

The first calibration and evaluation of the STICS soil-crop model on chickpea-based intercropping system under Mediterranean conditions

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Context

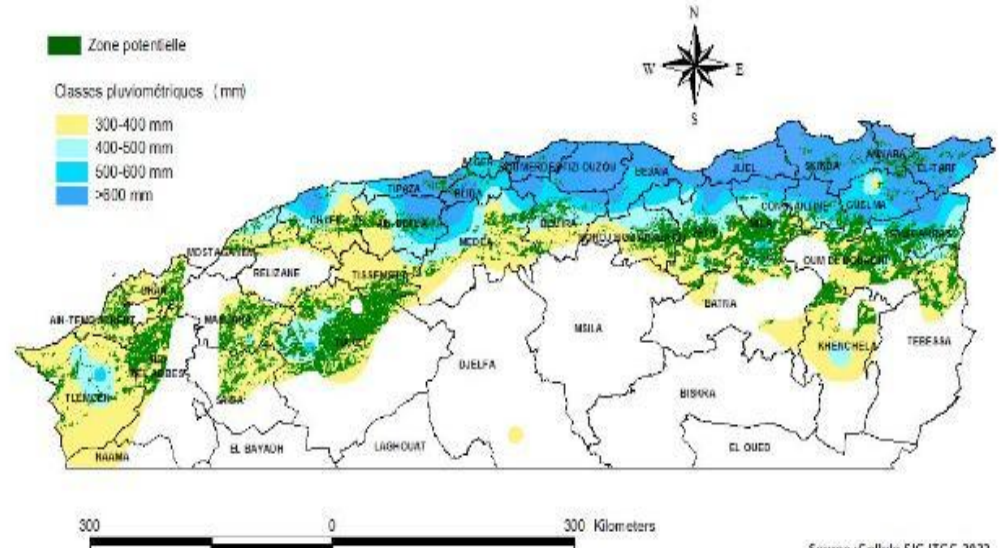
Climate and Soil

- Low and bad distribution of rainfall
- Poor N content in the soil
- High Temperatures

Agriculture practices

- Conventional Agriculture
- Cereal-Cereal Rotation (Rainfed wheat-wheat rotation)
- Low yields

Répartition de la zone potentielle des céréales par classes pluviométriques





Proposed Solutions :

Diversification of crops and cropping systems



Integration of legume crops through their intercropping with cereals



Study of intercropping through experimental trials and with models



Objective

Calibration and evaluation of the STICS crop model for durum wheat (var. Vitron) and Chickpea both in sole crop and intercropping systems.

Dataset

Experimental trial :

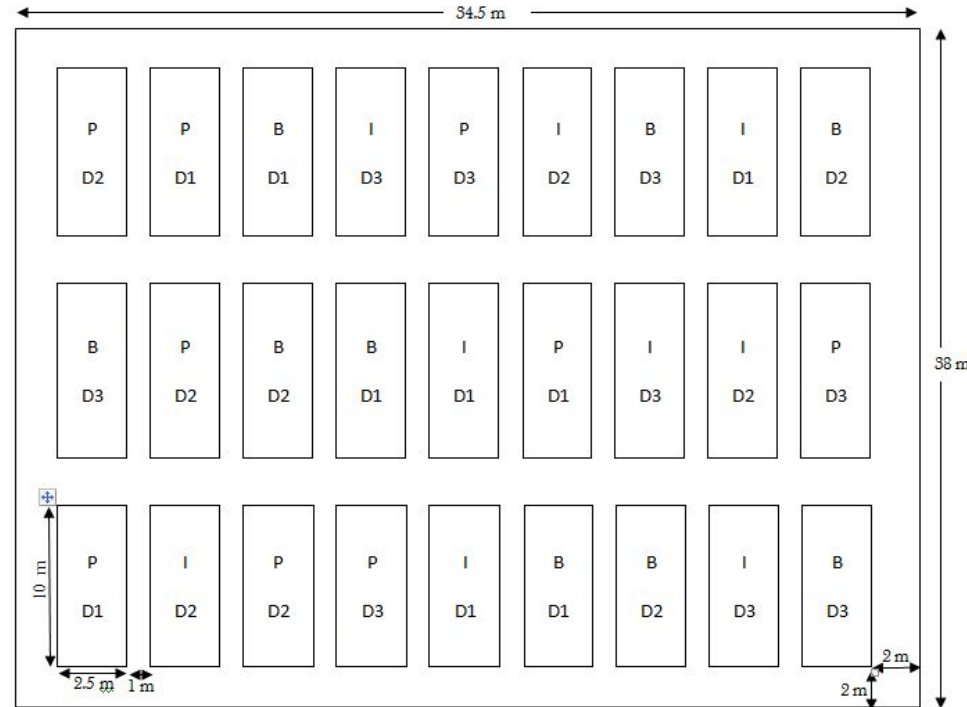
Data from 2 years experimentation (2018-2019 and 2019-2020) - Algiers (Oued Semmar - ITGC)

2 Factors :

- 3 Level of N input : N30, N60, and N100
- 3 cropping systems : Wheat monocrop (Vitron), Chickpea monocrop (FLIP 90/13 C) and their association.

