Alfalfa to get back into planetary boundaries

2025 world alfalfa congress
FRANCE REIMS-CHÂLONS

High yield alfalfa for low carbon livestock in a stressful climate

Brummer C. & Odorizzi A.

Plenary session 6

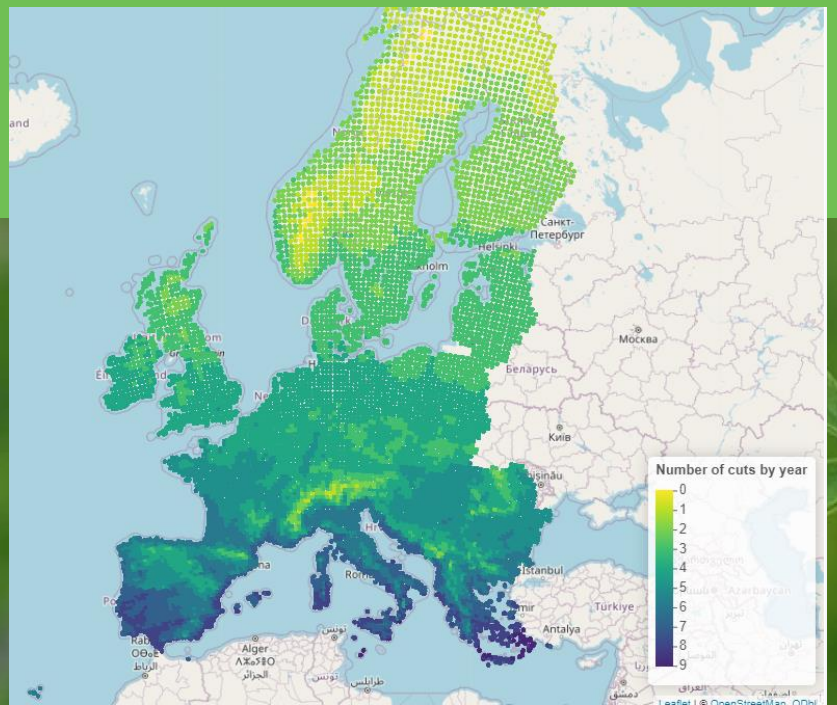
FROM 03 › TO 06 nov. 2025

Alfalfa to get back into planetary boundaries

2025 world alfalfa congress
FRANCE REIMS-CHÂLONS

Identifying agrometeorological zones for lucerne in present and future climates using STICS model

Pierre Sergent, Hélène Raynal, Bernadette Julier,
Gaëtan Louarn



BELI
Breeding European Le

FROM 03 › TO 06 nov. 2025

Stic

Background

- BELIS Project : Breeding European Lugumes for Increased Sustainability (2024-2027)
- Objectives of the modelling task
  - ***produce maps of projected yield gap at the European level for major legume species for which crop models are readily available***

- ***Focus on forage legumes (lucerne)***

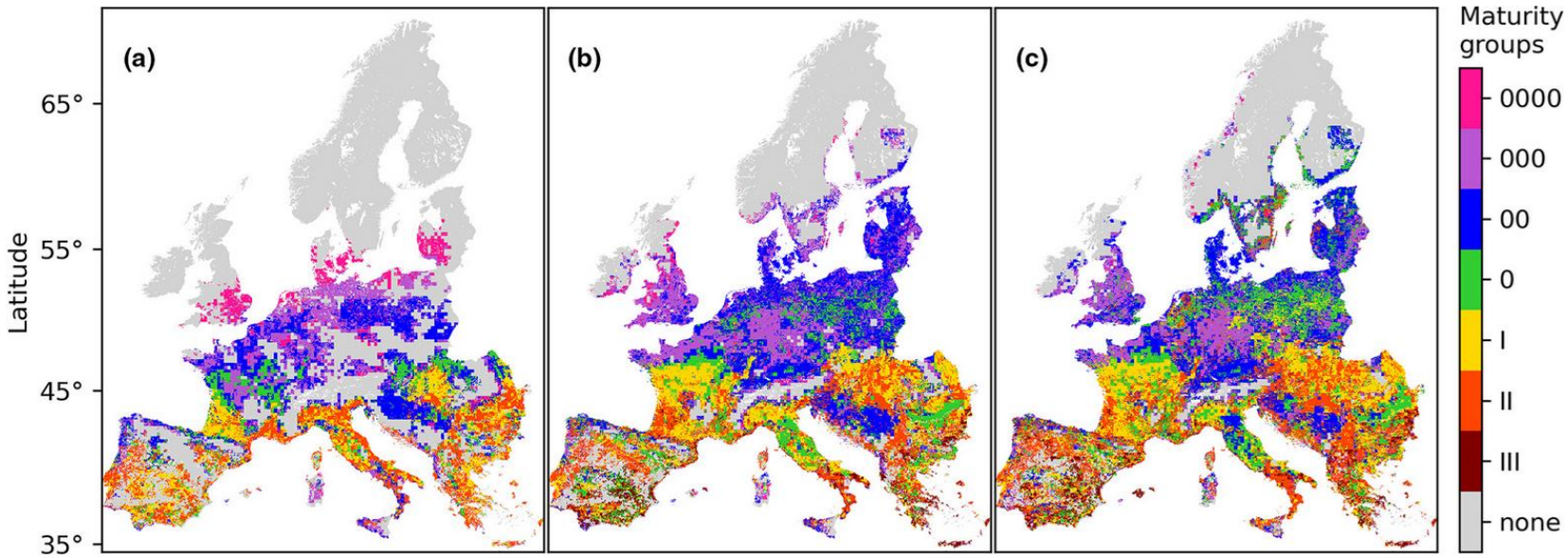
- ***Explore varietal suitability in different agrometeorological zones (present)***
- ***Explore future climate projections (IPCC) and potential changes in the boundary of agrometeorological zones***

Background

- Builds on:
  - ***Previous work on annual crops***

Nendel et al.
2023 (Soybean)

Suitability maps (maturity groups)
Maps of risk factors



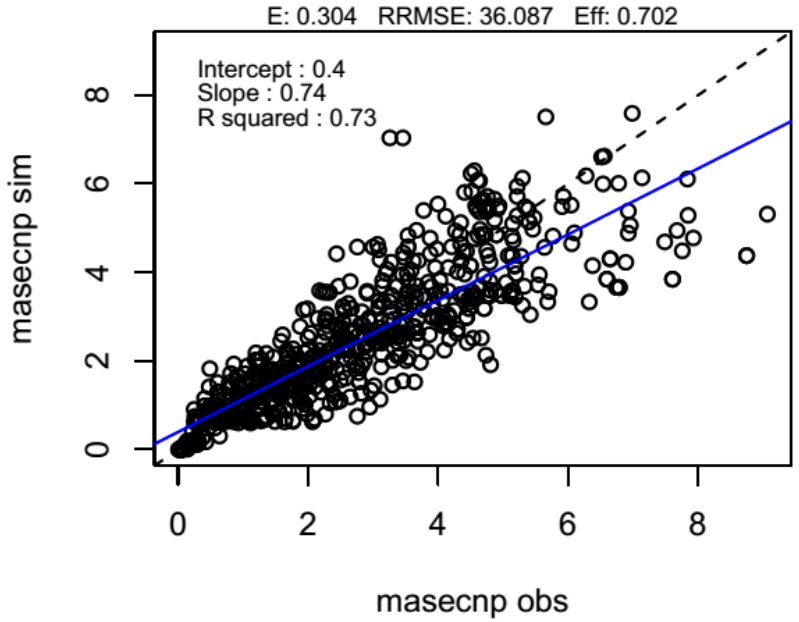
Background

- Builds on:
  - ***Modelling forage legumes with STICS crop model***

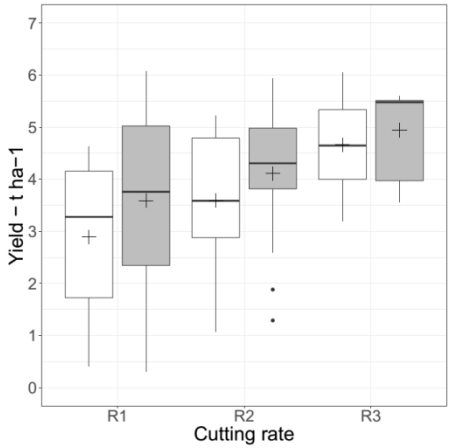
At the crop level (e.g. lucerne):

North type varierty (Europe)

