

Do crop rotations including temporary grasslands improve soil ecosystem services?

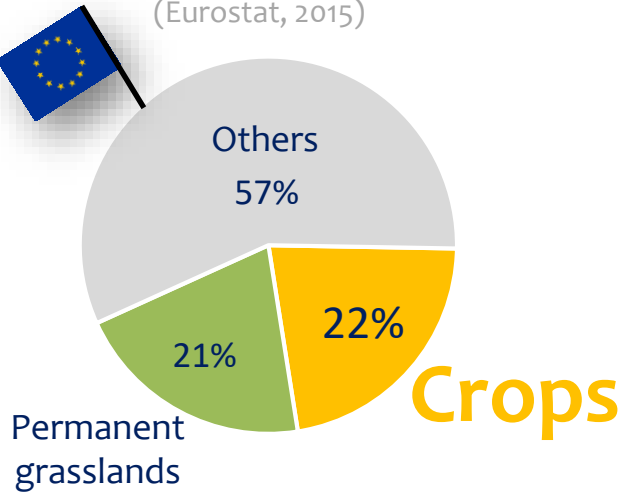


Kevin Hoeffner

L.F. Arias-Giraldo, M. Banse, A. Beylich, A. Chabbi, D. Cluzeau, D. Dumitrita, U. Graefe, G. Guzmán, V. Hallaire, J. Hanisch, B. B. Landa, D. Linsler, S. Menasseri, A. Nicolai, M. Öpik, E. Plaas, T. Roslin, M. Roucaute, T. Runge, M. Sandor, S. Scheu, R. Schmelz, I. Schmooch, R. Schütte, S. Schrader, S.-K. Sepp, M. Potthoff, T. Vahter, G. Pérès

EU land cover overview

(Eurostat, 2015)



In response to global changes



World population growth



Climate change



Healthy environment

...

