XIV[th] STICS seminar, 17-19 March 2026,
organized by ULiege-GxABT & INRAE

CLIMODIF: A Participatory Approach to Anticipate Climate Change Impacts using STICS

The Barrois in France as a pilot area

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Outline

- Introduction
- Material & methods
- First results & visualisation for reporting
- Conclusions

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Introduction: CLIMODIF Project

- **Developing a methodology** to assess **climate-change adaptation strategies** while ensuring the **sustainable multi-performance** of cropping systems in several agricultural sectors (**rapeseed**, **wheat**, **barley**, **pea** and **sunflower**)
- Four partners involved:
  - Applied research: ARVALIS and TERRES INOVIA
  - Fundamental research: INRAE
  - Cooperative group: VIVESCIA

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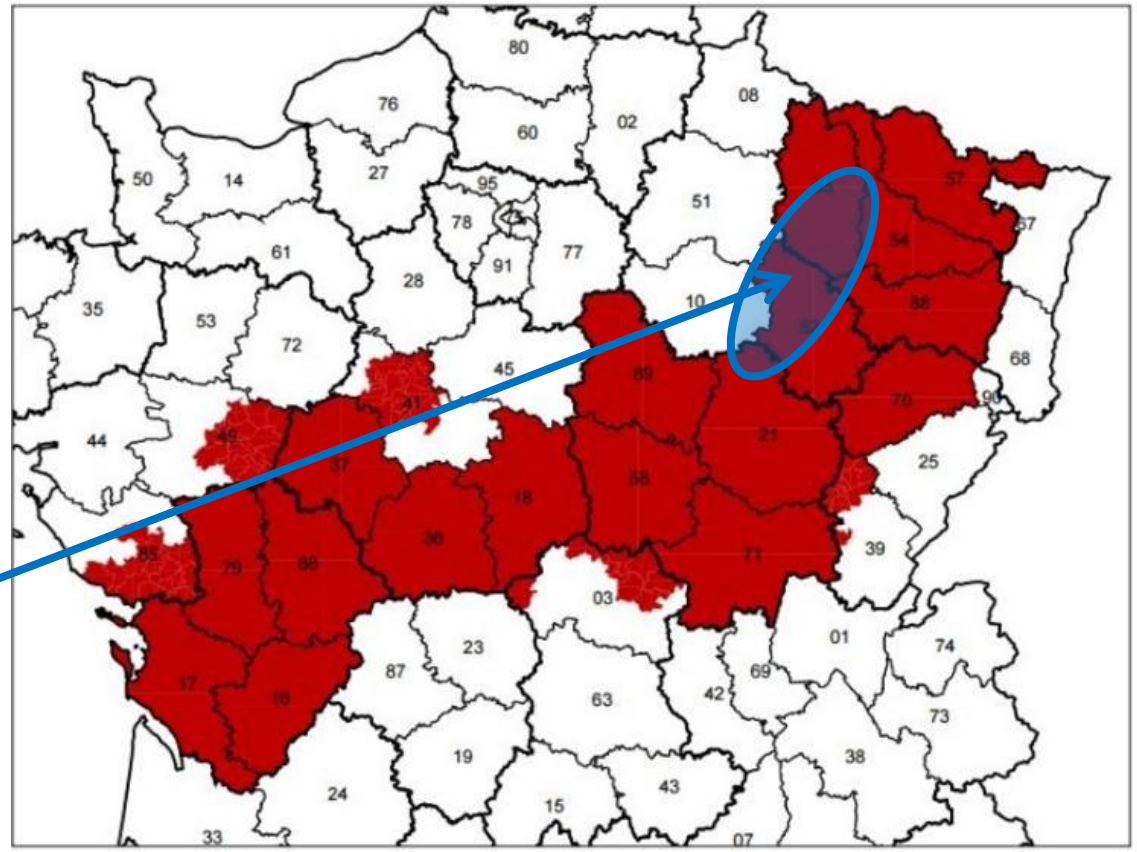
Introduction: The Barrois, a French “intermediate area”

- Farmland areas at the forefront of climate-change vulnerability

The Barrois area



Report “*zones intermédiaires*”, January 2019, *Ministère de l’agriculture et de l’alimentation* (French Ministry of Agriculture and Food)

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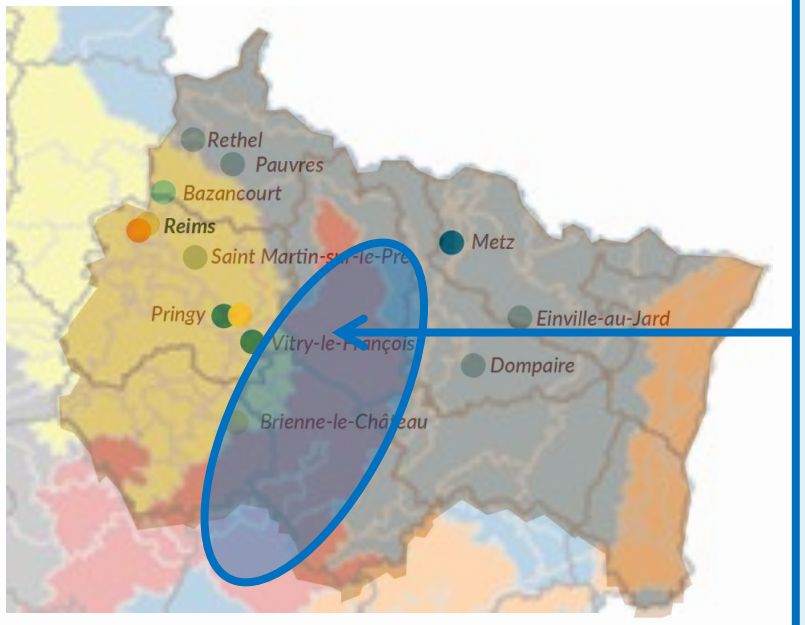
Introduction: The Barrois, a French “intermediate area”