Samplings : Sowing, tillering, flowering, harvest

Measured variables : LAI, biomass, yield, N uptake, soil N and water content, root depth.



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STICS overview

STICS (Simulateur multIdisciplinaire pour les Cultures Standard) is a soil-crop model which allows the simulation of sole crops and intercroppings.

Main simulated processes : Growth and development of the crop, water and N balance

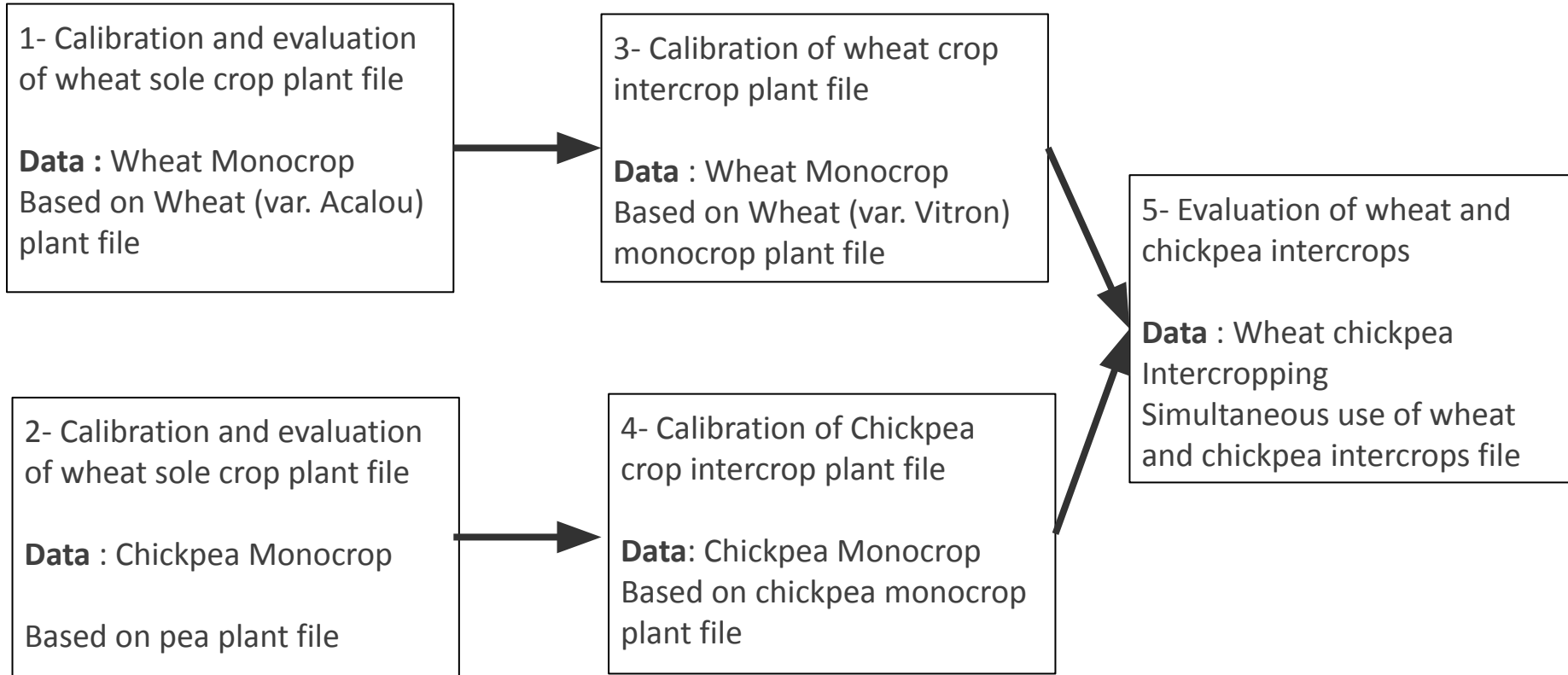


Methodology

Calibration method :

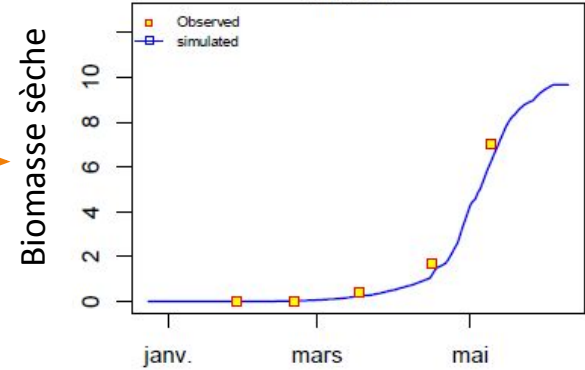
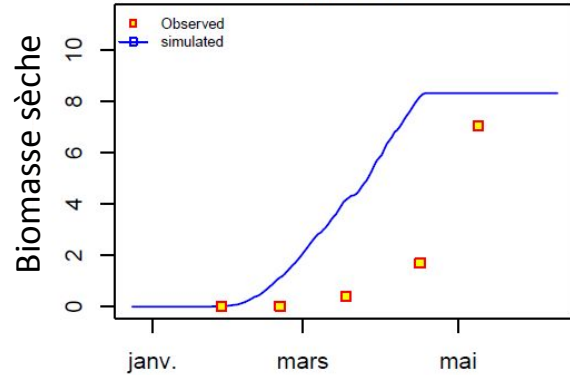
- Determination of parameter from literature or from observations and measures
- Sequential optimisation of parameters with observed variables (process by process)
- Optimisation method : simplex (JavaStics standard method)