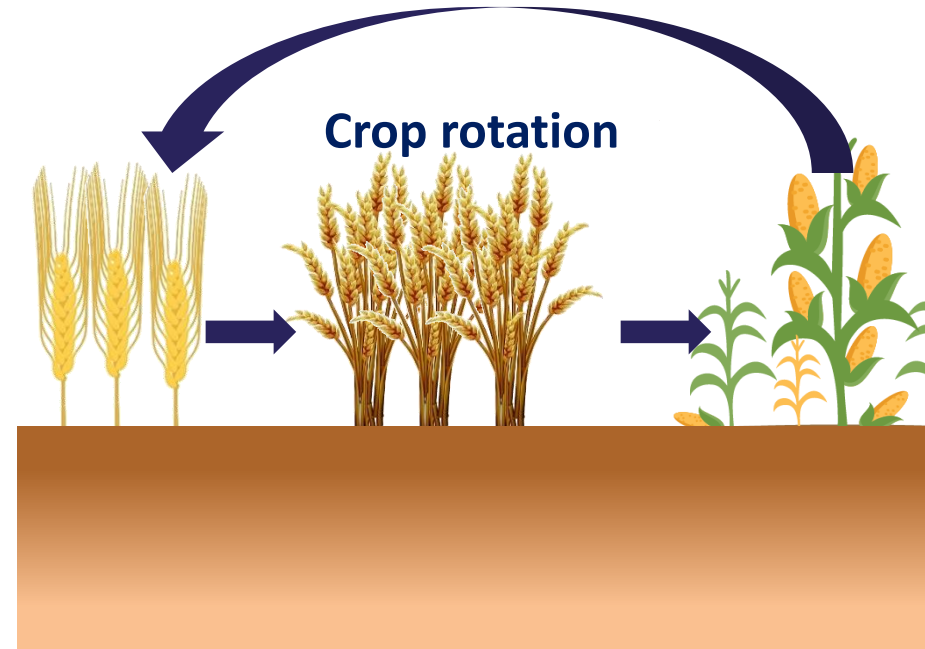
Crop management is changing



Tillage



Pesticide



Grassland soils

with adapted management

**Physically,
Chemically,
Biologically,**

superior to almost other
cultural systems

