Silvopastoral systems for the mitigation of nitrogen losses in the short and the long-term: a case study at dairy farm scale and research perspectives

Romane Mettauer, Edith Le Cadre and Olivier Godinot

Institut Agro Rennes Angers

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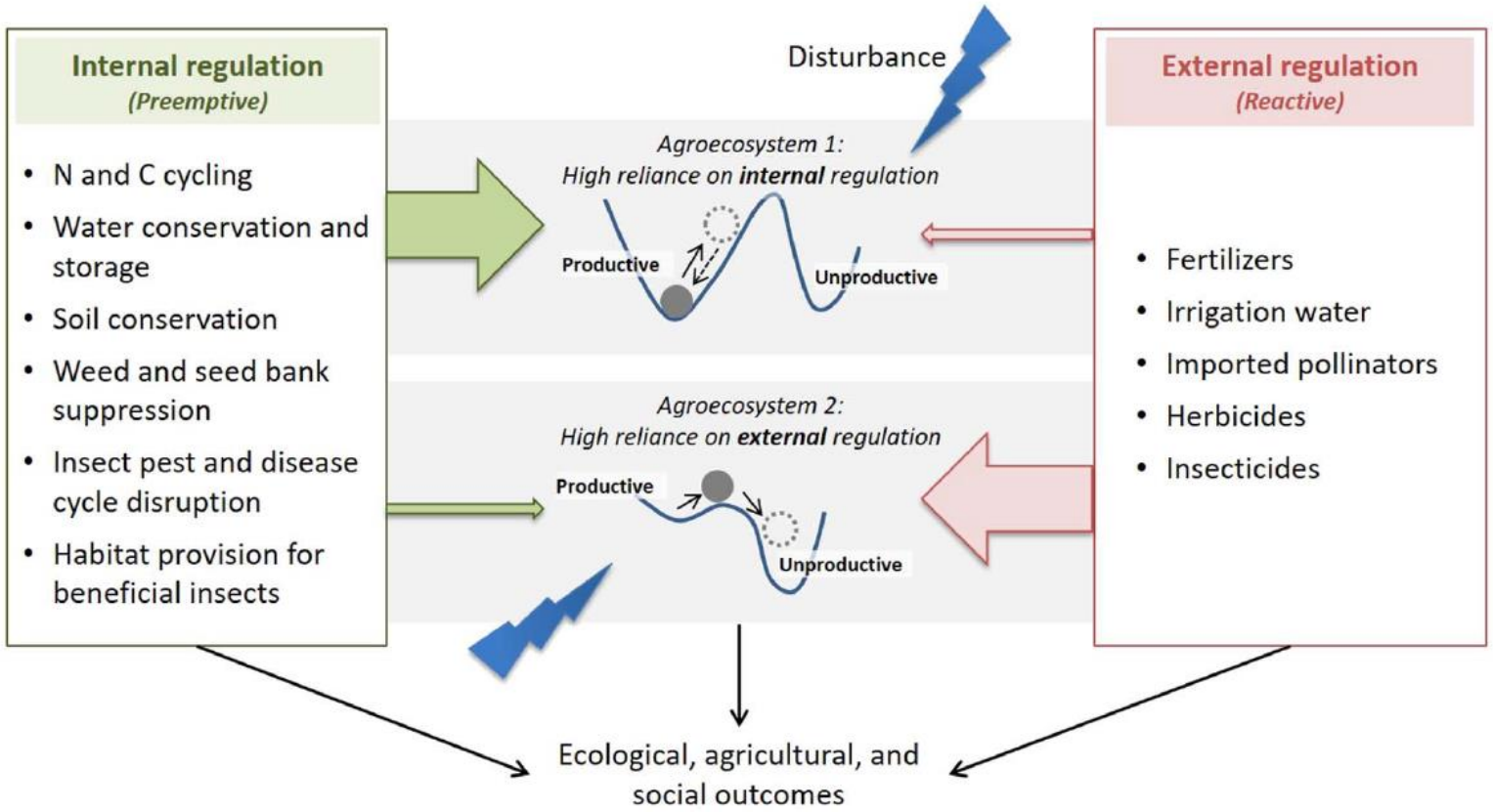
Mitigation of N losses: what sources of regulation?

Two types of regulations in the agroecosystems (Peterson et al., 2018)

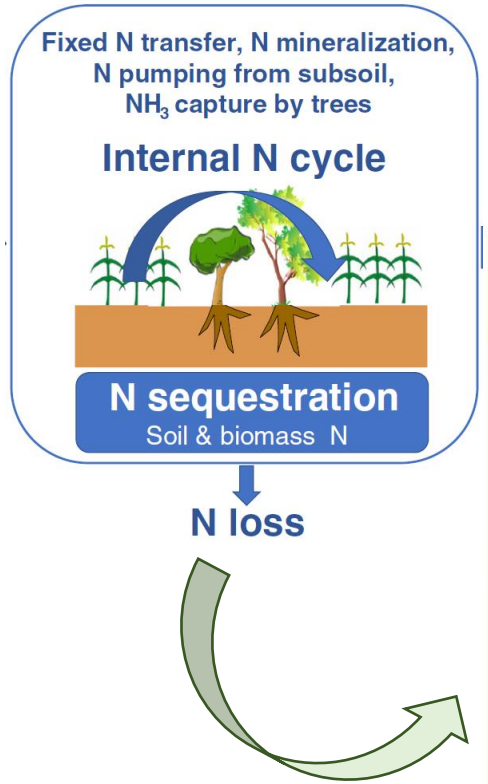


Mitigation of N losses: what about agroforestry?

