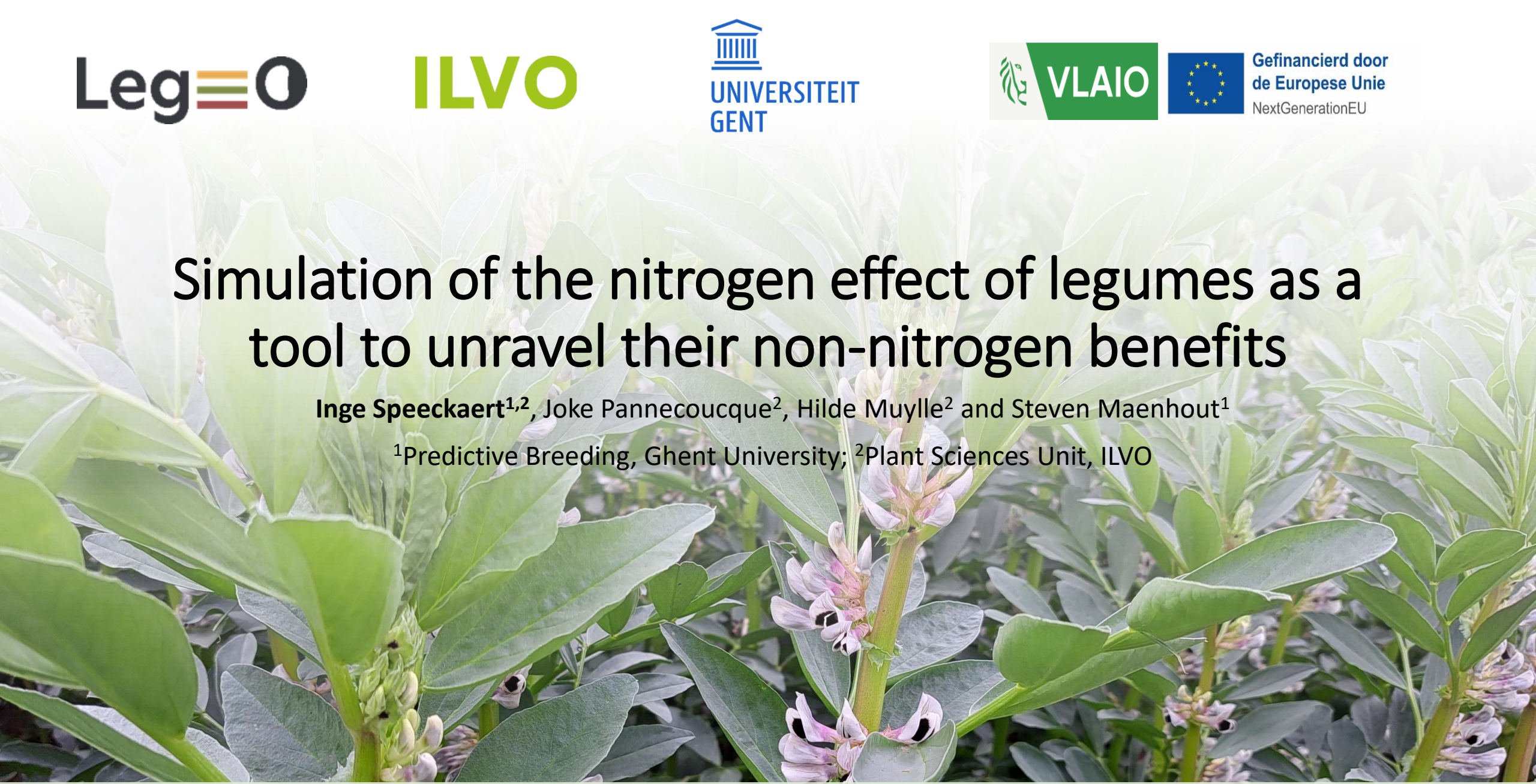

Simulation of the nitrogen effect of legumes as a tool to unravel their non-nitrogen benefits

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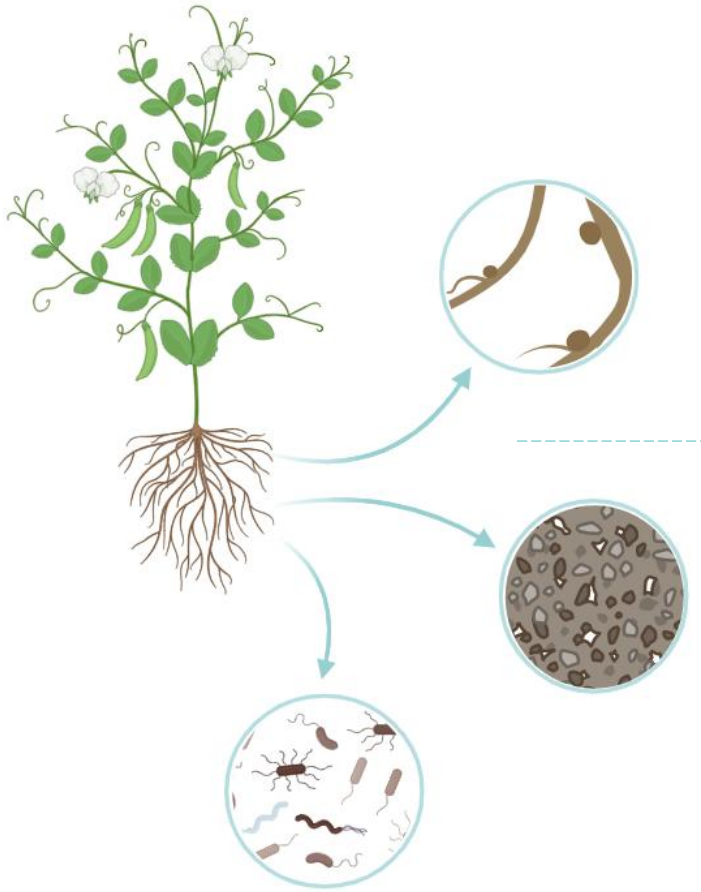
Gefinancierd door de Europese Unie NextGenerationEU