High contribution to ecosystem services

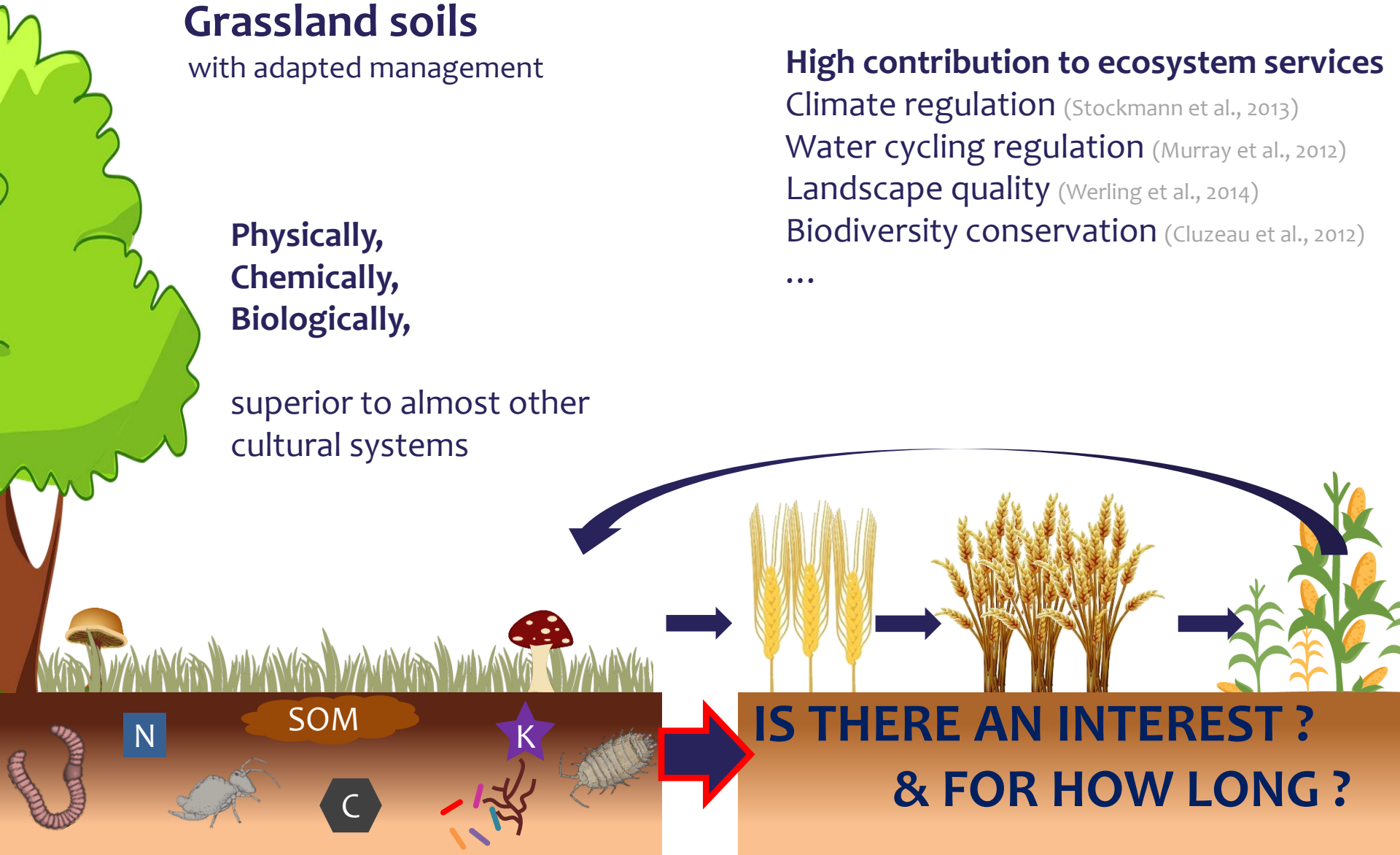
Climate regulation (Stockmann et al., 2013)

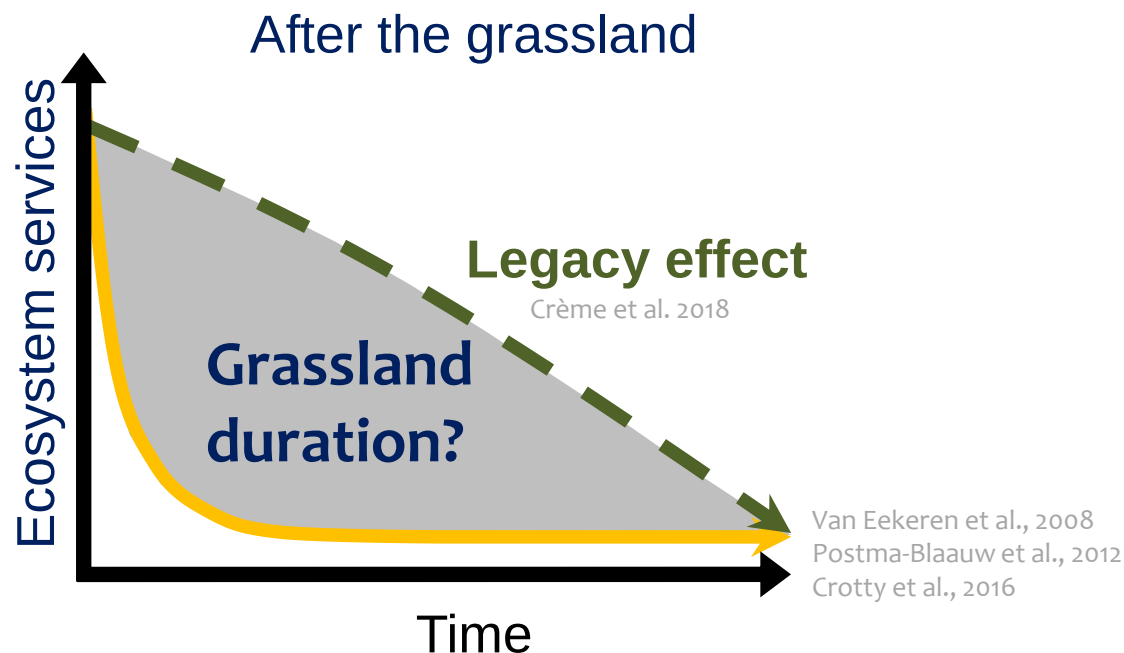
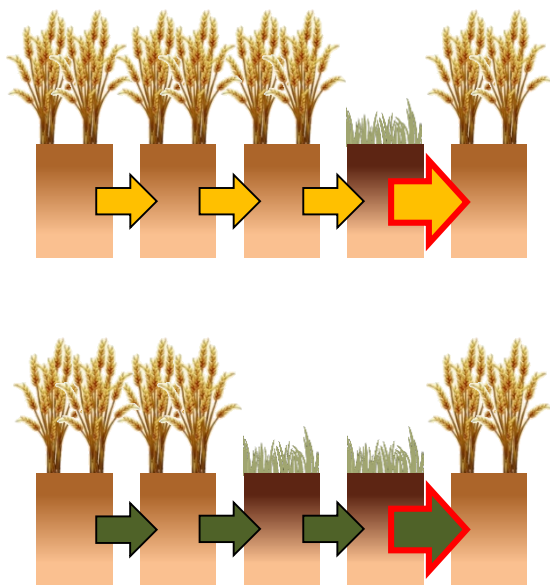
Water cycling regulation (Murray et al., 2012)