Characteristics

Shallow soils

- Stony light soils (“*petites terres à cailloux”)*: clay-limestone, stony and shallow (< 20 – 70 cm)
- Low yield potential: available water capacity around 50 – 80 mm

The water challenge

- Degraded semi-continental climate: low solar radiation, marked seasonal contrasts, and large temperature ranges
- Rainfall: poorly distributed (abundant in winter, low in summer, and variable in spring)

Farms vulnerable to climate change

- Simplified crop rotations: usual rapeseed > wheat > barley (economically optimal, but agronomically limiting due to weed pressure)
- Low and stagnating yields: < 6.6 t/ha for winter bread wheat (2007 – 2012) + no possibility of irrigation
- Predominantly large farms: economics of scale

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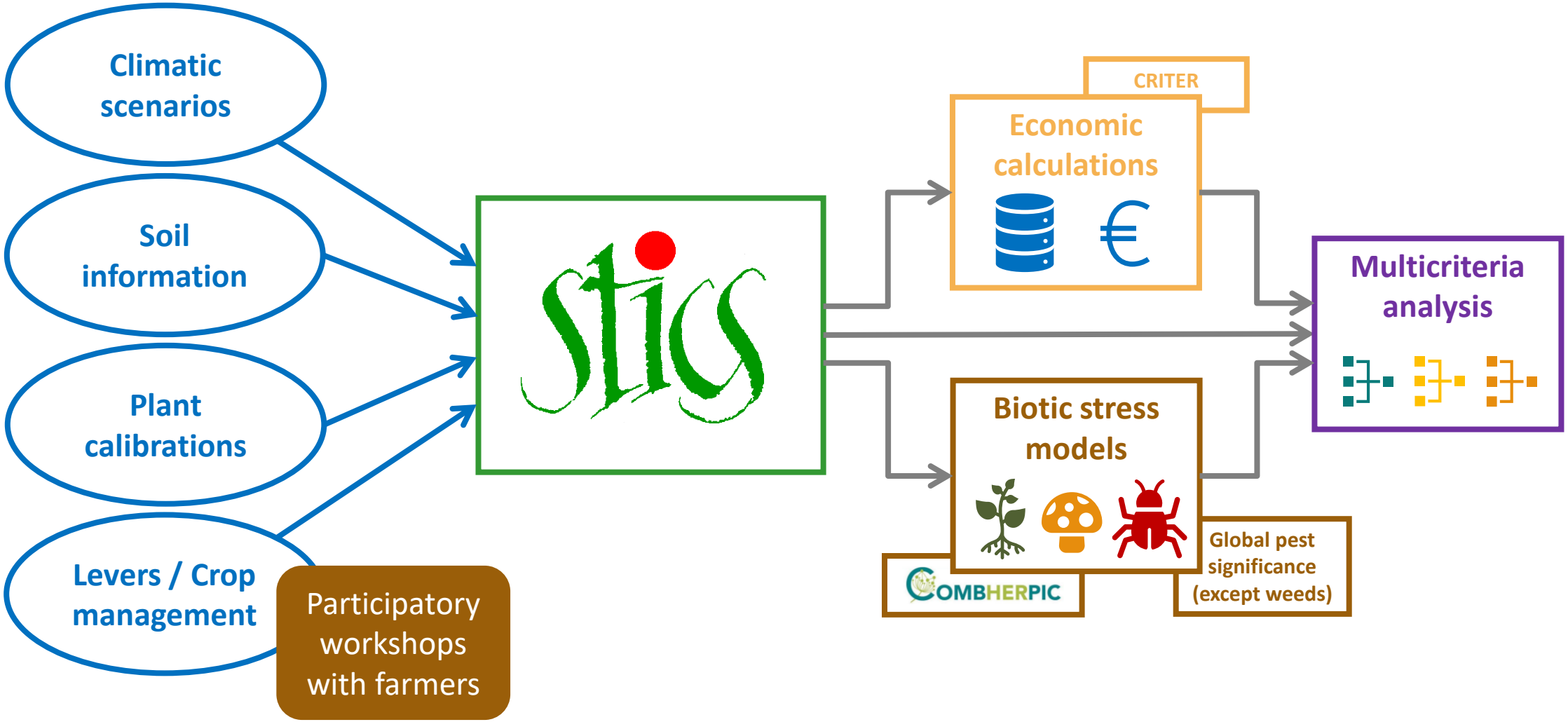
Introduction: How is STICS integrated into CLIMODIF?



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Introduction: Why STICS and not another one?

- **Comparison of 16 crop models (WOFOST, CHN, APSIM,….)** : several selection criteria (crops, abiotic & biotic factors, scales, integration of CO_2 effect, possible agronomic levers, ease of implementation, code accessibility, etc.)

