Evolution under climate change of the resilience of the services provided by the cultivated areas of the Pays de Fougères

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REDELAC (2023 -2024) - Resilience And Sustainability Of Lowland Dairy Farms To Climate Hazards

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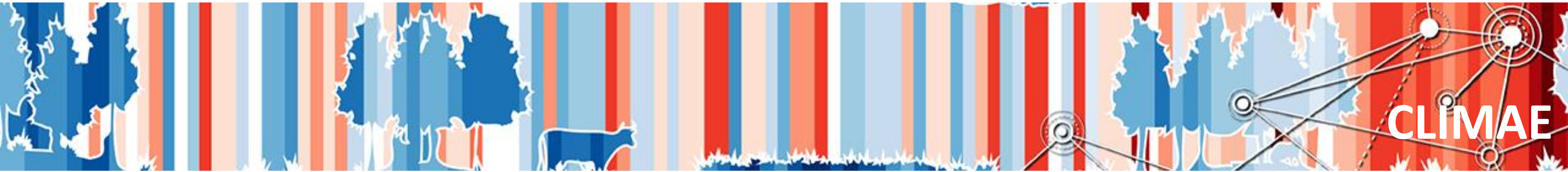
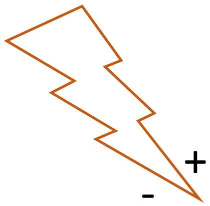


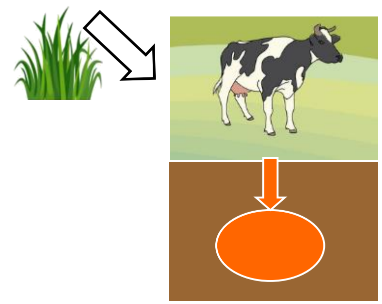
Background

Climate change
(climate hazards)



Dairy farming provides services

Food production, which depends on **feed production**



Mitigate GHG emissions by storing C

Impacts and adaptations depend on the forage system, local climatic conditions and seasons, as well as the public climate policies

REDELAC objectives

- Study the **impact** of future climate and anticipate the **adaptive evolution** of dairy farms

- **Test a methodology** based on models/tools

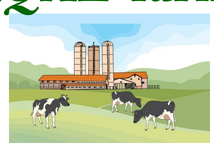
STICS

- **availability of feeds** and the evolution of **soil C stocks**

Indicators

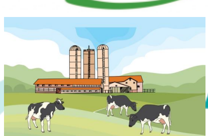
- evolution of **climate and feasibility** of crop/grassland **management** practices

AQAL-farm



- **adaptation of farms to feed resources**, and the consequences for **milk production** and **forage autonomy**