Landscape quality (Werling et al., 2014)

Biodiversity conservation (Cluzeau et al., 2012)

...

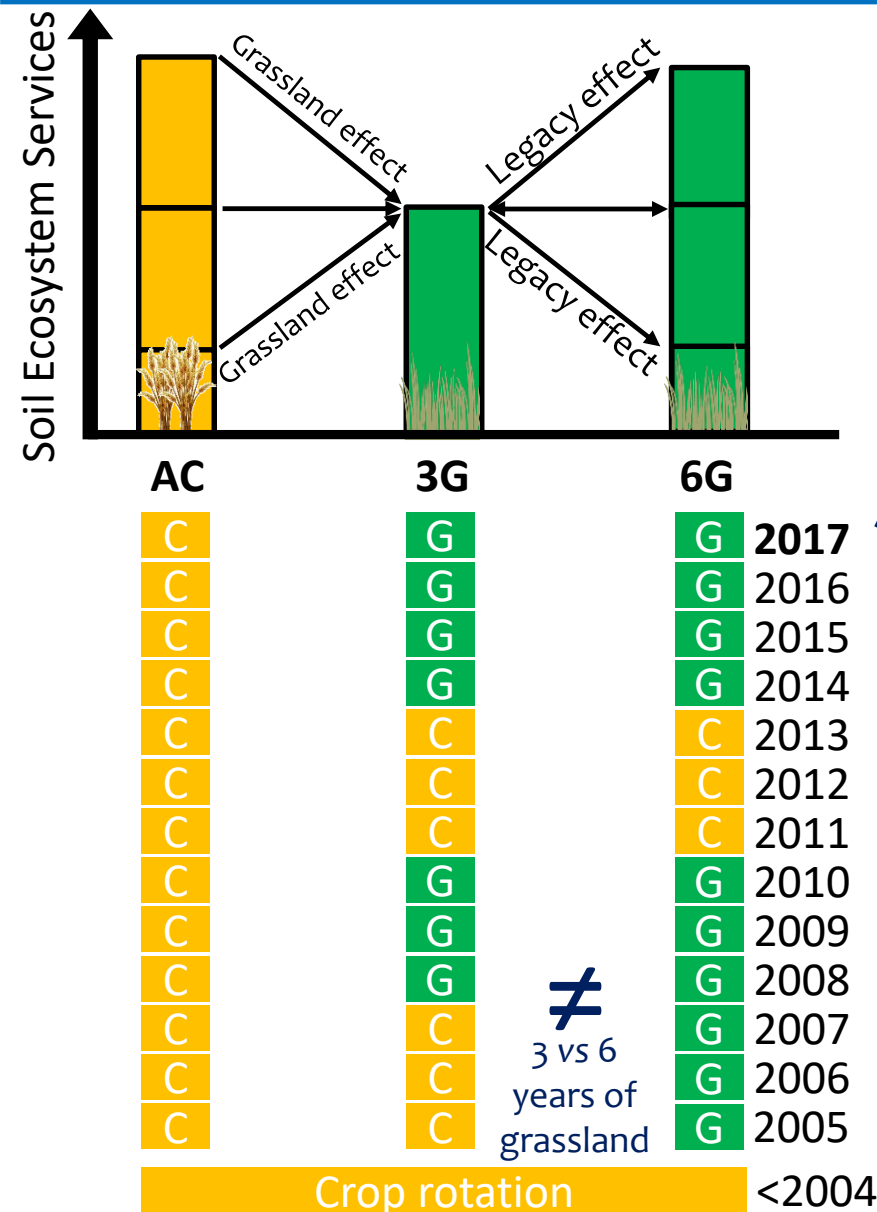




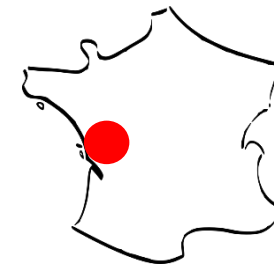
What is the legacy effect of including 6 years versus 3 years of grassland in the crop rotation on Soil Ecosystem Services ?