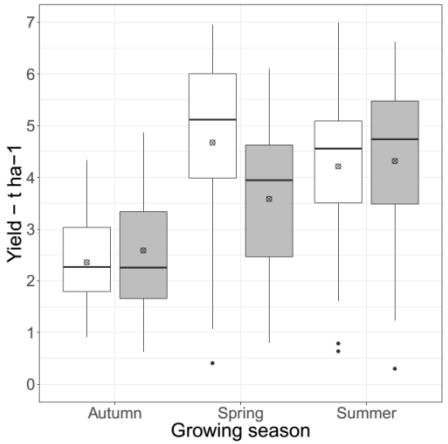
Yield



Cutting management



seasonality

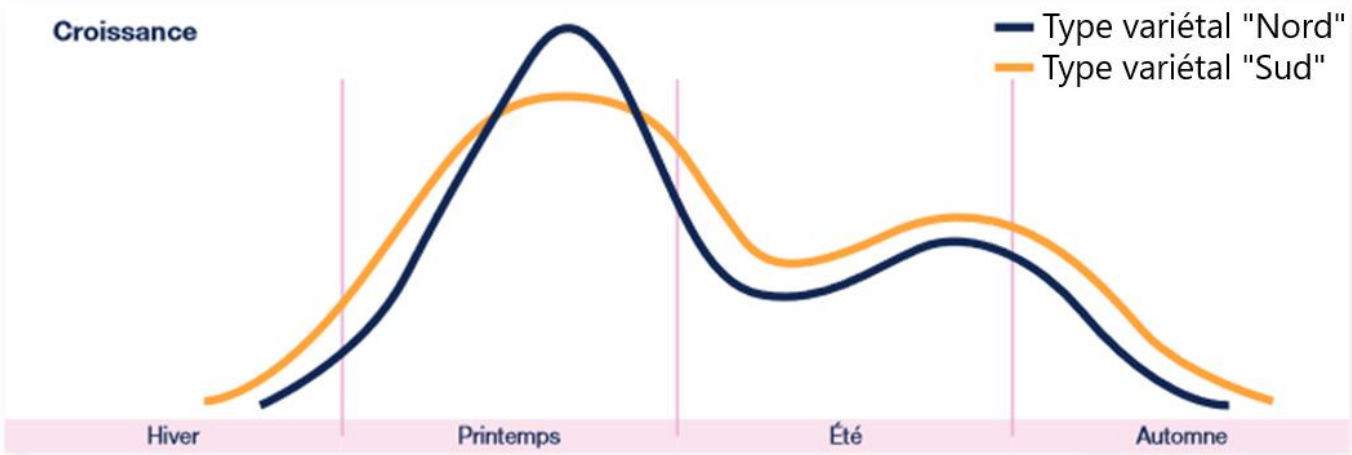


Stullu et al, 2018

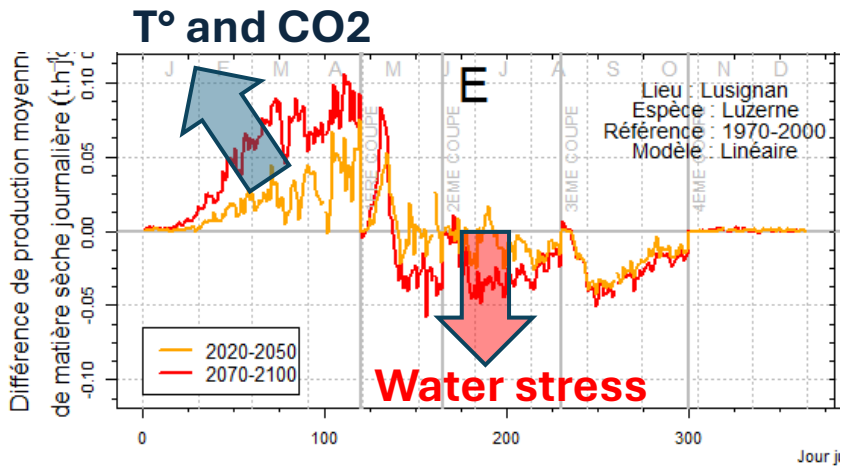
Objectives

- Challenges:

Modelling varietal differences? (GxE)



Climate change projections in Europe



Zaka et al, 2016

IPCC RCP 6.0

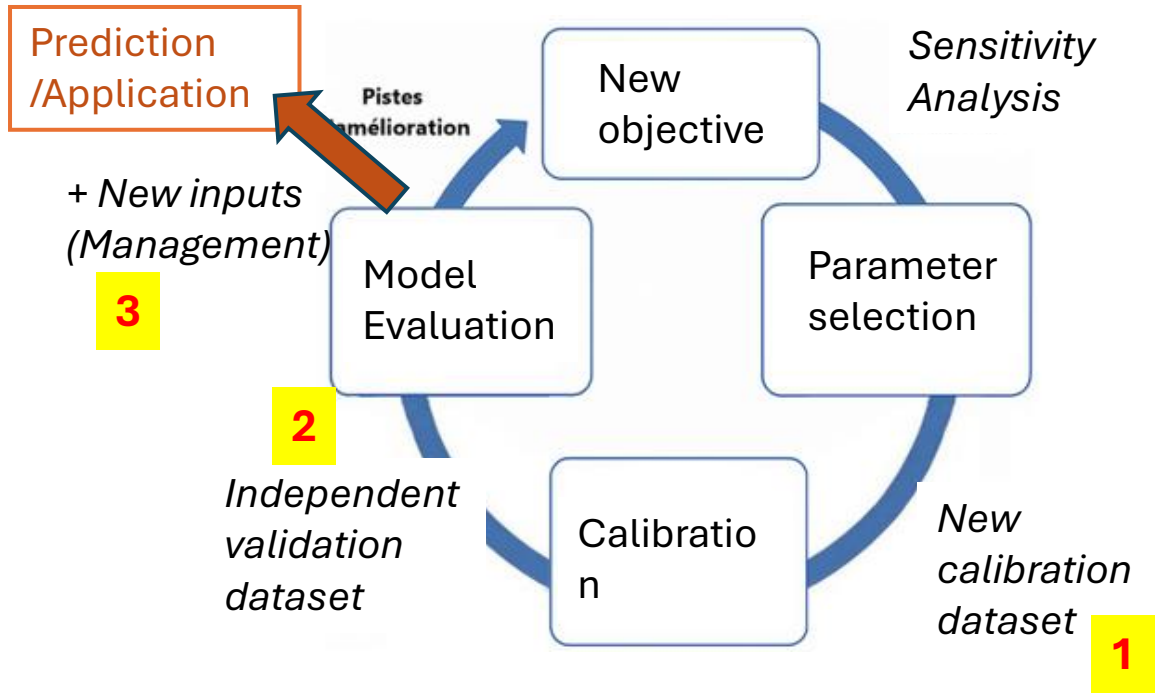
- ***Modelling forage legumes with STICS crop model***

Approach

- Deliverable :

- ***Produce maps of suitability for lucerne variety groups and maps of risk factors***

?

