



Assessment of the impact of climate change in temperate zone on grain legume yield and N₂ fixation

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Impact of climate change on grain legume yield and N₂ fixation in a temperate climate

Gatien Falconnier, Anthony Vermue, Etienne-Pascal Journet,

Laurent Bedoussac, Eric Justes





Why grain
legumes?



Objectives

- What will be the potential impact of climate change on legume performance ?
 - Faba bean (*Vicia Faba*) (winter cultivar)
 - Field Pea (*Pisum sativum*) (spring – winter cultivars)
 - = The two most widely grown legumes in Europe
- What are the factors responsible for changes in legume performance ?

Auzeville – Southwestern France

Environmental Stratification of Europe

Environmental Zone

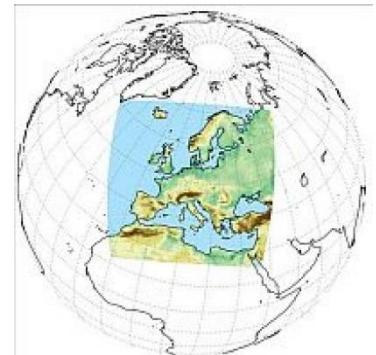
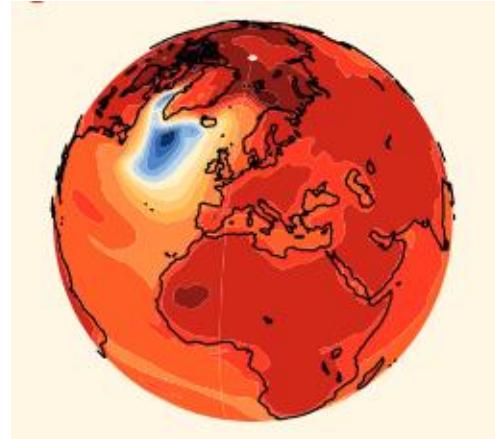
- [purple] ALN - Alpine North
- [teal] BCR - Boreal
- [light blue] NEM - Nemoral
- [blue] ATN - Atlantic North
- [pink] ALS - Alpine South
- [green] CON - Continental
- [light blue] ATC - Atlantic Central
- [dark green] PAN - Pannonian
- [light blue] LUS - Lusitanian
- [orange] ANA - Anatolian
- [brown] MDM - Mediterranean Mountains
- [yellow] MDN - Mediterranean North
- [tan] MDS - Mediterranean South



Metzger, et al (2005) *A climatic stratification of the environment of Europe*. Global Ecology and Biogeography 14, 549–563.

Climate scenarii

- Baseline : Meteorological record at Auzeville station (1995-2015)
- Mid-term (2020-2040) and long-term (2060-2080) periods
 - Two emission scenarios
 - Medium stabilization scenario « RCP 4.5 »
 - High emission scenario « RCP 8.5 »
 - 3 climate models = GCM/RCM combinations (Euro-CORDEX,
<http://www.euro-cordex.net/>)