Higher grassland duration in the crop rotation will enhance SES for the following crop

MATERIALS & METHODS



BLOC 1
BLOC 2
BLOC 3
BLOC 4



Five Soil Ecosystem Services

Biodiversity conservation

Micro-organisms Meso-fauna Macro-fauna

Soil maintenance

Aggregate stability

Food provision

Forage production

Pest regulation

Verticillium wilt

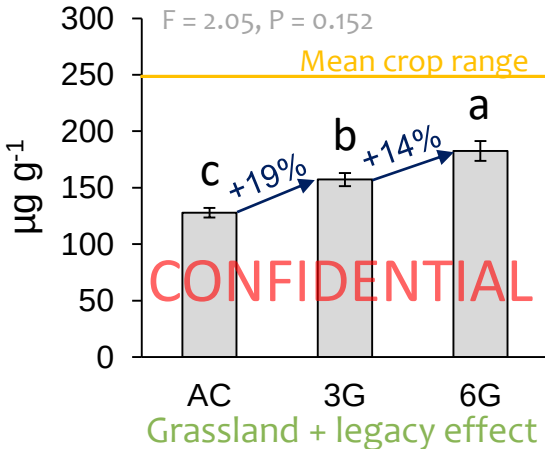
Water regulation

Infiltration

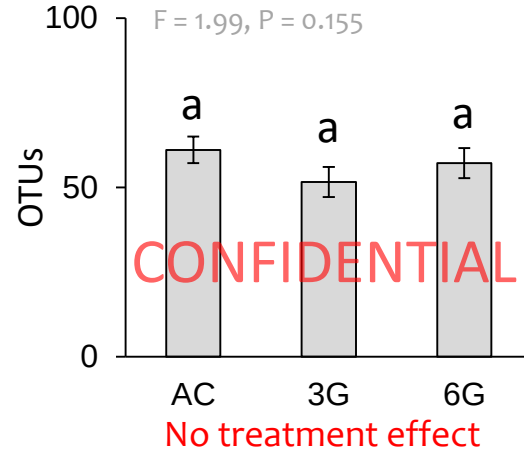
BIODIVERSITY CONSERVATION

Diversity

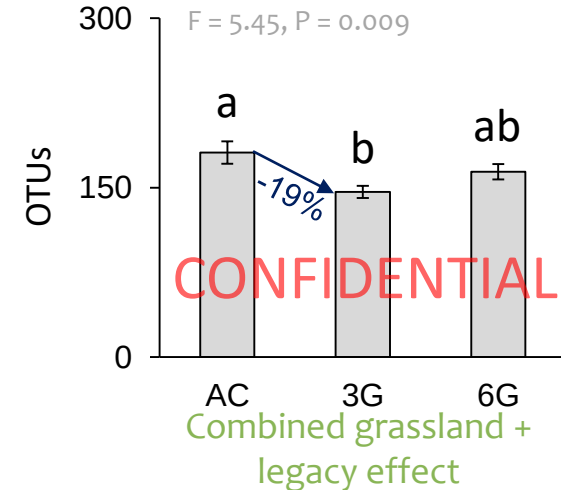
Microbial biomass

GEORG-AUGUST-UNIVERSITÄT
GÖTTINGEN

Bacterial richness

CSIC
Spanish Council of Research

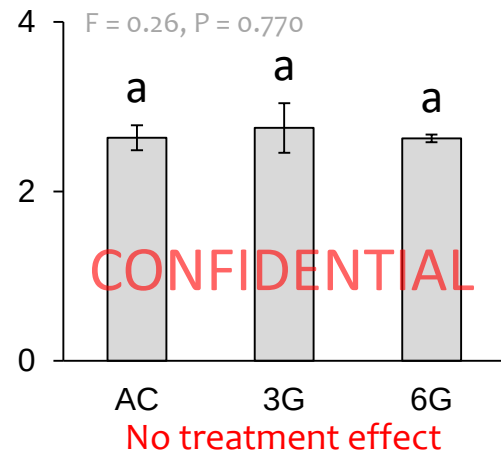
Fungal richness

CSIC
Spanish Council of Research

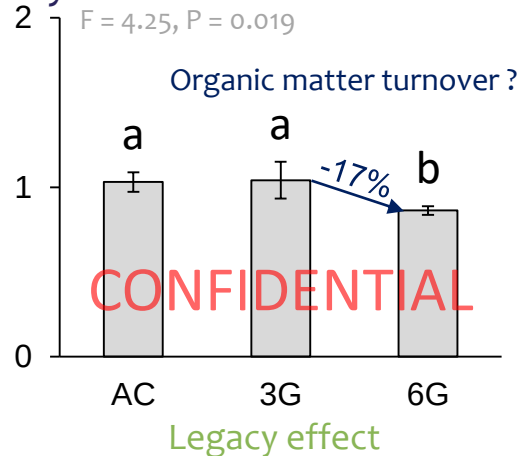
Potential microbial activity



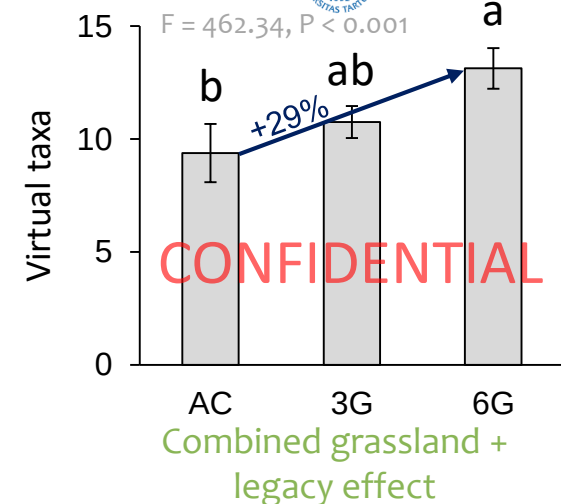
Fructose



Lysine



AMF richness

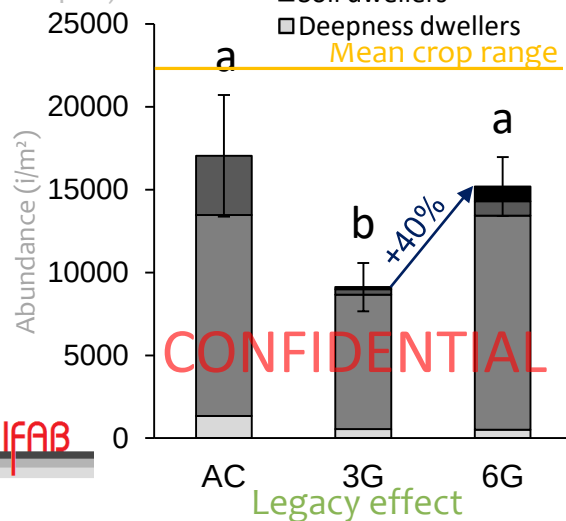


BIODIVERSITY CONSERVATION

Enchytraeid

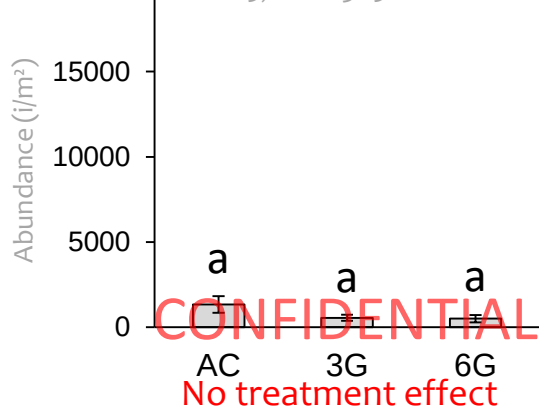
- Litter dwellers
- Opportunistic species
- Soil dwellers
- Deepness dwellers