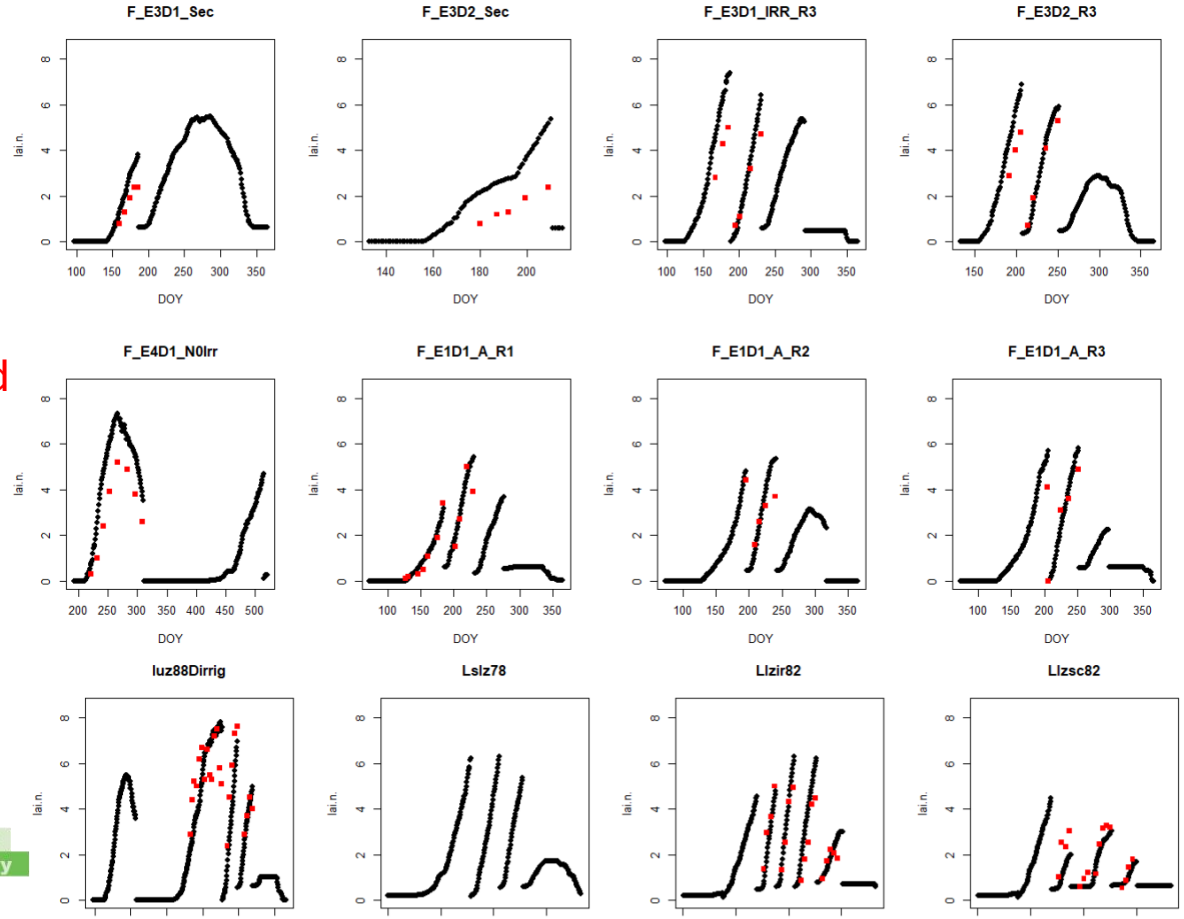


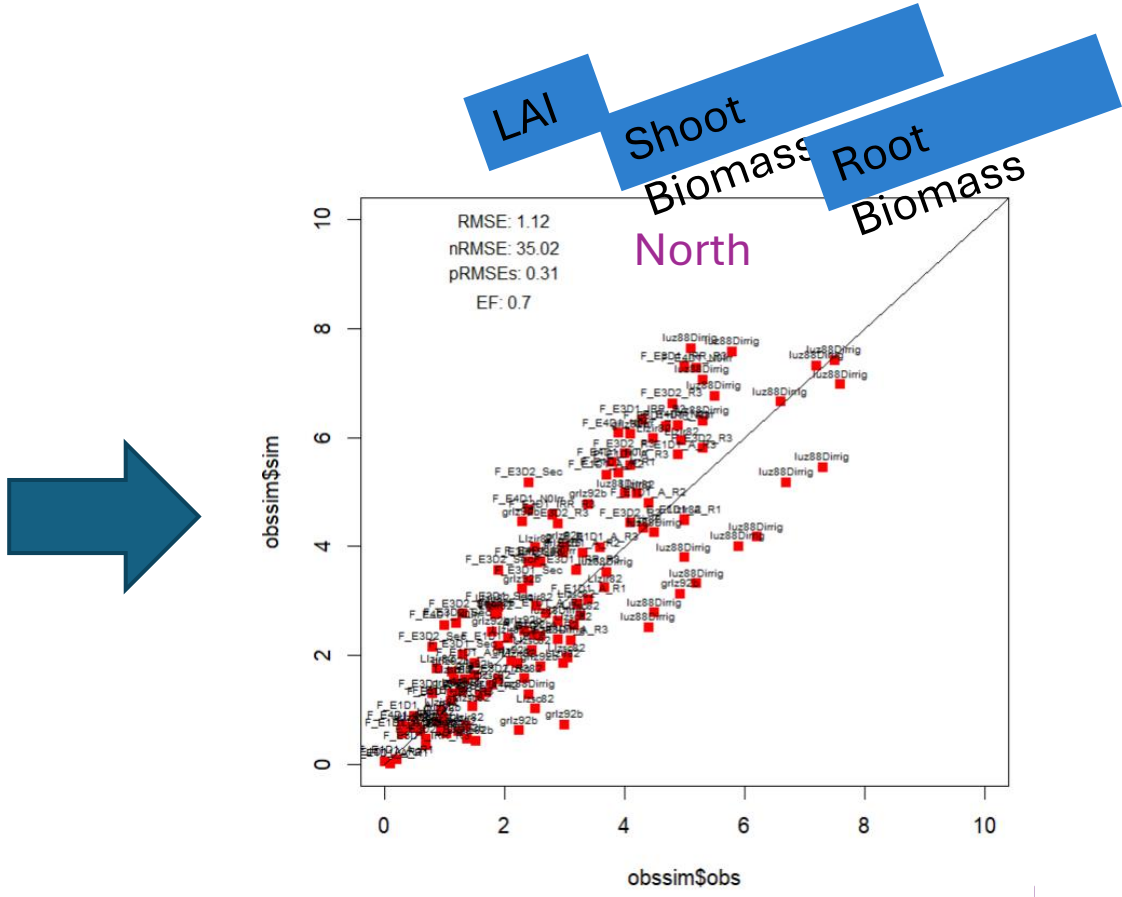
Work in progress!

Preliminary results: 1) Calibration of new varieties

- Detailed experiments with multive cutivar types

12 USMs North and South

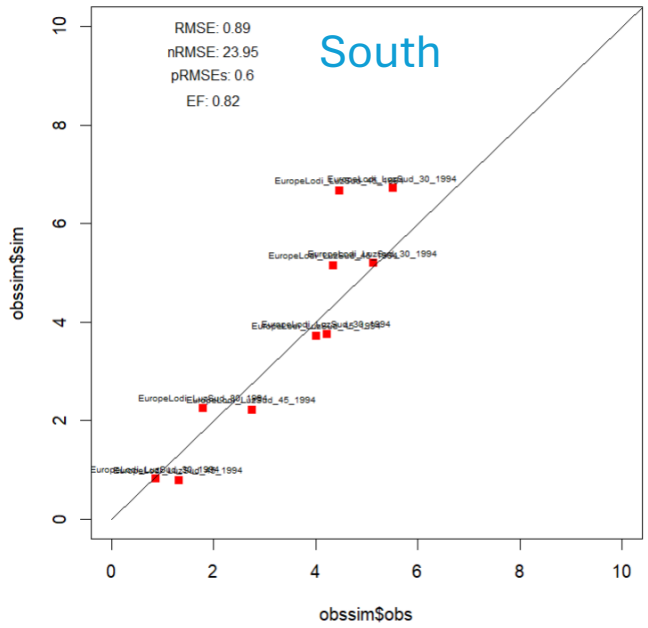




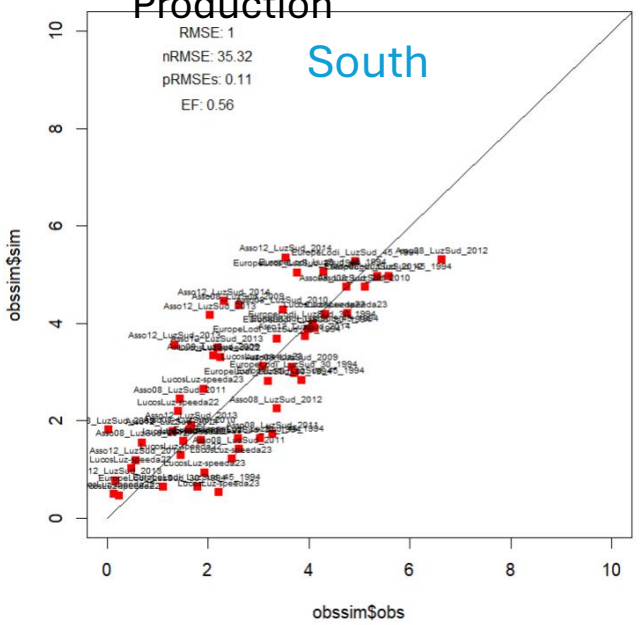
Preliminary results: 1) Calibration of new varieties

- Detailed experiments with multive cutivar types

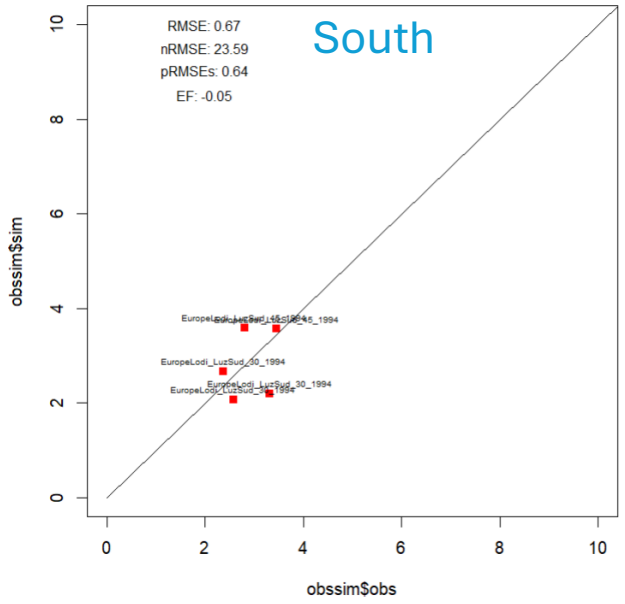
LAI



Biomass Production



Taproot Biomass



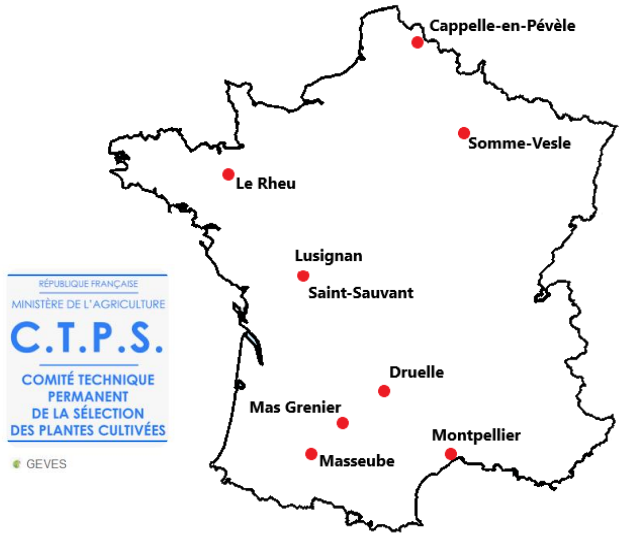
Good overall calibration of South type variety – fewer points + slightly larger model error

Preliminary results: 2) Model evaluation

- Validation dataset :

-Independent experiments with all climate / management inputs
-At least : **Shoot Biomass** for each cuts
-North and South on the same site compared for many years (n>6 y)
-France / Italy + Germany (?)

10 sites x 6-20 years USMs



RÉPUBLIQUE FRANÇAISE
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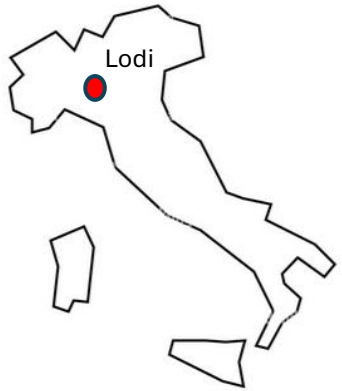
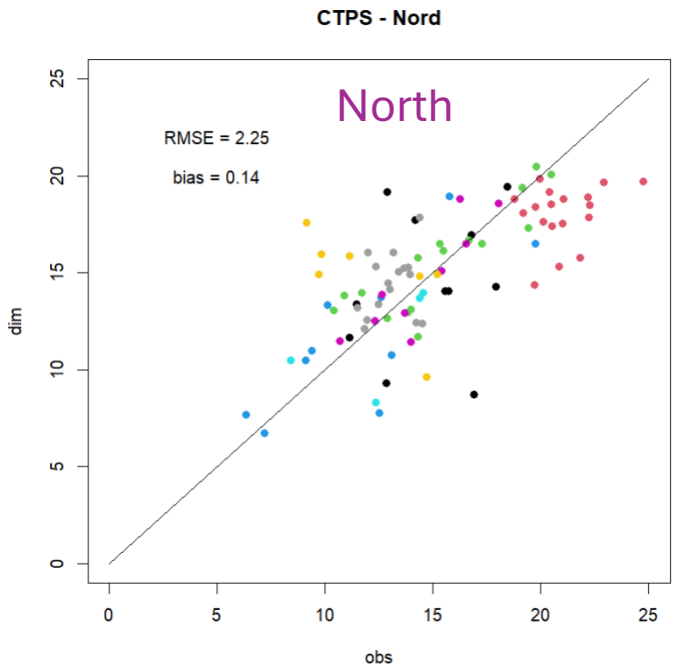
C.T.P.S.
COMITÉ TECHNIQUE PERMANENT DE LA SÉLECTION DES PLANTES CULTIVÉES
GEVES