Methodology



Evaluation

Graphic (Ex : Chickpea dry biomass before and after calibration) :



With statistical indicators :

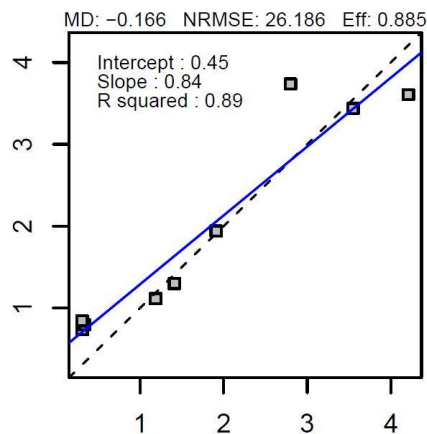
$$RMSE = \sqrt{\frac{\sum_{i=1}^N (Predicted_i - Actual_i)^2}{N}}$$

$$NRMSE = \frac{RMSE}{\bar{O}} * 100$$

$$R^2 = \left[\frac{\sum (S_i - \bar{S}_i)(O_i - \bar{O}_i)}{\sigma_S \sigma_O} \right]^2$$

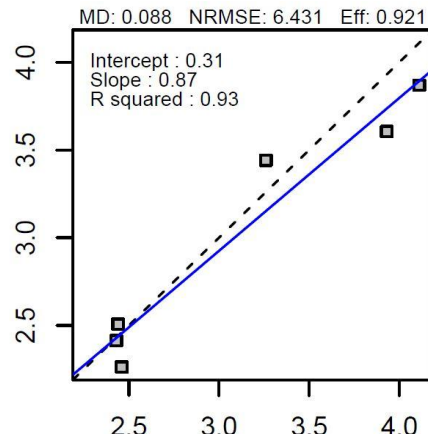
$$EF = 1 - \frac{\sum (O_i - S_i)^2}{\sum (O_i - \bar{O})^2}$$

Evaluation : Wheat Monocrop



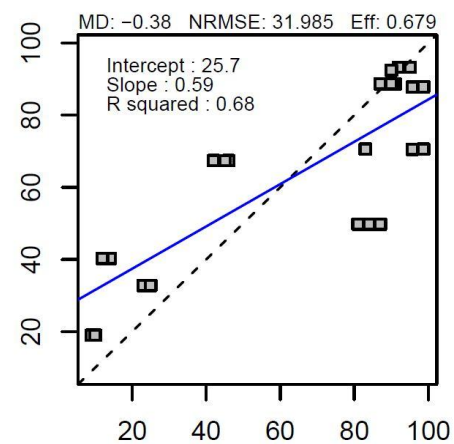
LAI
(m².m⁻²)

EF = 0,89
RMSE = 0,47
R² = 0,89



Yield
(t.ha⁻¹)

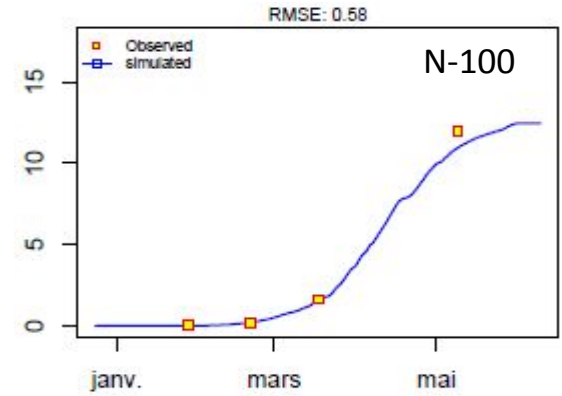
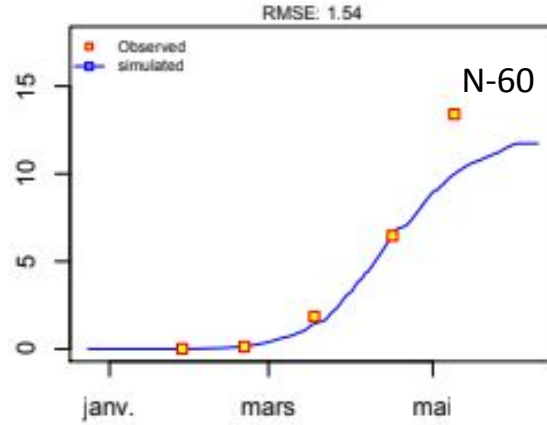
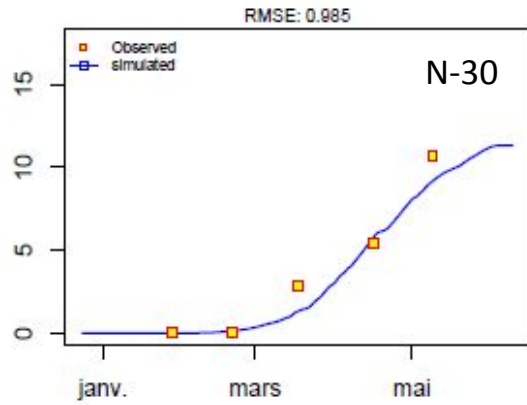
EF = 0,92
RMSE = 0,2
R² = 0,93