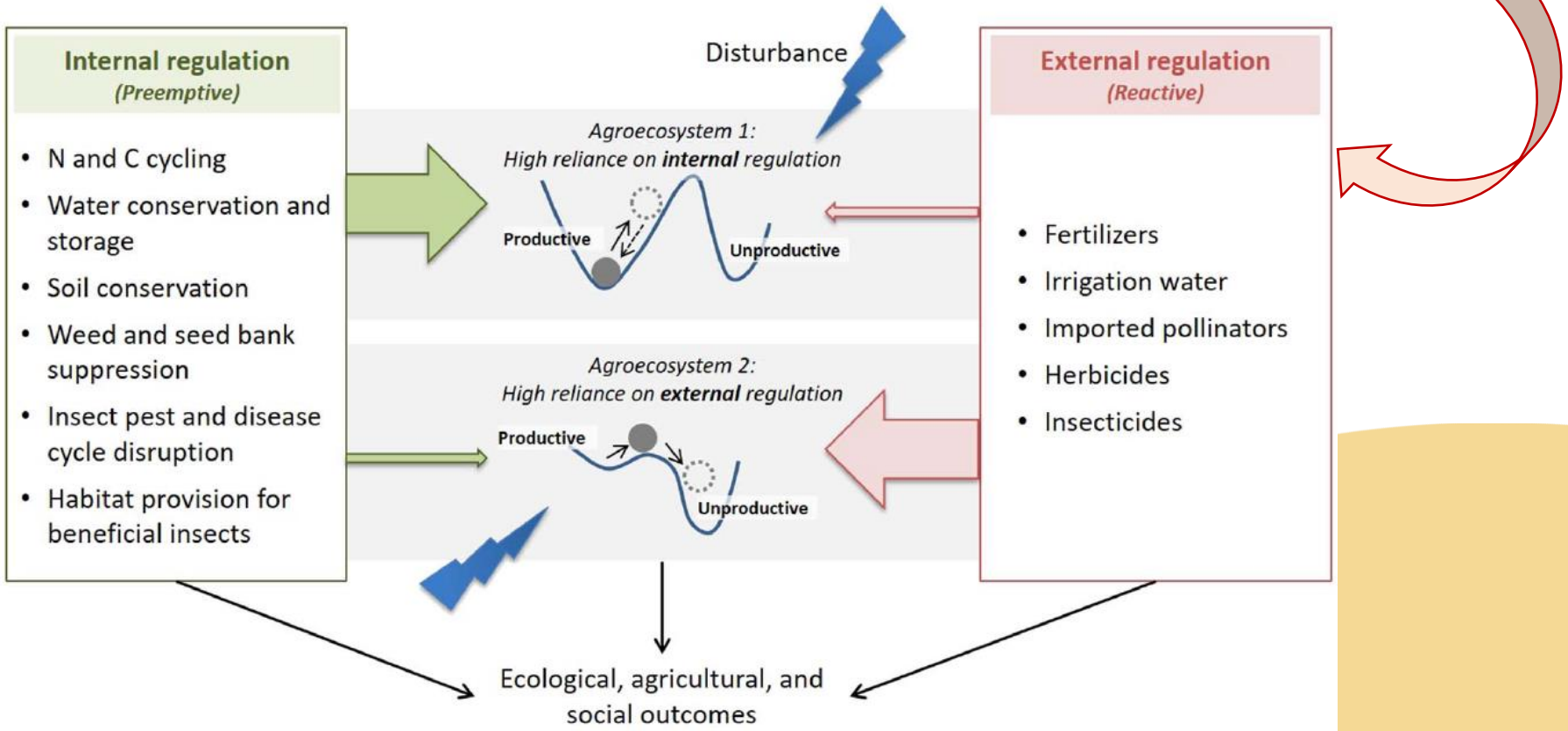
- **Agroforestry system:** combines trees with crops and/or livestock on the same field (Burgress and Rosati, 2018)

→ **Has gain attention as a way to mitigate N losses from agroecosystems** (Elrys et al., 2022; IPCC, 2022)