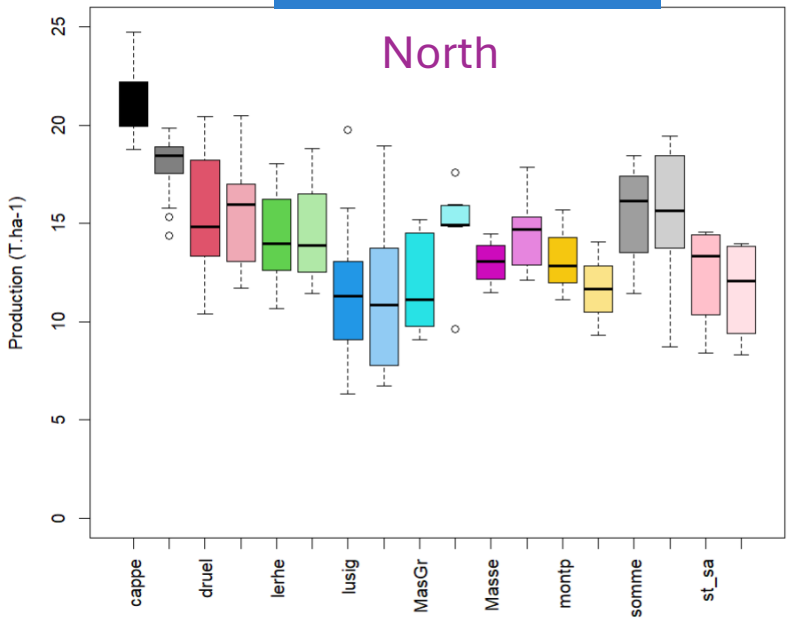


Preliminary results: 2) Model evaluation

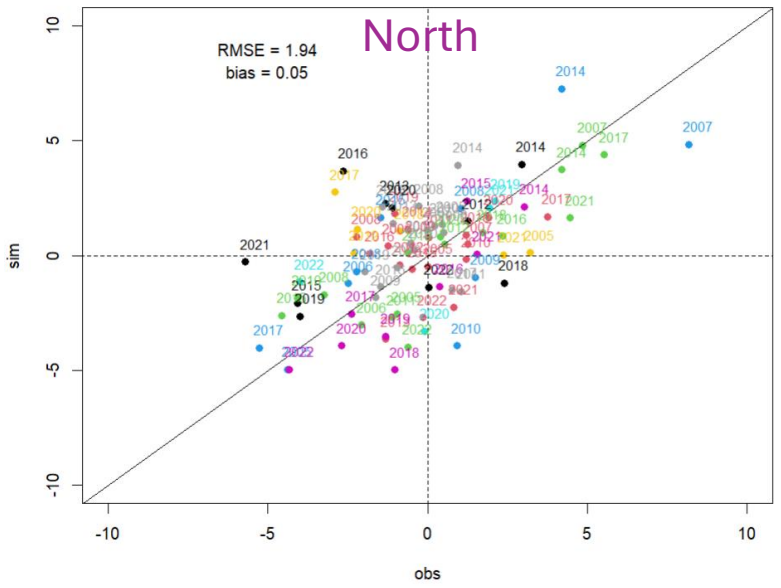
- Validation dataset :



Inter-site variation



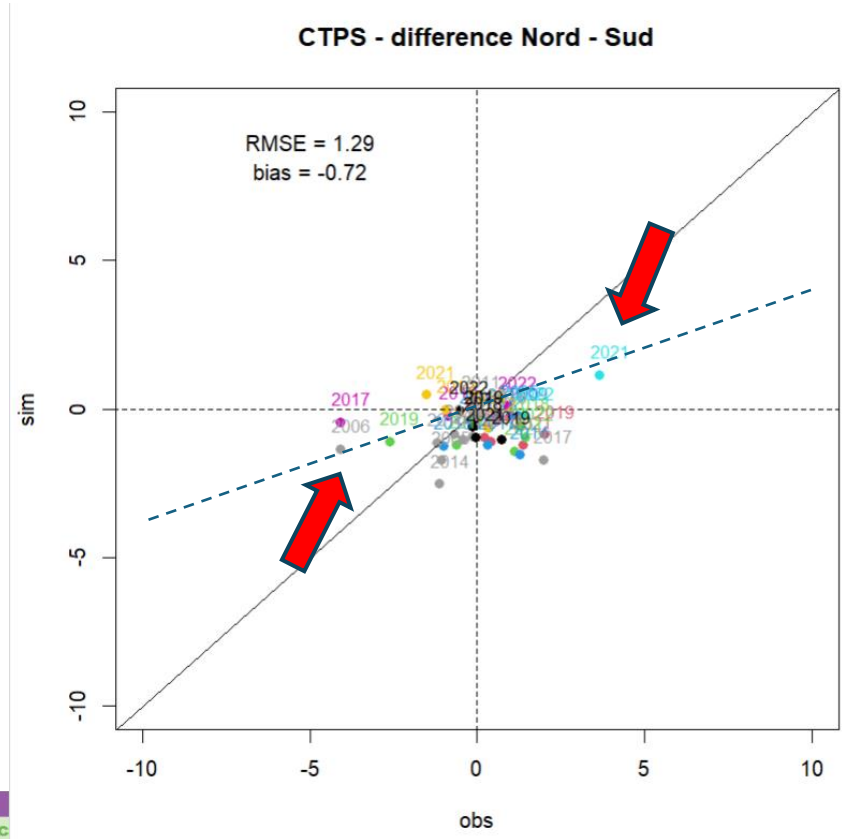
Inter-annual variation



Larger model error than the calibration (no bias)
Predicts well intersite and interannuel variability both for North and South varieties

Preliminary results: 2) Model evaluation

- Validation dataset :



Prediction of GxE interactions:

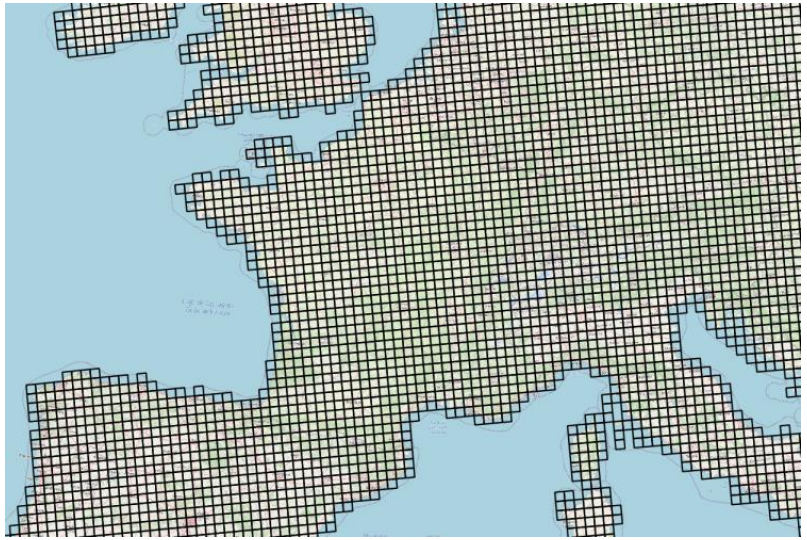
- Annual yield very close between elite cultivars (difference < 1,5T.ha-1) in most site x year situations

- The model captures well the site x year with important deviations, either in favour of North or South varieties,
...but it predicts lower yield difference between types

Preliminary results: 3) Automatic management modules

- Scaling up ?

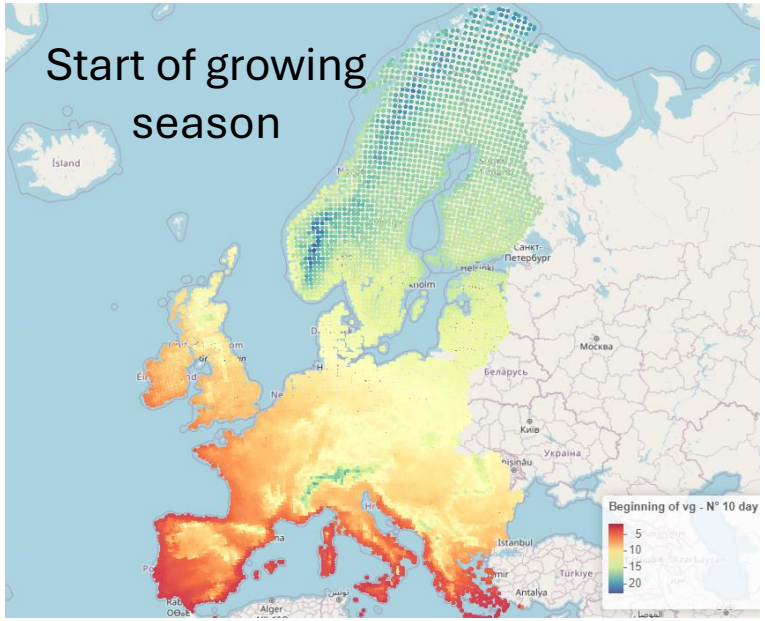
- Gridded approach

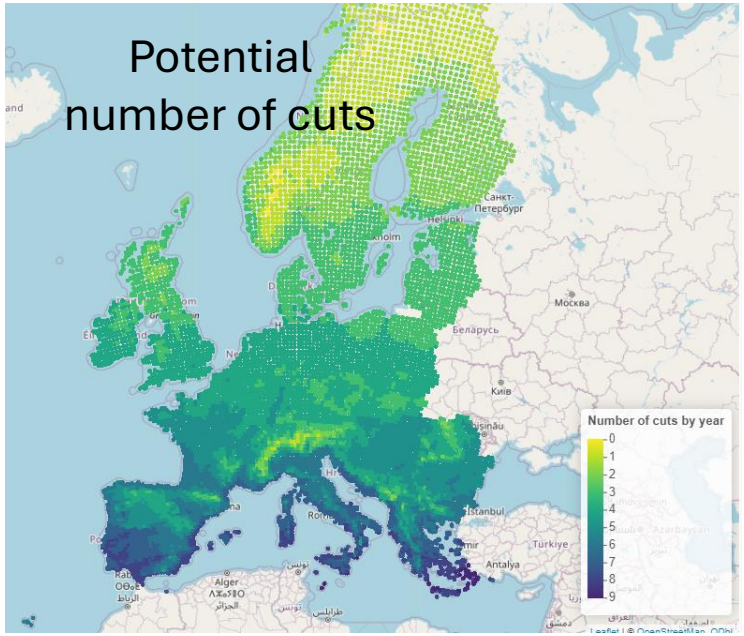


- 25x25 km grid, for the European Union and neighbouring countries.

