Enhancement of biodiversity in agriculture arable and grassland systems

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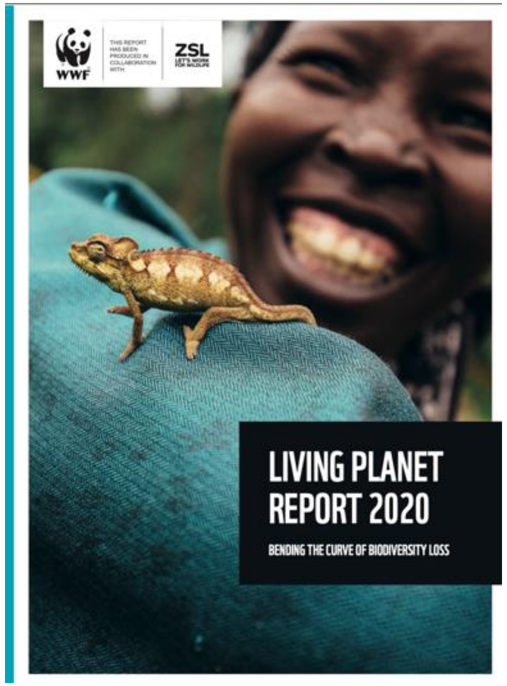
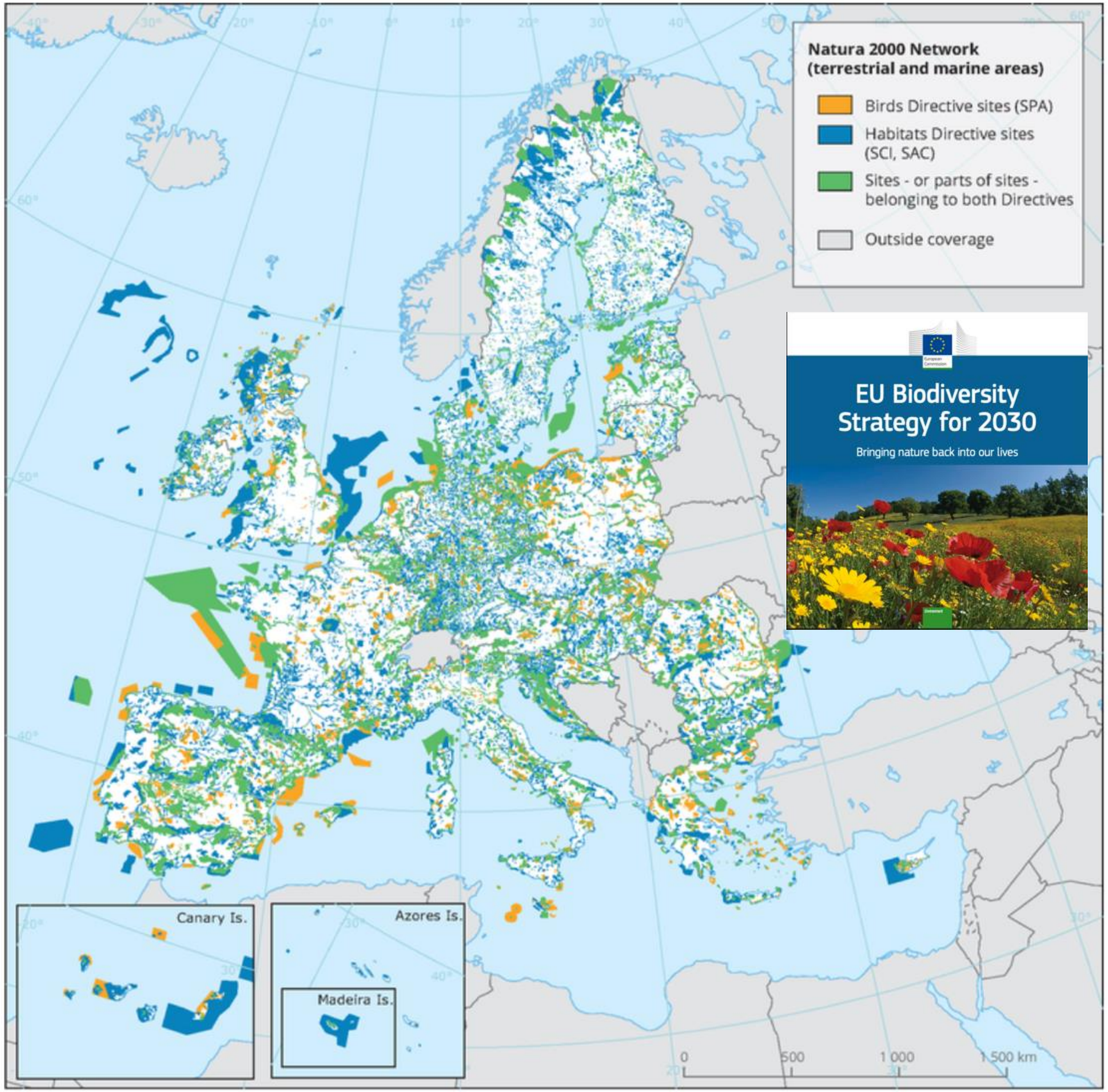


