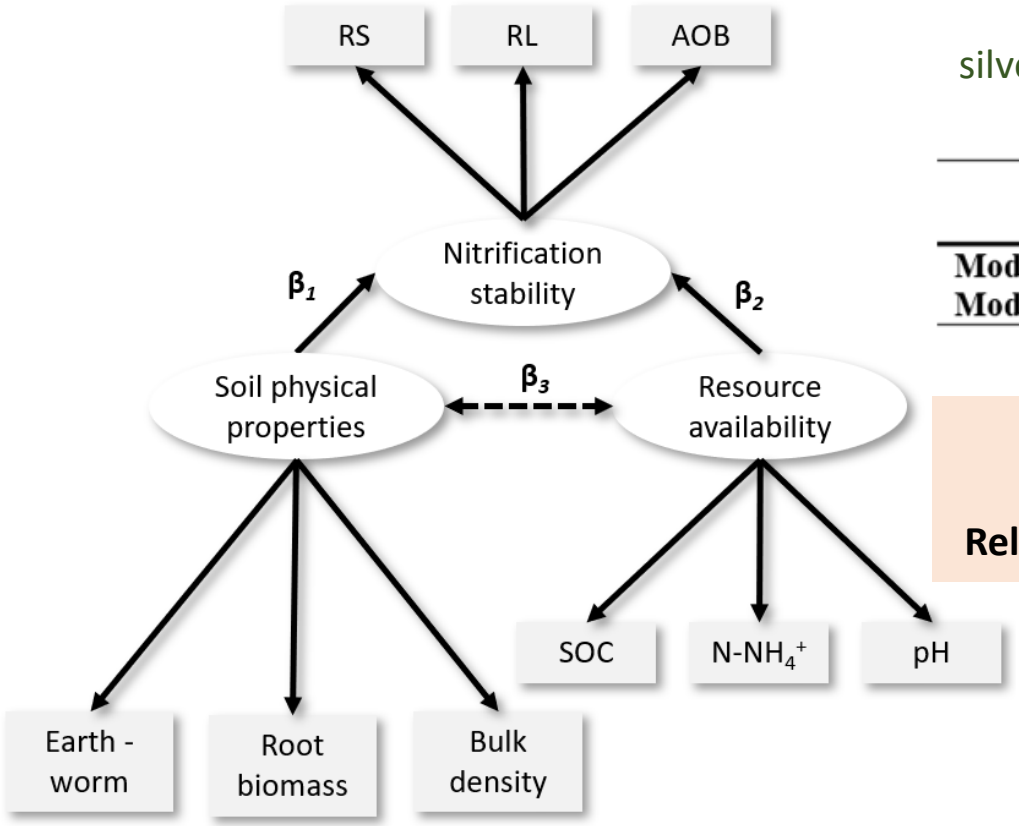
Result 1: Trees promote nitrification resistance



Result 2: Nitrification is resilient in silvopastoral systems



Result 3: Causal relations differ from one silvopastoral system to another



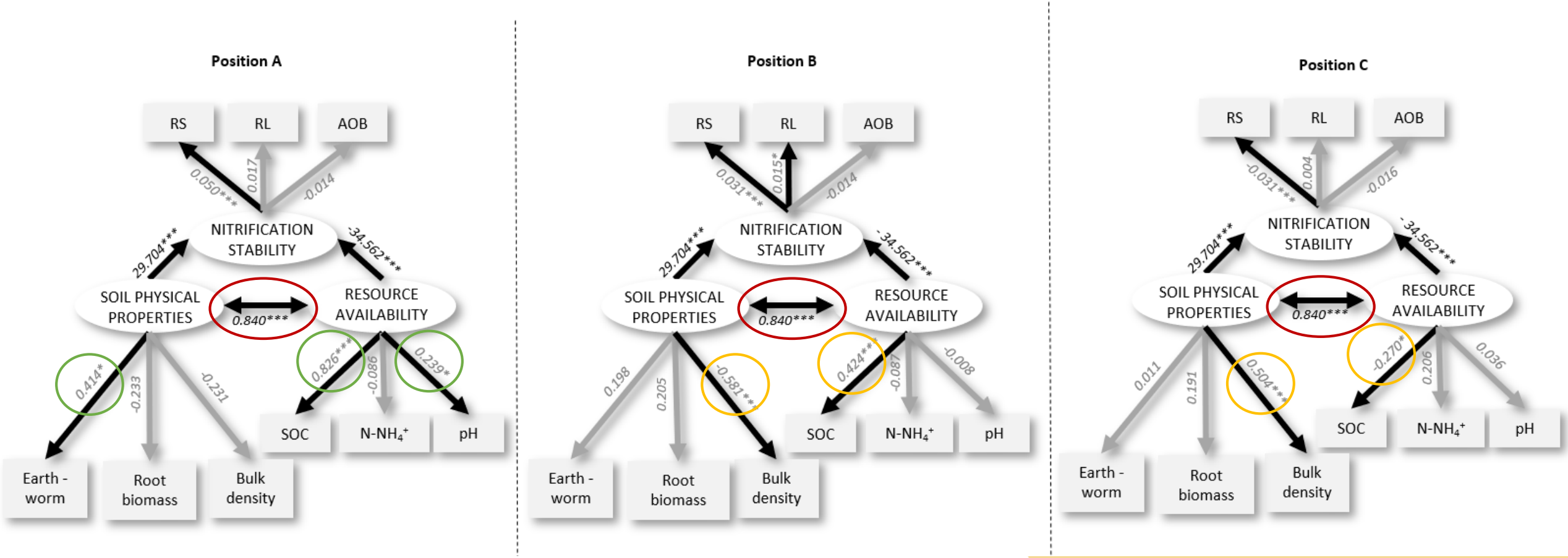
β_1, β_2 and β_3 are estimated commonly for all six groups :
silvopastoral system (hedgerow or alley cropping) x position to the trees (A, B or C)

	Chi² p-value						AIC
	AC-A	AC-B	AC-C	H-A	H-B	H-C	
Model A	0.142	0.020	0.153	0.027	0.016	0.001	4114
Model A'	0.174	0.110	0.032	0.053	0.005	0.001	4132

None of the tested model is retained for all six groups
=
Relations differ from one silvopastoral systems and from one position to another

Result 4: soil organic carbone and bulk density contribute to the stability of nitrification in grass alleys

Model A validated for the 3 positions in the alley-cropping system



Conclusion and perspectives

Alley-cropping tree rows and hedges promotes nitrification stability to flooding through the promotion of its resistance.

<u>BUT</u> this positive impact is limited to the close vicinity of trees.

Causal relations explaining nitrification stability seems to differ from one silvopastoral system to another.

None of the tested models fitted the data in the hedgerow systems

Results in the alley-cropping systems invites to consider management practices that favor soil organic carbon and soil bulk density to improve nitrification stability in the grass-alleys.

Limiting the activity of nitrification has gained attention as a way to regulate N losses in grazed pastures (Di and Cameron, 2018).

Altogether with a previous study on nitrification under stress-free conditions (Mettauer et al., 2024), silvopastures contribute to regulate N losses.

Thank you for your attention !

Any questions?

Contact: romane.mettauer@institut-agro.fr

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