- **STICS combines numerous advantages for the CLIMODIF project:**
  - Robust and validated model (Coucheney *et al.*, 2015)
  - Availability of resource persons (initiated and experts)
  - Consideration of all studied crops and crop rotations
  - Accessibility and interoperability in R
  - Richness of the simulated outputs

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Material and methods: General process

Work with farmers and experts

- Varieties cultivated in the Barrois area
- Validation of soils types (available water capacity, depth, stoniness, etc.)
- Reference crop management practices
- Levers to be tested (sowing date, …)

Use climate models and choose the RCPs

- Climate projections: CNRM-CM5 / ALADIN63, CNRM-CM5 / RACMO22E et EC-EARTH / RACMO22E
- RCPs: 8.5, 4.5, 2.6

Set up the USMs sequences

- Maximum 5-year crop rotations + 2 initialisation years
- Reference rotation : rapeseed > wheat > barley
- Initialisation of soil water and nitrogen balances using reference tables / experts

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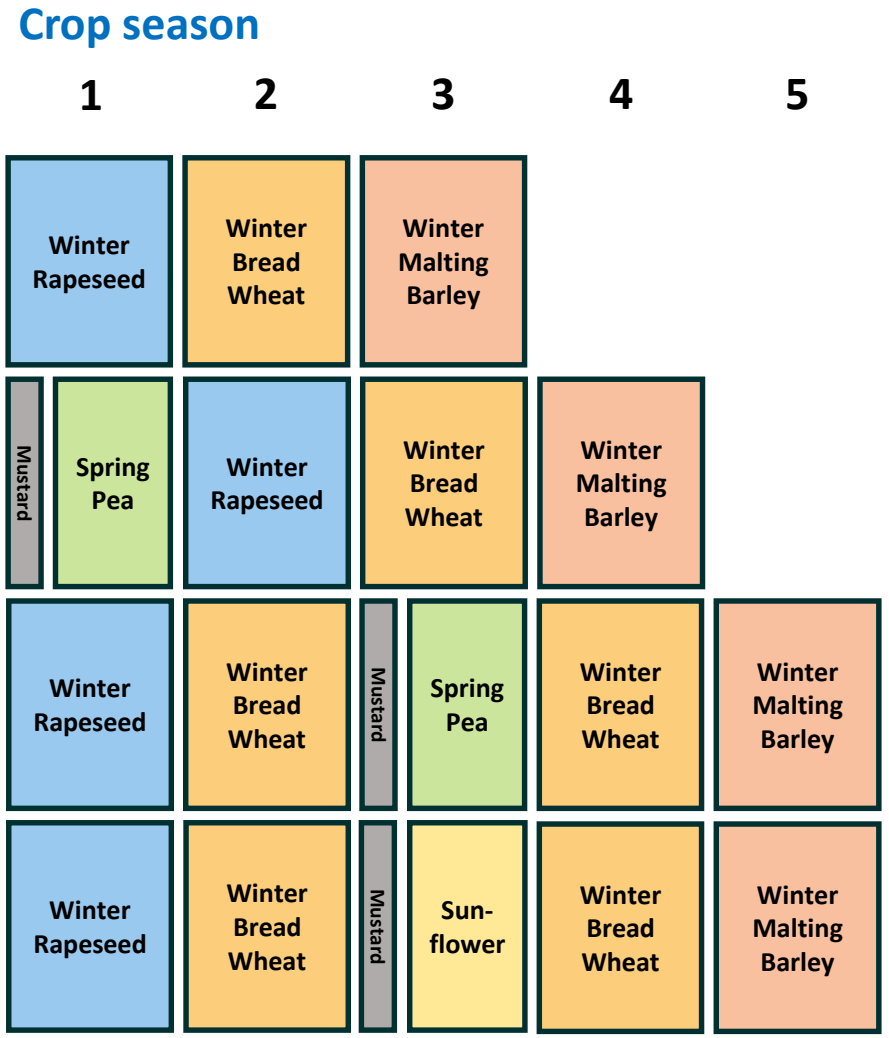
Material and methods: Crop rotations

- During a participatory workshop, the group of farmers proposed 4 crop rotations



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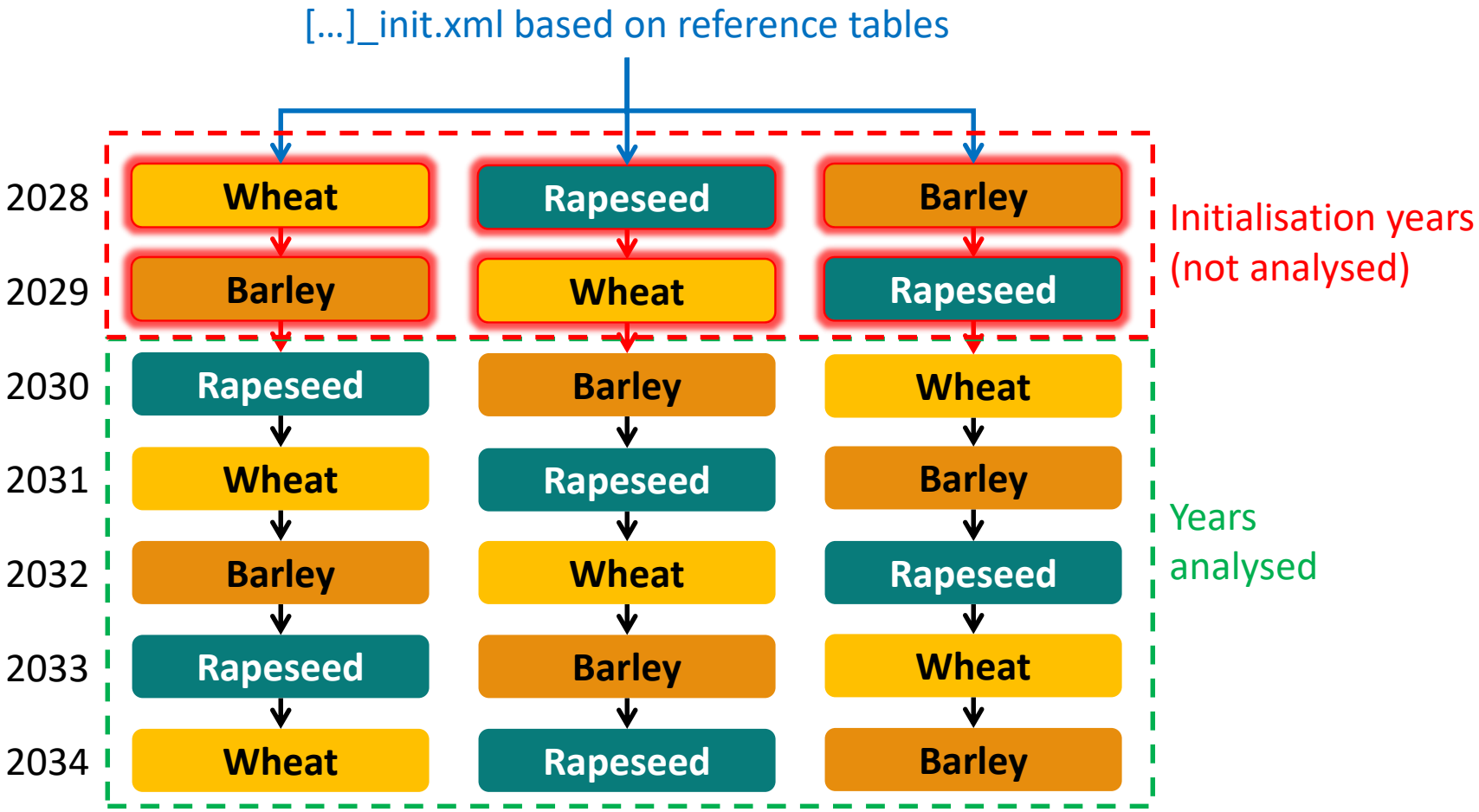
Material and methods: Example of a rotation sequence