Kim and Isaac, 2020



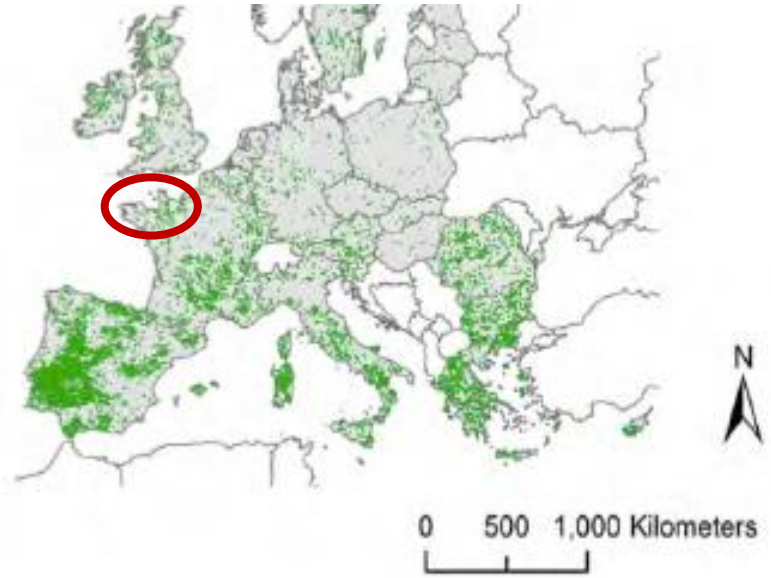
Yet, there is still much to explore



Aim of the study and case study

Aim: To explore the links between adoption of agroforestry, adoption of N-regulating farming practices and the regulation of N losses at farm level

Case study: Silvopastoral agroforestry in the Brittany region (France)



Agroforestry in Europe (den Herder et al, 2017)

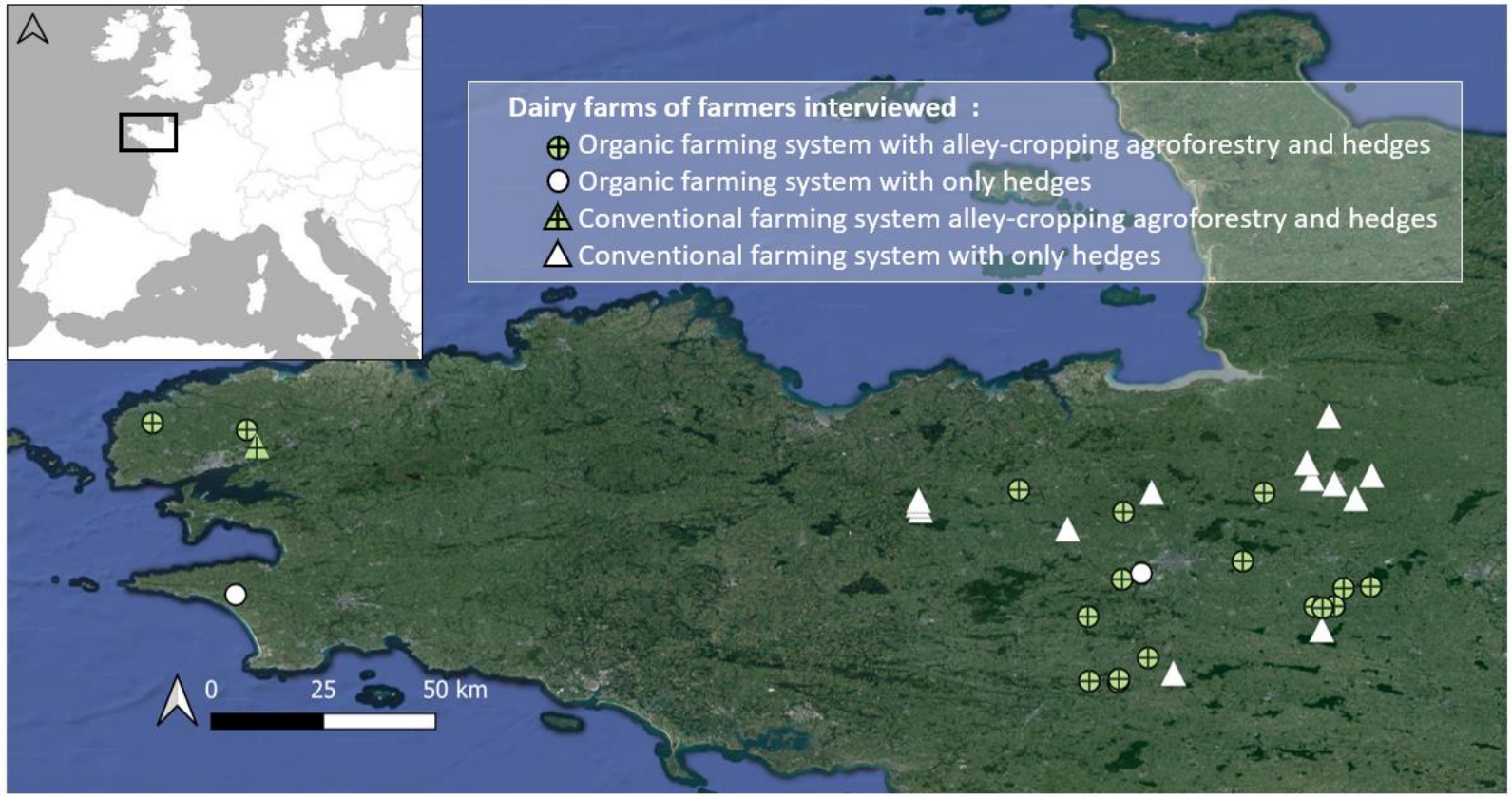
In the Brittany region (France) : Two co-existing forms of agroforestry linked with the presence of pastures in this region