CAP'2ER

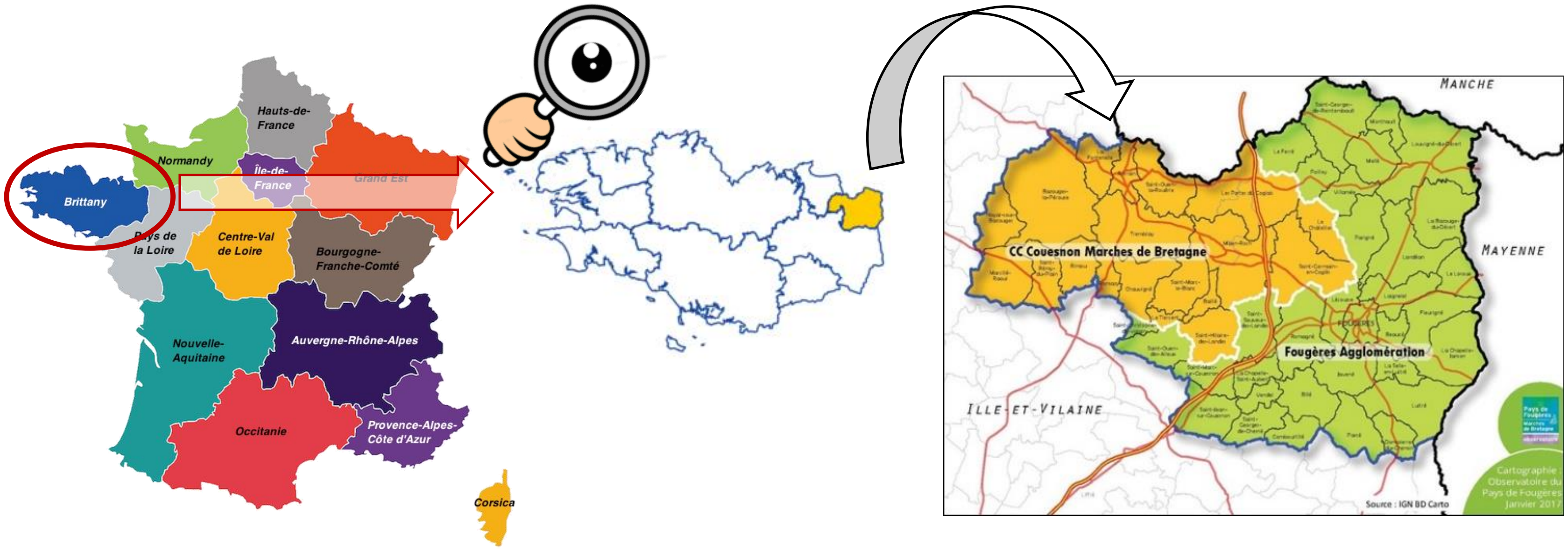


- **changes in the environmental footprint of farms** under climate change

Questions

- How can **feed production** and **C storage services** evolve on the scale of the farm's cultivated area?
- What **differences** can be expected between
  - **farms** with **different forage systems**?
  - future **climates scenarios** and **time horizons?**
  - **locations** within a territory?
- Will dairy farms experience **more or less years** when the **herd's feed requirements** are **not met**? And where **C stock** is **moving away** from its trend?
- **What climatic conditions** explain these exceptional years in terms of feed production? And C stock change ?

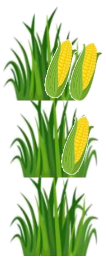
REDELAC's study is limited to



- A small (940 km²) area in Brittany: the Pays de Fougères
  - High **dairy farm density**, **interest** shown by **local stakeholders** in our questions
  - **Agricultural** territory, **soil and** (oceanic temperate) **climate favorable** to production
  - Drawn up a **territorial CAEP** => halve agricultural GHG emissions by 2050

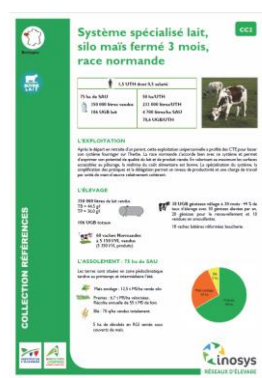
REDELAC's study is limited to

- 3 dairy farms representative of farms in Brittany (not real farms)
  - **≠ forage systems**



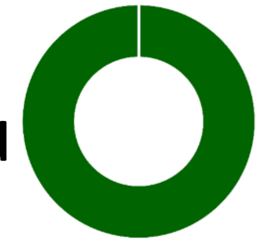
Farm	Description	Corn in forage area (%)
cc1	Conventional, corn all year round	48
cc2	Conventional, corn silo closed 3 months	29
cc8	Organic, all-grass	0