Rapeseed
= Winter rapeseed

Wheat
= Winter bread wheat

Barley
= Winter malting barley



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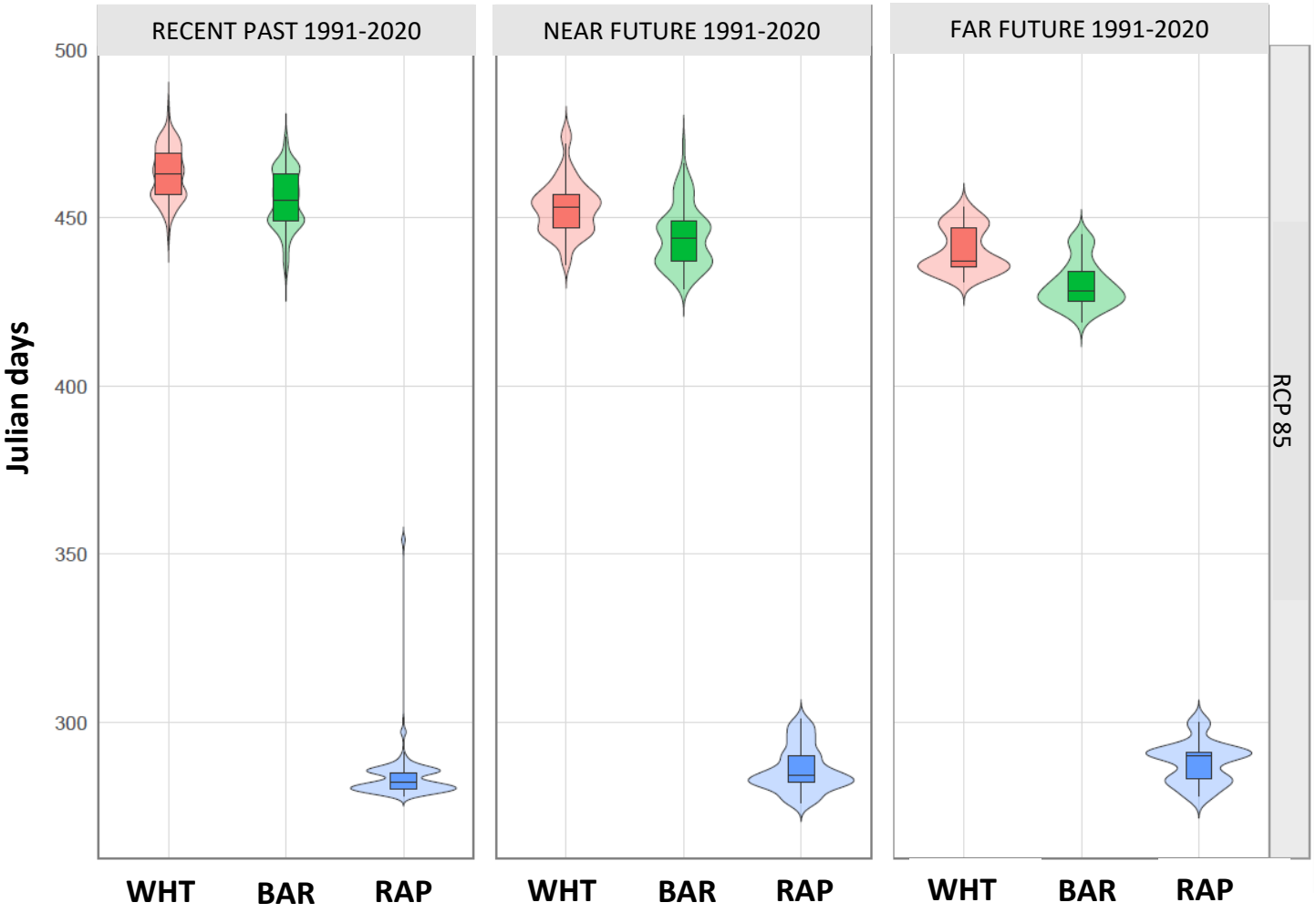
Results: Crop phenology