The 6th Mass Extinction

The Global Living Planet Index – 68% decrease in population sizes of mammals, birds, amphibians, reptiles and fish between 1970-2016 (WWF, 2020).

European farmed landscapes:

- Fertile Crescent (10,000 yrs)
- 39% of EU land area, 10.3 million farms
- Much biodiversity has evolved with agricultural practices, climate and underlying geology etc.
- Intensification and specialization v's land abandonment



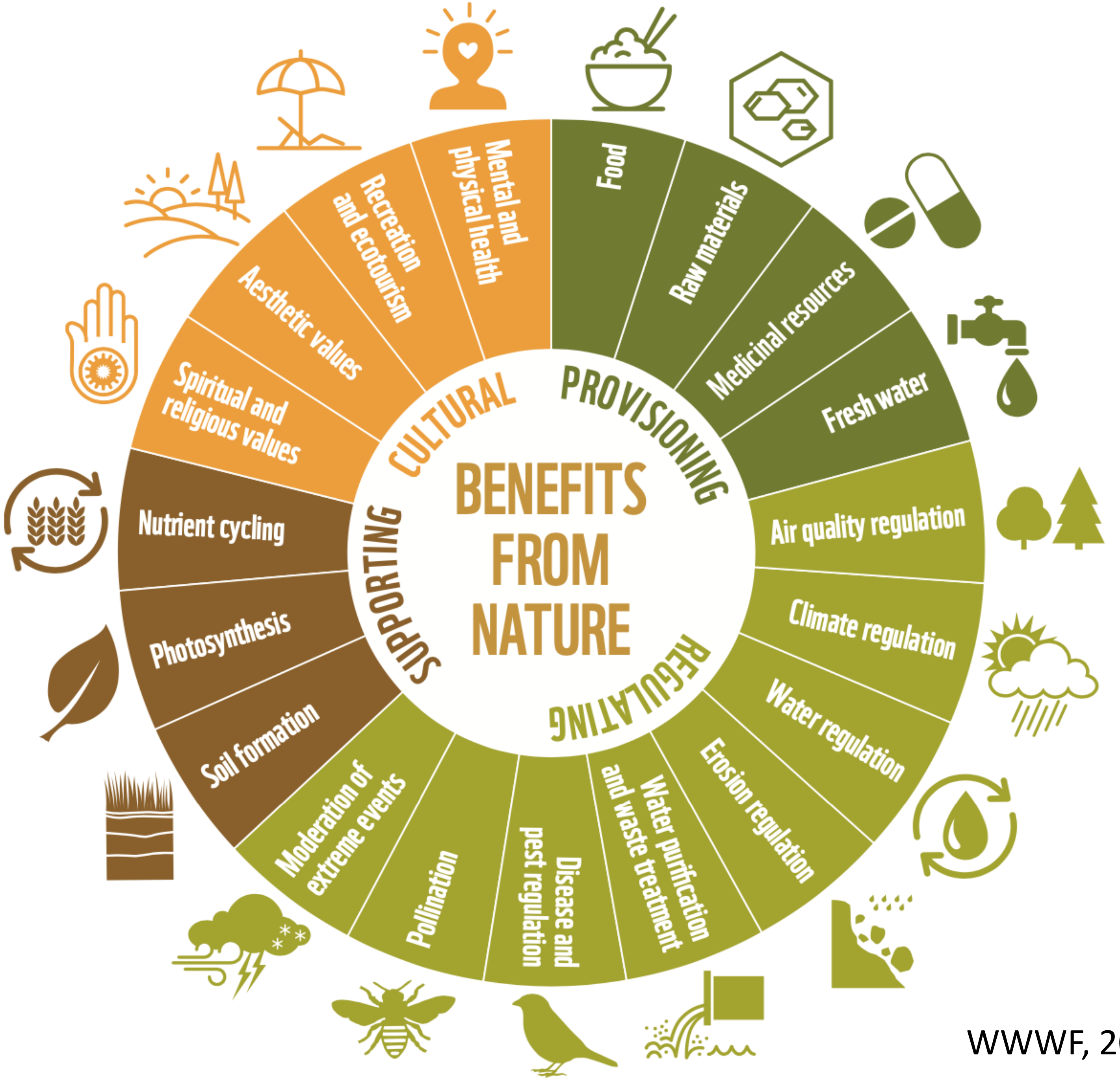
Natura 2000 Network

- 18% of land area and 10% of sea area
- Increase to 30% of land and sea area
- Strict legal protection for 10% of both land and sea area

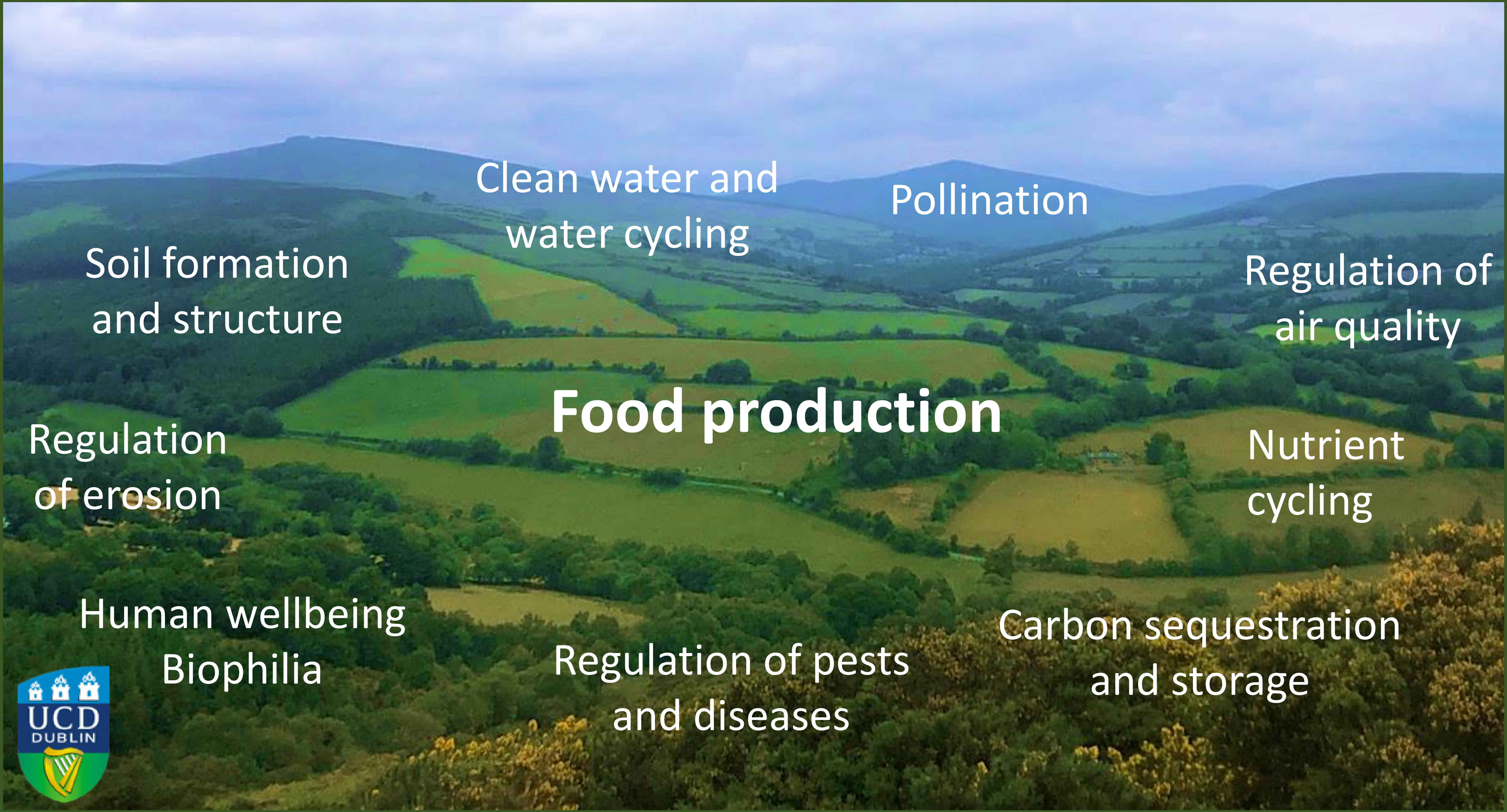
- https://www.eea.europa.eu/data-and-maps/figures/natura-2000-network-terrestrail-and