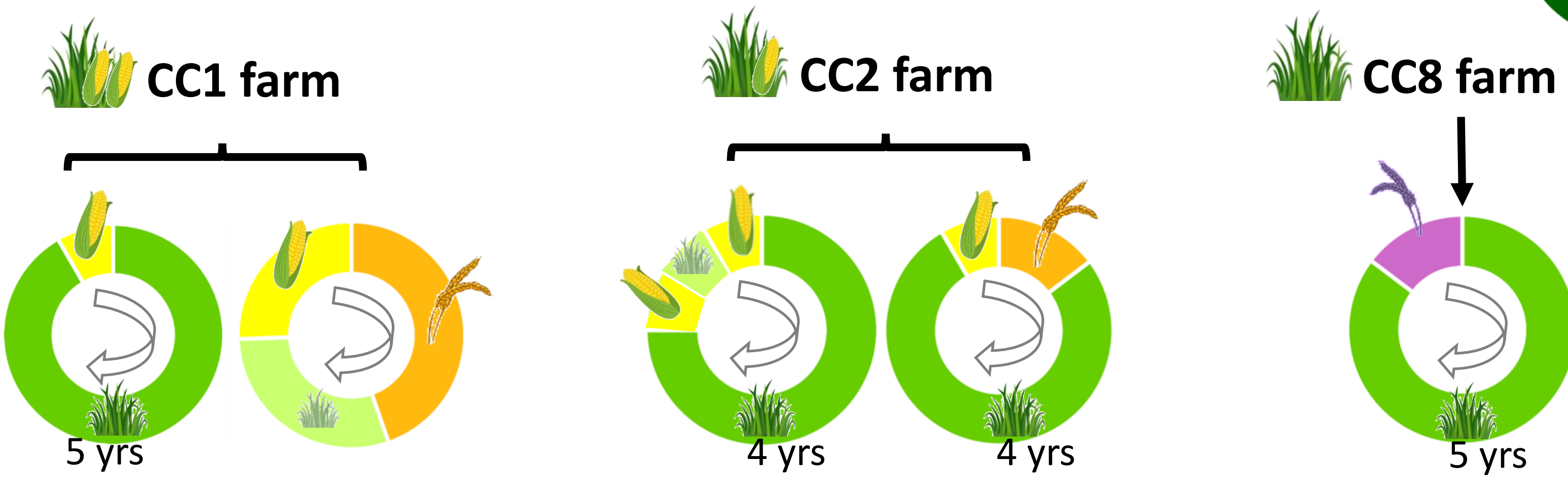
- **Well described** by the "Chambre d'Agriculture de Bretagne"



The land on each farm

- Cultivated in **1 or 2 rotations**, with a **few ha in perm. grassland**

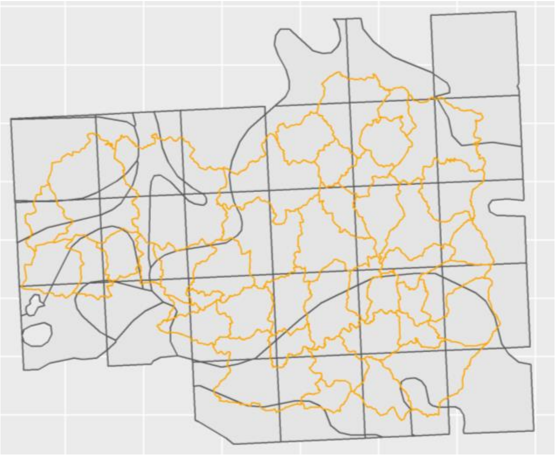




- Most crops/grasslands are used to produce **feed for the herd**
  - Corn => corn silage
  - Grass => Grazing hay or grass silage
  - Wheat => sale, farm concentrate
  - Meslin => farm concentrate

STICS simulations

- STICS
  - **Research version** derived from v10.0, which fixes some bugs
  - **Improved parameterisation** of grasslands 
    - **BNF activation** to simulate **white clover** in ryegrass-clover associations