- Crop phenology date of reaching the stage “maximum acceleration of leaf growth, end of juvenile phase”



- Reference crop rotation for RCP 8.5
- Advanced phenological stage: -22 days for wheat between the recent past and the far future, -24 days for barley.
- Little to no differences for rapeseed
- Reduction in the total length of the crop cycle for all crops

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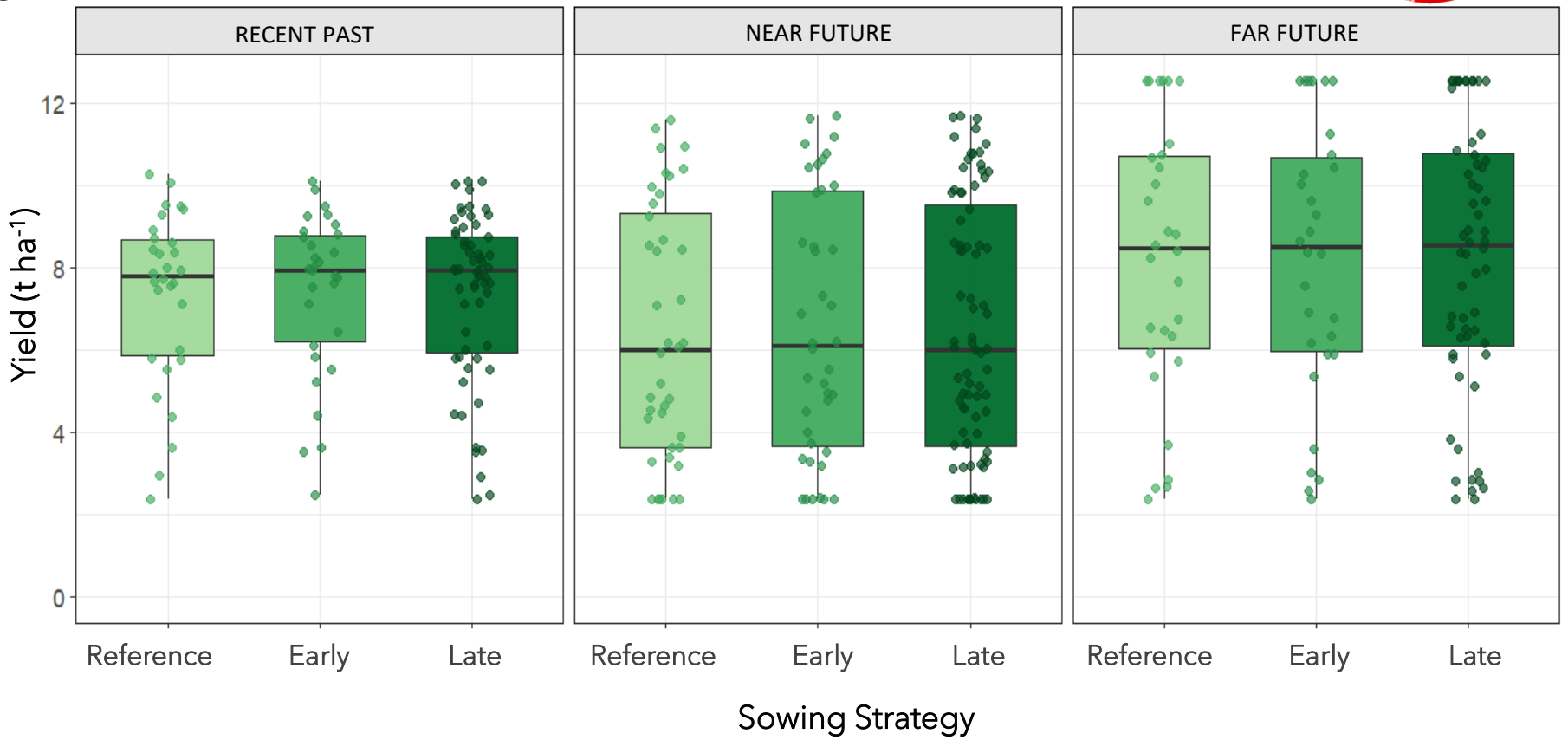
Results: Yield

Crop management practices comparison within one rotation: sowing date

Example of how winter common wheat **yield** varies depending on **the sowing date**

- Sowing strategy according to farmer :
  - Reference : 10/02
  - Early : 09/25
  - Late : 11/15
- Lower potential yield (≈ -17%) for wheat on near future for all sowing strategy
- But increase on the far future (≈ +6%)
- Low yield variation between sowing modality

WINTER WHEAT YIELD FOR **RCP 85**



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Results: Yield

Crop management practices comparison within one rotation: mineral fertilization strategy

