The Importance of Multi-species Grassland Leys in Crop Rotations to Enhance Ecosystem Services

Carsten S. Malisch, Jørgen Eriksen, Ralf Loges, John A. Finn, Caroline Brophy, Olivier Huguenin-Elie

AARHUS UNIVERSITY
DEPARTMENT OF AGROECOLOGY

CARSTEN STEFAN MALISCH
TENURE TRACK ASSISTANT PROFESSOR

Few grasslands leys in EU (and even less diverse)

Grasslands leys in Europe 8% of all agricultural land
(median: 4%, range 0-48%)

Smit *et al*, (2008); 10.1016/j.agsy.2008.07.004

Reasons given by British farmers for not introducing multispecies leys

- Reduced digestibility
- Difficulty to control broadleaved weeds
- Persistence of herbs

Jordan *et al,* (2023); 10.1080/21683565.2022.2146253

Permanent grassland
© Agroscope

Grassland ley
© CAU Kiel

Aims of this presentation

- What are the best leys for multiple services and production systems?
- Are concerns towards diverse grasslands justified?
- Research needs?

Carsten S. Malisch
Jørgen Eriksen

Ralf Loges

John A. Finn

Caroline Brophy

Olivier Huguenin-Elie

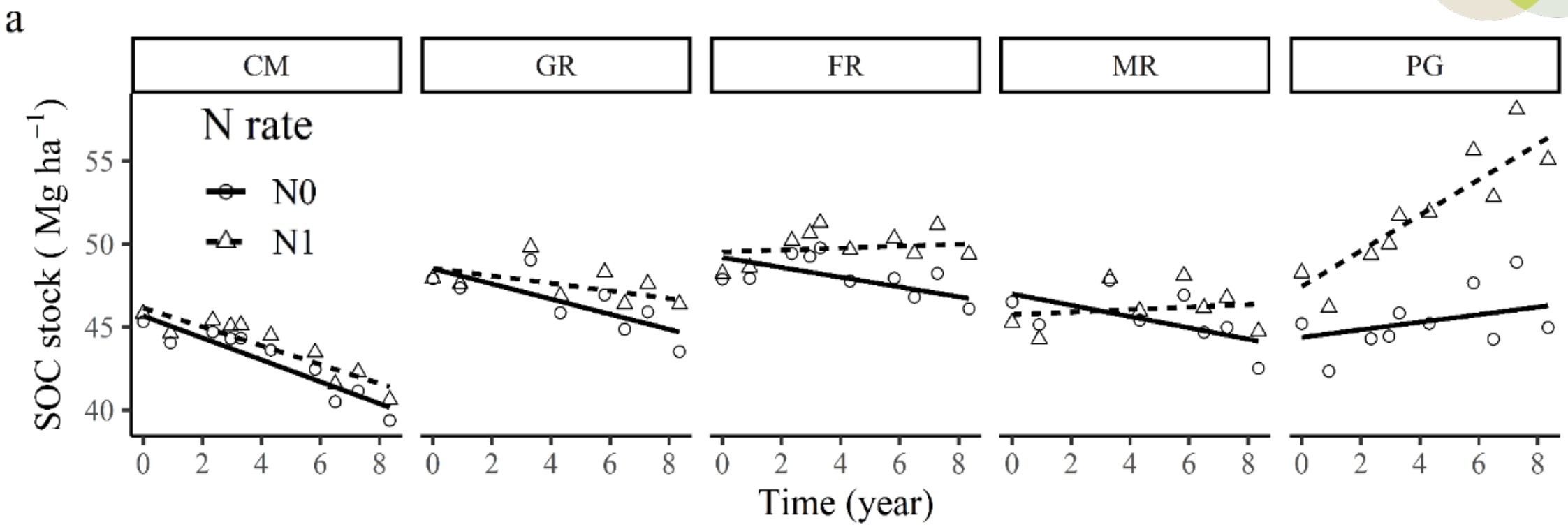
(Diverse) temporary Grasslands can provide benefits independent of production systems

Benefits for Arable systems

General benefits

Benefits for livestock / Mixed systems

Absence of grassland ley always results in C losses

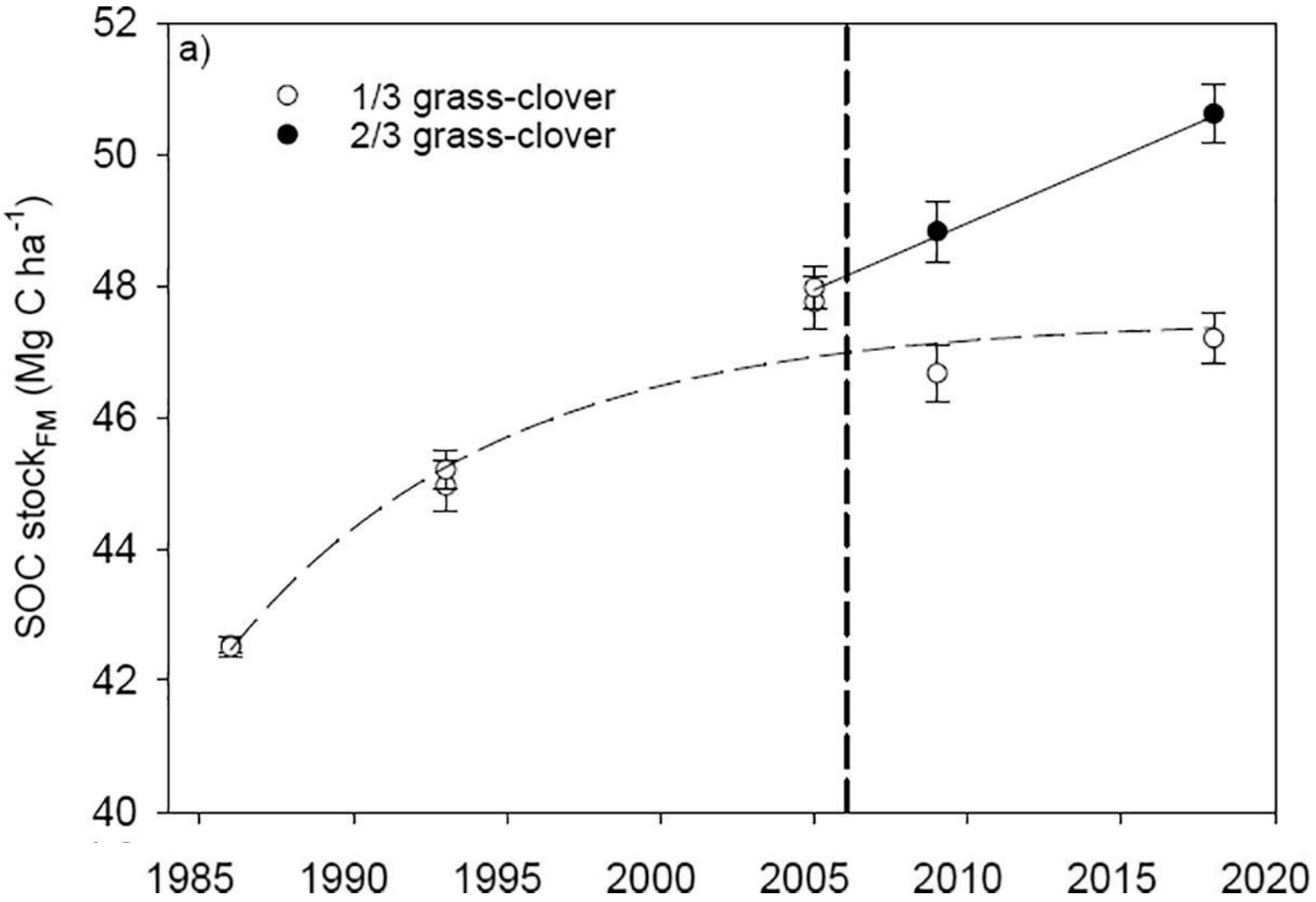


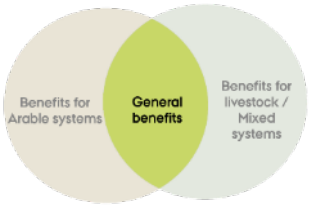
CM: Continuous silage maize
GR: Grain rotation
FR: Forage rotation (1 year ley)
MR: Mixed rotation (1 year ley)
PG: Permanent grassland