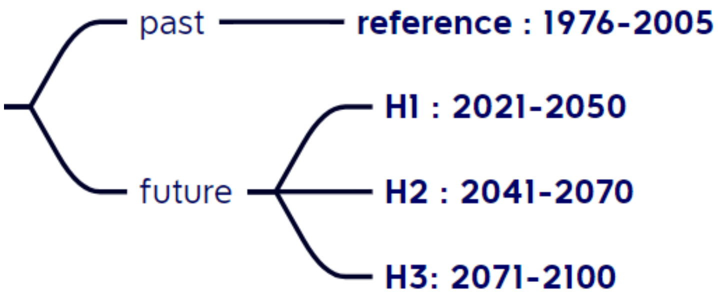


- Resolution:
  - **Pedoclimatic units (PCU)**

  = intersection of climate & soil resolution

  grays polygones

  - **30-year time horizons**



STICS simulations

- Simulations of rotations and permanent grasslands for
  - **1 PCU** (soil with WHC=80mm **<=** geographic database of French soils + previous studies)
  - **1 climate scenario** <= DRIAS-2020 dataset
    - 1 global-regional climate model pair: **CNRM-CM5/ALADIN63**
    - 1 GHG emission scenario: **rcp8.5** (no climate regulation, +5°C by 2100)

WARNING

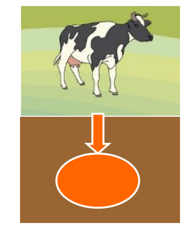
Preliminary results

Each head of the rotation
⇒ Crop/grassland yield each year

2 uses of temporary grassland
⇒ grazing, hay/ silage

Analysis of results

- Calculation of annual feed and soil C stocks at farm scale
  - Based on **areas** allocated to each rotation and **grassland/crop yield** or **soil C stock simulated** by STICS