XIVth STICS seminar, 17-19 March 2026
organized by ULiege-GxABT & INRAE

Precrop effect of legumes



Nitrogen effect:

Increased nitrogen availability through biological nitrogen fixation

Non-nitrogen effect:

All non-nitrogen related benefits, e.g., improved soil structure, improved soil water retention, reduced incidence of diseases and altered soil microbial community

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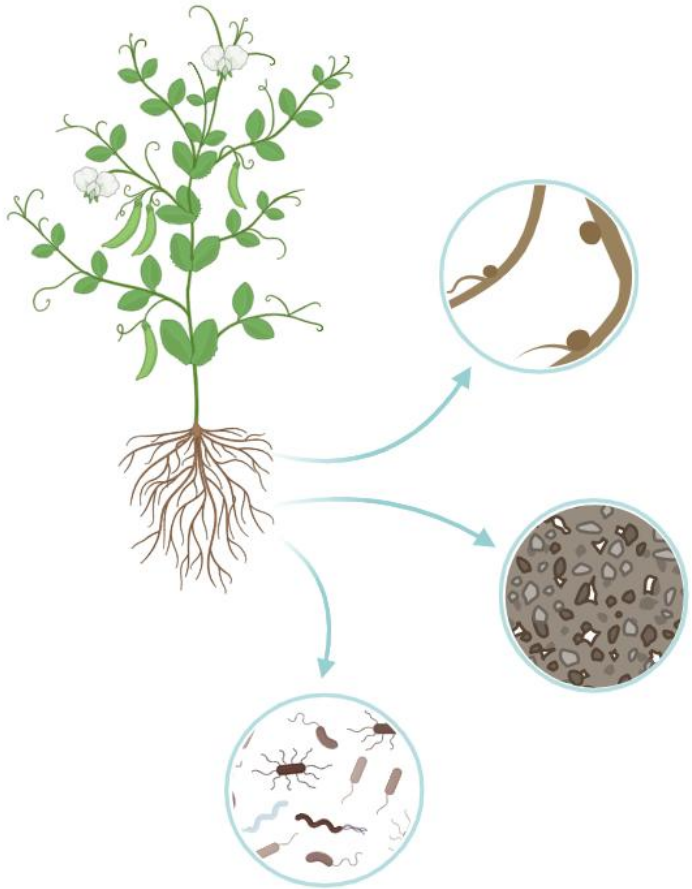
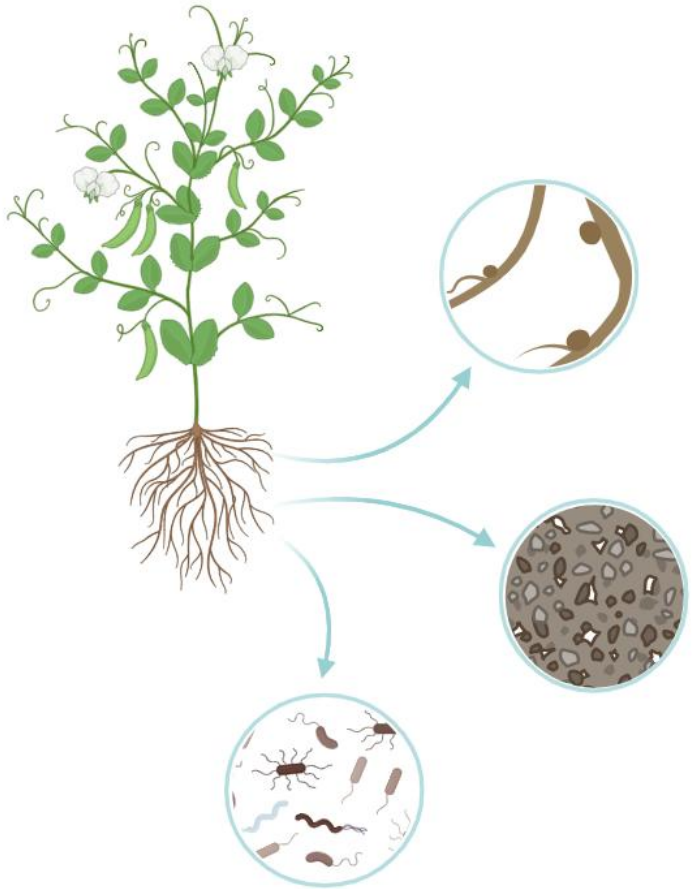
Research question



What is the magnitude of the non-nitrogen effect?

Research question



What is the magnitude of the non-nitrogen effect?

- Estimate the nitrogen effect with STICS
- Residual variation in yield = non-nitrogen effect