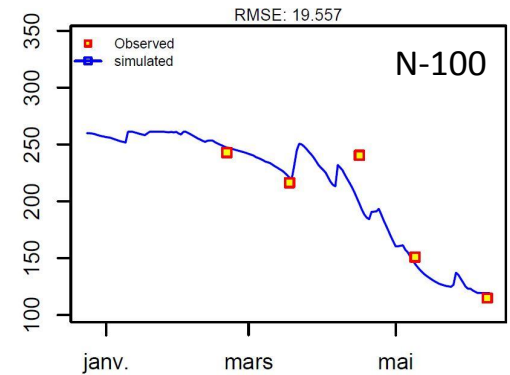
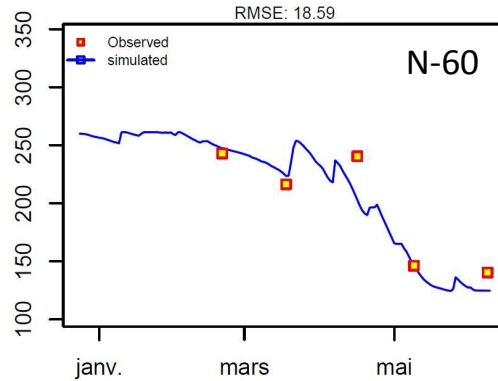
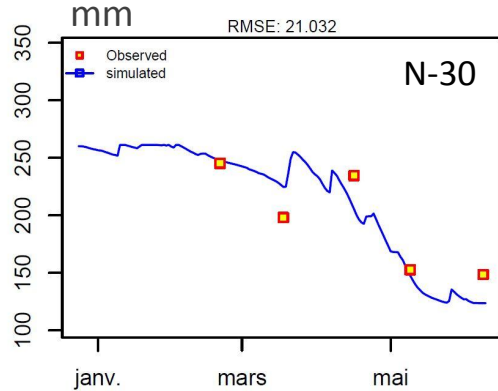
Root depth
(cm)

EF = 0,68
RMSE = 19,6
R² = 0,68

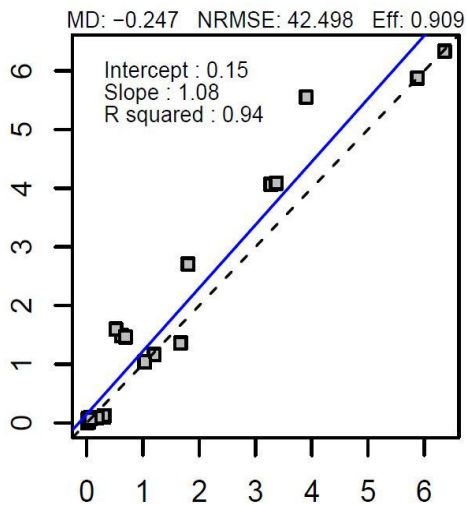
Dry biomass accumulation: t.ha⁻¹



Soil water stock dynamic (80cm): mm

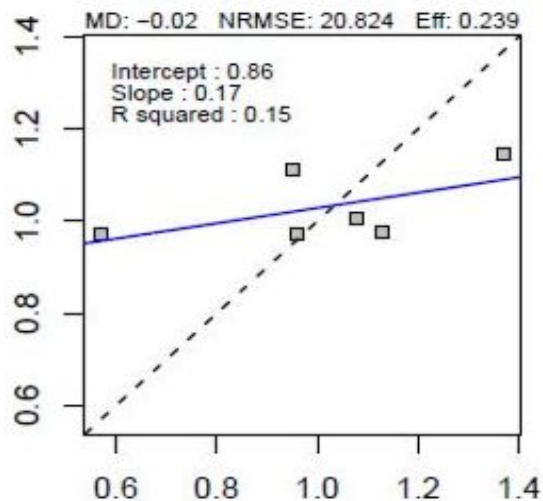


Evaluation : Chickpea monocrop



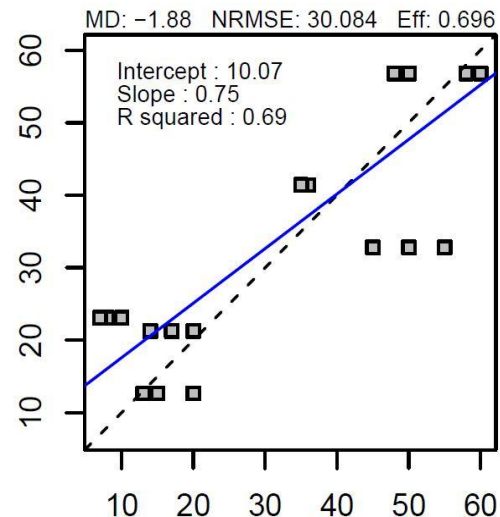
LAI
(m².m⁻²)