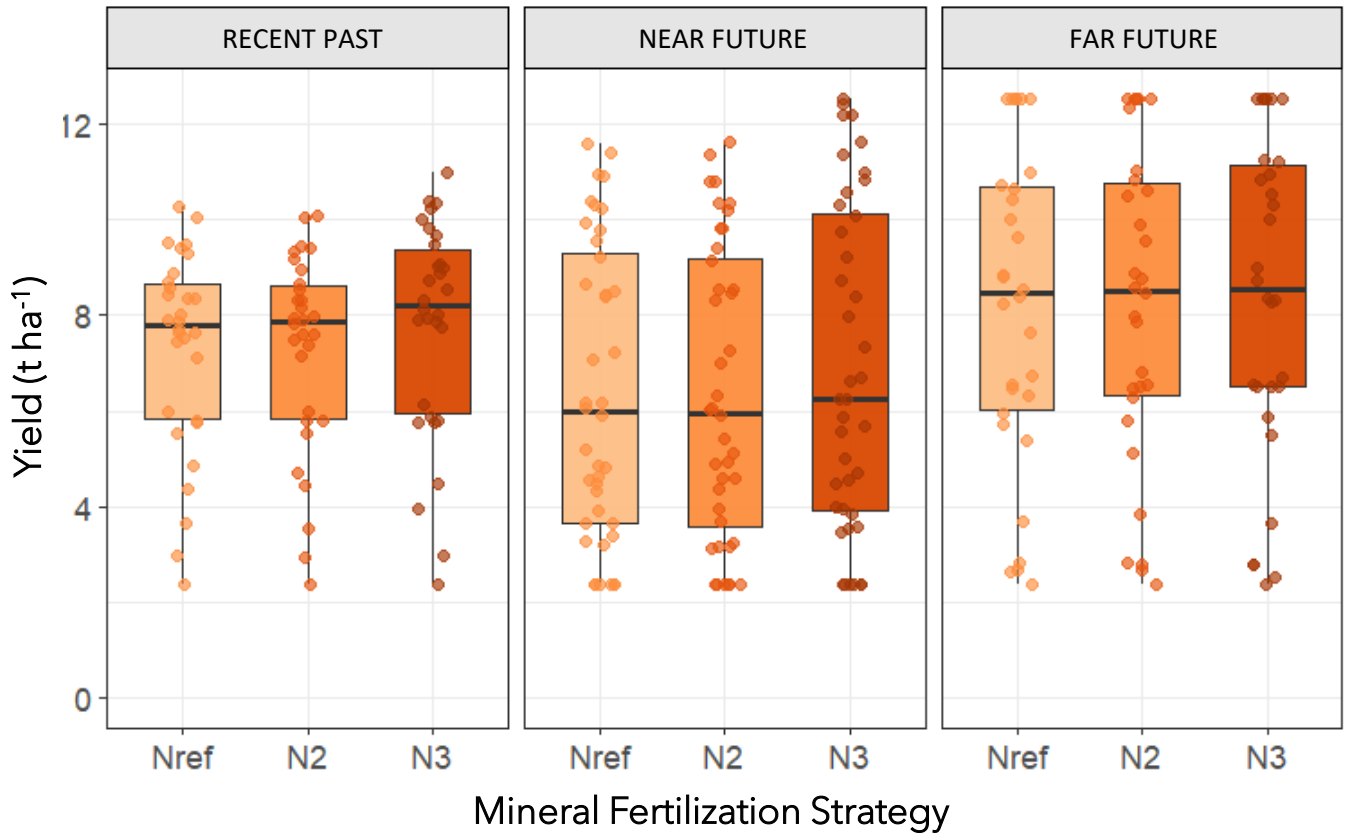
First Result

- 3 Mineral Fertilization Strategy for wheat :
  - Nref : 40 – 100 – 40 UA
  - N2 : 40 – 80 – 30 – 30 UA
  - N3 : 0 – 90 – 90 UA

- With our current parametrisation (still ongoing) no clear results about the most optimal mineral fertilization strategy for yield

- Slight increase with N3 on recent past (+ 0.45 t ha-1) and near future (+ 0.25 t ha-1)

WINTER WHEAT YIELD FOR **RCP 85**



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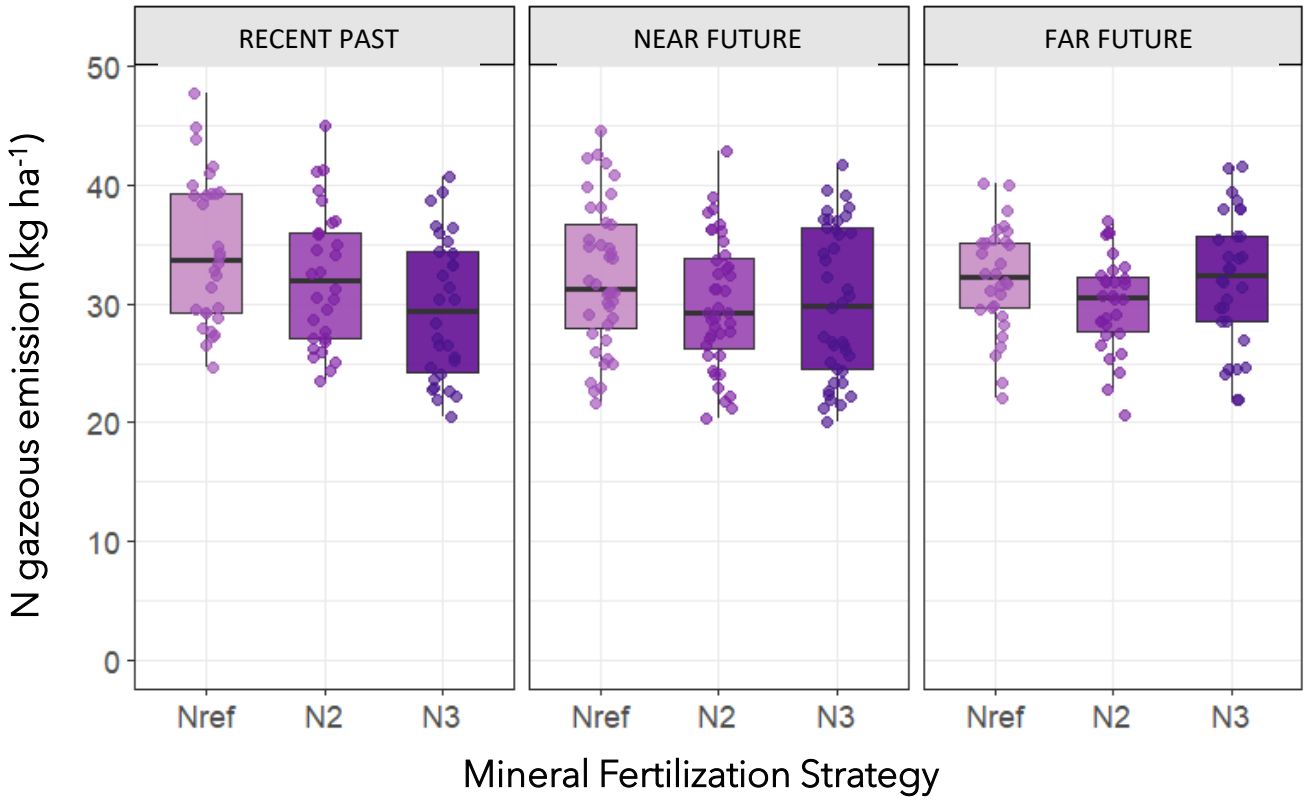
Results: N gaseous losses