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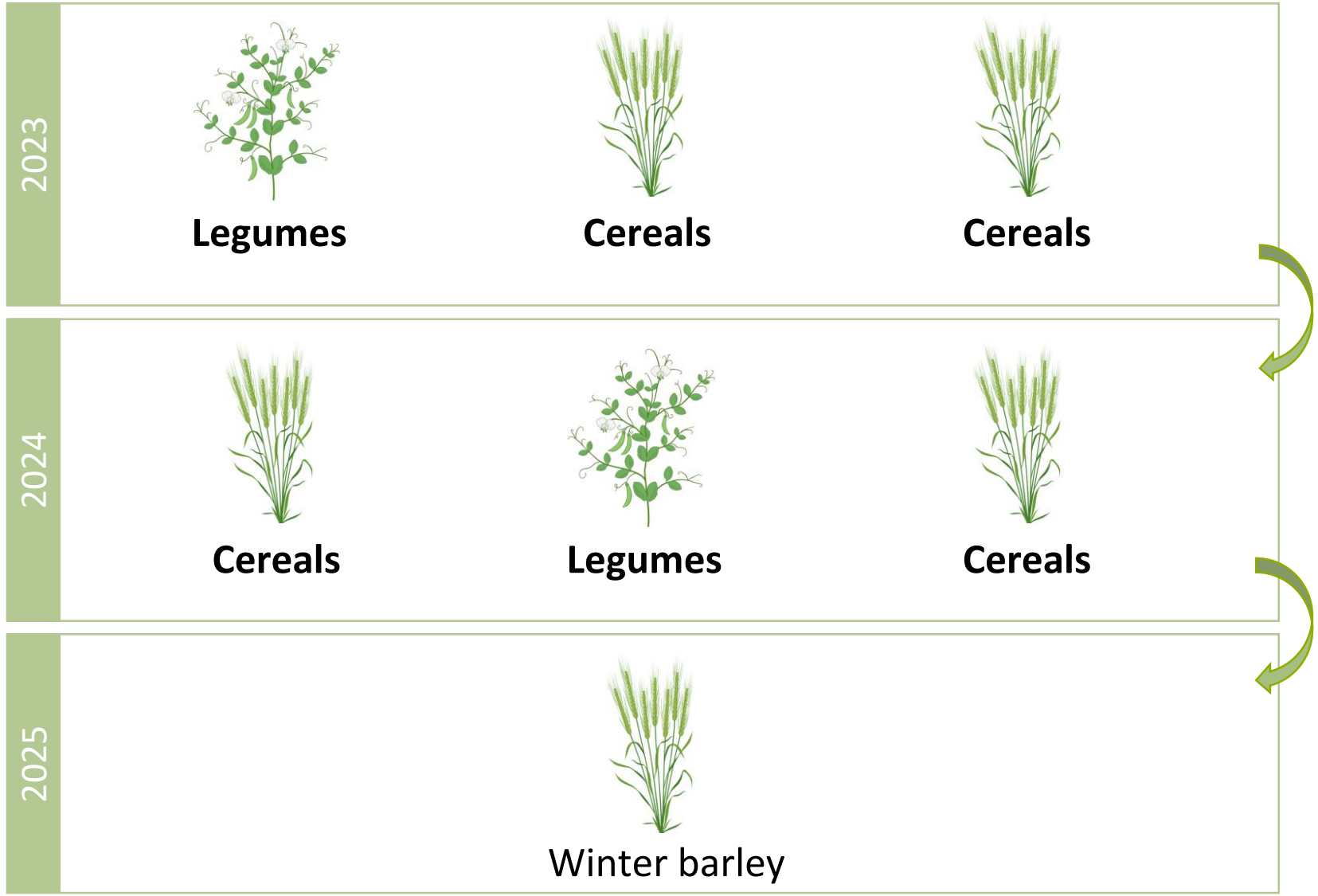
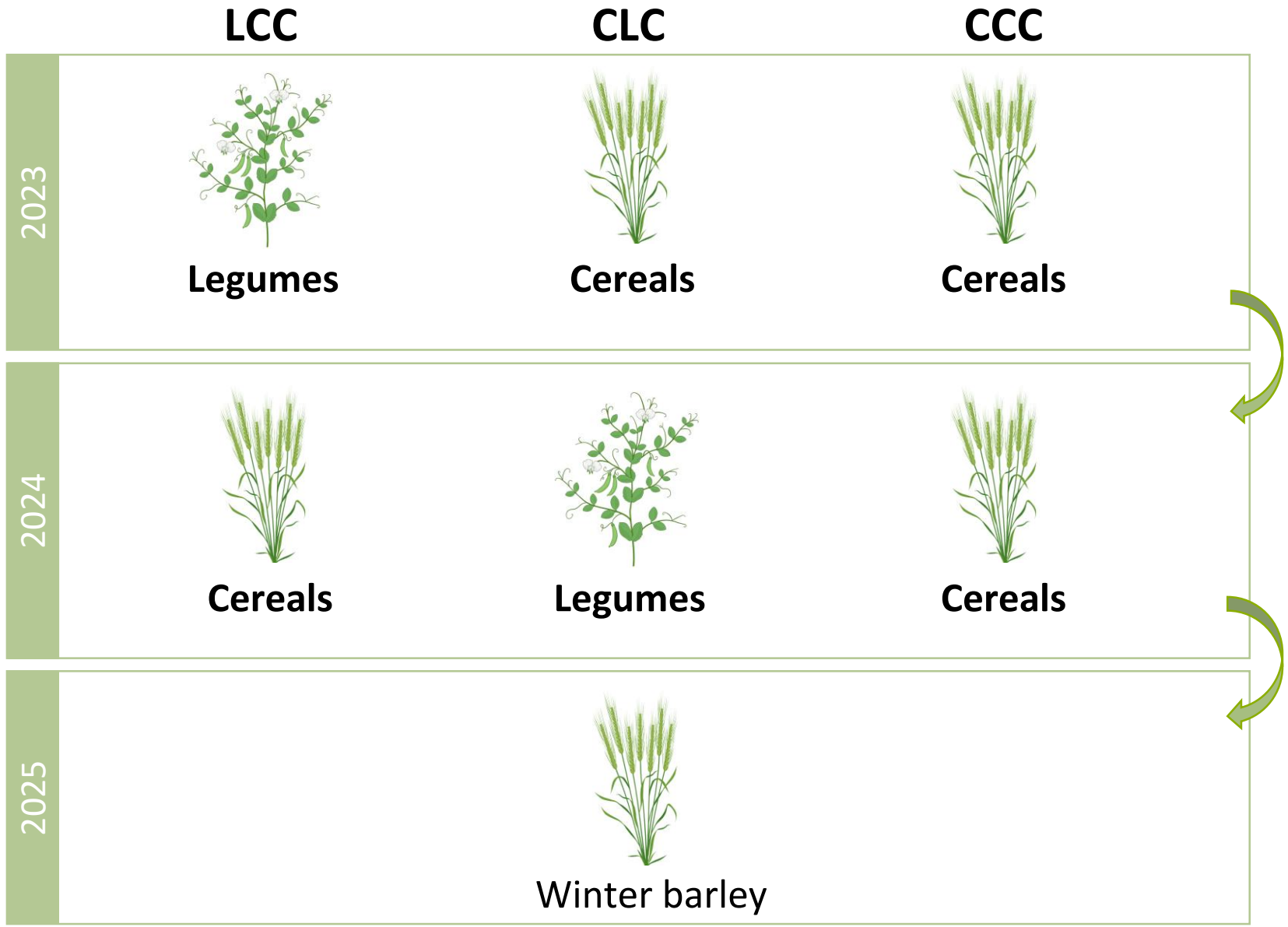
Experimental design