N0: unfertilized
N1: 240 kg N to non-legumes

De los Rios *et al.*, (2022); 10.3390/agronomy12020338

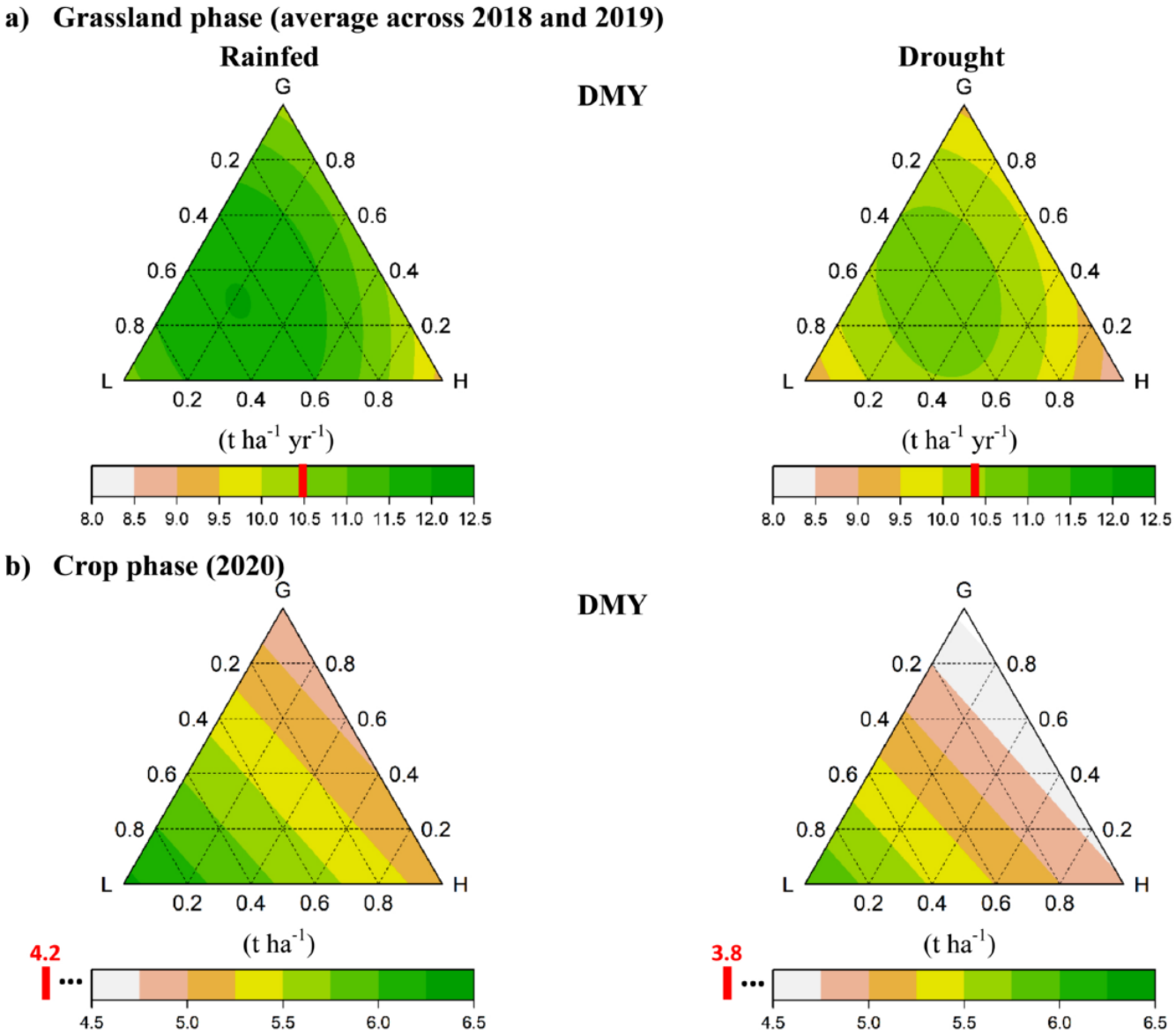
Increased ley duration is directly linked to higher SOC stocks