- Adaptive management: managing model inputs!

Sowing date, havest schedule





Conclusions

- Ongoing Work!
- Complete validation dataset in northern Europe (Germany)
- Deploy grided model and assess production maps in current climates…
- Simulate IPCC climate scenarios…

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Thank You for your attention!

BELIS
Breeding European Legumes

Funded by
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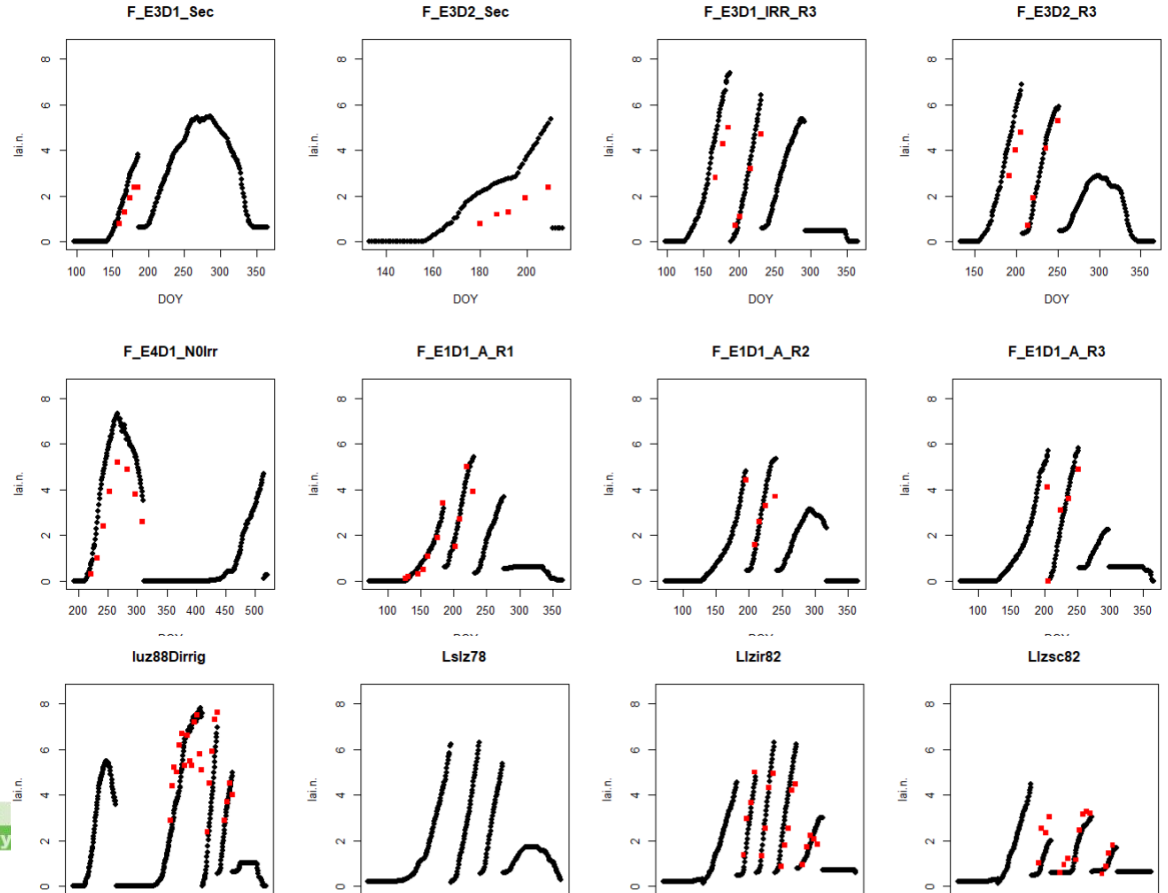
FROM 03 › TO 06 nov. 2025

T6.3 – Identifying agrometeorological zones to improve legumes varietal offer in present and future European climates

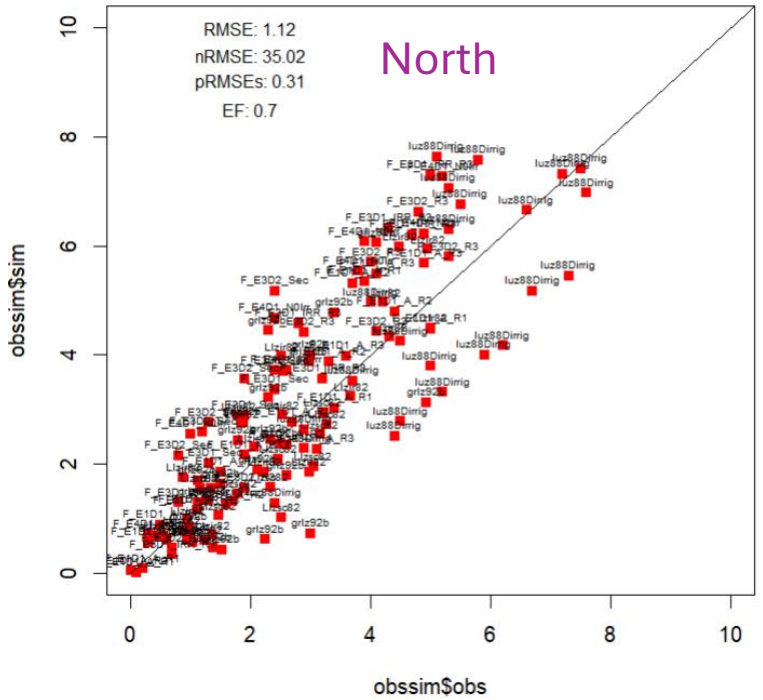
BELIS
Breeding European Legumes

1) Model calibration for North-South varieties:

12 detailed USMs



LAI



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ifa congress FRANCE REIMS · CHÂLONS

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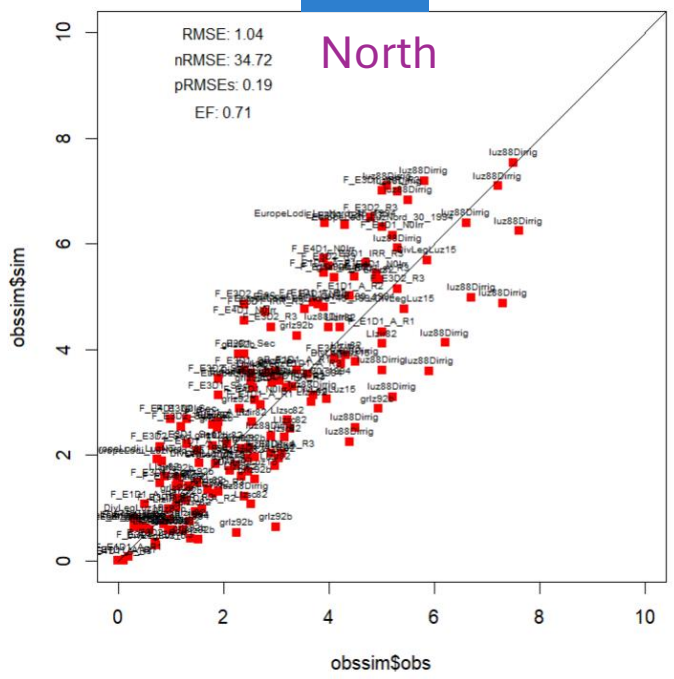
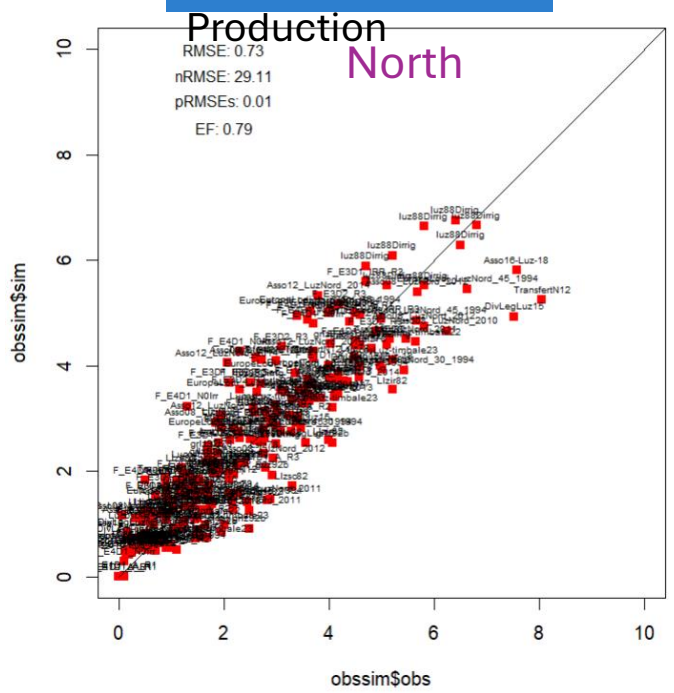
1) Model calibration for North-South varieties:

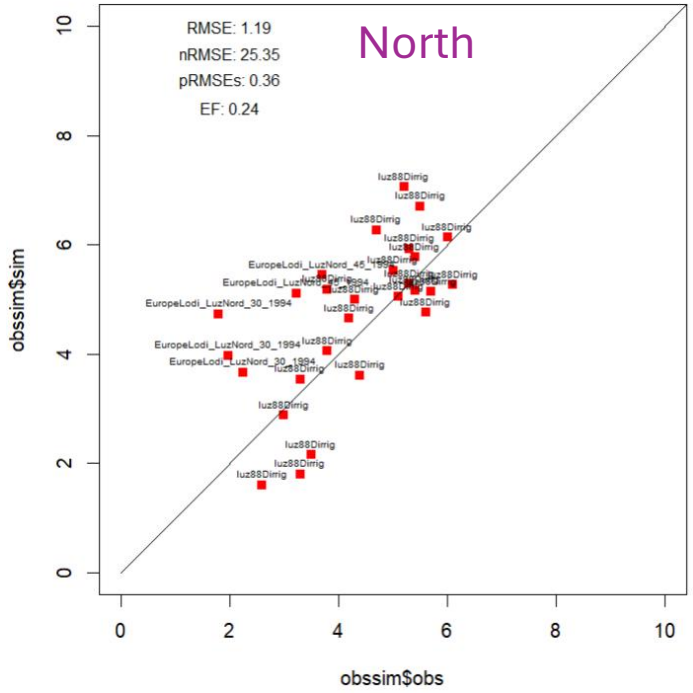
LAI



Biomass Production



Taproot Biomass



Good overall calibration of North type variety for the main plant compartment dynamics

T6.3 – Identifying agrometeorological zones to improve legumes varietal offer in present and future European climates

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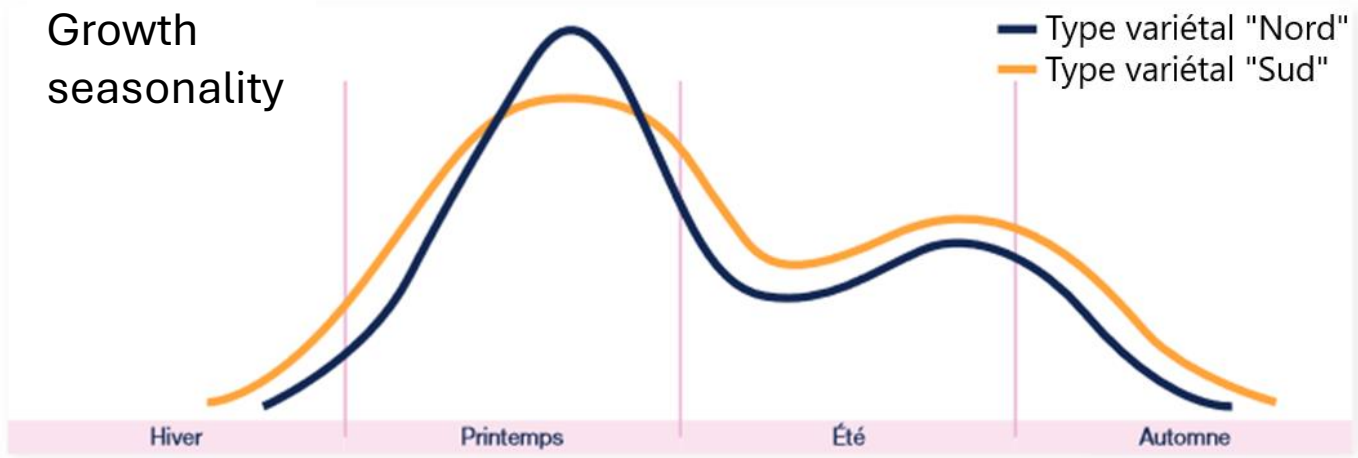
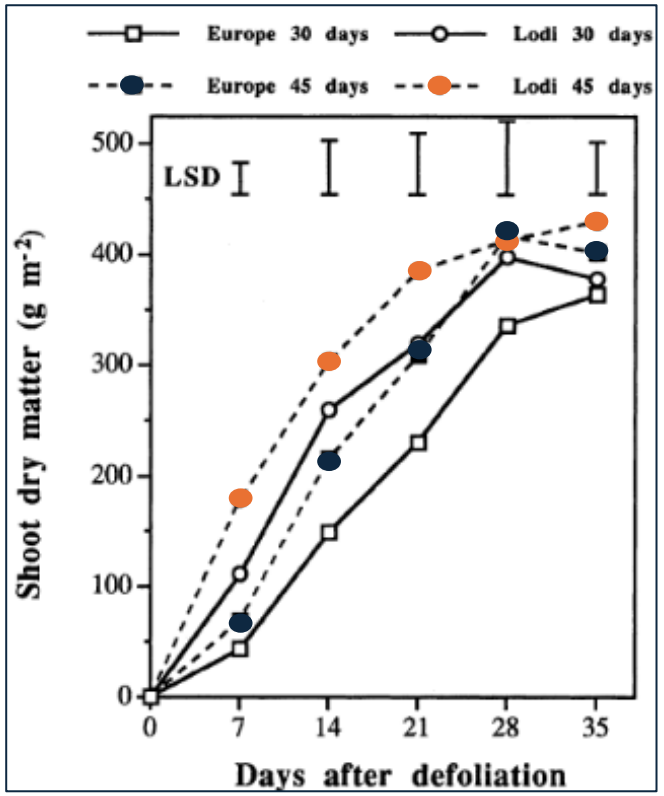
1) Model calibration for North-South varieties:

Only « North » type variety available



« South » type:

Incresed growing season duration
Faster / shorter regrowth dynamics
Increased CN reserves



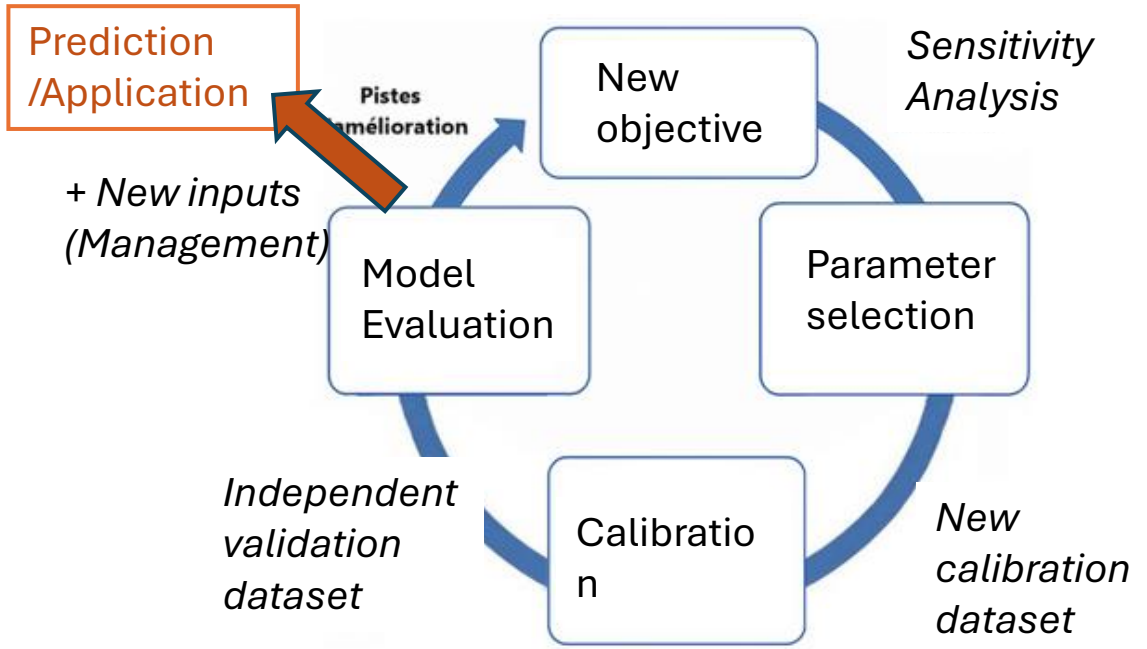
Avice et al, 1996

T6.3 – Identifying agrometeorological zones to improve legumes varietal offer in present and future European climates

BELIS
Breeding European Legumes

Objectives of BELIS :

- ***Produce maps of suitability for lucerne variety groups and maps of risk factors***



T6.3 – Identifying agrometeorological zones to improve legumes varietal offer in present and future European climates

BELIS
Breeding European Legumes

Background:

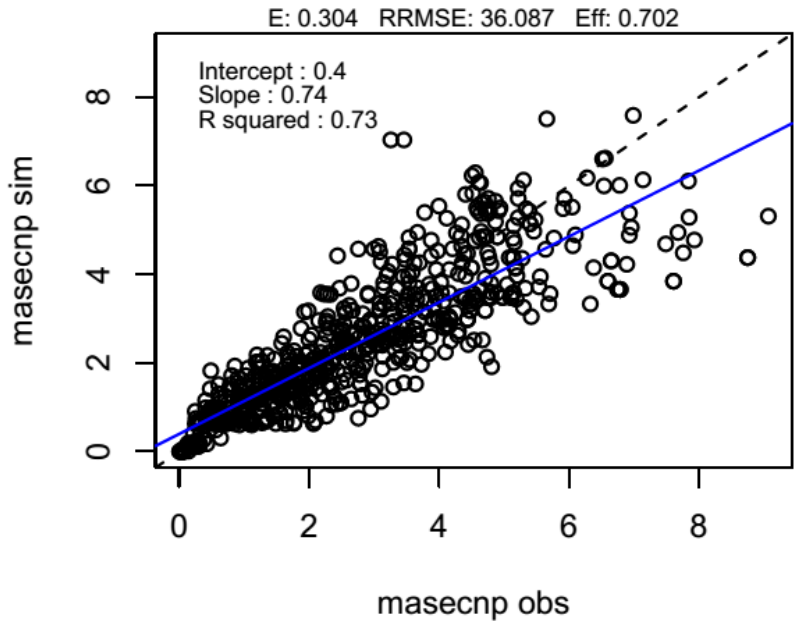
- ***Modelling forage legumes with STICS***