Legumes: faba bean, pea, kidney bean

Cereals: barley, wheat, durum wheat

Experimental design



Legumes: faba bean, pea, kidney bean

Cereals: barley, wheat, durum wheat


Pre-crops 2023

Field observations

Measurements

- **Soil samples:**
  - Before precrop sowing 2024 and after precrop harvest 2024
    - 0-30, 30-60 cm
    - Mineral NO3 and NH4, water content
  - After winter barley harvest 2025
    - 0-30, 30-60, 60-90 cm
    - Mineral NO3 and NH4, water content
- **Phenology:**
  - Emergence, stem elongation, heading, flowering, maturity
- **Biomass:** around flowering (BBCH 60 – only in 2025)
- **Harvest:**
  - Grain and biomass yield
  - Grain and total plant N content
  - Grain moisture content

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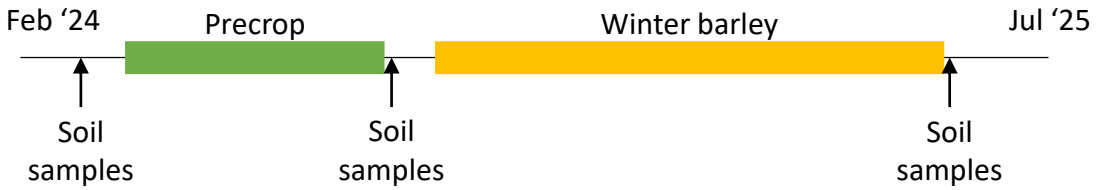
STICS simulations

Simulations:



Model:

- **Inputs:**
  - Initial soil data (feb '24)
  - Management details
- **Plant files:** barley (spring and winter), wheat, faba bean and pea
- **Continuous simulation**: a simulation per plot

Goal:

- Model the **N-effect** of precrops: i.e. N mineralisation of residues and NO_3 availability for following crop
- Can N-effect explain all yield variation?