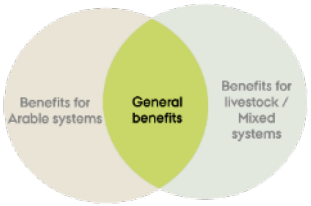




Jensen *et al.*, 2022;
10.1016/j.geoderma.2022.116022

Increasing ley species richness increases yields and yield stability

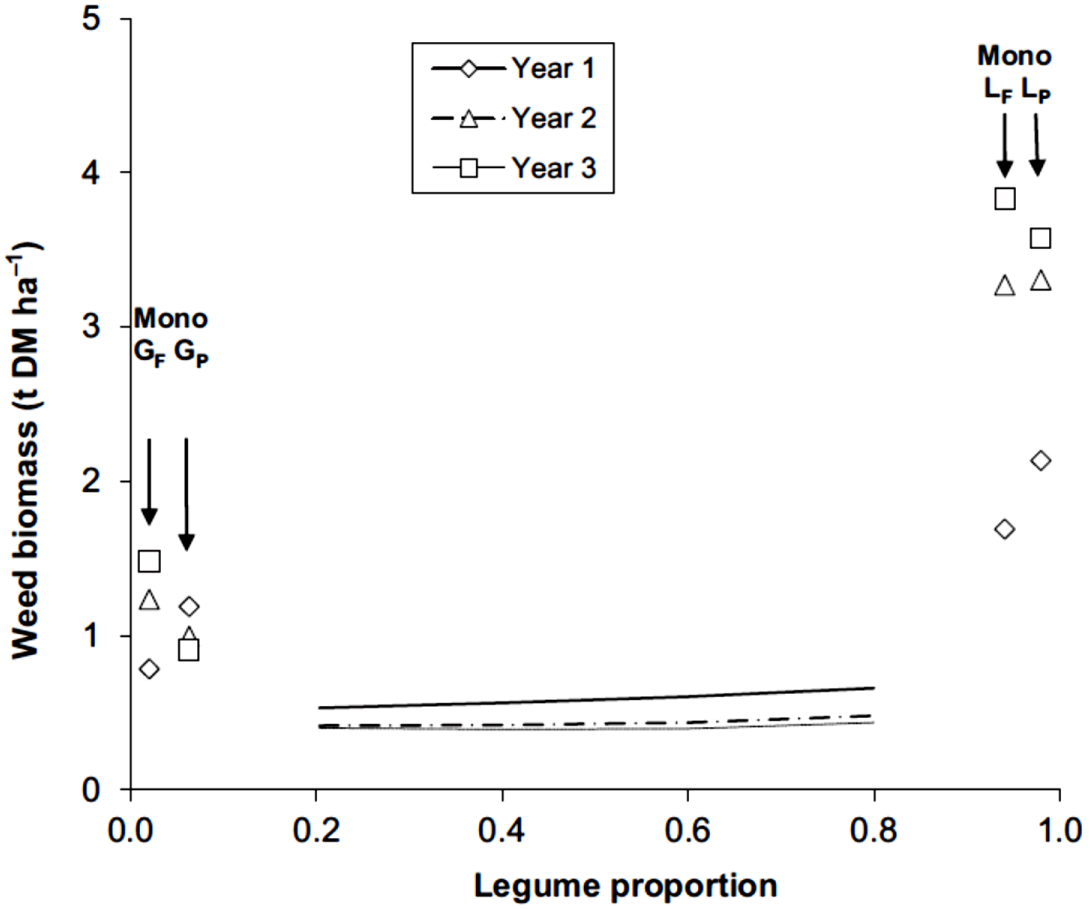




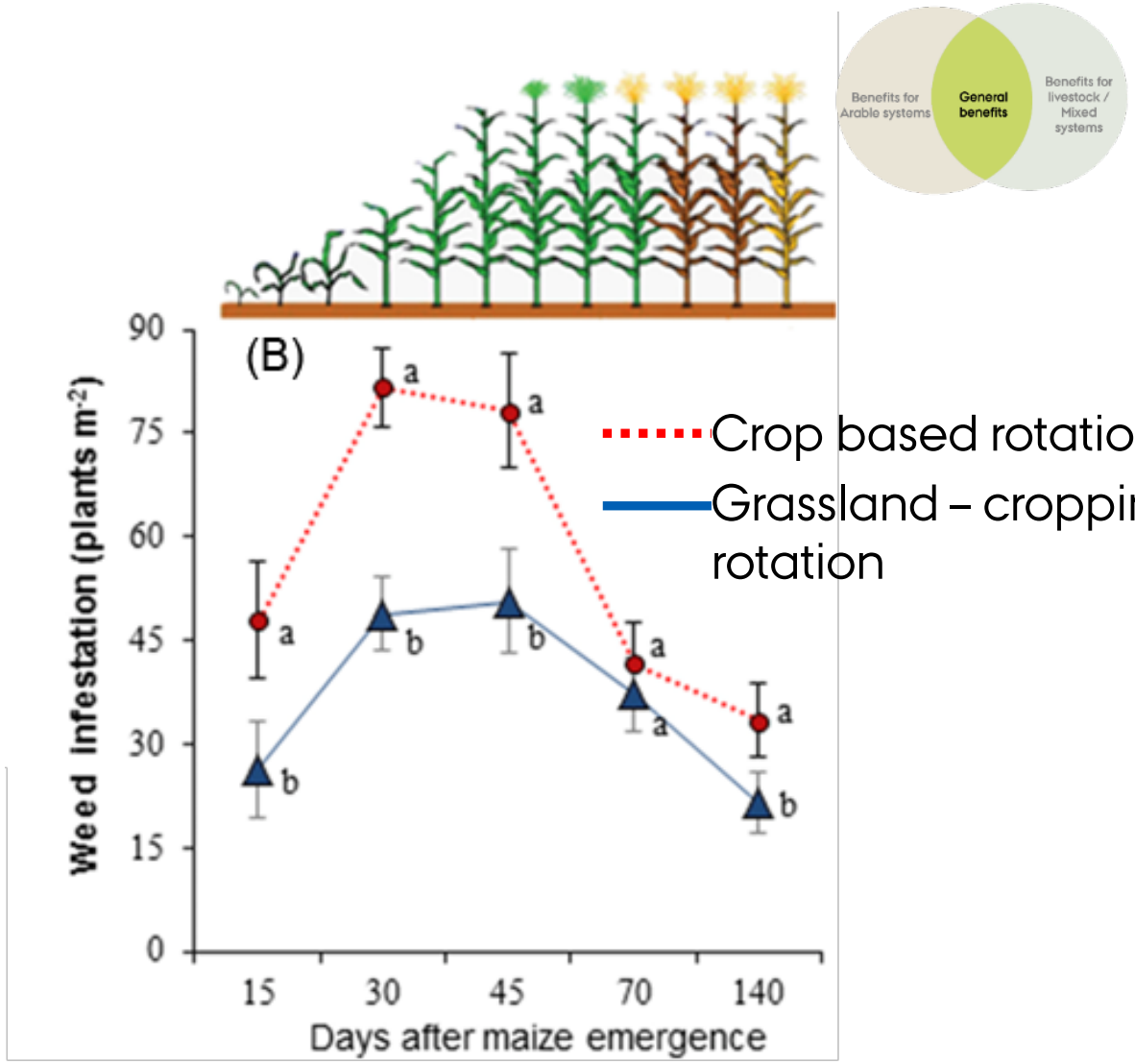
Multispecies ley under drought © Loges

Grange *et al.*, 2022; 10.1016/j.eja.2022.126531

Weed suppression is enhanced by grassland leys in crop rotation

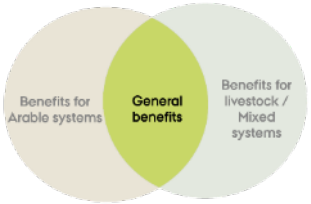


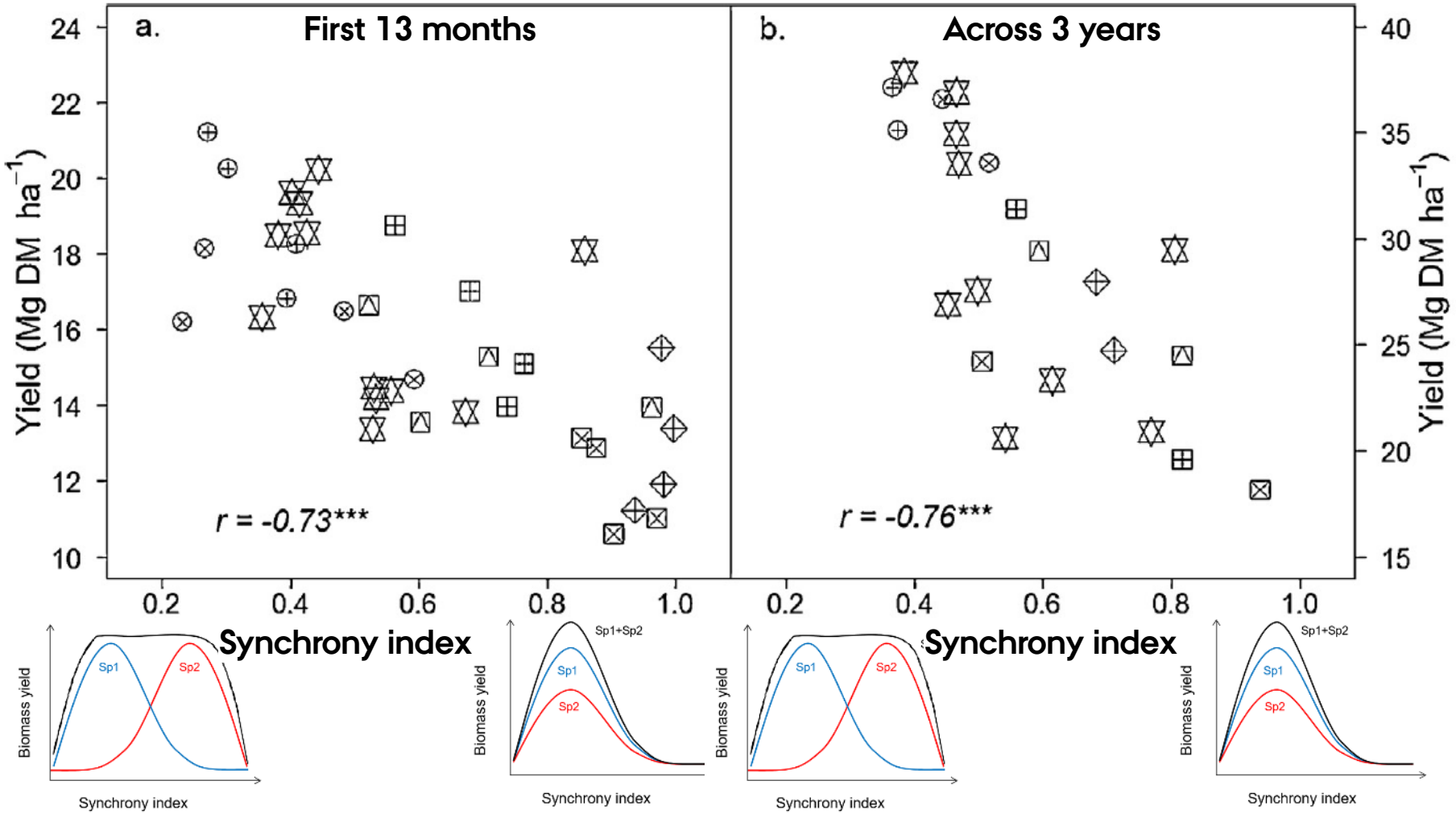
Connolly *et al.*, 2018;
10.1111/1365-2664.12991



Dominschek *et al.*, 2021;
10.1016/j.jclepro.2021.127140

Asynchrony as tool to increase persistence by reducing autocompetition?