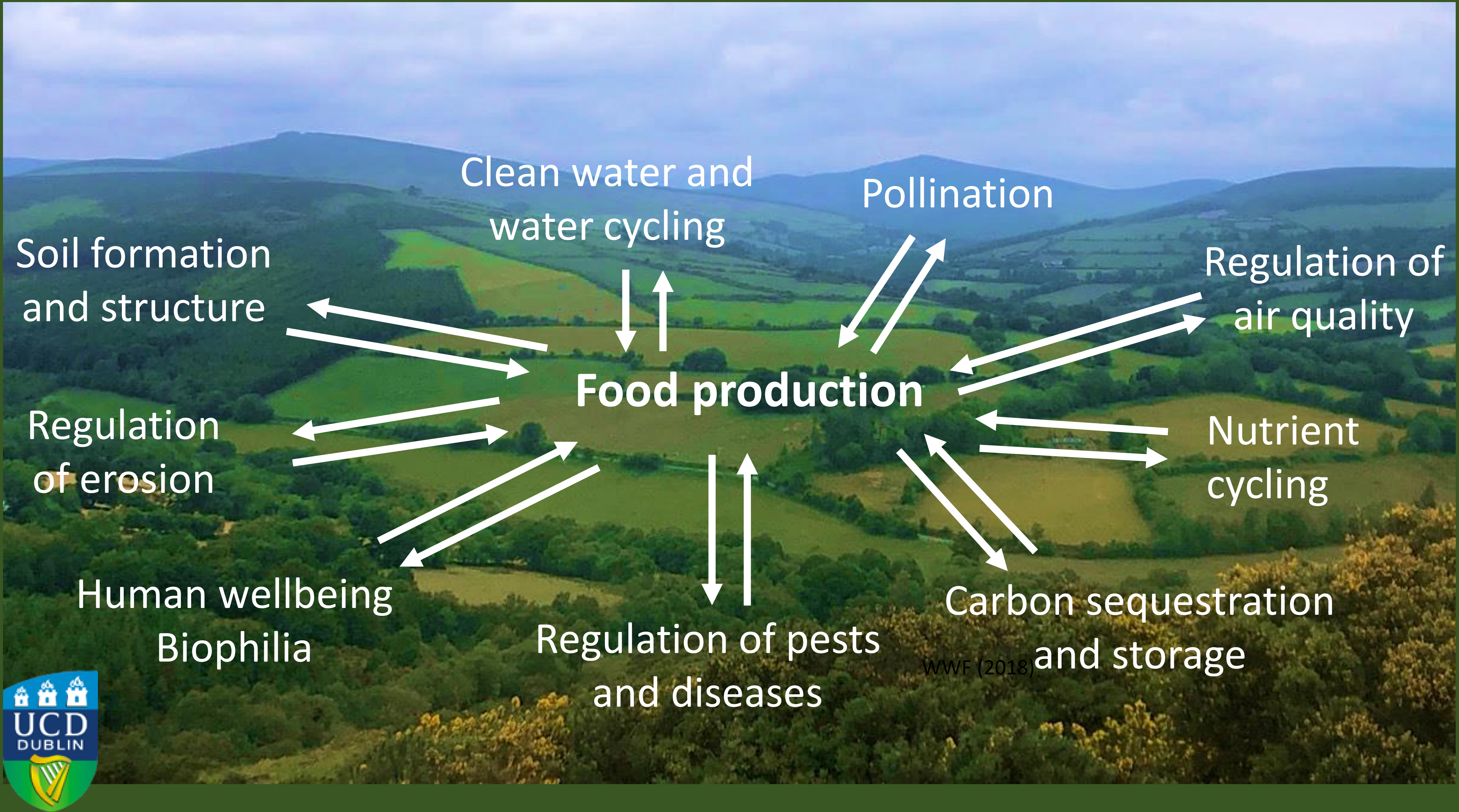
Not just nice to have!