EF = 0,91
RMSE = 0,56
R² = 0,94



Yield
(t.ha⁻¹)

EF = 0.21
RMSE = 0.239
R² = 0.15

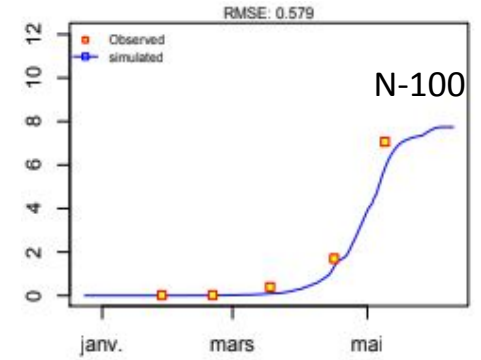
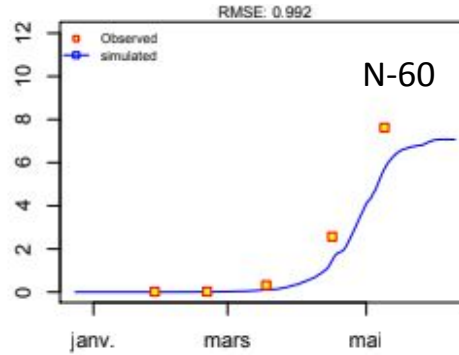
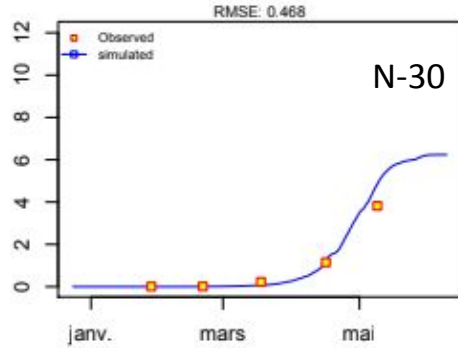


Root depth
(cm)

EF = 0,7
RMSE = 9,96
R² = 0,69

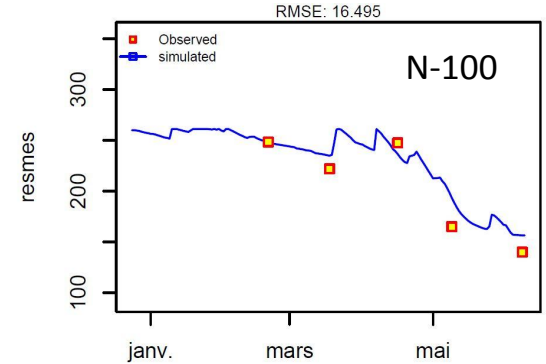
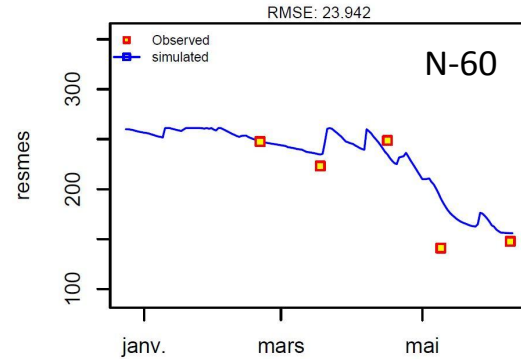
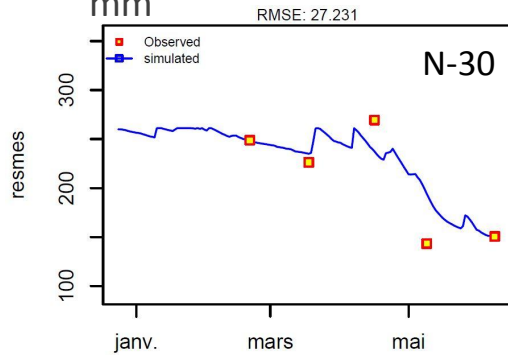
Dry biomass accumulation:

t.ha⁻¹

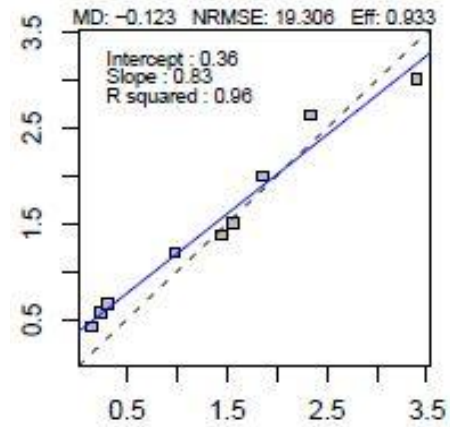


Soil water stock dynamic (80cm) :