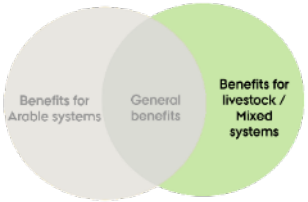




- *L. perenne – C. intybus*
- *L. perenne – T. repens*
- *L. perenne – T. pratense*
- *C. intybus – T. repens*
- *C. intybus – T. pratense*
- *T. repens – T. pratense*
- 4 species mixture

Husse *et al*. (2016); 10.1016/j.fcr.2016.04.021

Increasing species richness improves milk yields in Jersey cows

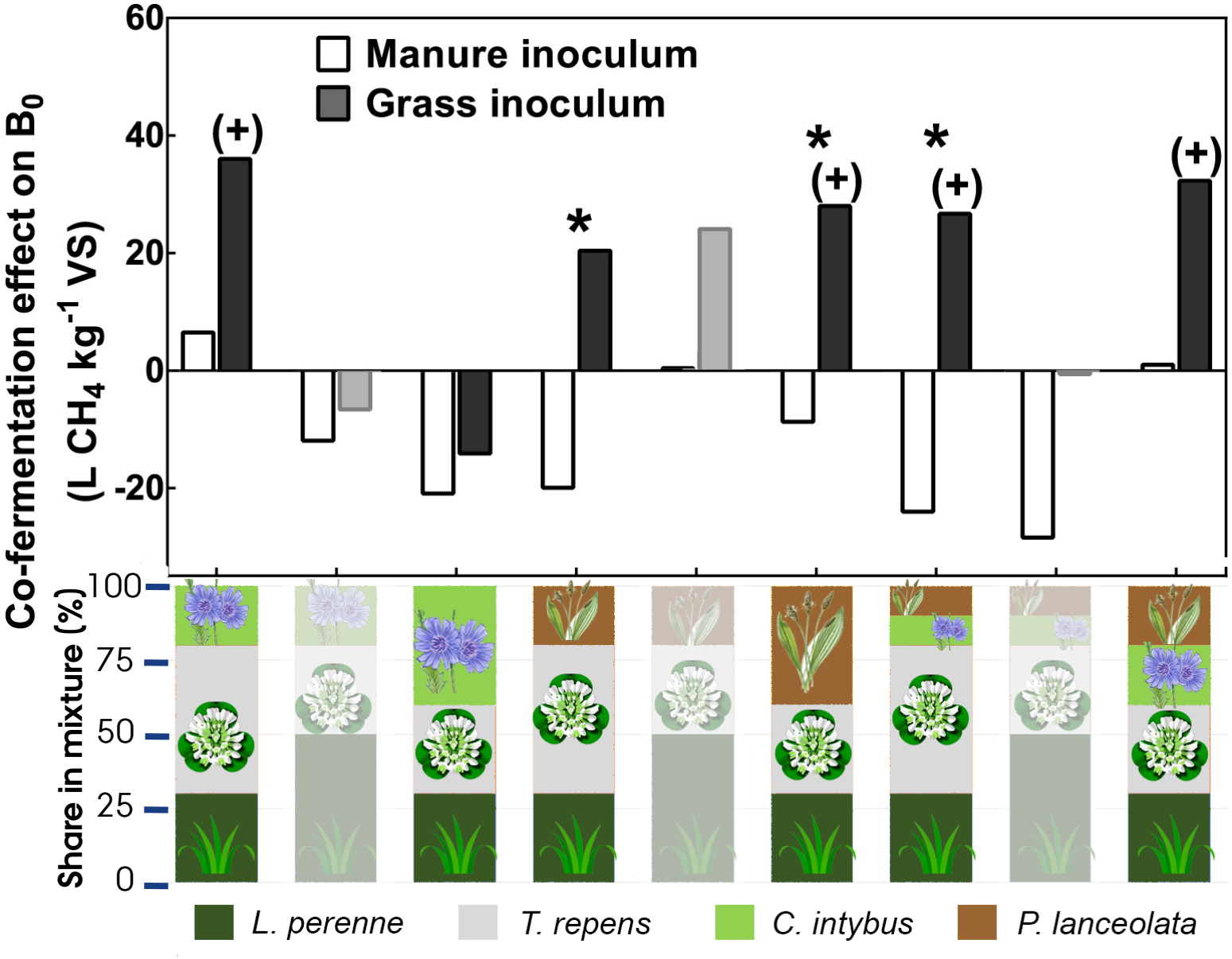


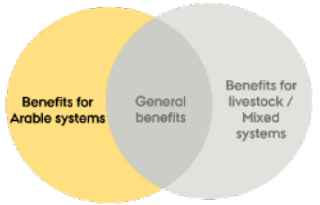
	2-18 May 2019		15-30 August 2019	
	Binary	Diverse	Binary	Diverse
Days in milk	49	49	154	154
Energy (MJ ME kg DM^{-1})	12.5 (0.0) Aa	12.1 (0.0) Ba	11.3 (0.1) Ab	11.1 (0.1) Bb
OM digestibility (%)	87 (0.2) Aa	84 (0.2) Ba	80 (0.4) Ab	77.9 (0.4) Bb
Dry matter uptake (kg day^{-1})	13	15	11	13
Milk yield (kg ECM cow^{-1} day^{-1})	29.4 (0.9) Ba	30.3 (1.0) Aa	22.1 (0.6) Bb	23.5 (0.6) Ab