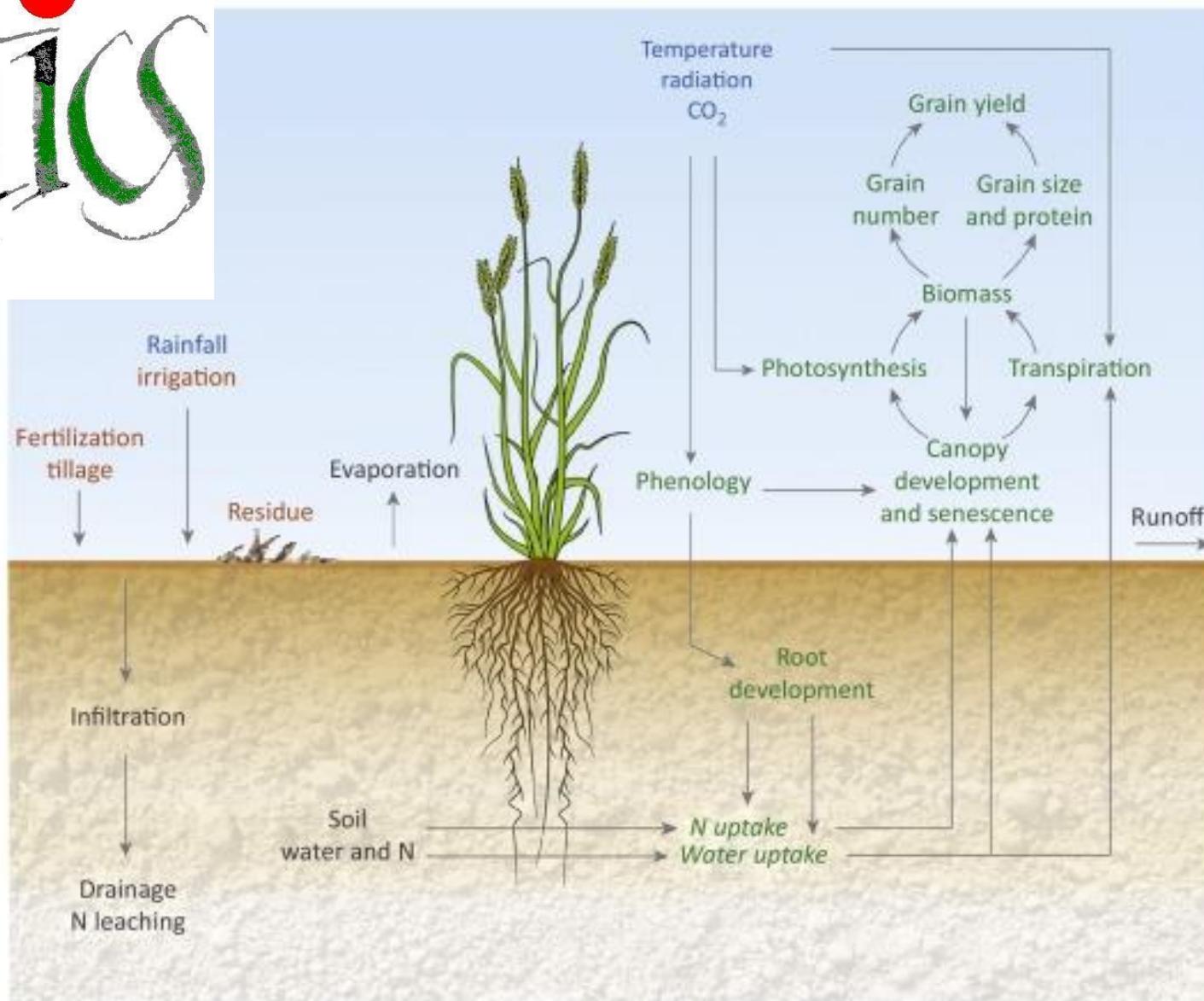


Changes in Temperature and Rainfall

- Daily average temperature (averaged across the growing season)
 - Medium emission scenario (RCP 4.5): +1°C to +2.6 °C
 - High emission scenario (RCP 8.5) : +2.4°C to +4.1 °C
- Total growing season rainfall :
 - Medium emission scenario (RCP 4.5): -4% to +5%
 - High emission scenario (RCP 8.5) : -4% to +3%