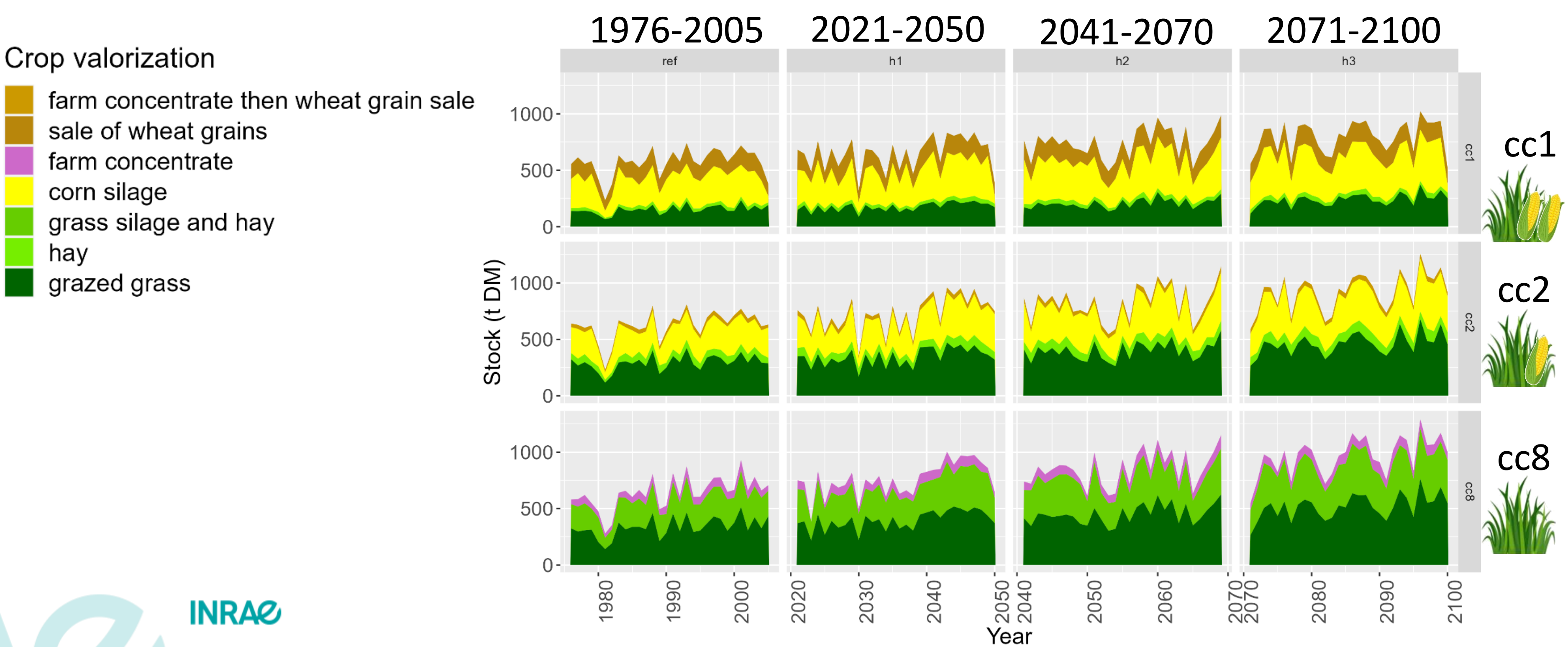


  - **Losses** from field to animal, excepted from grazed grass

- Other resilience indicators
  - **Theoretical herd feed requirements** based on herd size/composition and theoretical feed intake of heifers/cows
  - **“Deficit” years** = years when feed stocks from the year's production < feed requirements
  - **“Resistance”** = feed stocks from the year's production / feed requirements in deficit years

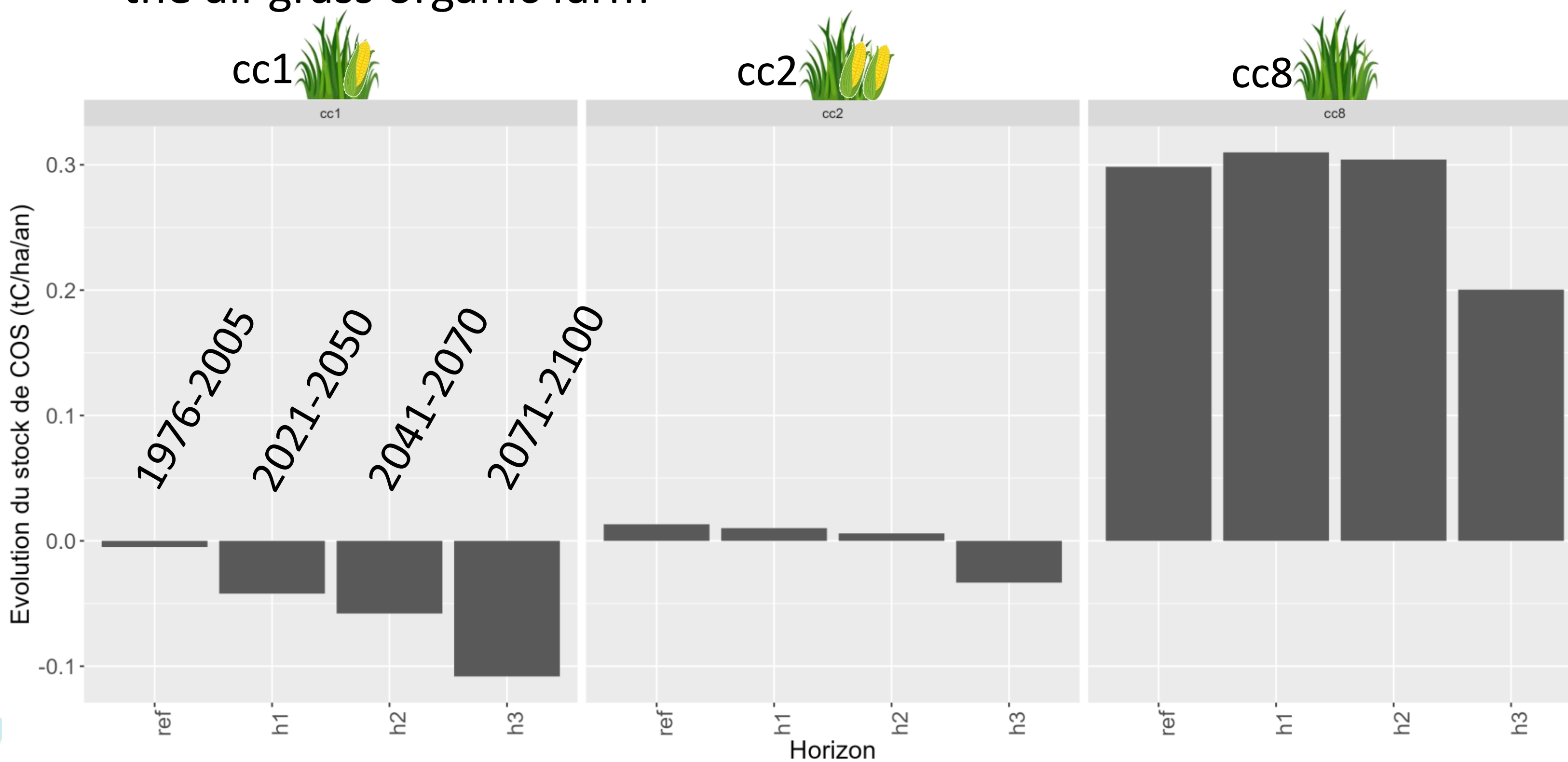
Evolution of feed production service on the scale of the farm's cultivated area