A,B: Differences between treatments
a,b: Differences between measurement periods

Loza et al, 2021;
10.3390/agriculture11020175

Methane formation in Biogas plants is enhanced if herbs are co-fermented

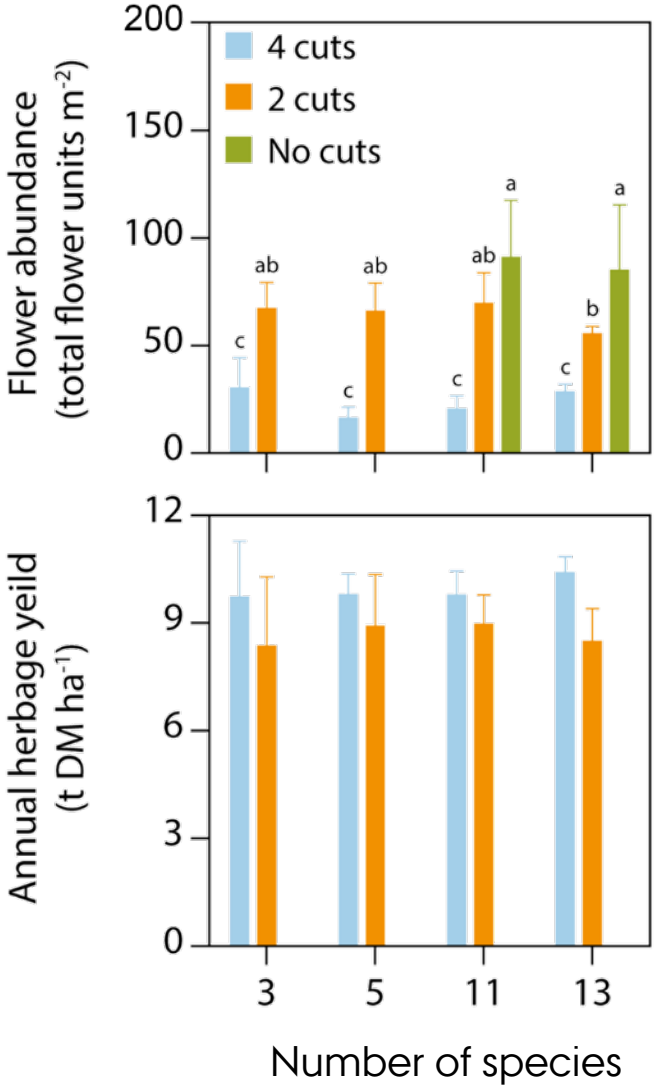


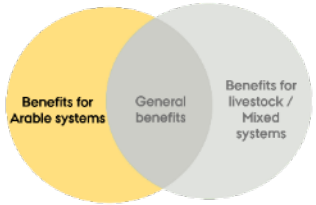


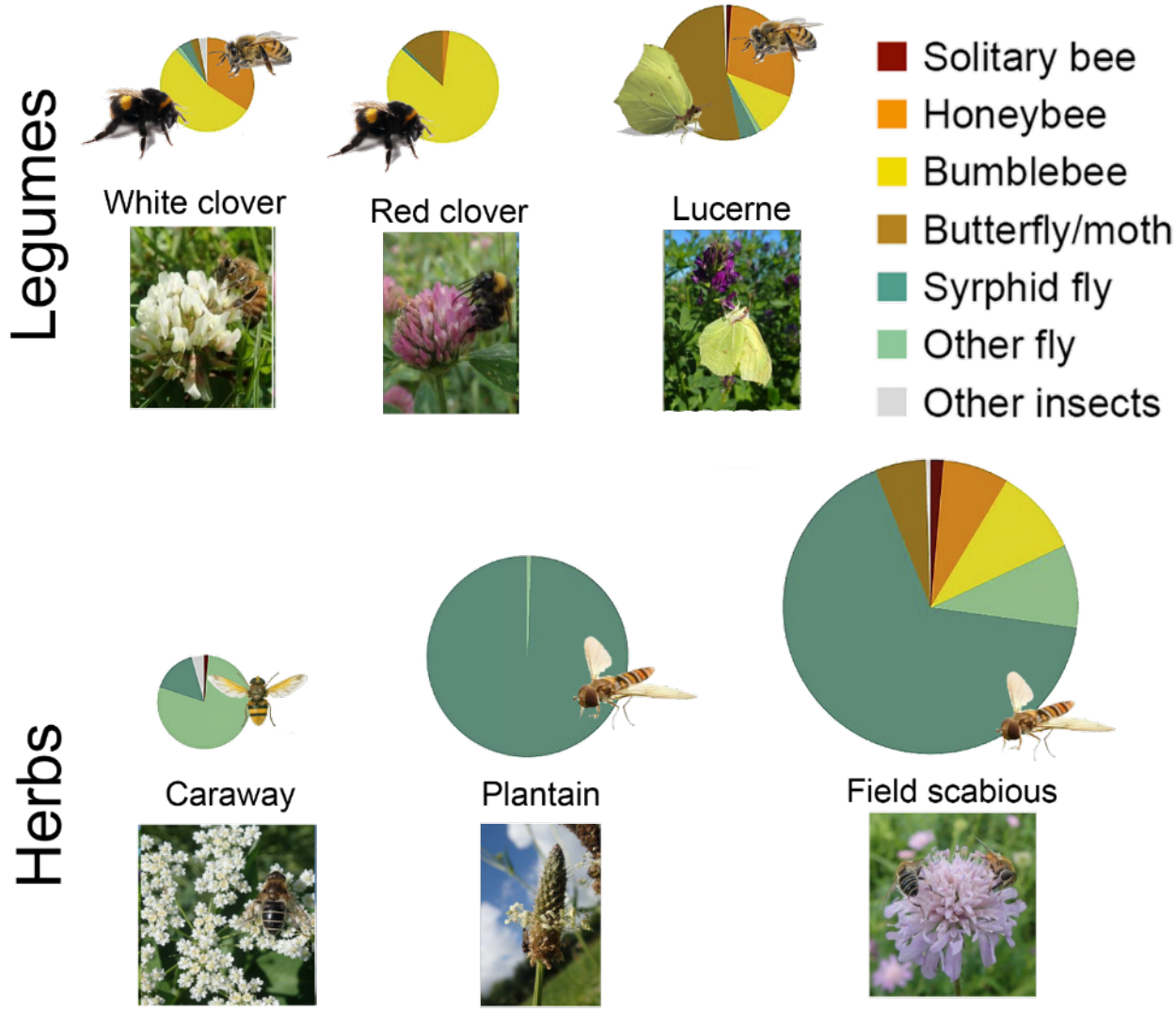
Dark bars: 30% grass in mixture
Light bars: 50% grass in mixture