- Biodiversity and the ecosystem services that it facilitates the delivery of, fundamentally underpin the sustainability of our agricultural systems
- Estimated that global value of ES is US$ 125 trillion per year (WWF, 2018)



WWWF, 2018


Clean water and
water cycling
Pollination
Soil formation
and structure
Regulation of
air quality
Food production
Regulation
of erosion
Nutrient
cycling
Human wellbeing
Biophilia
Carbon sequestration
and storage
Regulation of pests
and diseases
UCD
DUBLIN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WWF (2018)
UCD
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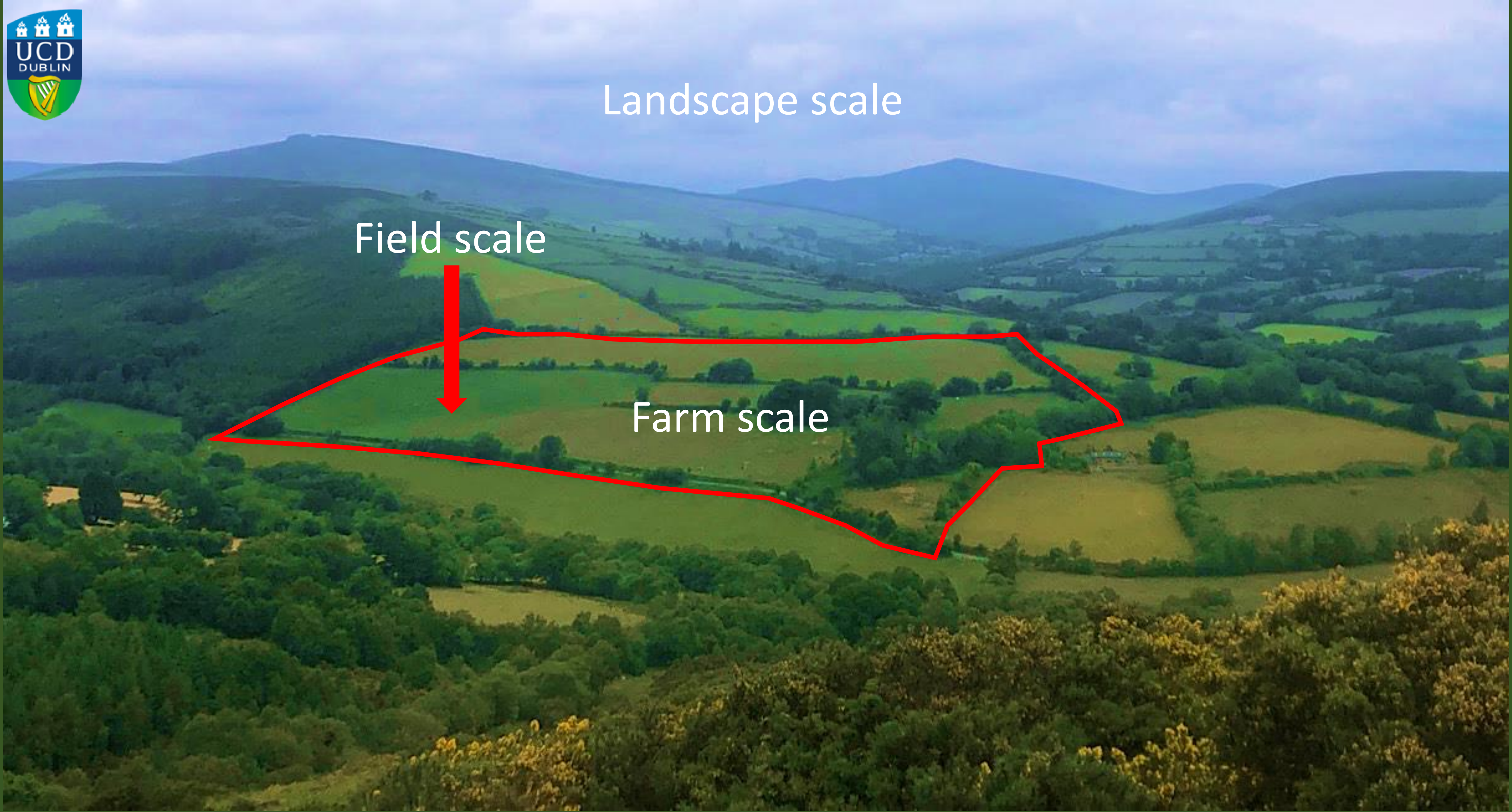
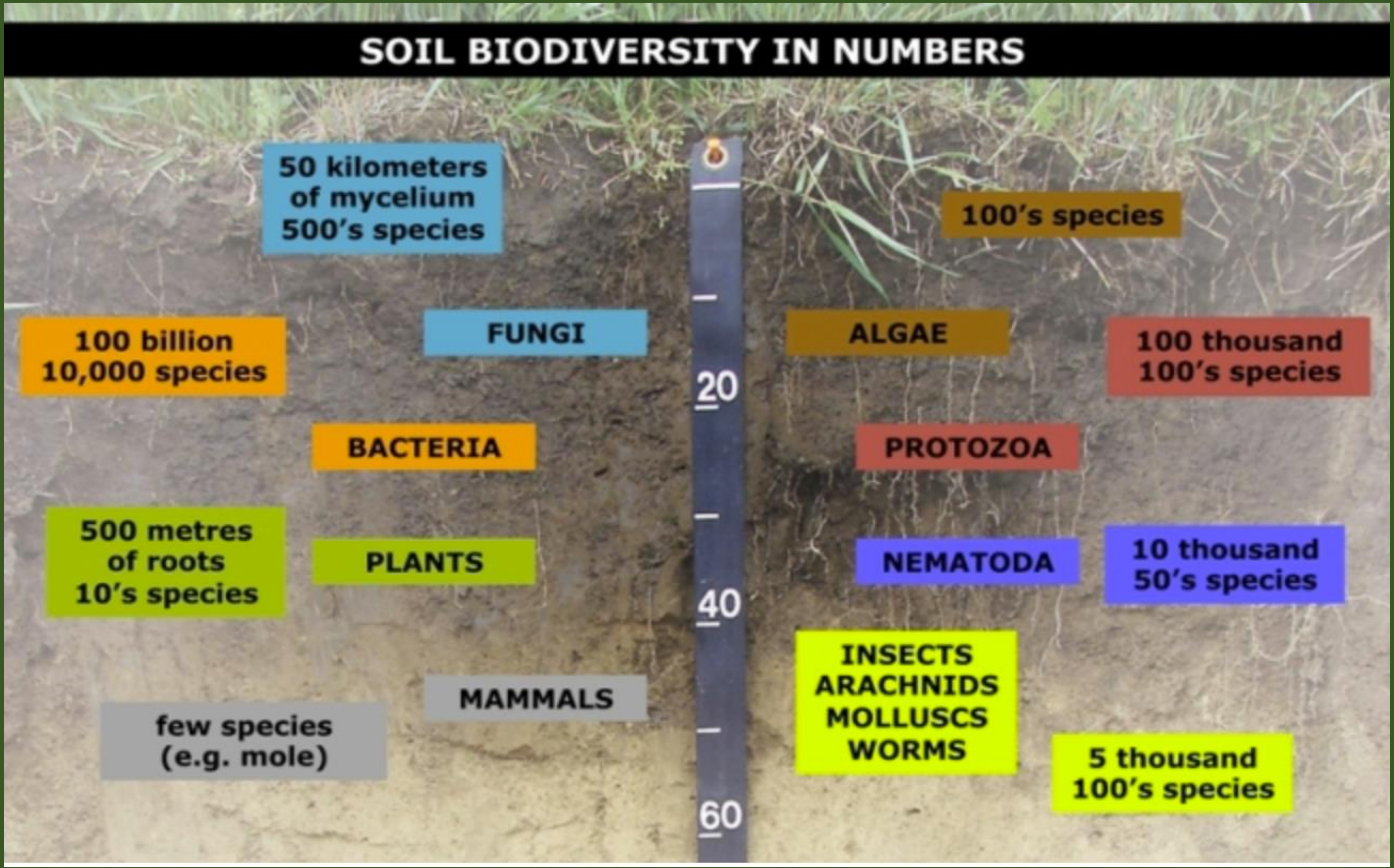