Cropping system experiments

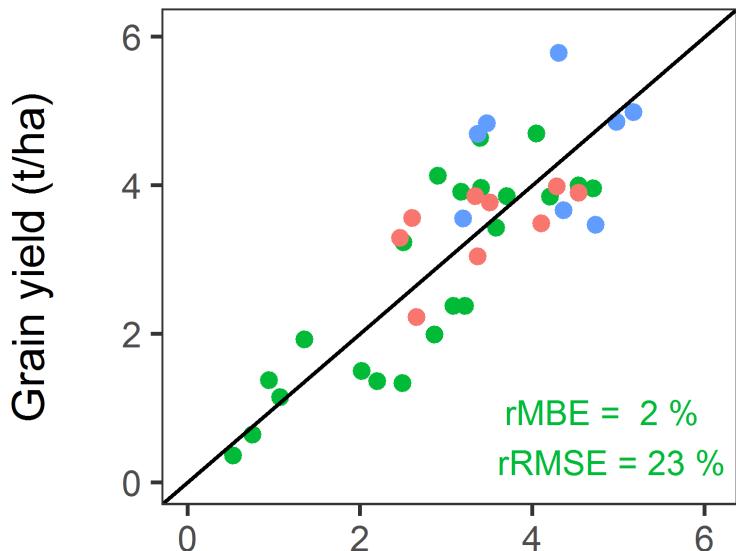




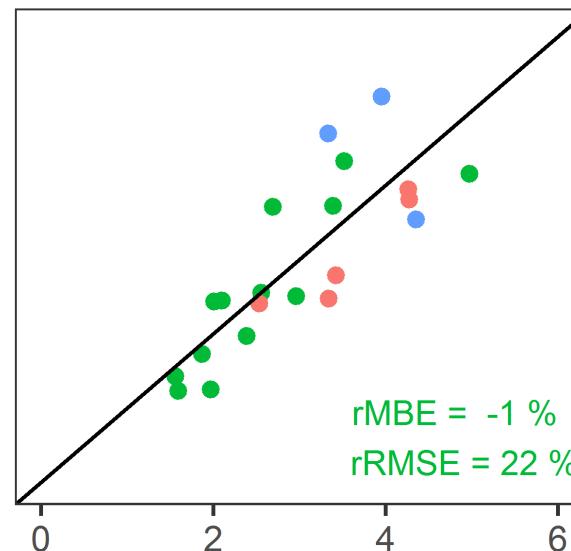
Source: Chenu et al. (2017) *Contribution of Crop Models to Adaptation in Wheat*. Trends in Plant Science 22, 472–490.

Simulated

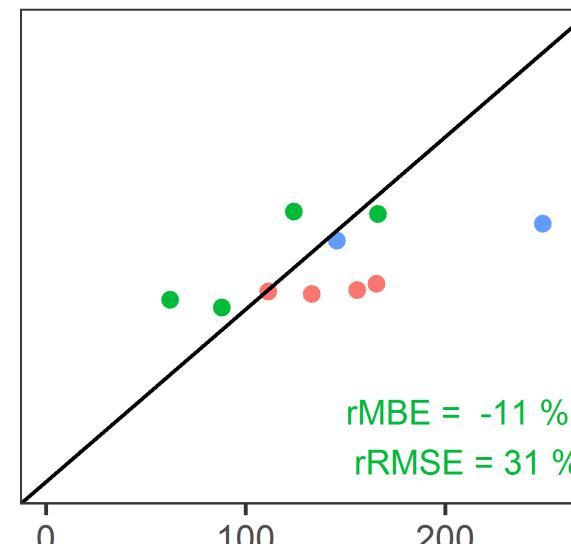
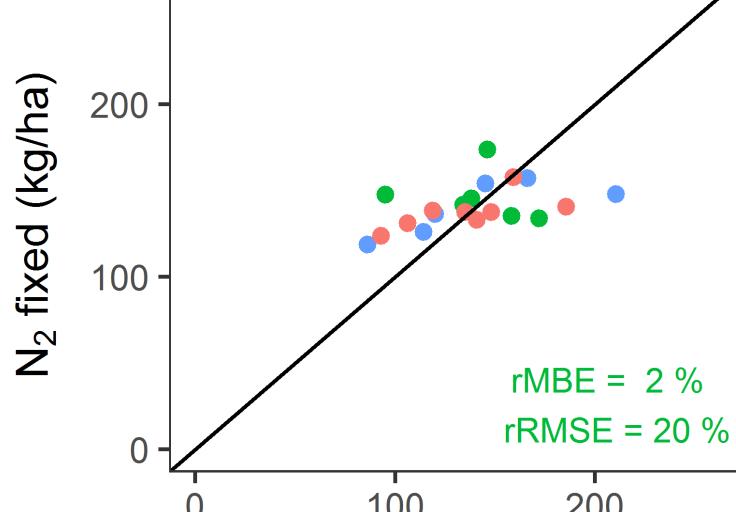
Calibration