STICS

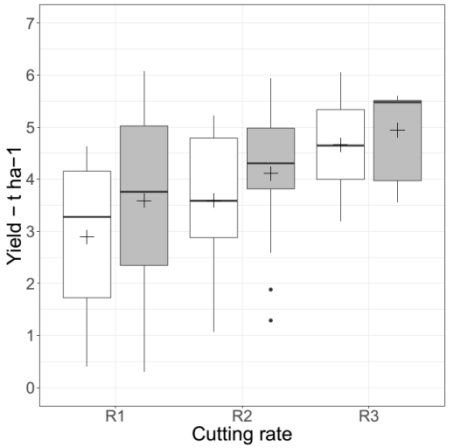
At the crop level (e.g. lucerne):

North type varierty (Europe)

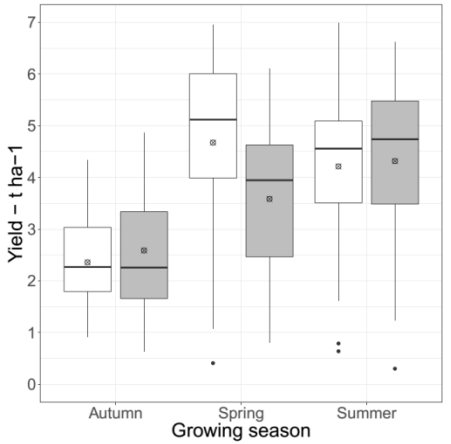
Yield



Cutting management



seasonality



Stullu et al, 2018

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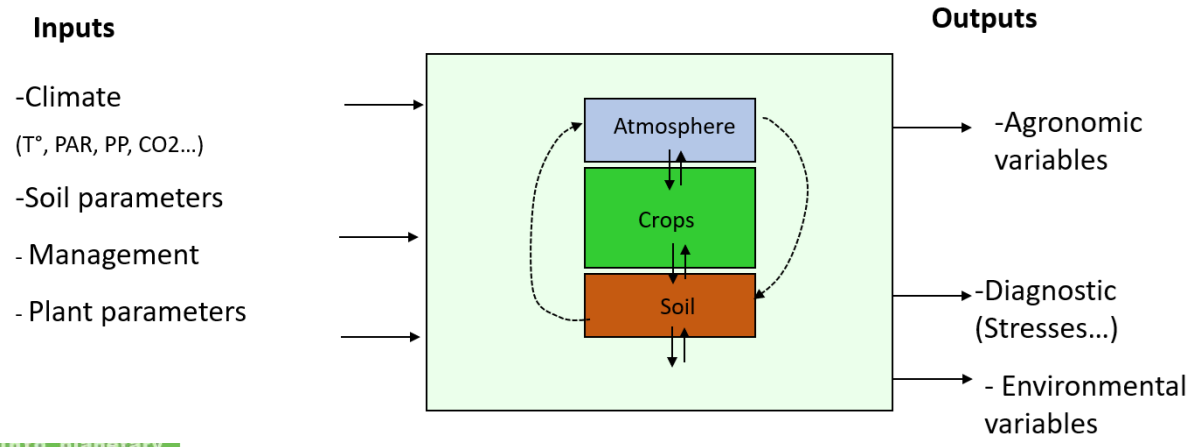
Background

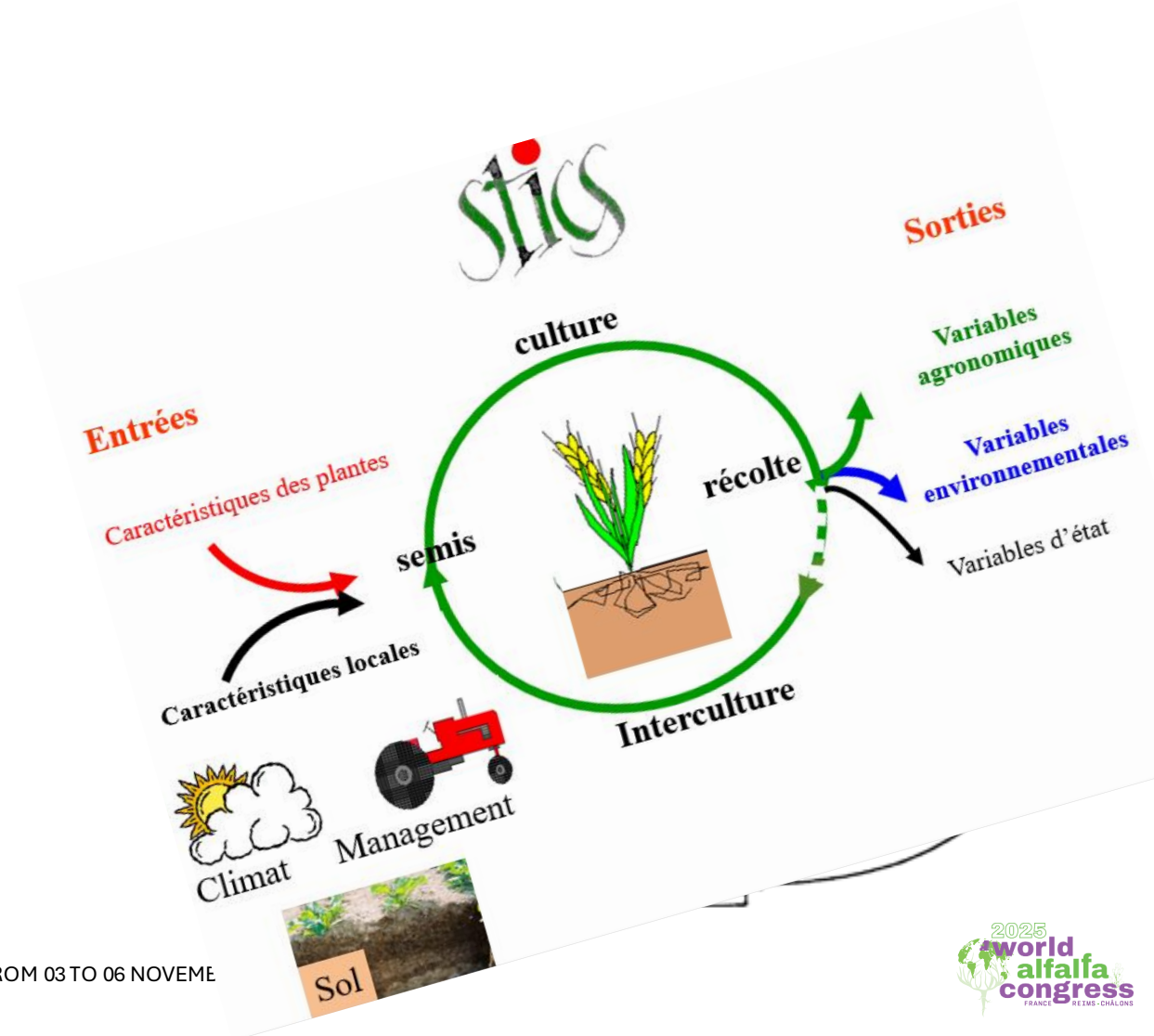
- Using:

Ou pas?

- ***Crop models***

  Dynamic, mecanistic
  Soil-plant-atmosphere system
  Soil + climate + Farmer's management





T6.3 – Identifying agrometeorological zones to improve legumes varietal offer in present and future European climates

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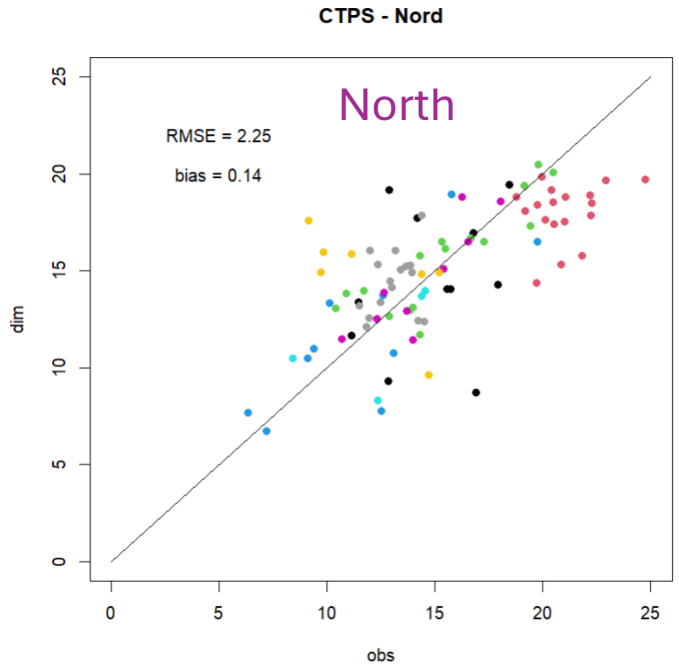
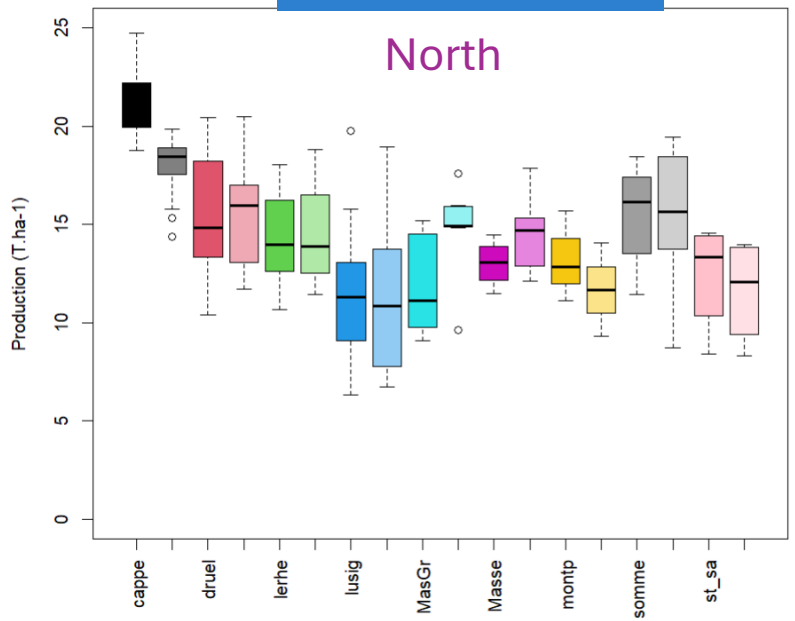
Breeding European Legumes