Cong et al. (2018);
10.1016/j.biombioe.2018.09.009

Less cuts increase flowering with low yield reduction

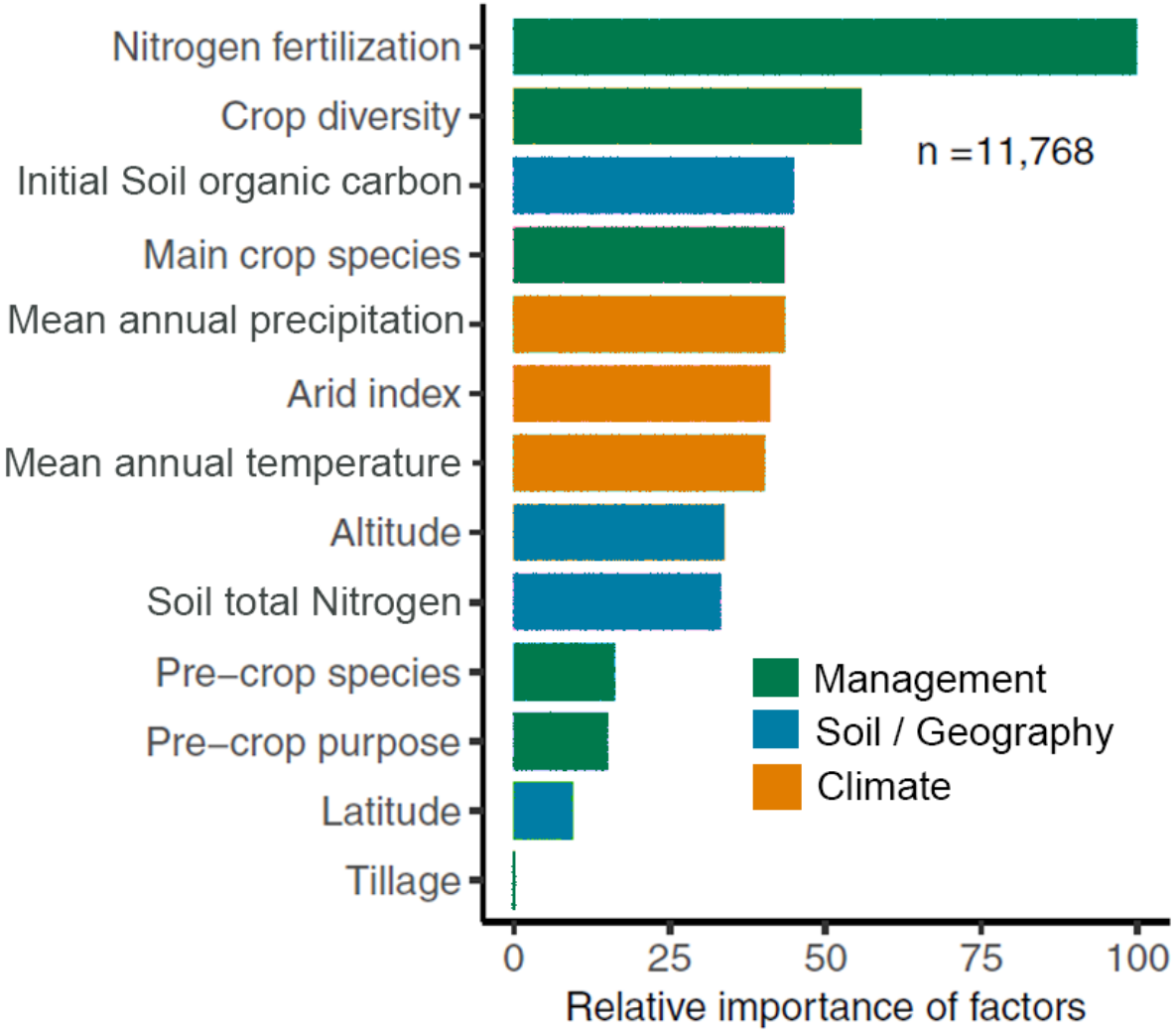


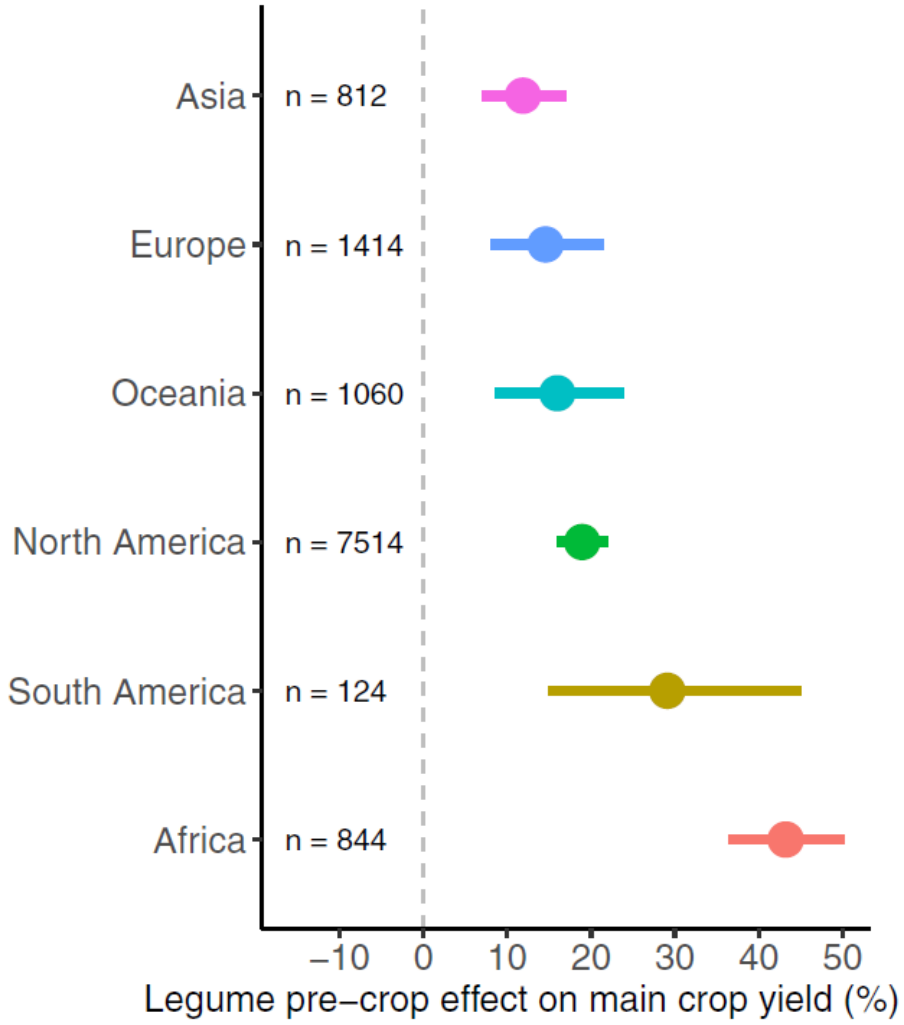




Cong et al, 2020, 10.1016/j.agee.2020.107062

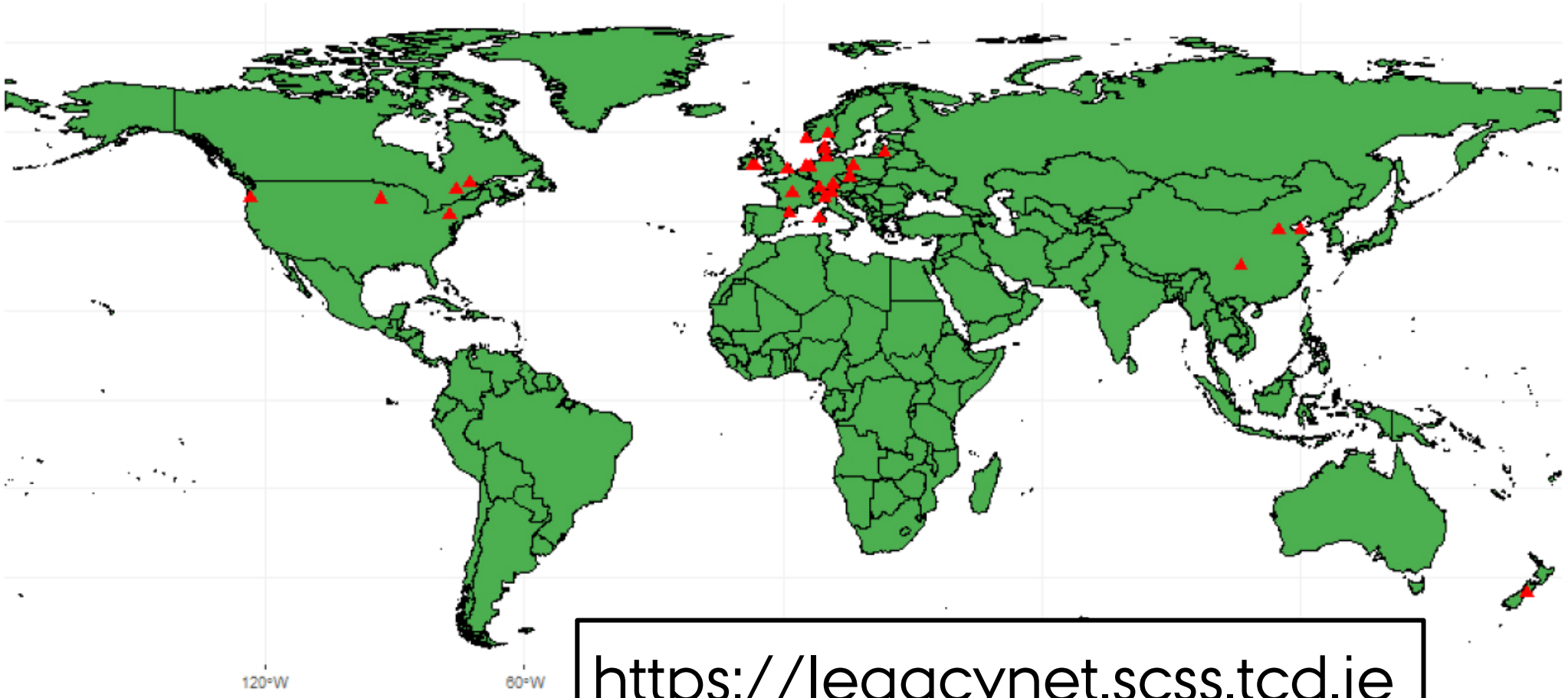
Research gaps: Impact of Climate, soil and interactions





Zhao et al. (2022);
10.1038/s41467-022-32464-0

Greater generality from multi-site experiments: Example LegacyNet



https://legacynet.scss.tcd.ie

Summary

- Multispecies grasslands provide benefits across entire crop rotation
- Optimal mixture composition in grassland might not provide biggest benefits for follow on crop
- Arable and livestock/mixed systems both benefit from diverse grasslands
- Benefits also depend on management, climate and soil/geography
- More multisite experiments / meta analyses are required

Potential ley for mixed farm
© Loges

Potential ley for arable farm
© Agroscope

Increase in spatial diversity

Agroscope

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Thank you very much for your attention