Evaluation



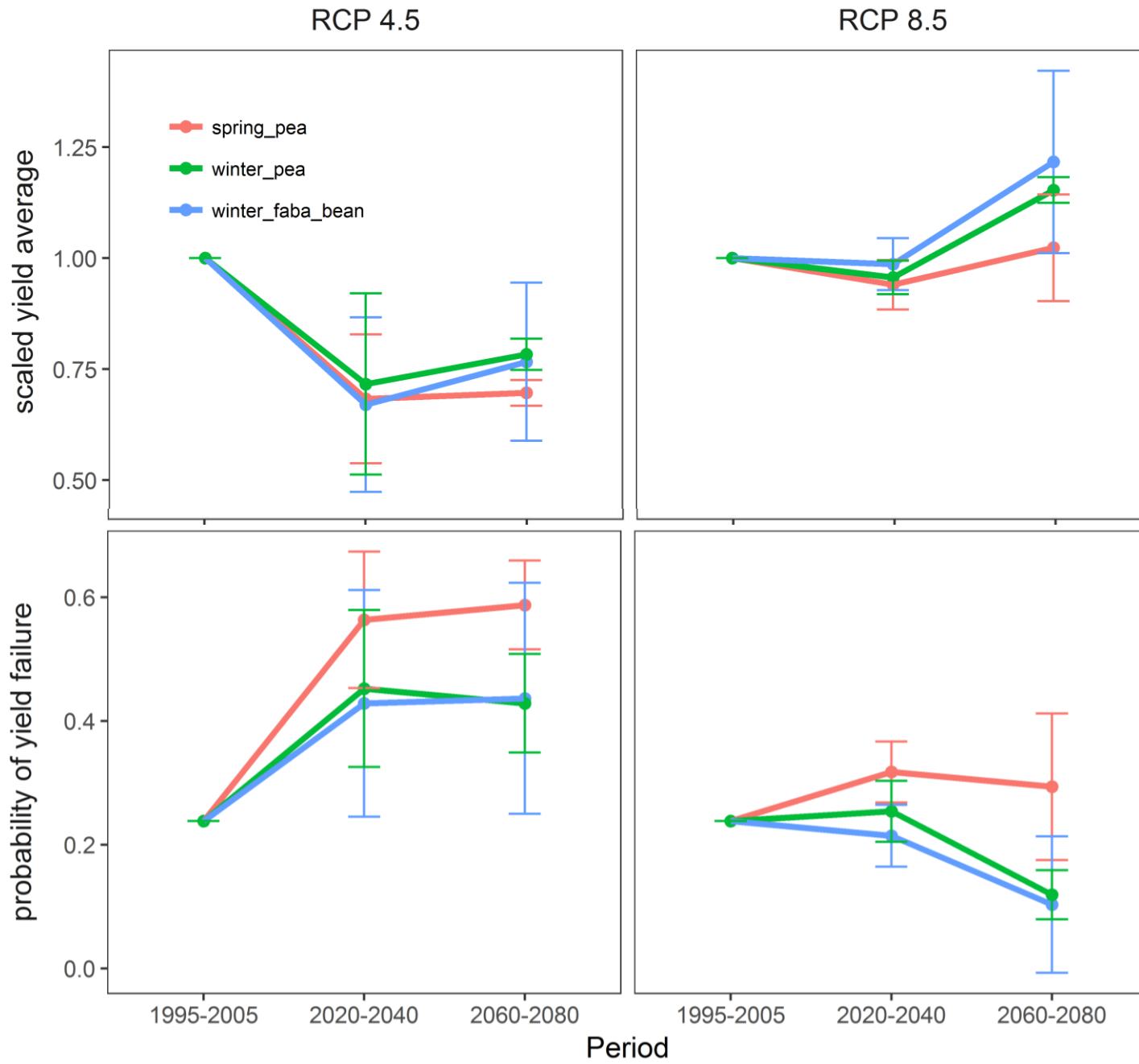
• spring pea
• winter fb
• winter pea



Falconnier et al.
Calibration and evaluation of the STICS soil-crop model for faba bean to explain variability in yield and N₂ fixation. Submitted to European Journal of Agronomy