Crop management practices comparison within one rotation: mineral fertilization strategy

First Result

- 3 Mineral Fertilization Strategy for wheat :
  - Nref : 40 – 100 – 40 UA
  - N2 : 40 – 80 – 30 – 30 UA
  - N3 : 0 – 90 – 90 UA
- Not much difference of N gazeous emission from denitrification/volatilisation for Near et Far Future.
- **N3** strategy seems to reduce N emissions on recent past but not on future climate condition
- … more variables to analyse (i.e : Qles, SOC)

N GAZEOUS LOSSES FOR **RCP 85**



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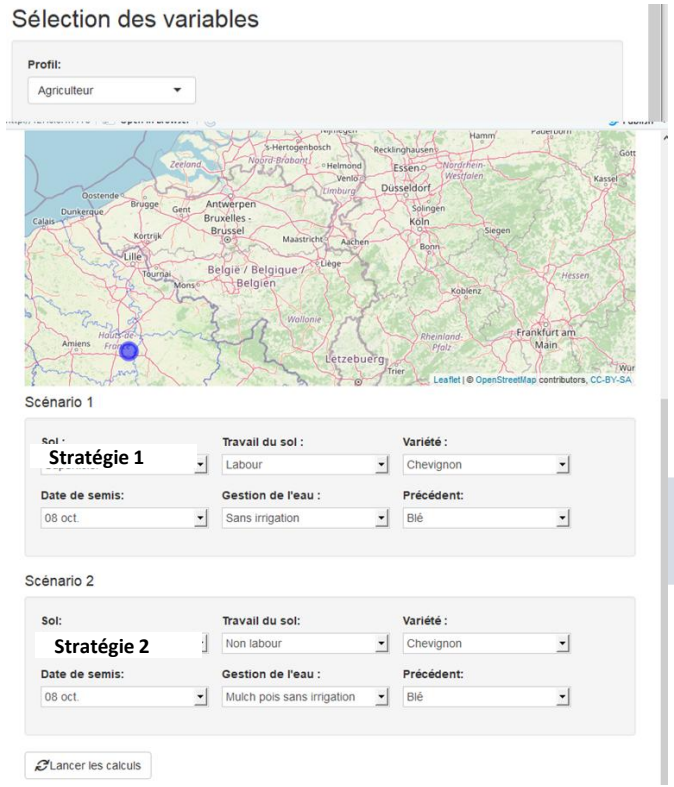
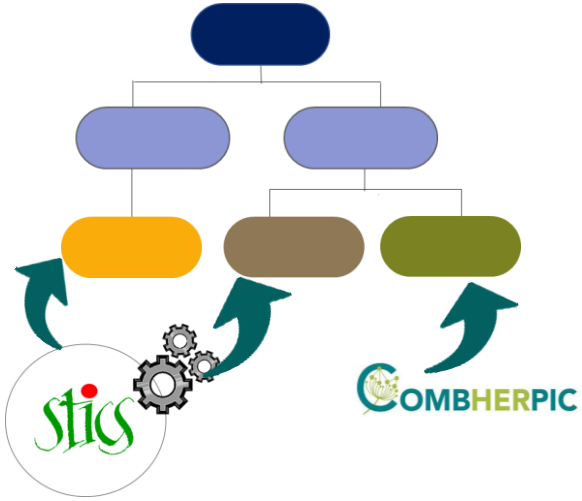
Visualisation

- Explore different variation of crop management **within** crop rotation **AND** **compare rotations with each other** for a set of agronomic and economic indicators