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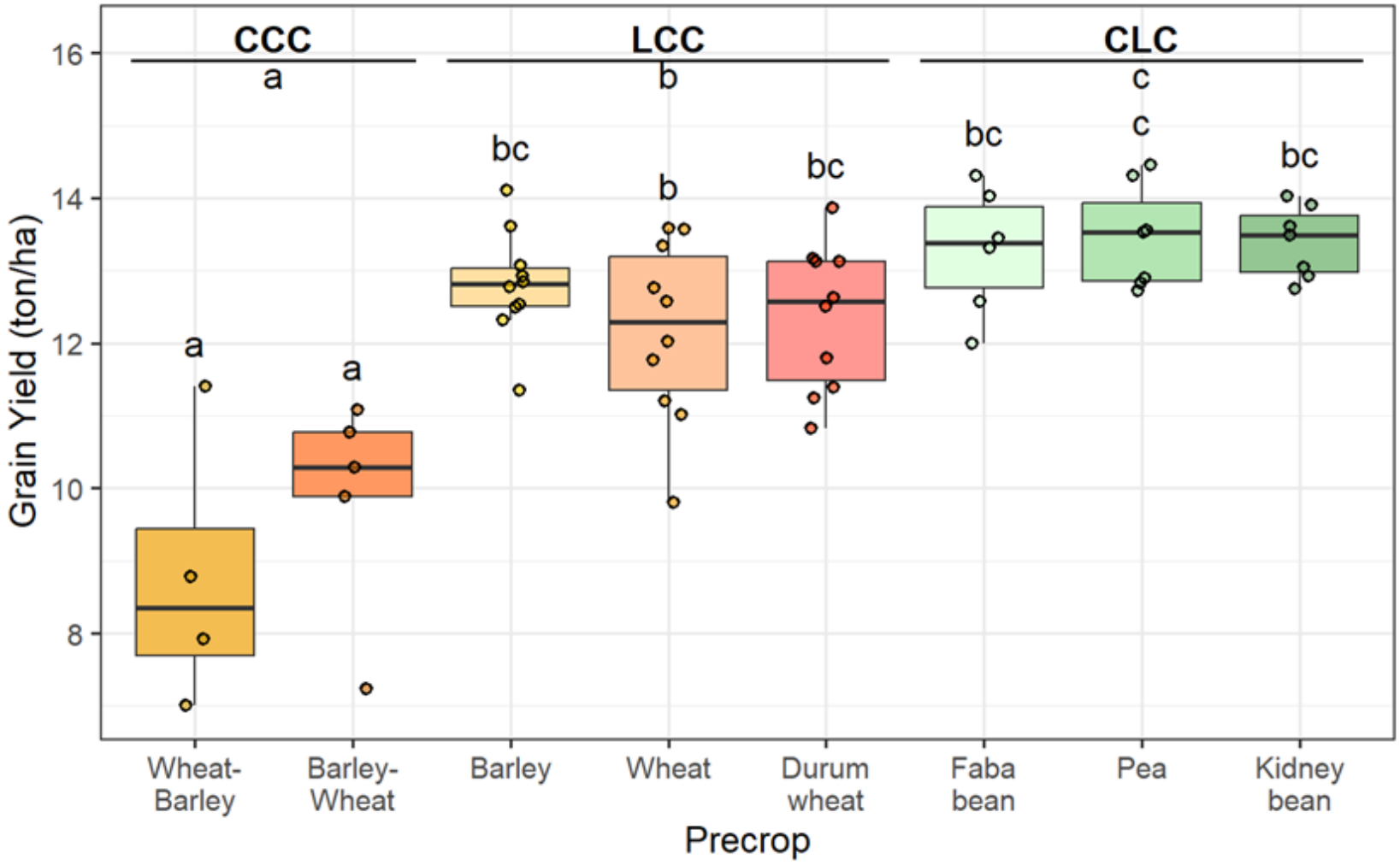
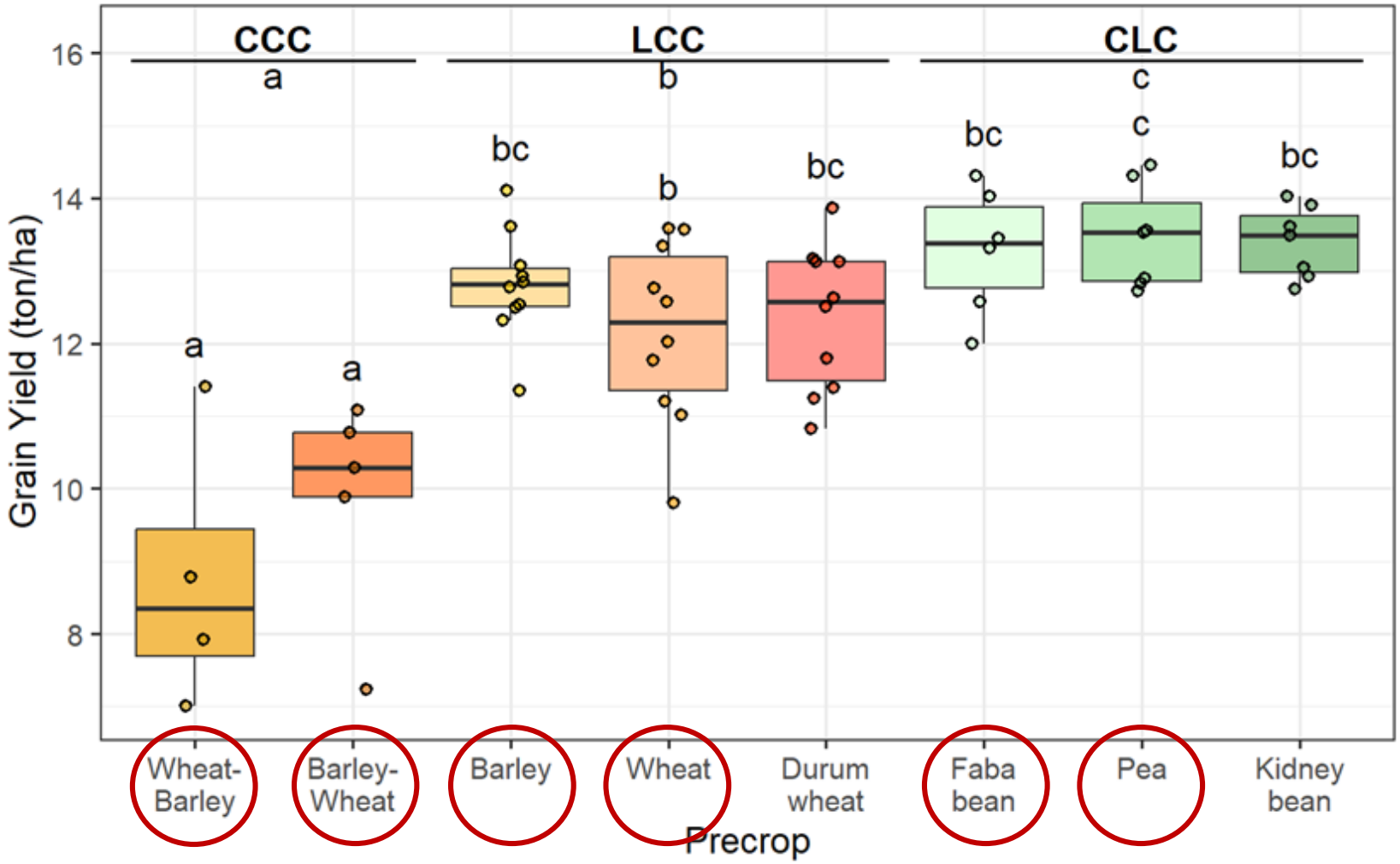
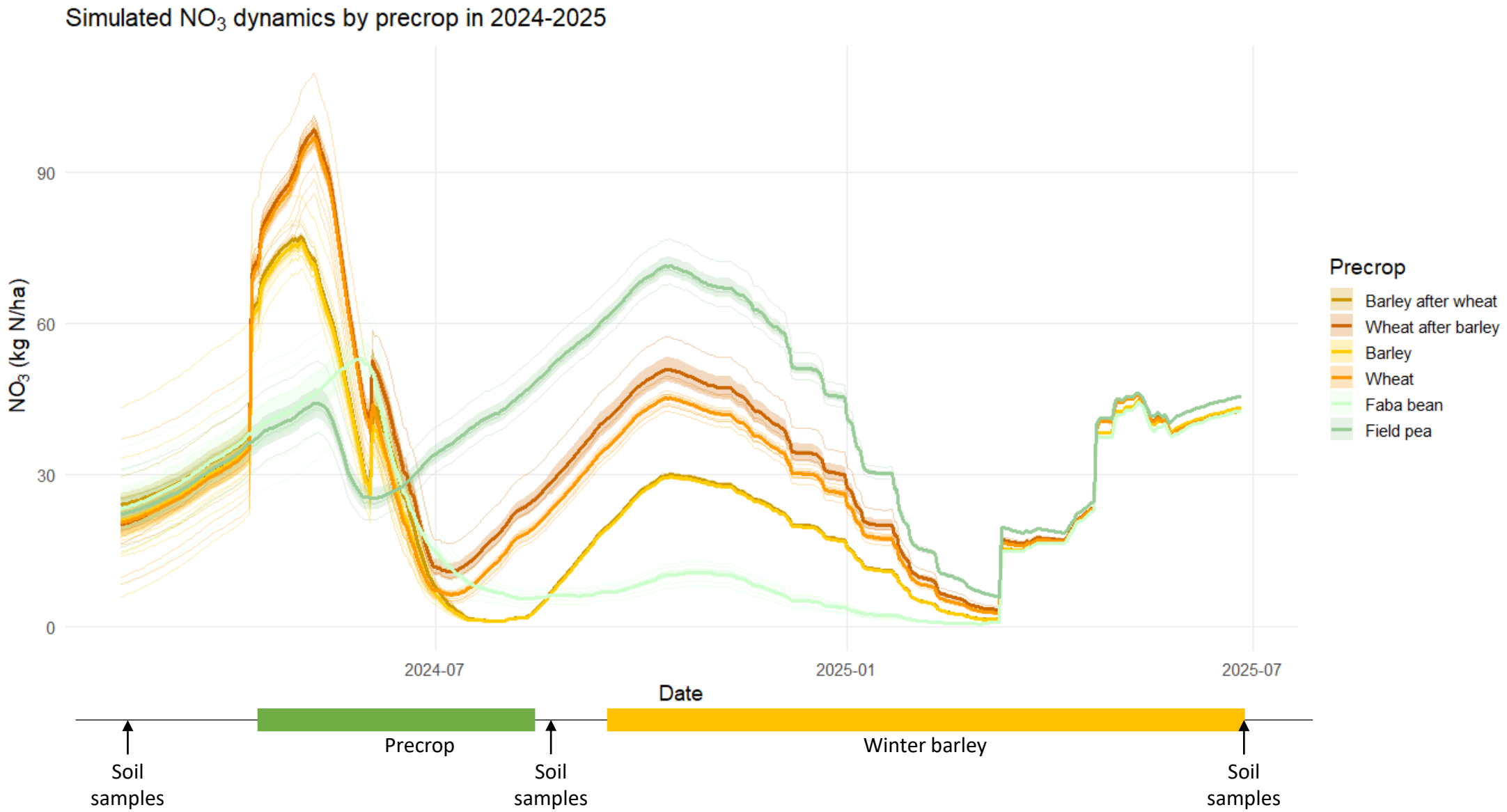
Field observations – winter barley yield