Bocage hedgerows = trees alignments bordering the fields

Alley-cropping agroforestry = trees rows planted within the fields

Methodology: semi-directive surveys

33 semi-directive surveys: organic (n= 19) and conventionnal (n=14) dairy farms that maintained hedges (n= 33), planted hedges (n=25) and/or planted alley-cropping agroforestry (n=18)



Closed questions
farming pratices performed in 2022
+
Map of the farms by explicitly accounting for the surface planted with hedges and tree rows
=
Calculation of the farm gate N balance, as a proxy for the risk of N losses (N inputs – N outputs)

Open questions
motivations for agroforestry and links between agroforestry and management of N on the farm
=
Disentangling the links between adoption of agroforestry and of N-regulating practices

Result 1 : variations of the farm-gate N balance according to the presence of trees

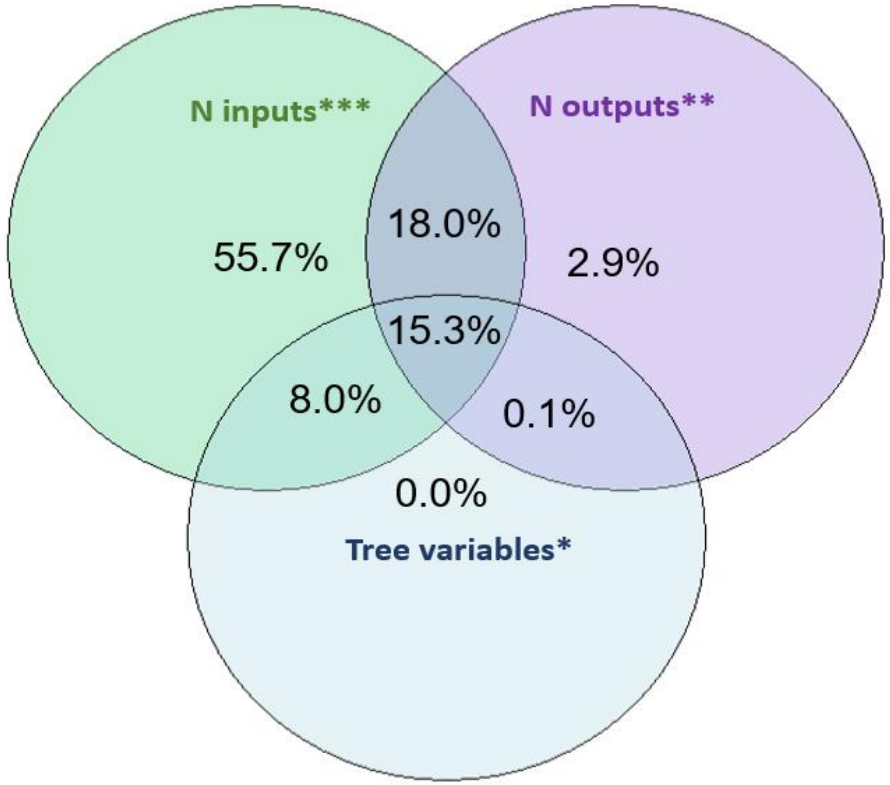
Results of the farm-gate N balance (kgN ha^{-1} yr^{-1}) and comparision to European references [1]

Min: 24.2 | Q1: 39.6 | Med: 53.3 | Moy: 78.5 | Q3: 97.9 | Max: 242.2

Low inputs farming systems

Organic farms | Conventional farms | Intensive farms

High variability → Do agroforestry contribute to explain this variability ?



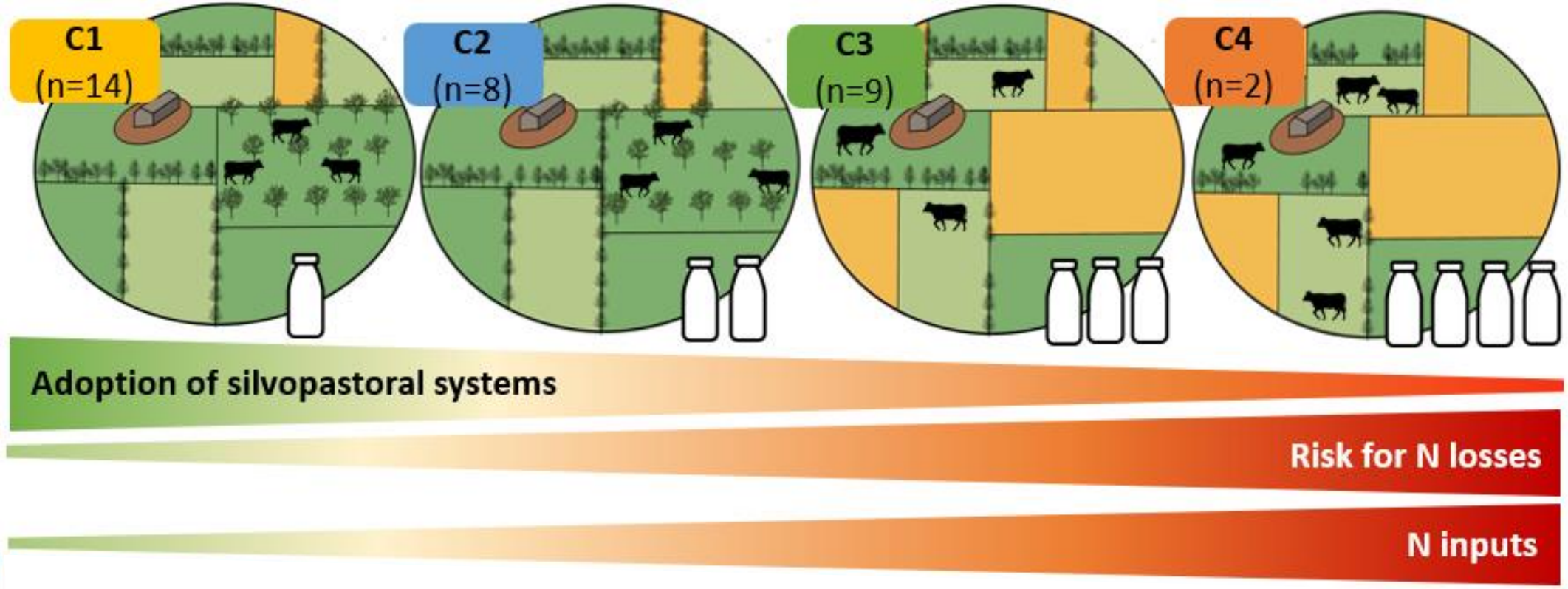
Yes, through its interaction with the management of N inputs and N outputs