Observed

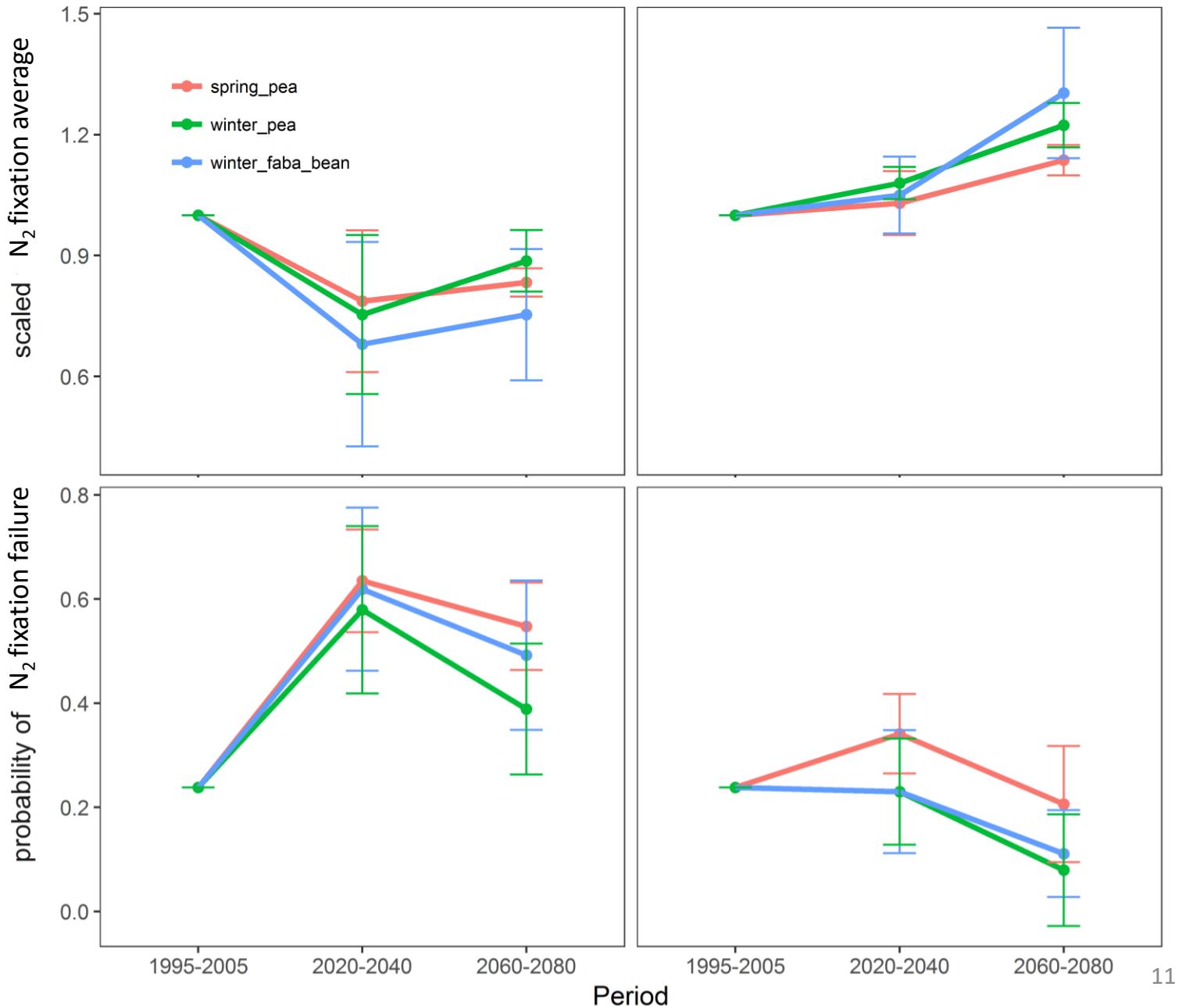
Grain Yield



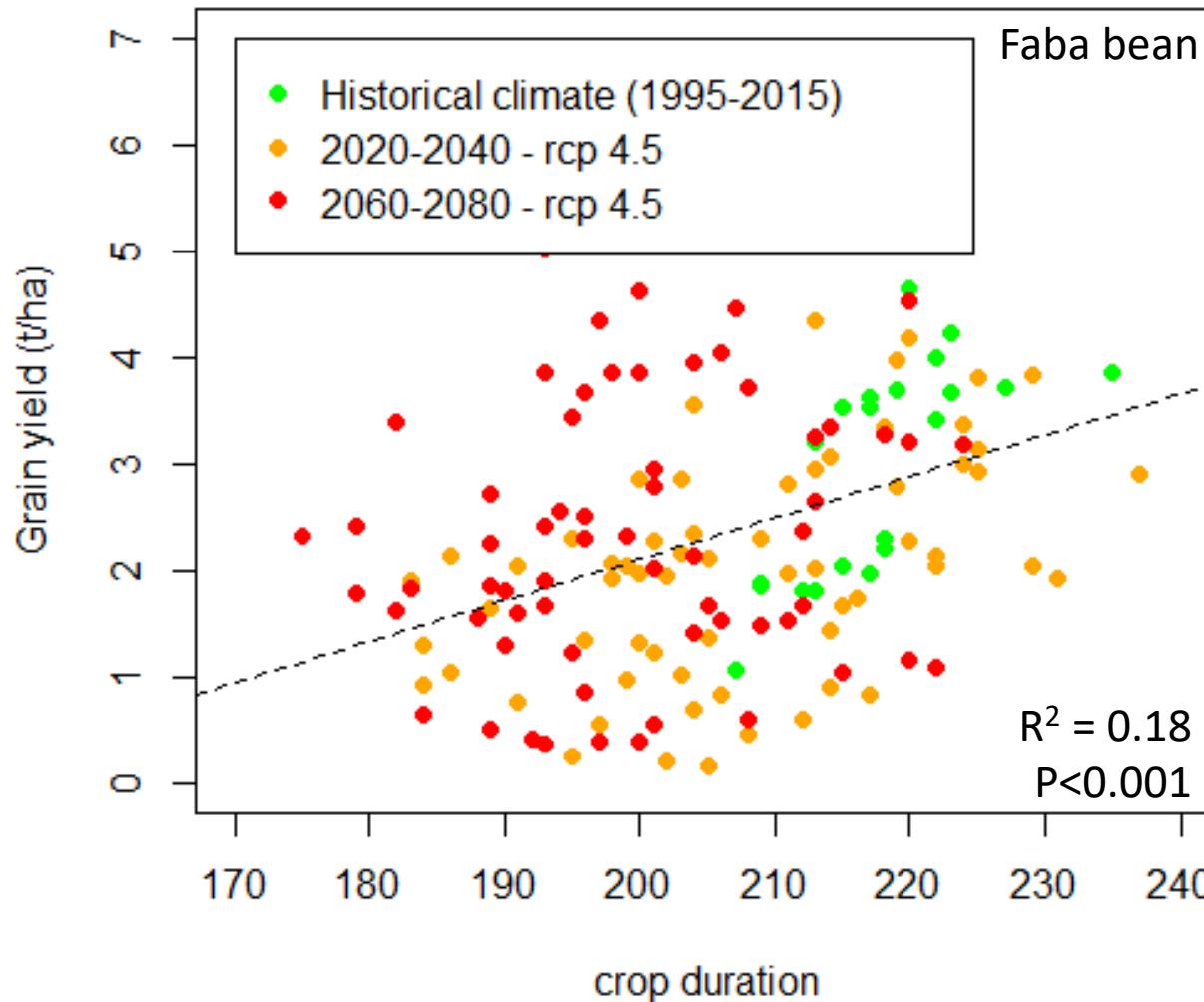
N_2 fixation

RCP 4.5

RCP 8.5

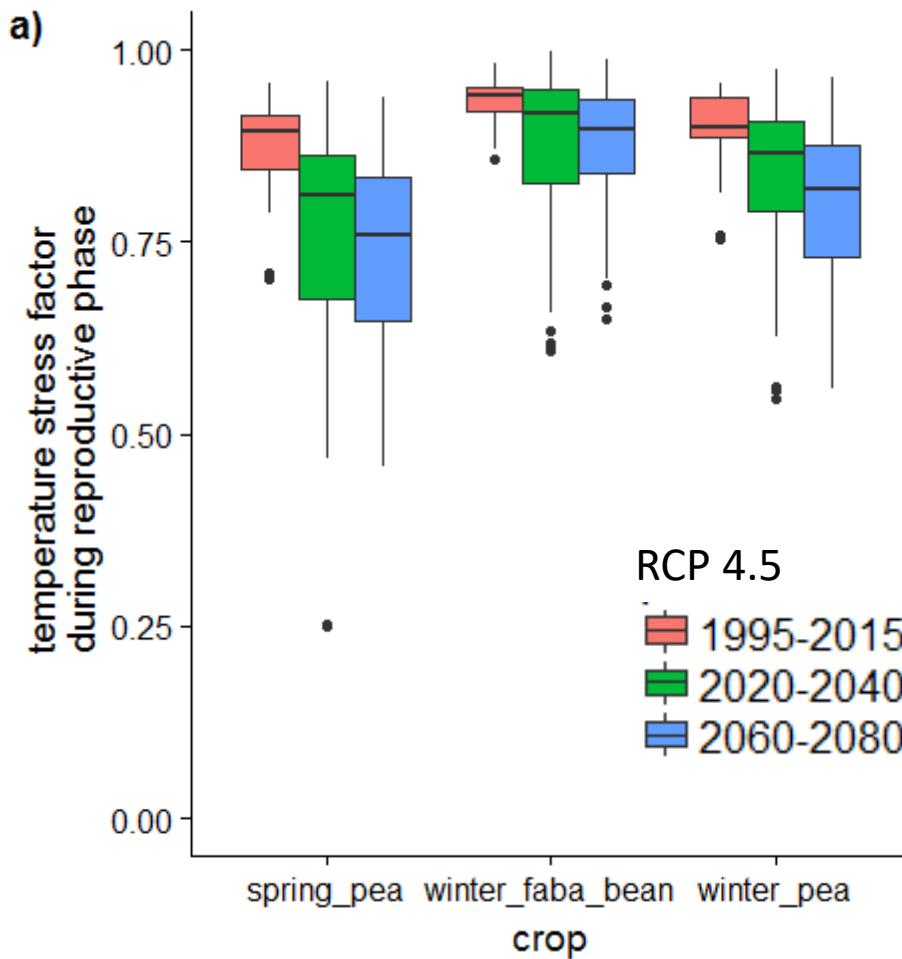


Higher temperatures reduce crop duration



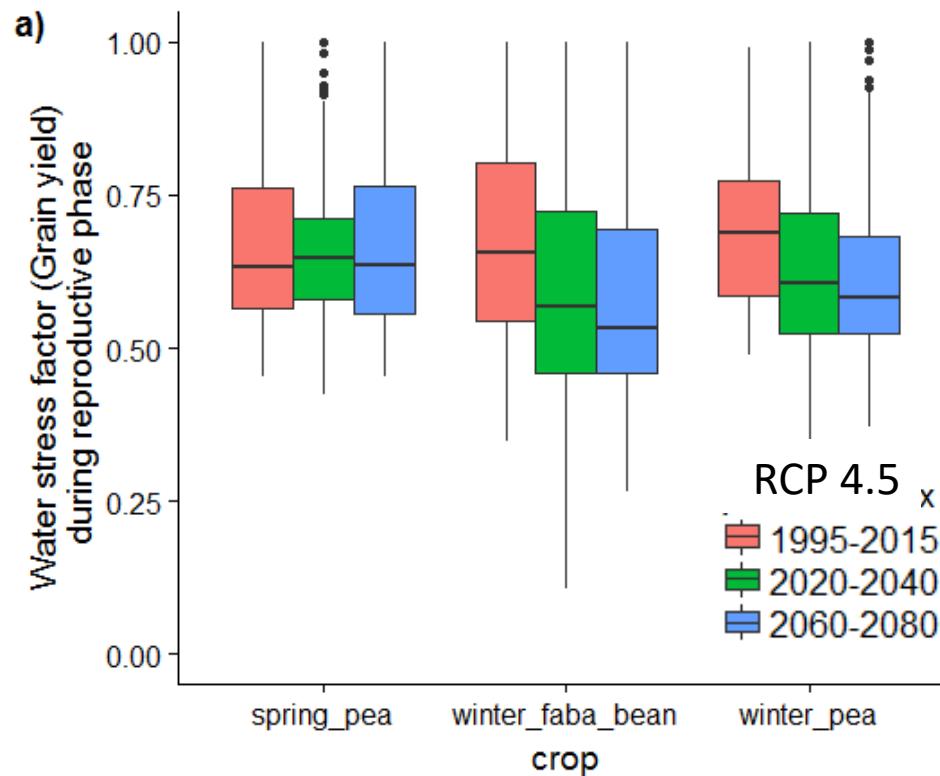
Higher temperatures reduce radiation use efficiency- interrupt grain filling

Reduction of radiation use efficiency



Water stress

Actual:maximal plant transpiration



Conclusion

- Potential impact of climate change on legume performance ?

Depend on the emission scenario

e.g faba bean a 25% decrease in N₂ fixation = 30 kg of Nitrogen loss for cropping systems.

- Main driving abiotic stresses ?

Higher temperatures : decrease in crop duration, RUE, stop grain filling

Water stress: reduces biomass accumulation and more severely nitrogen fixation

CO₂ fertilisation compensates for these stresses, but only under high emission scenario.

Thank you !