mm

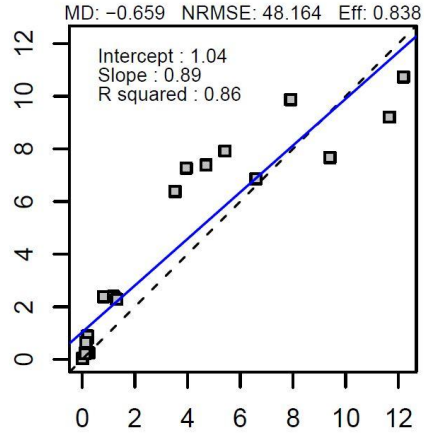


Evaluation : Wheat intercrop



LAI
($\text{m}^2 \cdot \text{m}^{-2}$)

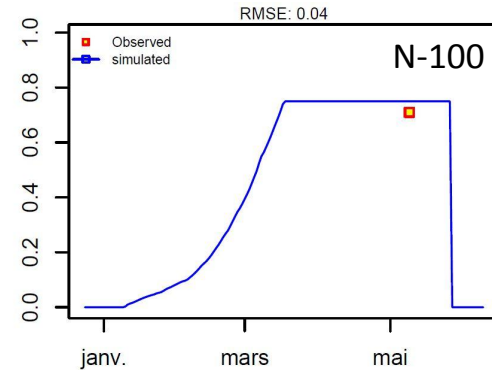
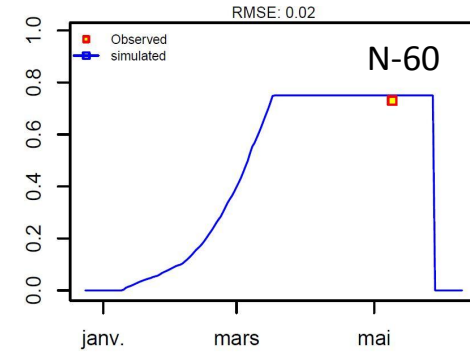
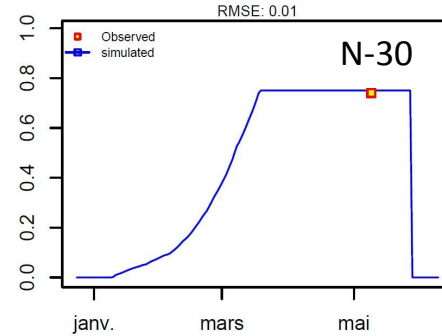
EF = 0,93
RMSE = 0,26
 $R^2 = 0,98$



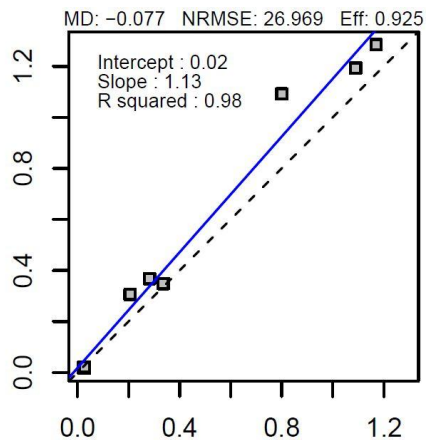
Dry Biomass
($\text{t} \cdot \text{ha}^{-1}$)

EF = 0,84
RMSE = 1,6
 $R^2 = 0,86$

Crop height (m)

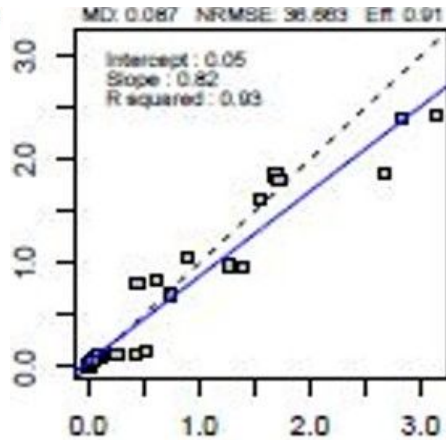


Evaluation : Chickpea intercrop



LAI
($\text{m}^2 \cdot \text{m}^{-2}$)