$F = 4.62, P = 0.021$



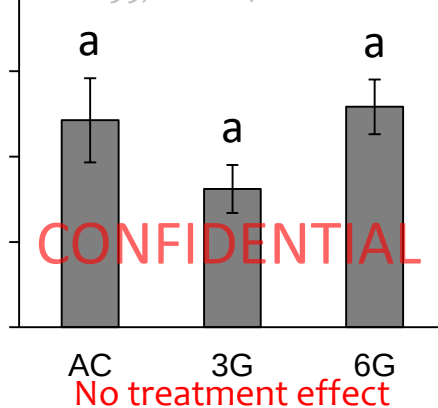
Deepness dwellers

$F = 1.25, P = 0.305$



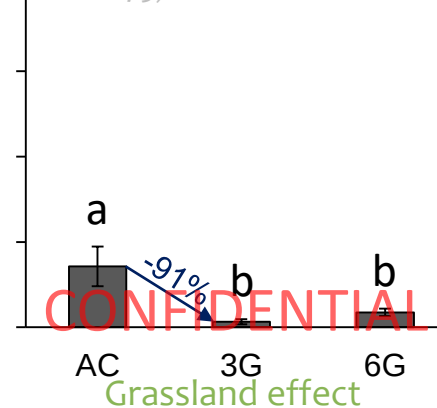
Soil dwellers

$F = 2.99, P = 0.071$



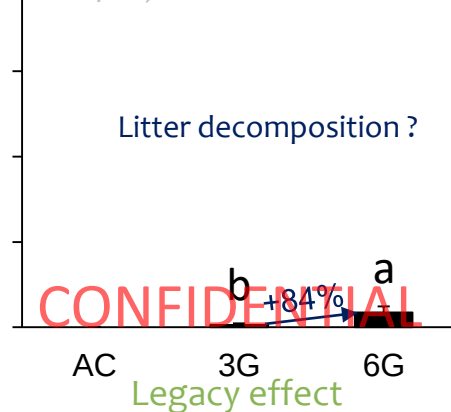
Opportunistic species

$F = 12.75, P < 0.001$



Litter dwellers

$F = 4.62, P = 0.021$



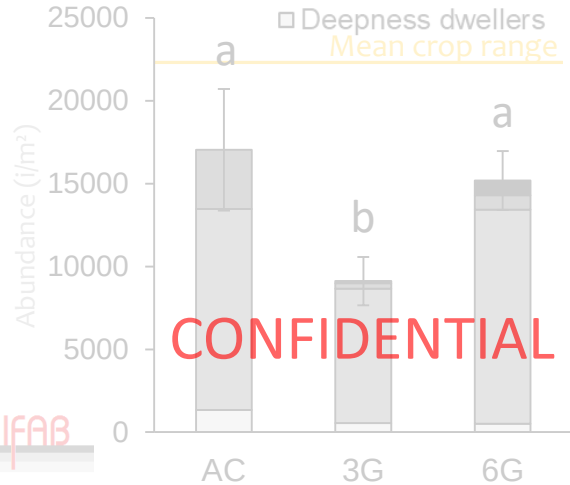
BIODIVERSITY CONSERVATION

Enchytraeid

 $F = 4.62, P = 0.021$

- Litter dwellers
- Opportunistic dwellers
- Soil dwellers
- Deepness dwellers

Mean crop range

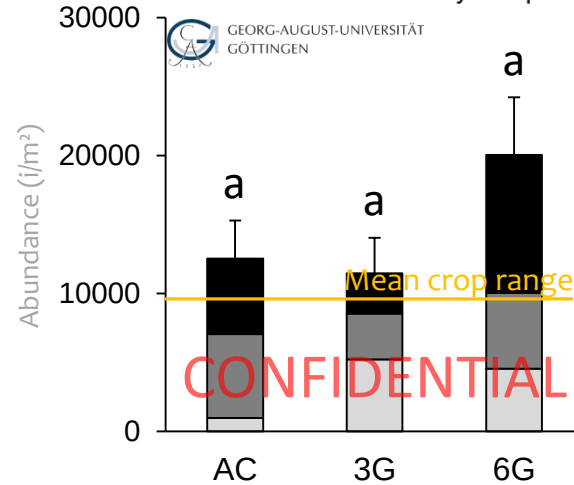


CONFIDENTIAL

Collembola

 $F = 2.05, P = 0.152$

- Epi-edaphic
- Hemi-edaphic
- Eury-edaphic



CONFIDENTIAL

No treatment effect

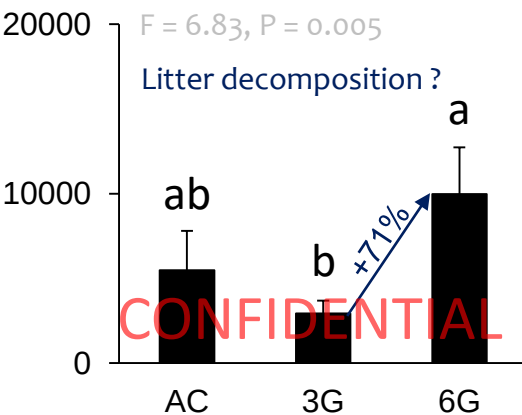


Flickr.com

Epi-edaphic

 $F = 6.83, P = 0.005$

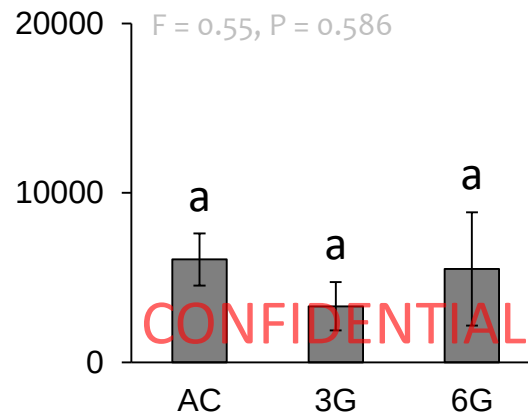
Litter decomposition ?