Increase in temporal diversity

eagasc
Agriculture and Food Development Authority

C A U
Christian-Albrechts-Universität zu Kiel

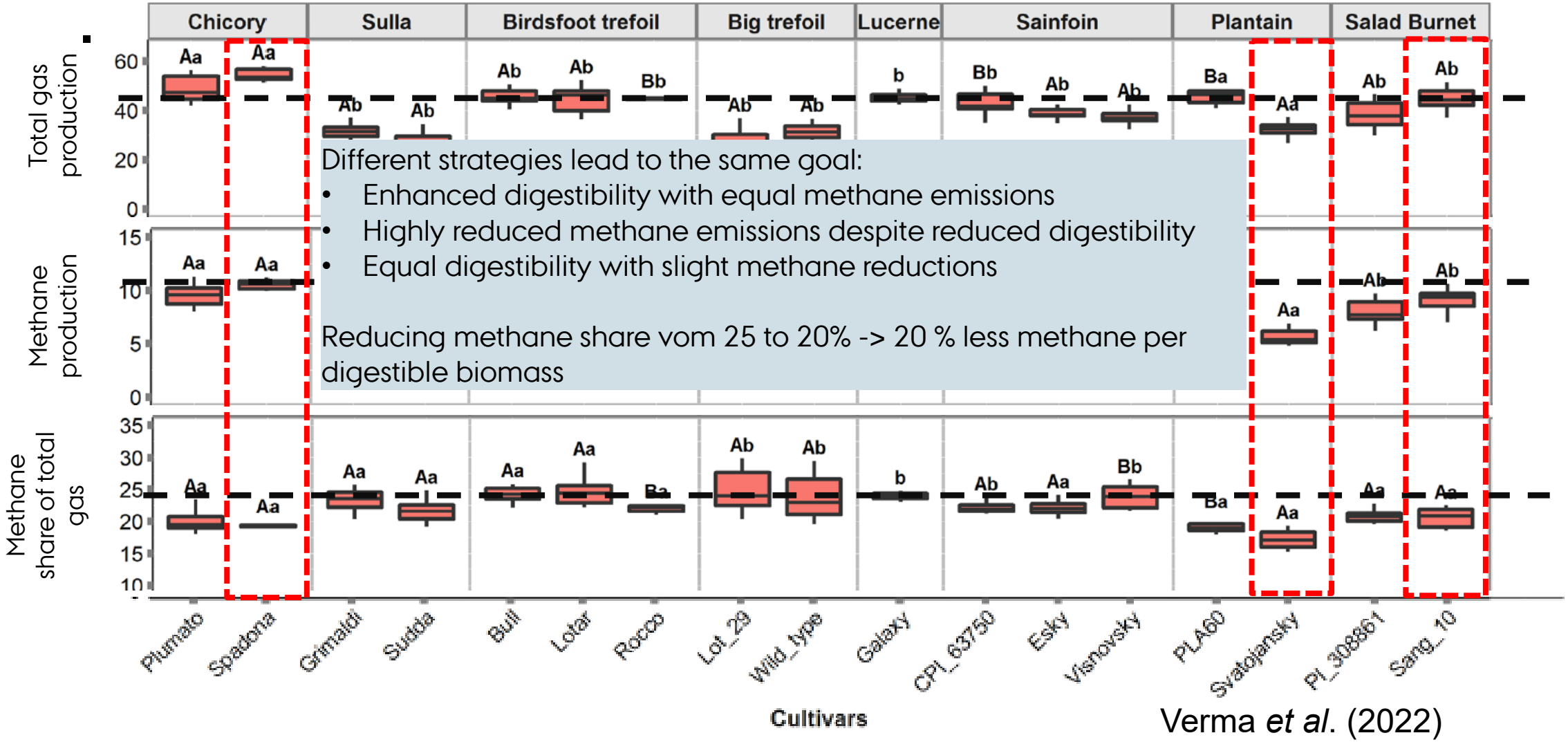
AARHUS UNIVERSITY

Images of winter wheat taken on same day

In old crop rotation after 1 year of grass clover

In new crop rotation after 2 year of grass clover

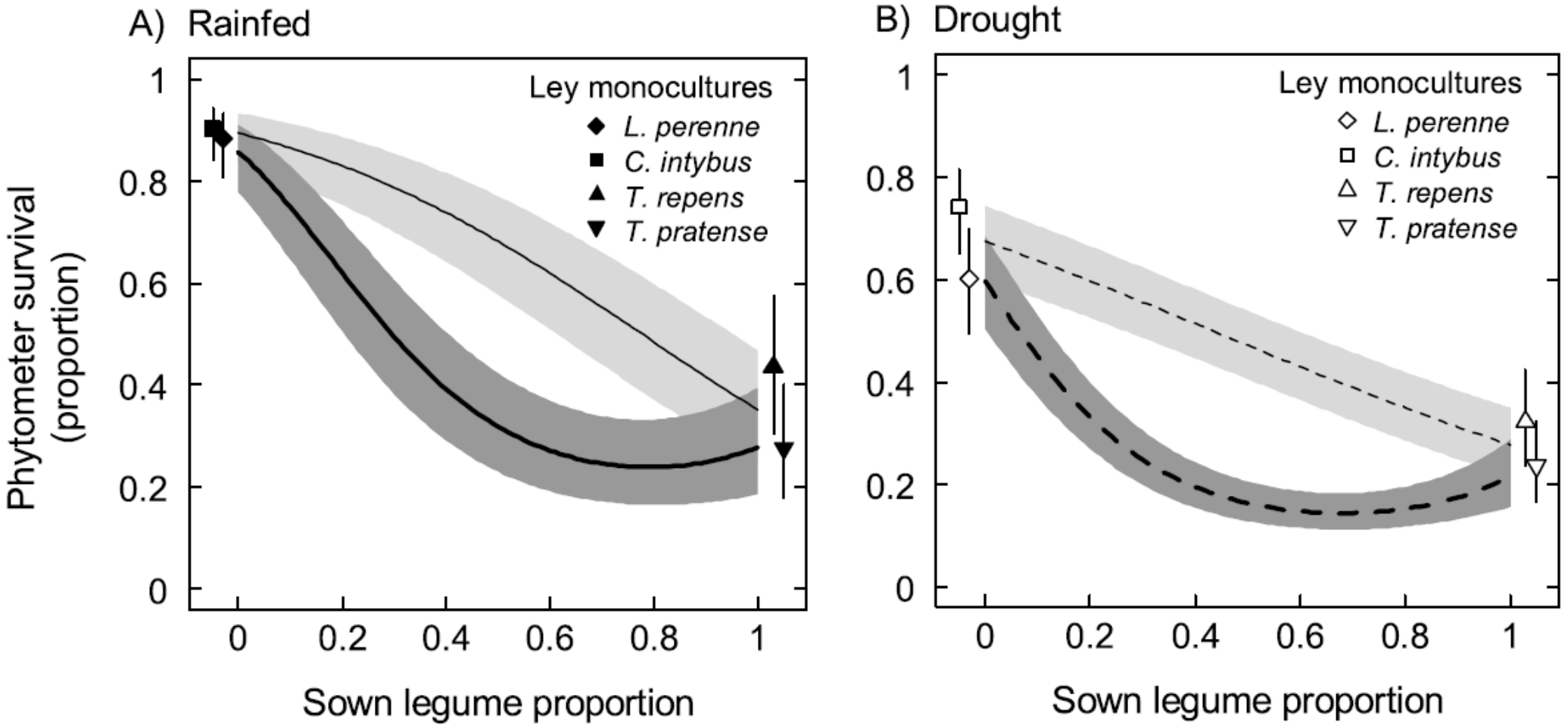
Future: Including bioactive herbs into mixtures



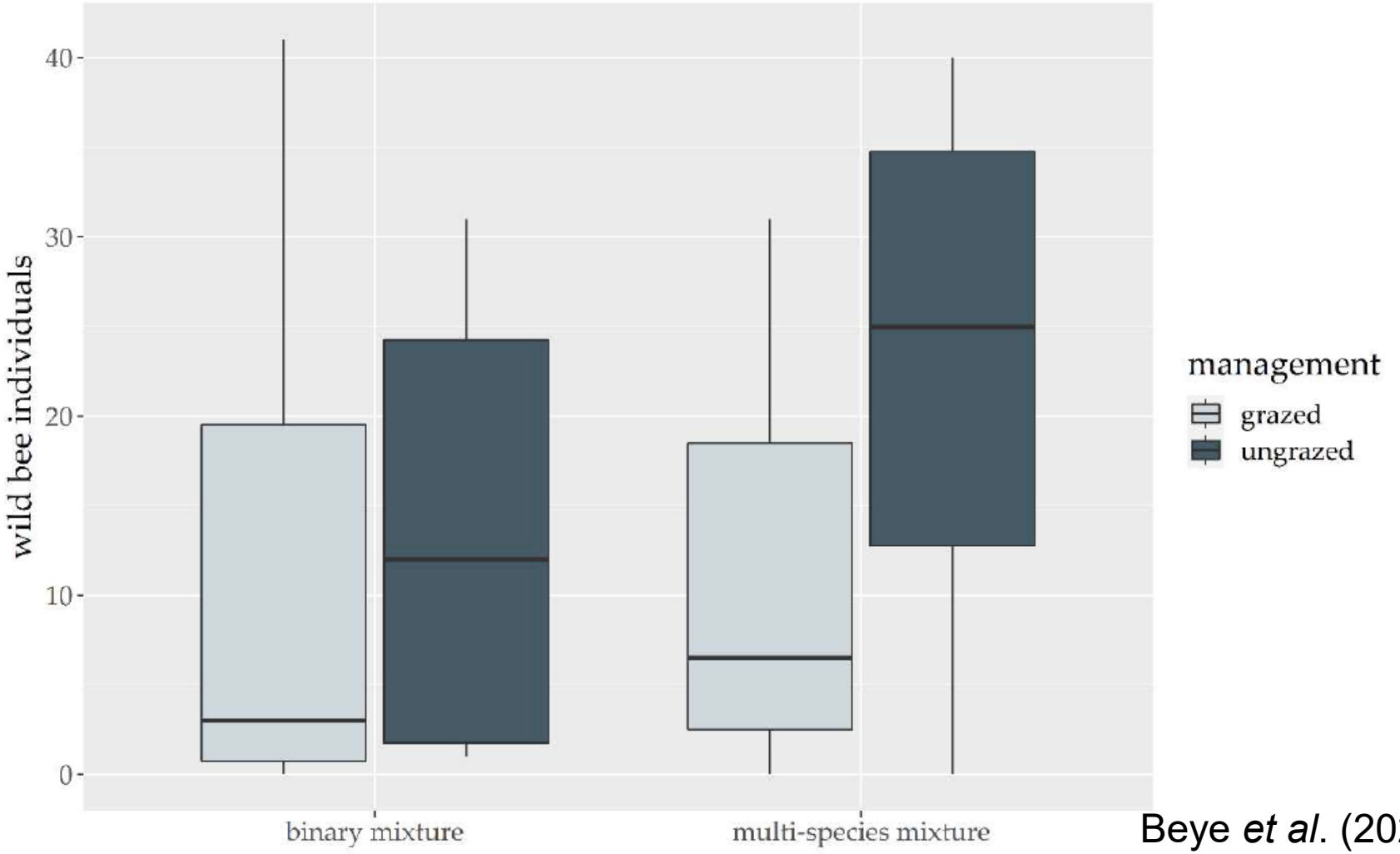
Verma *et al*. (2022)
10.1038/s41598-022-14424-2