But this impact did not account for much

As compared to a situation without trees, adoption of agroforestry contributed to limit the farm-gate N balance by 0.5% to 4.5% only!

[1] Puech et Stark, 2023;Quemada et al., 2020; Reimer et al., 2020

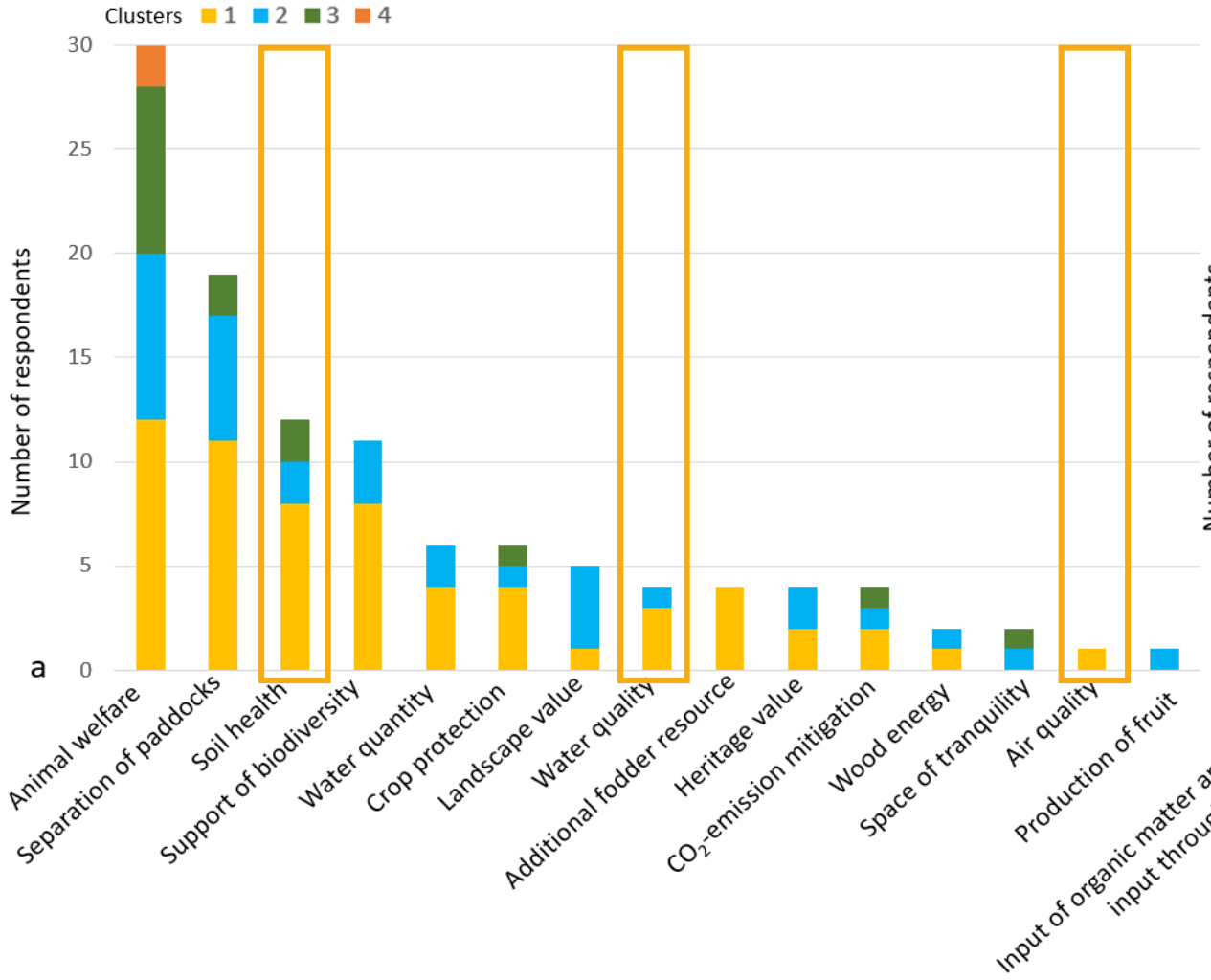
Result 2 : Exploring the combinations between farming practices and adoption of silvopastoral systems