Field observations – winter barley yield



NO3 availability ‘24-’25



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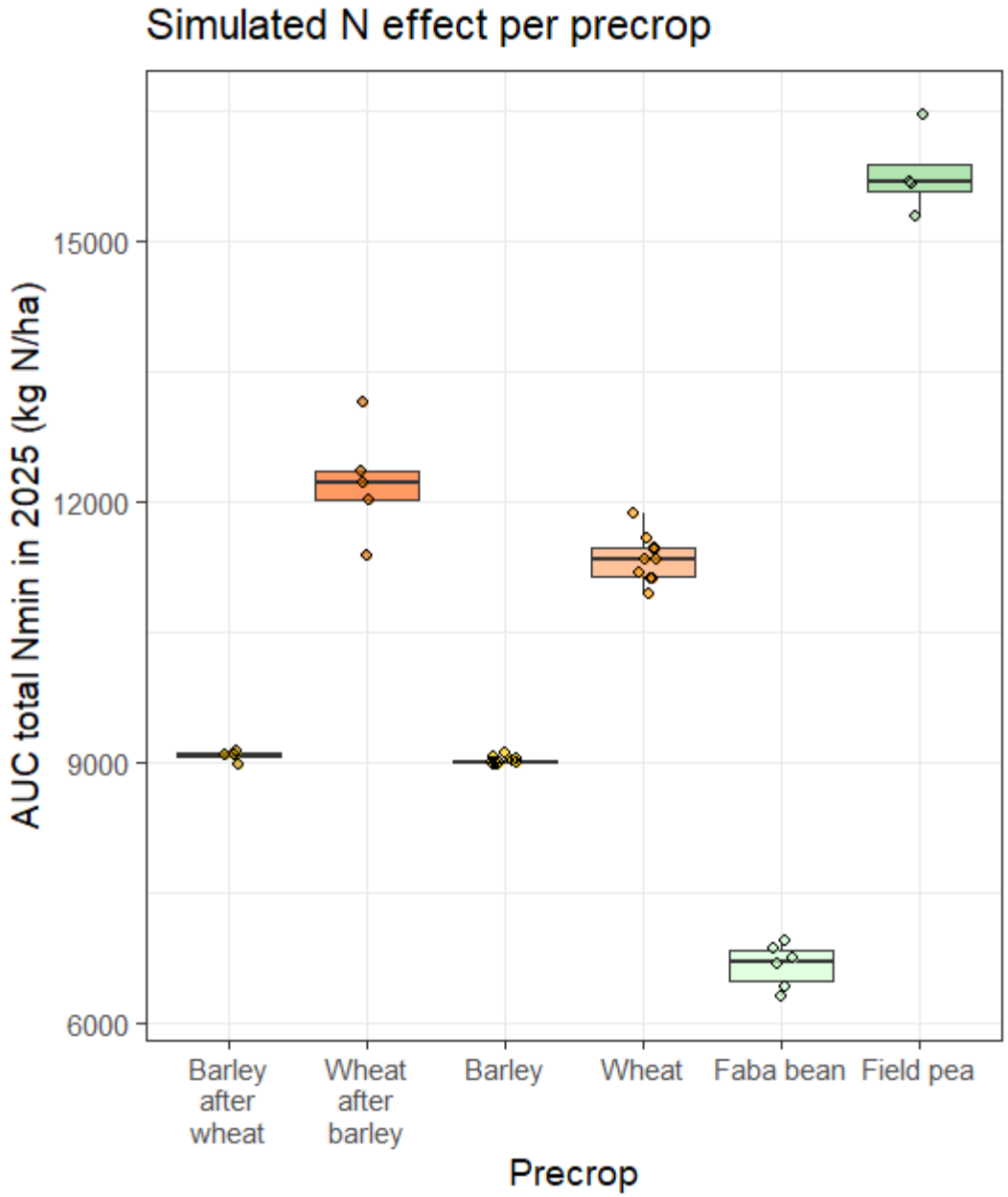
Area under the curve as proxy of N effect