Mixture performance under rainfed and drought including legumes

M. Suter et al./Agriculture, Ecosystems and Environment 240 (2017) 329–339

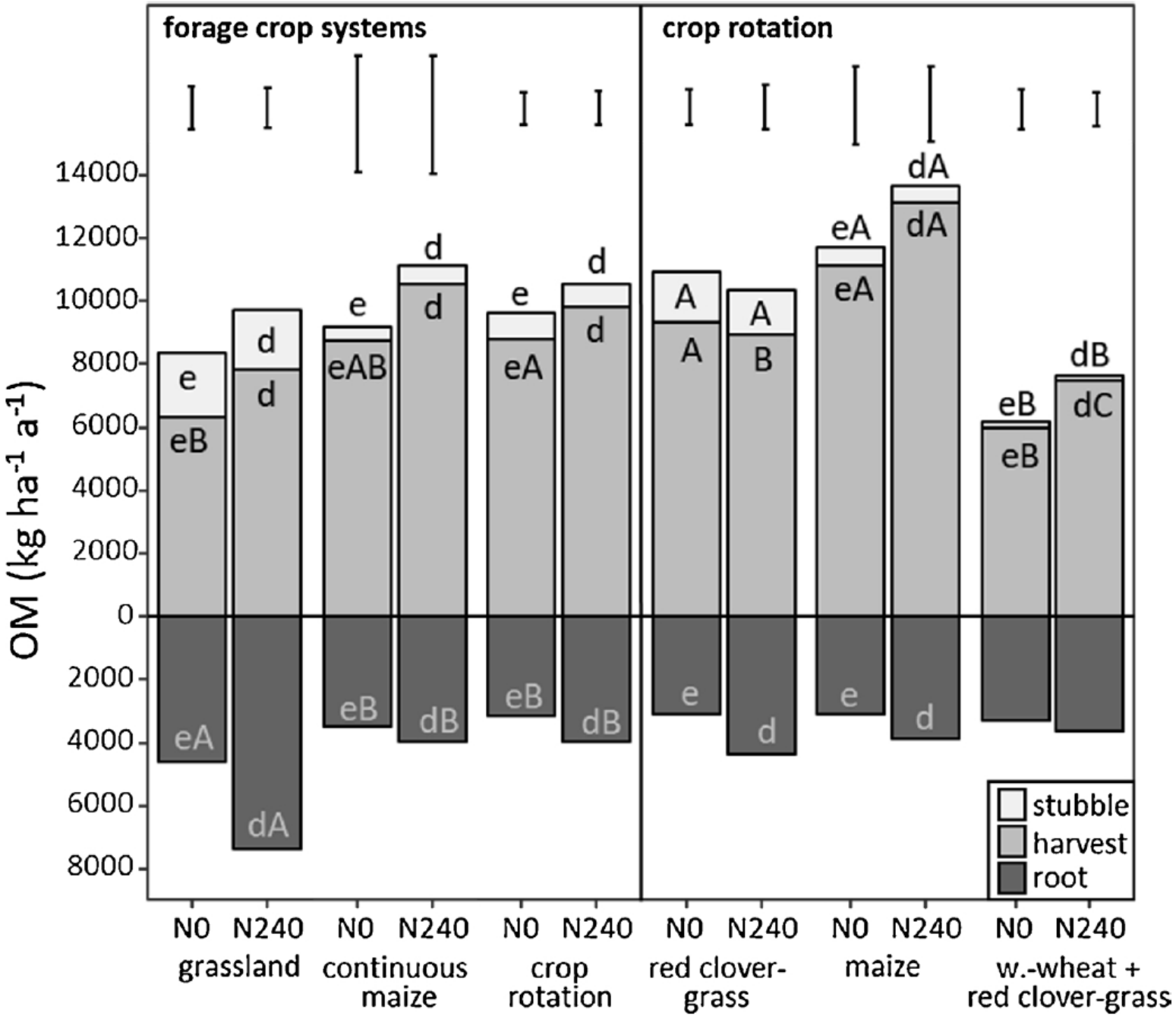


Especially grazed multispecies mixtures had high pollinator abundance

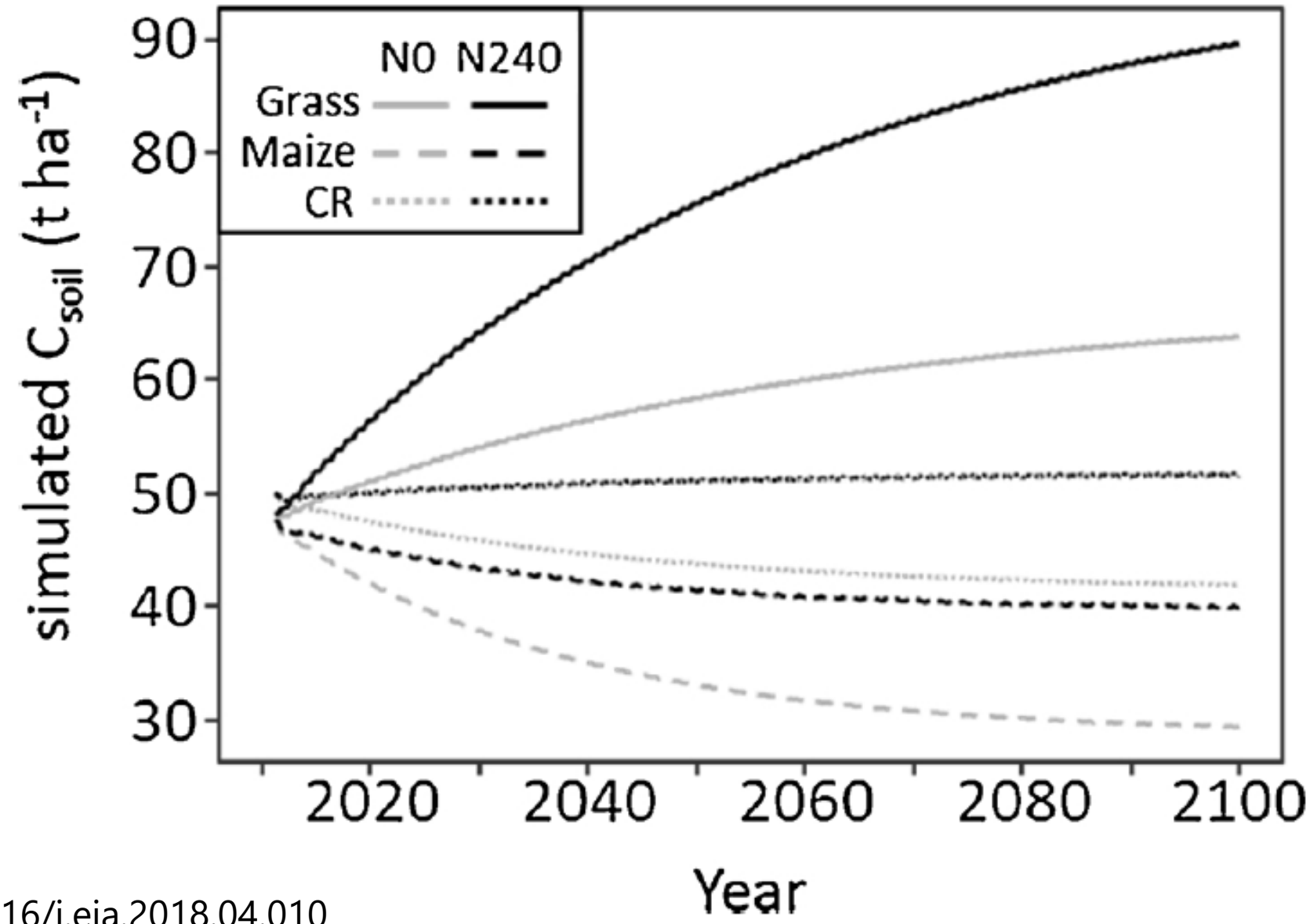


Beye *et al*. (2022)
10.3390/agronomy12051080

Above- and belowground biomass formation in maize, Crop rotations and permanent grassland



Loges et al, 2018: 10.1016/j.eja.2018.04.010



Loges et al, 2018: 10.1016/j.eja.2018.04.010