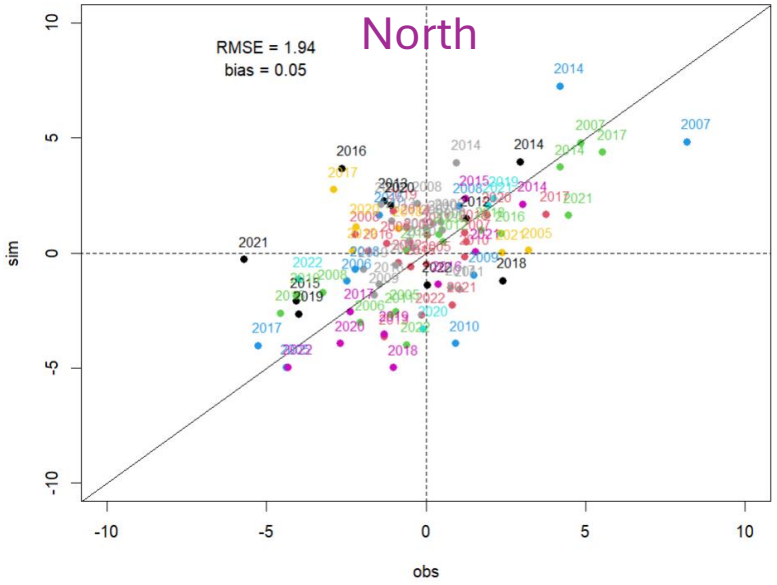
2) Model evaluation for North-South varieties:



Inter-site variation



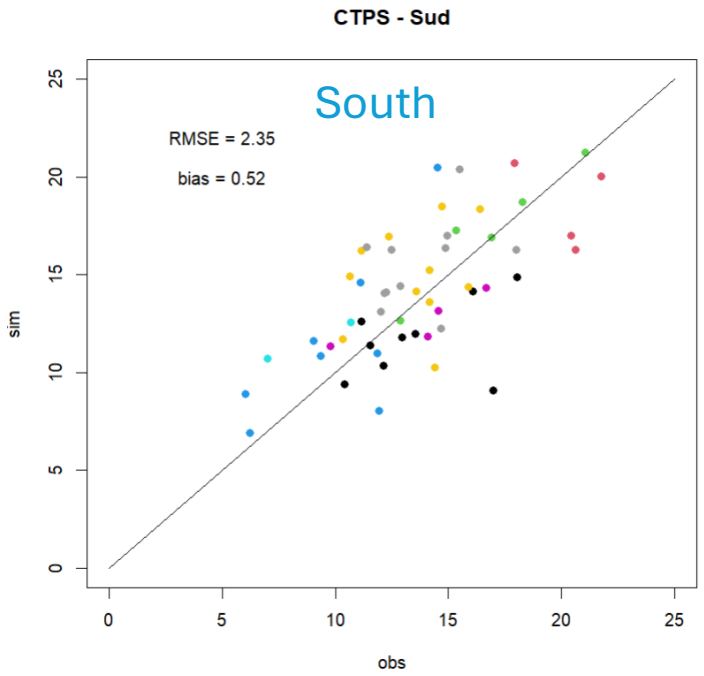
Inter-annual variation



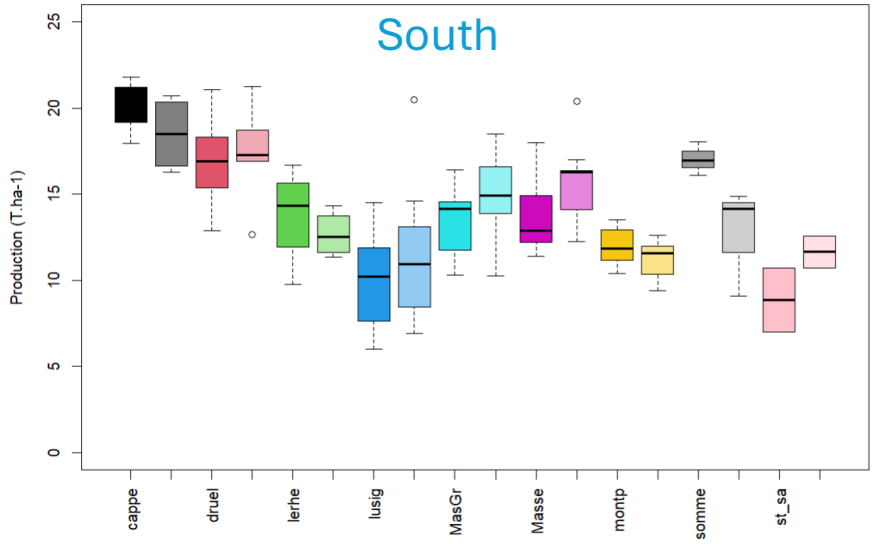
Good overall prediction without bias – capture inter-site and intar-annual variability of production

T6.3 – Identifying agrometeorological zones to improve legumes varietal offer in present and future European climates

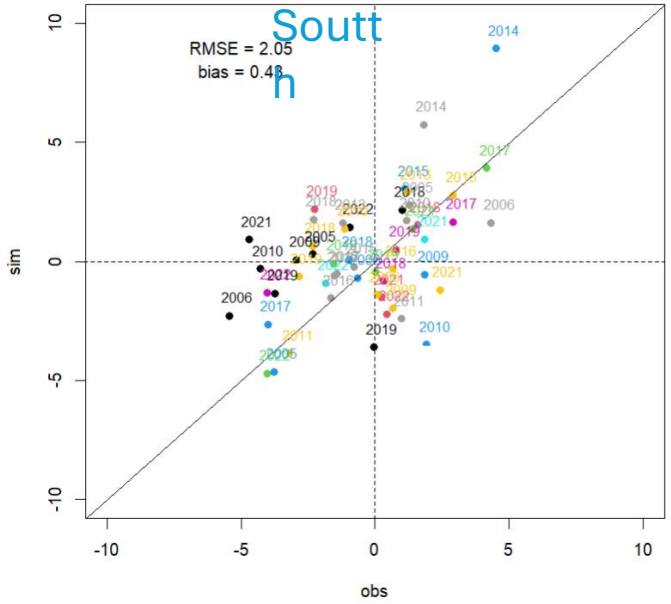
2) Model evaluation for North-South varieties:



Inter-site variation



Inter-annual variation

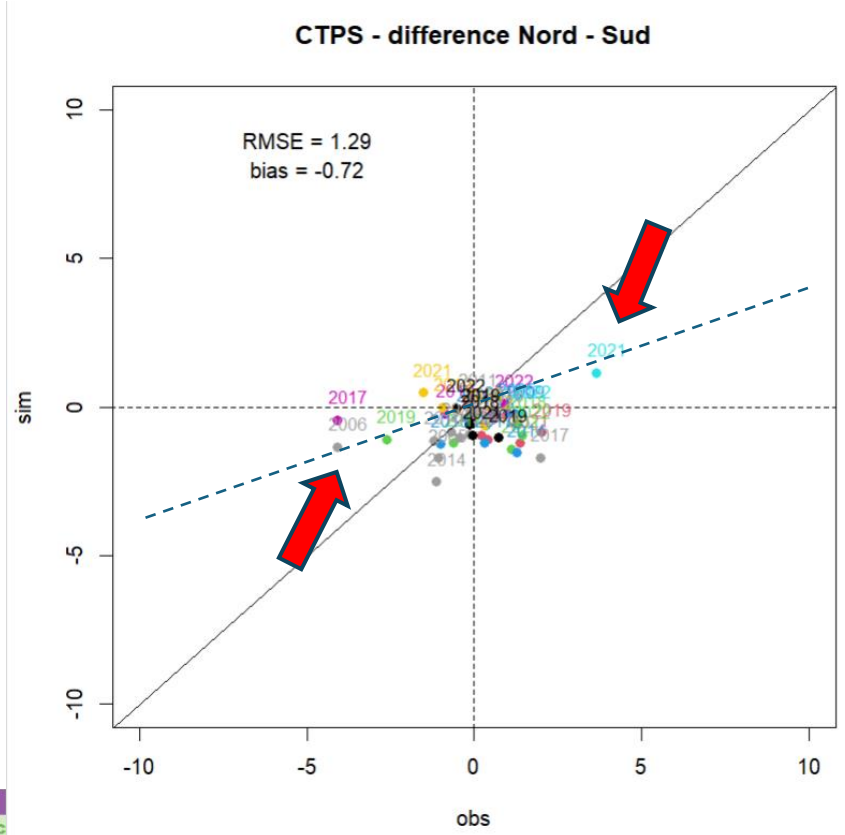


Good overall prediction - capture inter-site and intar-annual variability of production but with a small bias (+0,4 T.ha-1)

T6.3 – Identifying agrometeorological zones to improve legumes varietal offer in present and future European climates

BELIS
Breeding European Legumes

2) Model evaluation for North-South varieties:



Prediction of GxE interactions:

- Annual yield very close (difference < 1,5T.ha-1) in most site x year situations

- The model captures well the site x year with important deviations, either in favour of North or South varieties, but it predicts lower yield difference between types (cf Bias)