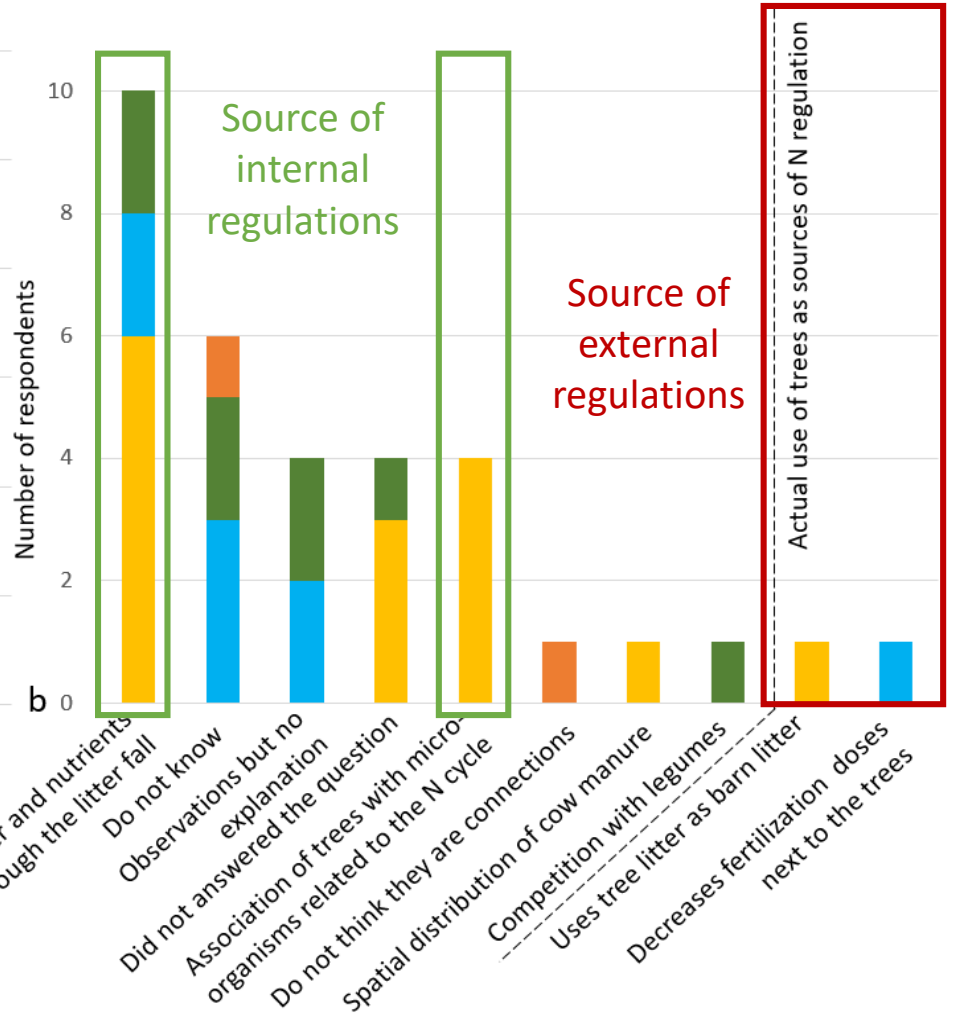
Farms that had adopted sylvopastoral systems the most presented low farm-gate N balance and hence low risk for N losses.

Result 3 : Motivations of farmers for agroforestry and links with N management on farm