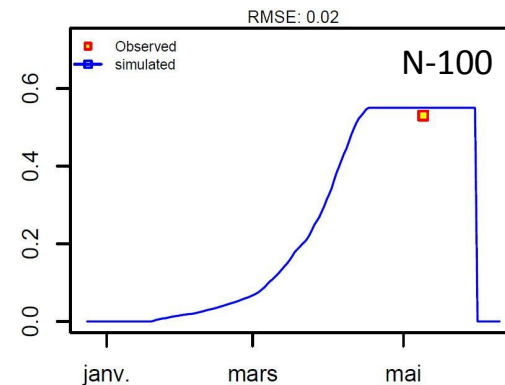
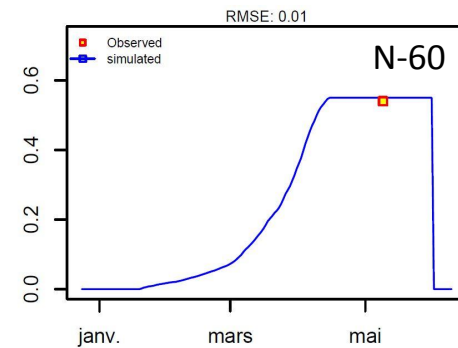
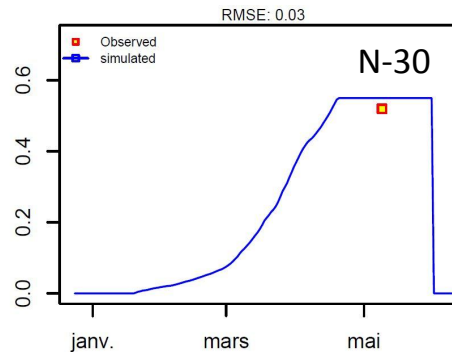
EF = 0,93
RMSE = 0,28
 $R^2 = 0,98$



Dry Biomass
($\text{t} \cdot \text{ha}^{-1}$)

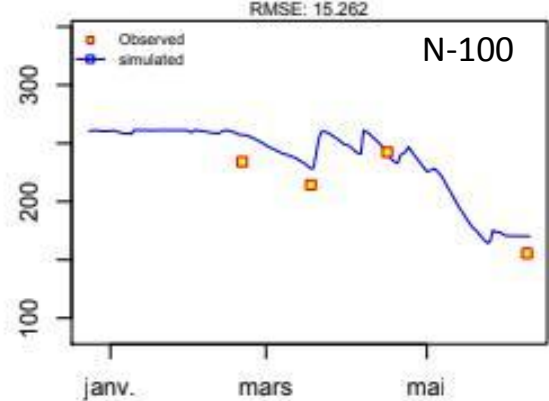
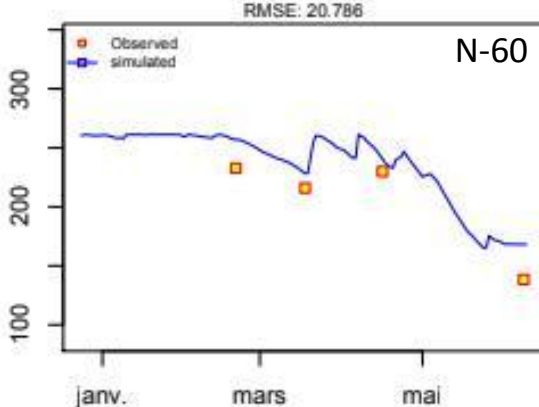
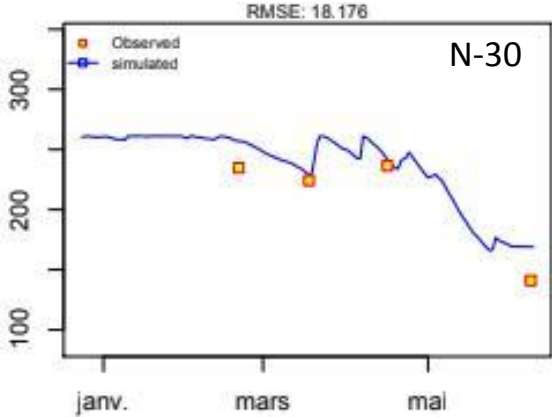
EF = 0,84
RMSE = 0.415
 $R^2 = 0.93$

Crop height (m)



Soil water stock dynamic (80cm) :