CONFIDENTIAL

Legacy effect

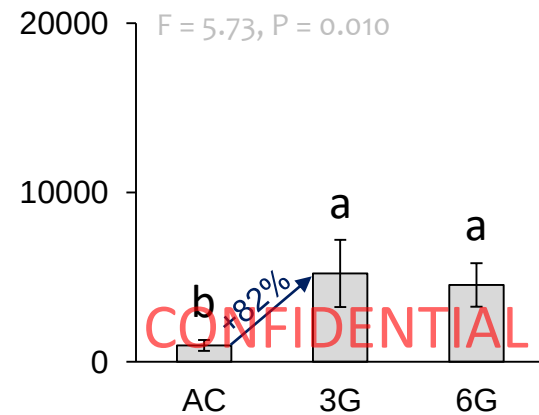
Hemi-edaphic

 $F = 0.55, P = 0.586$ 

CONFIDENTIAL

No treatment effect

Eu-edaphic

 $F = 5.73, P = 0.010$ 

CONFIDENTIAL

Grassland effect

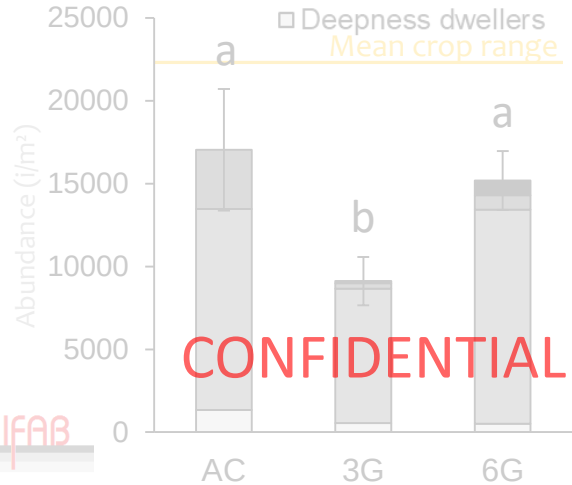
RESULTS & DISCUSSION

BIODIVERSITY CONSERVATION

Enchytraeid

$F = 4.62, P = 0.021$

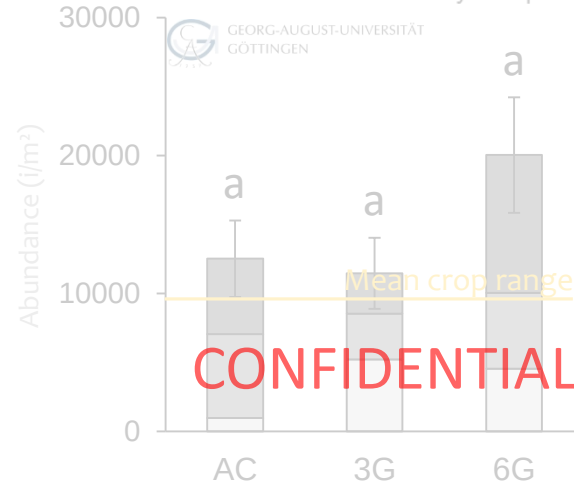
- Litter dwellers
- Opportunistic dwellers
- Soil dwellers
- Deepness dwellers



Collembola

$F = 2.05, P = 0.152$

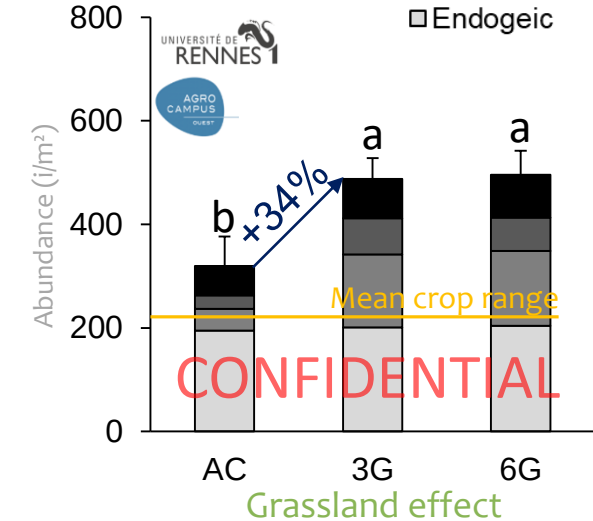
- Epi-edaphic
- Hemi-edaphic
- Eury-edaphic