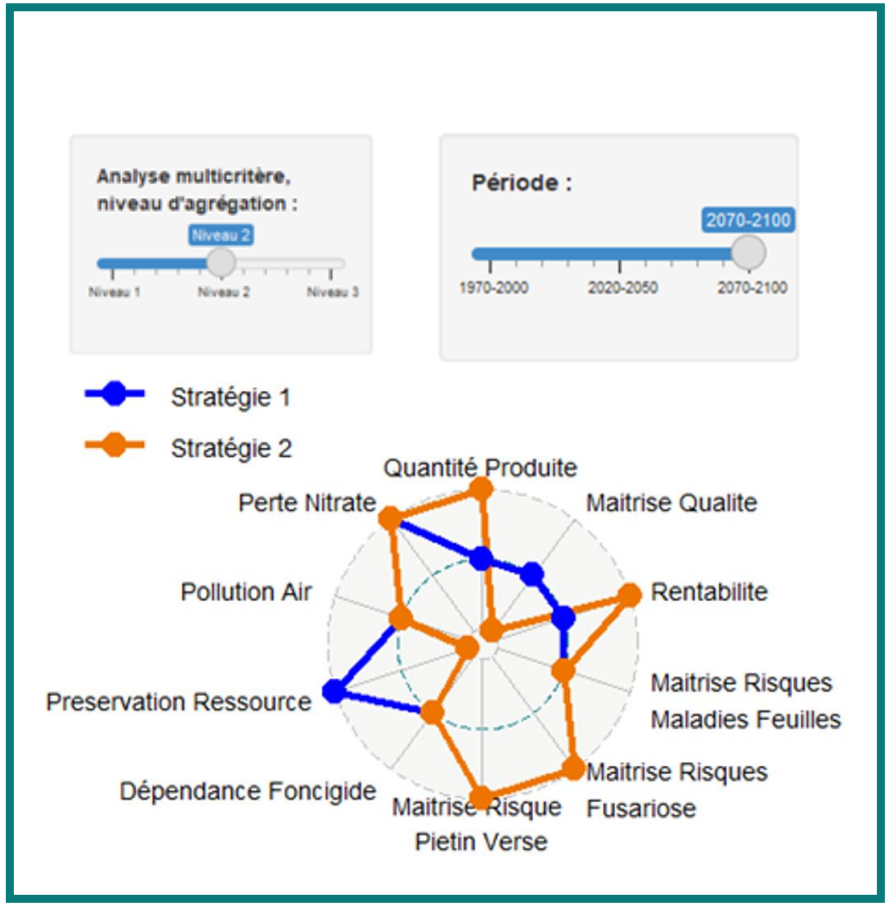
Selecting strategies (rotation and leverage) to test in a user-friendly interface (Rshiny)



STICS + another approach to complete a multi-criteria assessment



DATABASE



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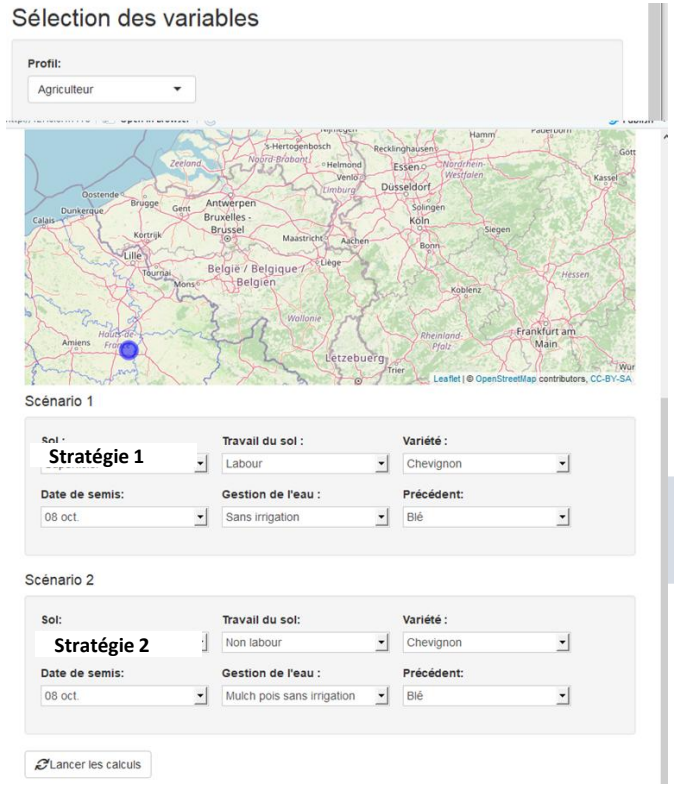

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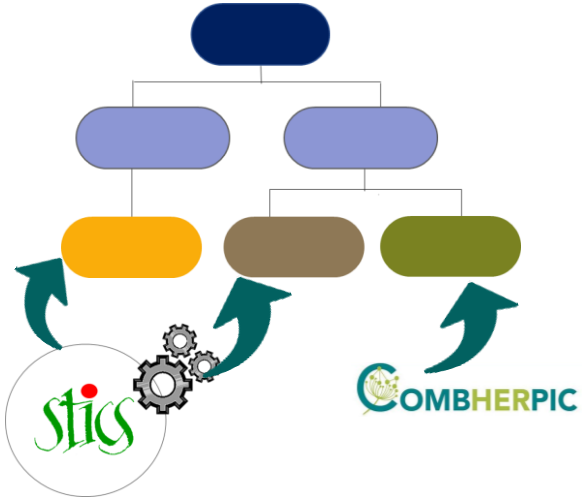
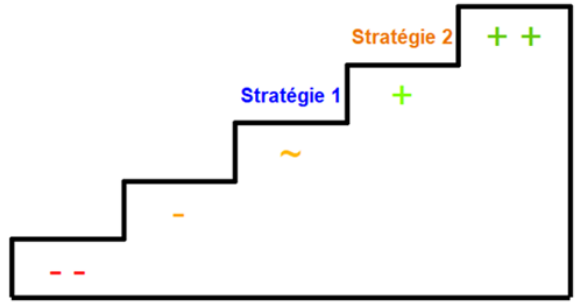


DATABASE

Relative relevance of strategies in the Barrois region



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Conclusions

- CLIMODIF aims to propose a transferable & adaptable methodology with applied focus (linked to on-the-ground issues) to share about **tendencies** with farmers

- STICS, a key piece for its implementation

  → Currently, comparisons between predictions and observations

- Other components & models involved

  → E.g., to consider the importance of weed management and price context in the pilot area

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Thank you for your attention

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