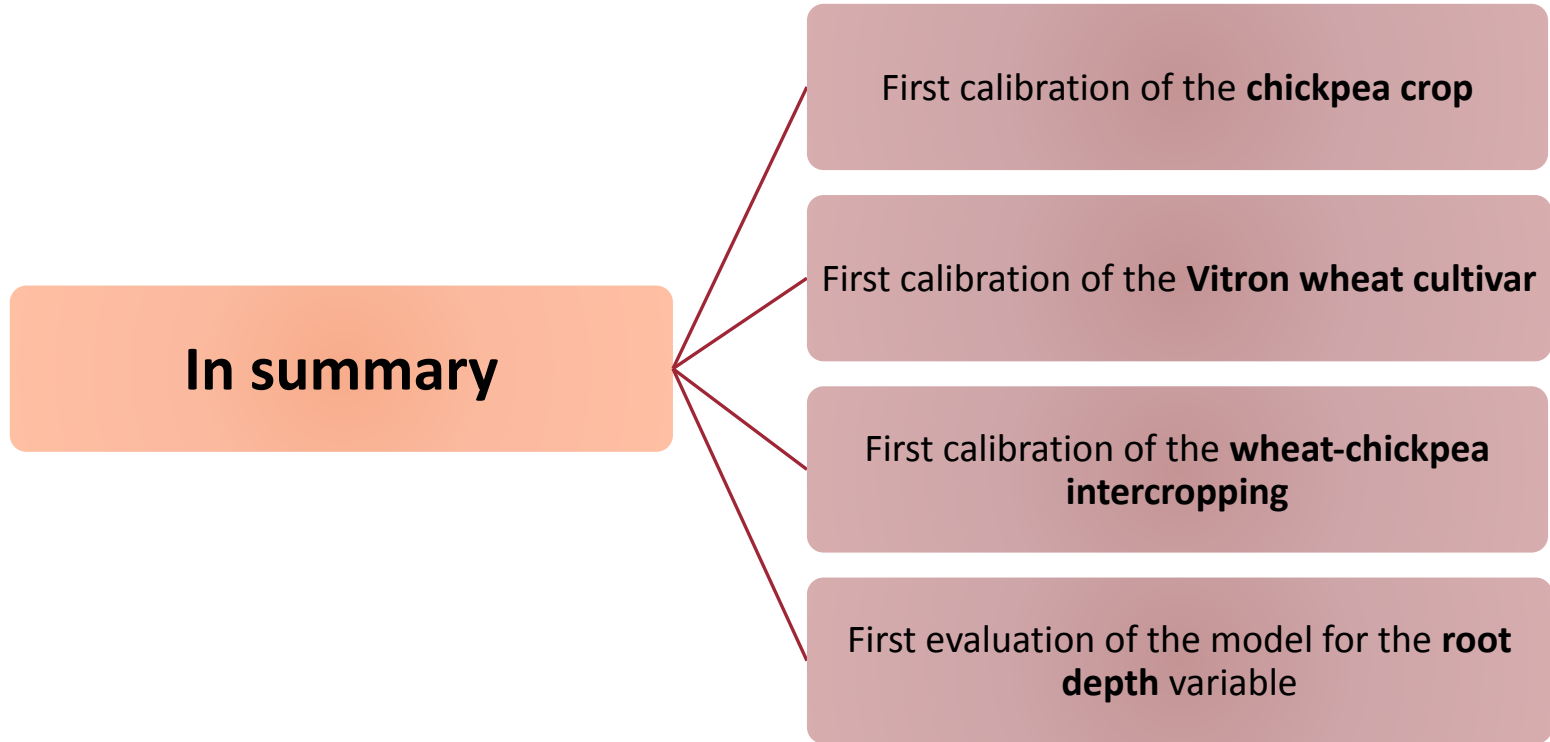
mm



Model performance

- **Good simulations of most of crop and soil variables** under a gradient of N input and contrasting meteorological conditions between the two years.
- Simulations of chickpea yield need to be enhanced in future works -> Inaccuracy partially explained by loss due to biotic stress.
- Good first evaluation of root depth.
- Good simulations of growth of both intercrops species despite **differences in height.**

Conclusion





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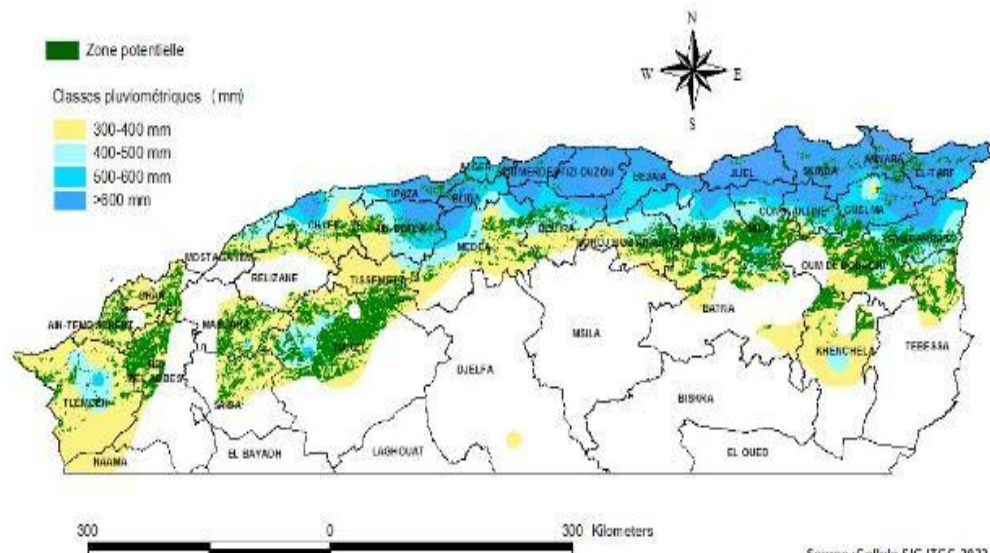
Perspectives

Validating the result and extending the domain of validity to Algerian semi-arid conditions

Calibration of new crops in Algerian conditions (pea-barley intercropping)

Testing scenarios of climate change to predict cropping system behaviour

Répartition de la zone potentielle des céréales par classes pluviométriques





Thank you for
your attention

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