- **Feed stocks ↗** by **+15%** in h1, **+30%** in h2 and by **+40%** in h3
- **Fewer years** for which production does not meet the herd's DM feed requirements (↘ **deficit years** and **resistance** ↗)



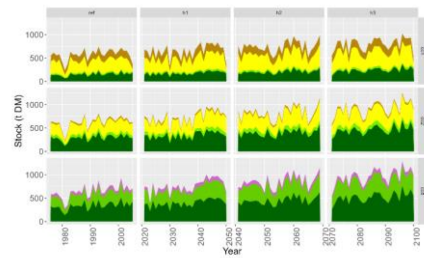
Evolution of C storage service on the scale of the farm's cultivated area

- Ref. period: the **all-grass** organic farm **stores C**, unlike the other 2 farms whose C stocks are stable
- Future: trend towards **soil C depletion** or lower stock increase for the all-grass organic farm



What explains these evolutions at farm scale ?

- ↗ in feed stocks

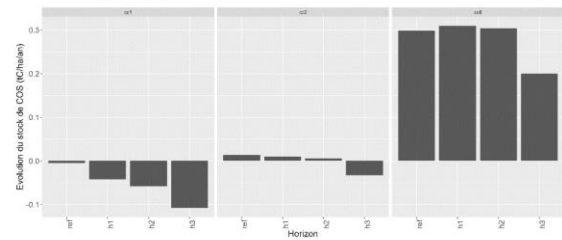


- **Slight ↗** in annual **rainfall** (changes in distribution)
- **↗ in temperature**
- ↗ in PET but **stable actual ET** due to CO_2 effect

Period	R (mm)	T (°C)	PET (mm)	CO_2 (ppm)
ref	1015	10.8	805	354
h1	+15	+0.9	+78	+119
h2	+29	+1.7	+113	+224
h3	+55	+3.3	+200	+453

What explains these evolutions at farm scale ?

- Trend towards lower soil C stocks



- ↗ **SOC mineralization** not fully offset by ↗ **C inputs** (with only a fraction stabilised in SOM)

Period	cc1 Min. (t C/ha)	cc1 Inputs (t C/ha)	cc2 Min. (t C/ha)	cc2 Inputs (t C/ha)	cc8 Min. (t C/ha)	cc8 Inputs (t C/ha)
ref	3.5	4.0	3.6	4.1	4.5	5.4
h1	+ 0.4	+ 0.4	+ 0.5	+ 0.5	+ 0.5	+ 0.6
h2	+ 0.8	+ 0.9	+ 0.9	+ 1.1	+ 1.0	+ 1.2
h3	+ 1.3	+ 1.4	+ 1.4	+ 1.6	+ 1.7	+ 1.9

Conclusions

Based on the simulated example (one PCU and one climate scenario), in the Pays de Fougères:

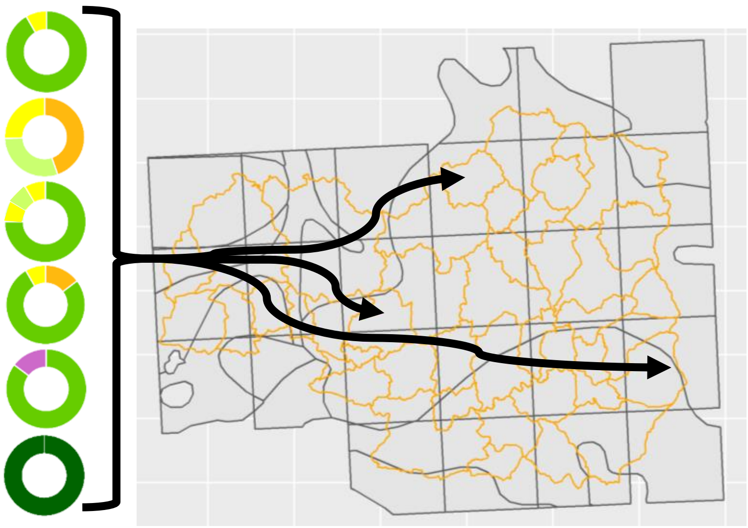
- **Climate still favorable** to production in the future
- **Increase in overall feed stocks** and better coverage of herd feed requirements
- **C destocking** or lower C stocking for all-grass organic farms
- **N_2O emissions slightly enhanced** by climate change

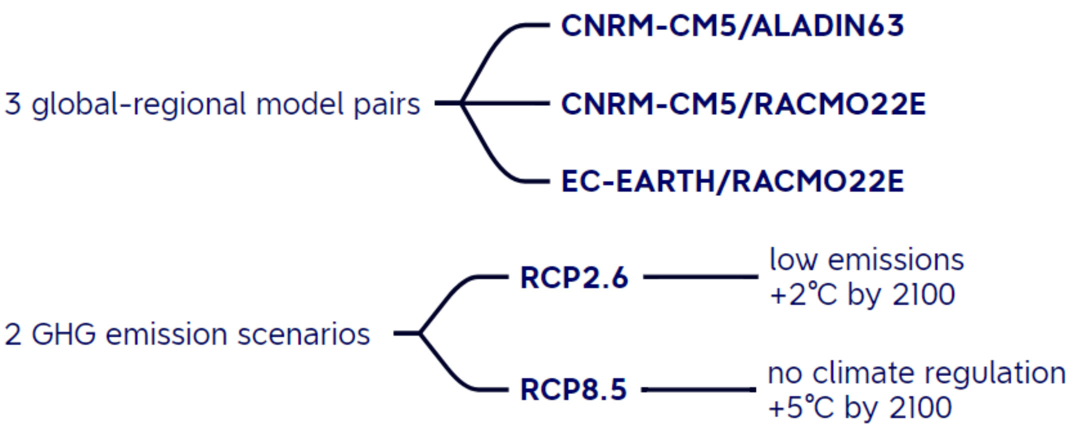
⇒ Possible **antagonism** between **food security/local consumption** issues and **C footprint reduction**?

⇒ Possible evolution of farms towards **greater proportion of grass** and **fewer concentrates** in the animal diet?

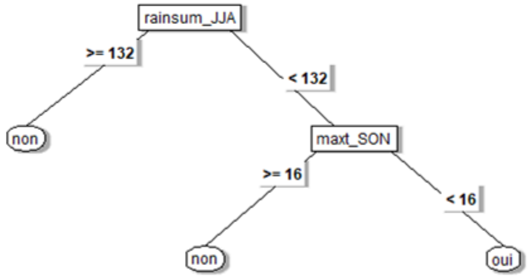
Prospects

- Extension of STICS simulations to the entire plan
  - Simulation for **all PCU** in the territory and **all** future **climate scenarios**





Prospects



- Additional analysis of results
  - **Resilience** of **soil C storage**
  - Changes in **forage quality**
  - **Accessibility of grass** for grazing (soil bearing capacity)
  - Animal **heat stress**
- Supply of information required for AQAL-farm model simulations
  - **Grass growth** and **accessibility**
  - Annual **feed stocks**
  - Forecast **feeding plan**, etc.

Thank you for your attention