Fit yield response with AUC as covariate:

Yield ~ Precrop * AUC + (1:Block)

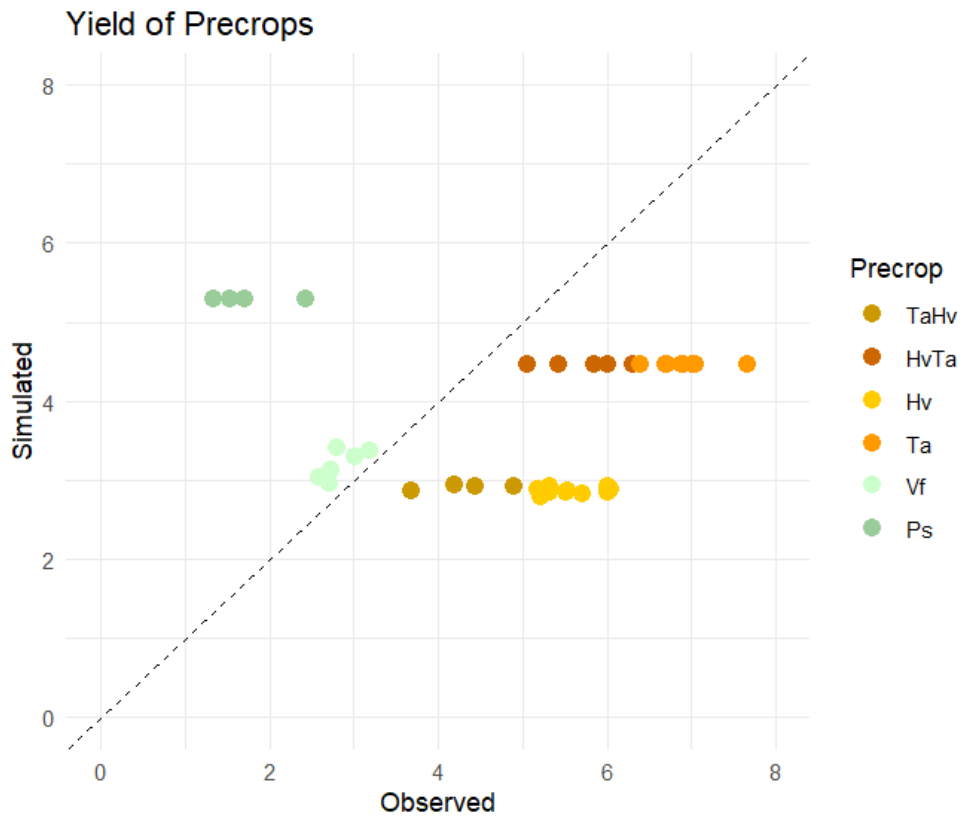
Both AUC and Precrop are significant:

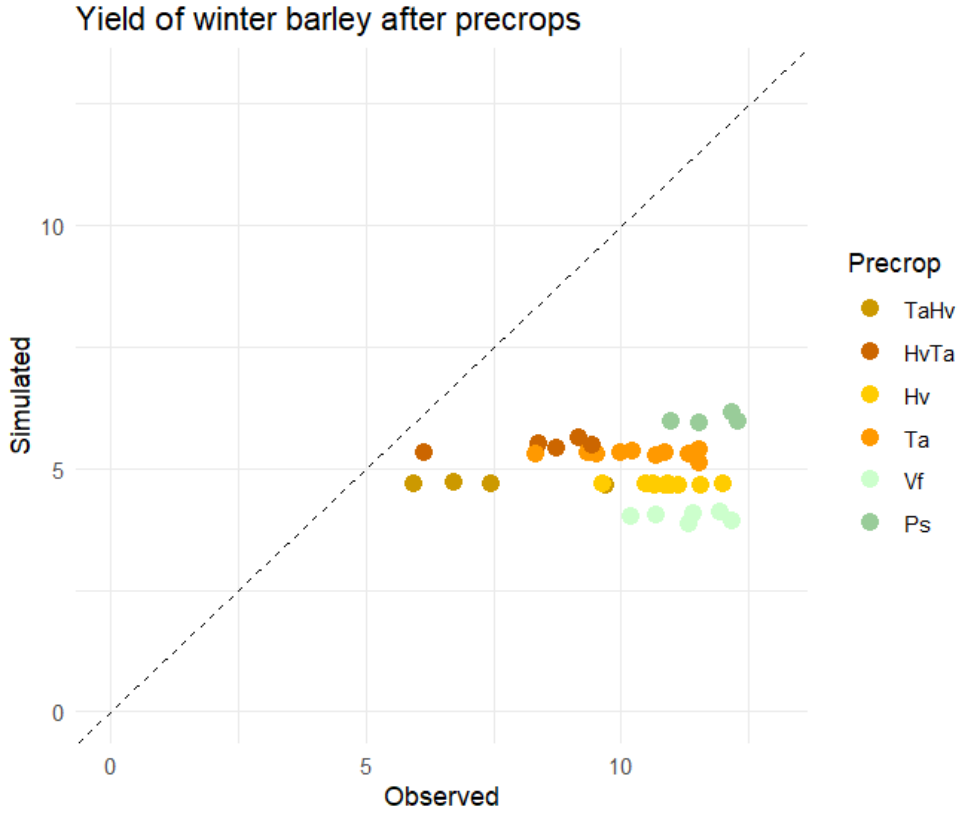
- There is a residual non-N effect that causes higher yield after legume precrops
- Correlation Yield ~ AUC: -0.09582272