Earthworm

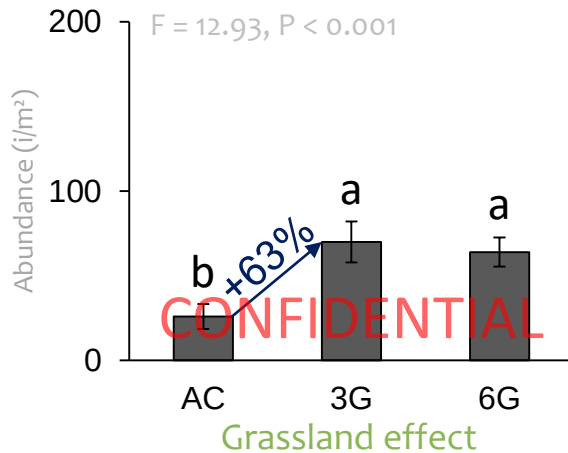
$F = 10.19, P < 0.001$

- Epigeic
- Epi-anecic
- Strict-anecic
- Endogeic



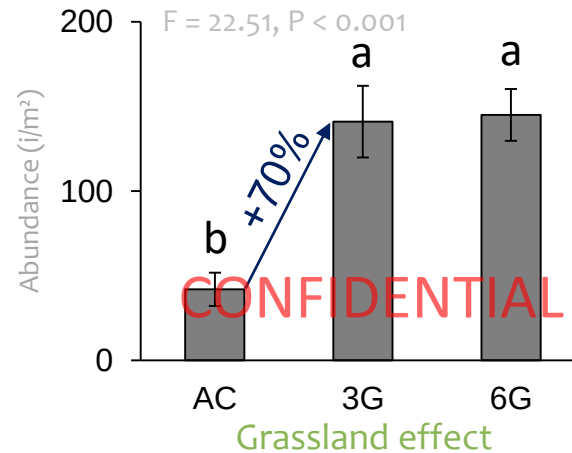
Epi-anecic

$F = 12.93, P < 0.001$



Strict-anecic

$F = 22.51, P < 0.001$



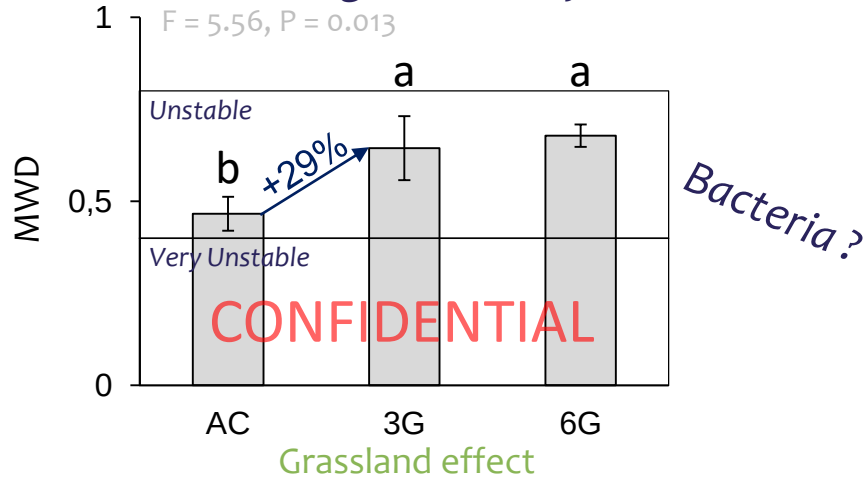
Water regulation ?
Litter decomposition ?

Bastardie et al., 2003
Hoeffner et al., 2019

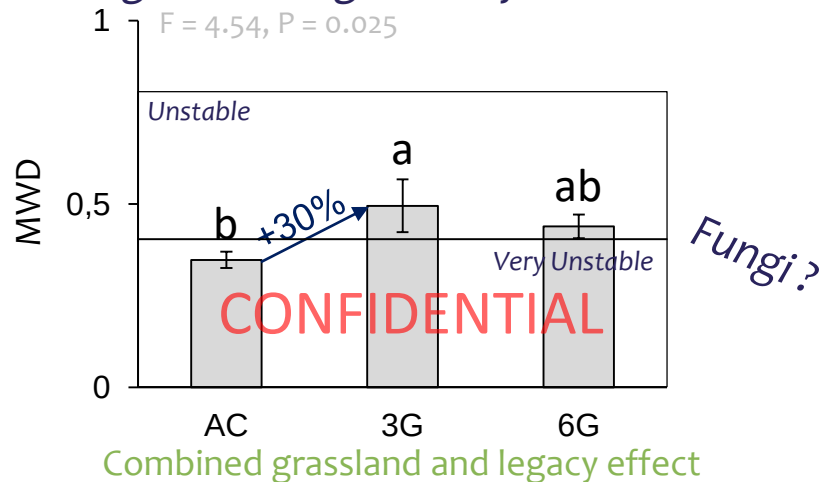
SOIL MAINTENANCE

Aggregate stability (Le Bissonnais 1996)

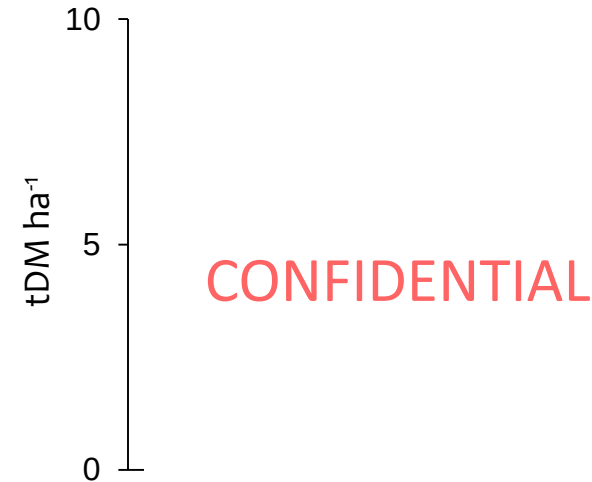
Slow watering = Smoothy rain event



High watering = Heavy rain event



FOOD PROVISION

Forage production 

CONCLUSION

Micro-organisms	Grassland effect	Legacy effect
Microbial biomass	✓ +19%	✓ +14%
Microbial activity	✓	✓ ≈ -17%
Fungal diversity	✓	✓ -19%
Bacterial diversity	✗	✗
AMF diversity	✓	✓ +29%

Meso-fauna	Grassland effect	Legacy effect
Enchytraeid abundance	✓ +/-?	✓ +40%
Ench. funct. structure	✓ -91%	✓ +84%
Collembola abundance	✗	✗
Collemb. funct. structure	✓ +71%	✓ +82%

Macro-fauna	Grassland effect	Legacy effect
Earthworm abundance	✓ +34%	✗
Earthworm funct. structure	✓ ≈ +66%	✗

Soil Maintenance	Grassland effect	Legacy effect
Aggregate stability	✓	✓ +30%

Food provision	Grassland effect	Legacy effect
Forage production	✓	✗

SoilMan

This is only part of the results

Different SES

From micro-organisms to macro-fauna
=> Strengthens the diagnosis

- Grassland and legacy effect found for different SES
- Grassland and legacy effect on SES are sometimes combined
- For biodiversity conservation, legacy effect is visible at different level (abundance, biomass, funct. structure or diversity)
- For some aspect there is a real interest to integrate 6 years of grassland in the crop rotation

Acknowledgements

The SoilMan project (grant number 01LC1620) was funded through the 2015-2016 BiodivERsA COFUND call for research proposals with the following funders:



European Commission



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Eesti Teadusagentuur
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FORMAS