Motivation for agroforestry



Agroforestry as a way to manage N at farm scale



Agroforestry was rarely adopted as a way to regulate N losses

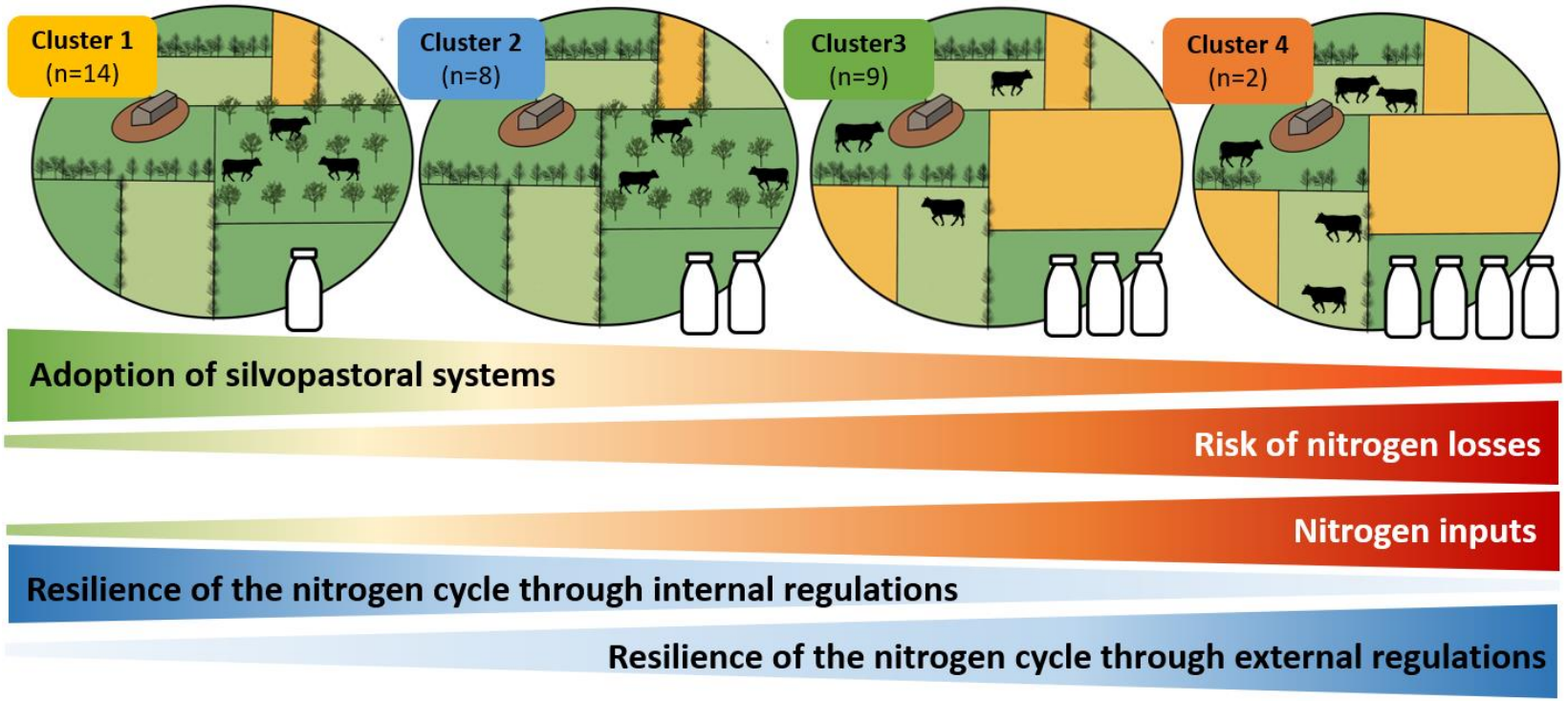
Conclusion and implications

Sylvopastoral systems contributed to regulate N losses at farm scale, but most of the impact resulted from a systemic effect rather than a direct impact of the integration of trees at farm scale.

Implications

- Synergies between adoption of agroforestry and management of N at farm scale exists (this study, Komainda et al., 2023, Mahieu et al., 2021) but are rarely adopted by farmers. Hence, the need for building bridges between scientific and operational communities to enhance the role of agroforestry in the regulation of N losses.

- This study raises questions about the contribution of agroforestry to the transformation toward resilient farming systems



Thank you for your attention !

Any questions?

Contact: romane.mettauer@institut-agro.fr

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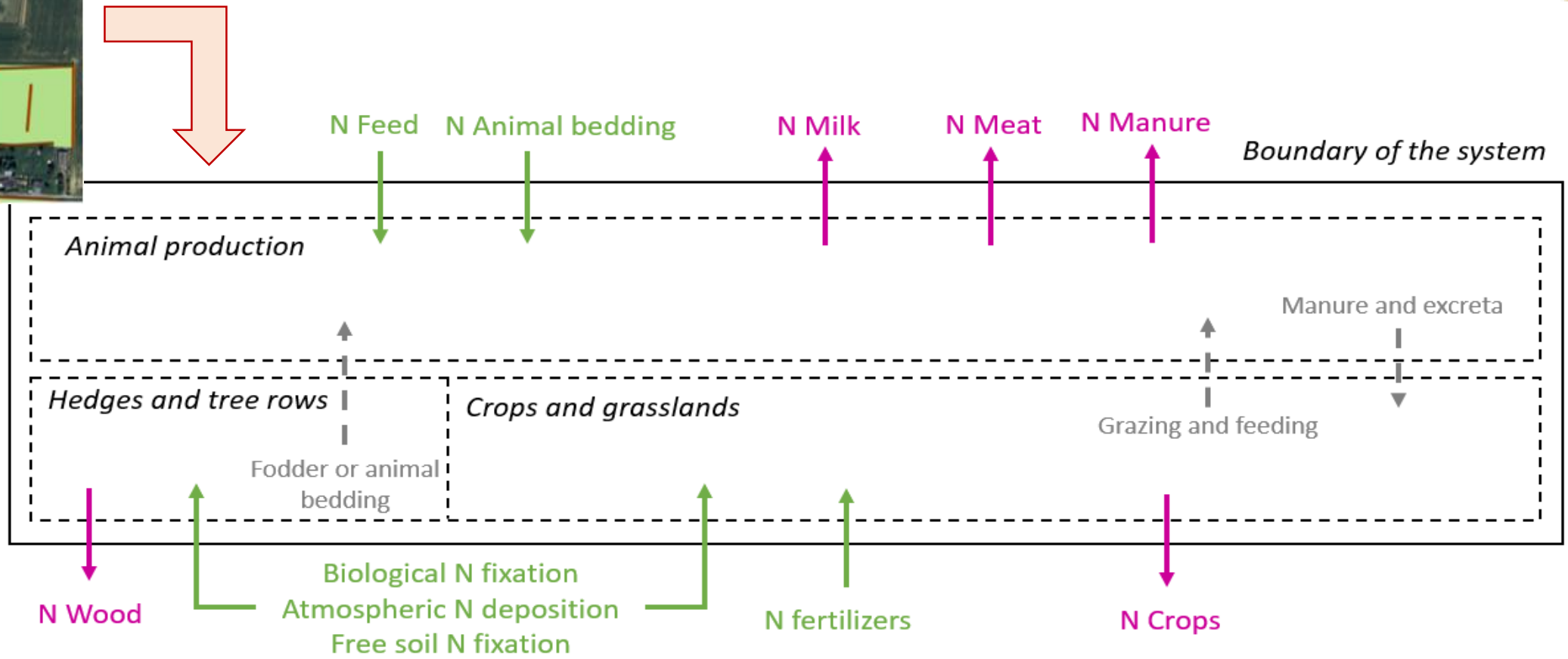
Methodology : farm-gate N balance