Work in progress: fit of the model

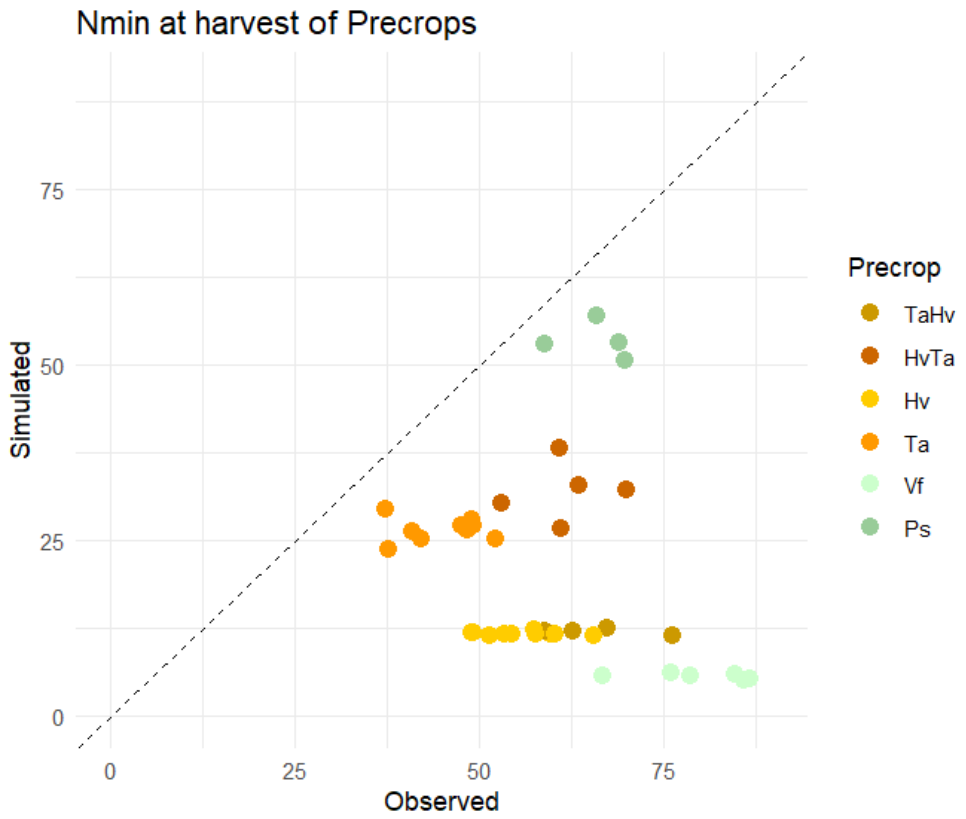
- Simulated versus observed: yield

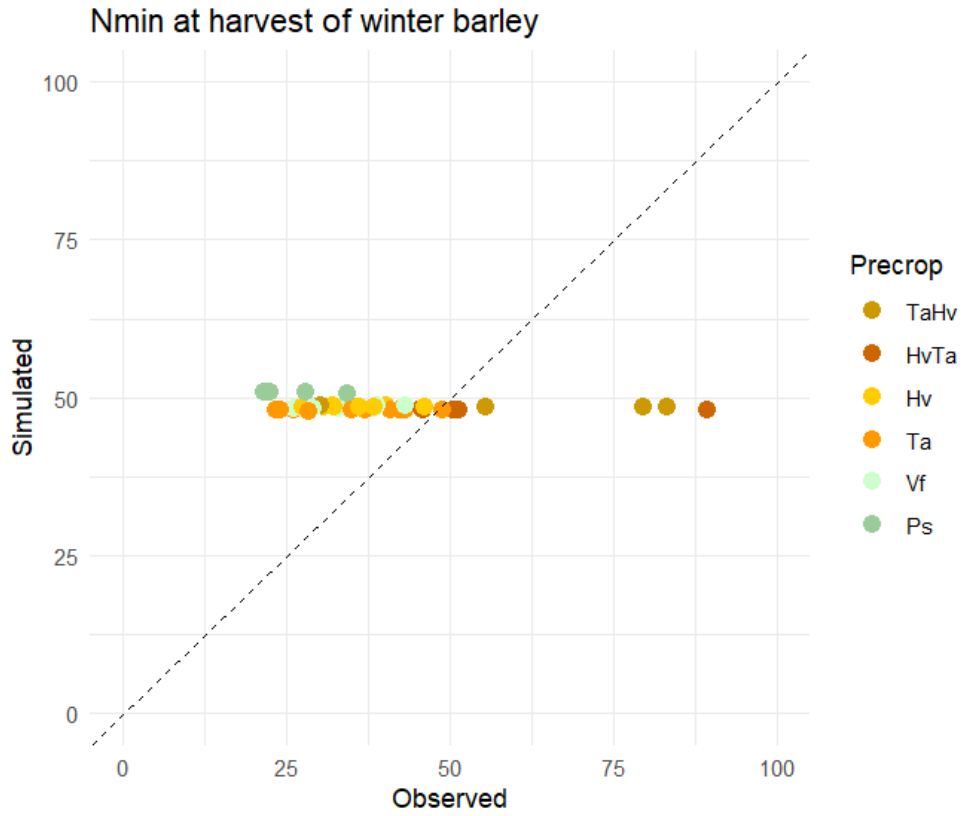




Work in progress: fit of the model

- Simulated versus observed: Nmin





How to improve model simulations?

- STICS as means of interpolation of observations
- Calibration of plant parameters (limited data)
- Reset initial values after precrop harvest
  - Better estimation of N availability?
  - BUT mineralisation of precrop residues not accounted for
- Main issue = mineral N availability

Take home messages

- Using STICS to estimate the **nitrogen effect** of legumes seems promising
- Use STICS rather as method for **interpolation**
  - Estimate mineralisation of crop residues and mineral N availability
- BUT **model performance** should improve
  - Plant file calibration (but limited data)
  - Better mineral N estimation

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