BNF trees = %legumes × Tree biomass x N content wood x %Ndfa x 0.01 (Lin et al., 2016)

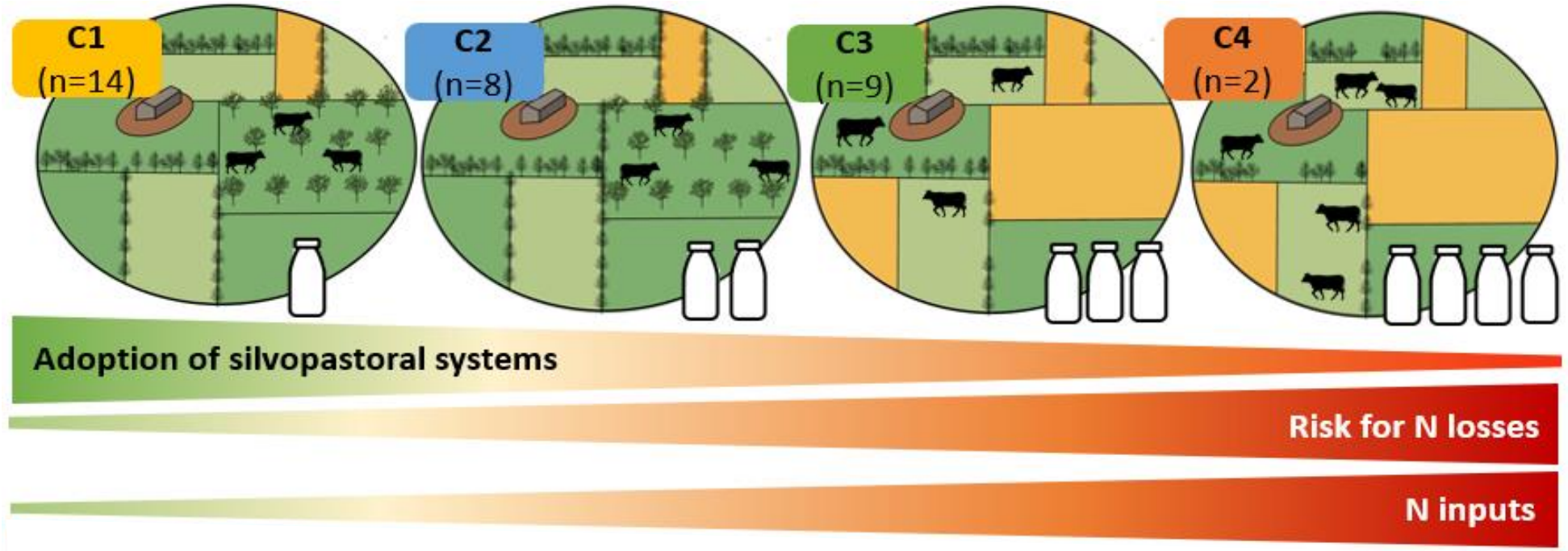
Result 2 : Exploring the combinations between farming practices and adoption of silvopastoral systems

Extensive farming systems, mostly organic, low N inputs
mean FGB : 42.0 kgN ha^{-1} an^{-1}

Extensive farming systems, mostly organic, higher N inputs through biological fixation
mean FGB : 71.9 kgN ha^{-1} an^{-1}

Conventional farms, higher N inputs
mean FGB : 107.7 kgN ha^{-1} an^{-1}

Highly intensive farming systems, extremely high N inputs (especiallty fertilizers)
mean FGB : 229.3 kgN ha^{-1} an^{-1}



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