Landscape scale
Field scale
Farm scale

Examples of services facilitated through soil biodiversity

- Nutrient and carbon cycling
- Regulation of water movement
- Soil formation, structure and maintenance
- Regulation of pests
- Climate regulation

https://esdac.jrc.ec.europa.eu/themes/soil-biodiversity



https://esdac.jrc.ec.europa.eu/themes/soil-biodiversity

In field options for arable systems

- No till / min till
- Cover crop and inter-cropping
- Field margins
- Conservation headlands
- Beetle banks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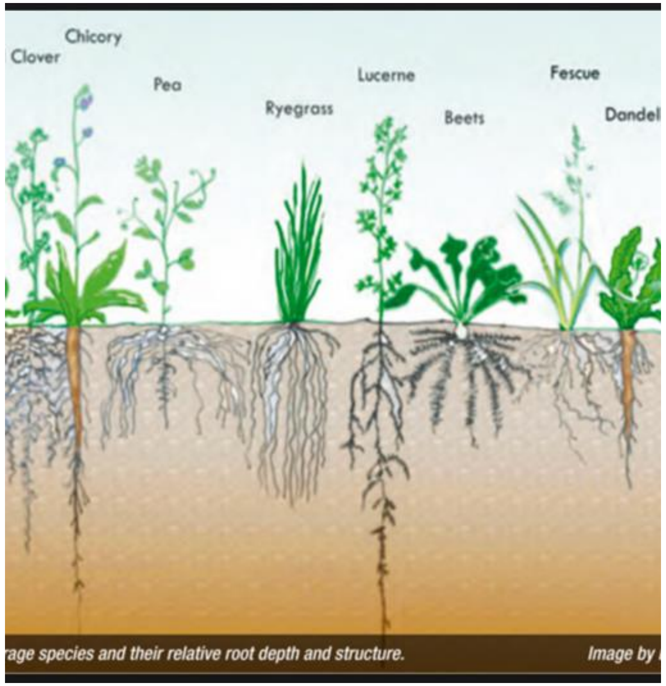


Multispecies swards

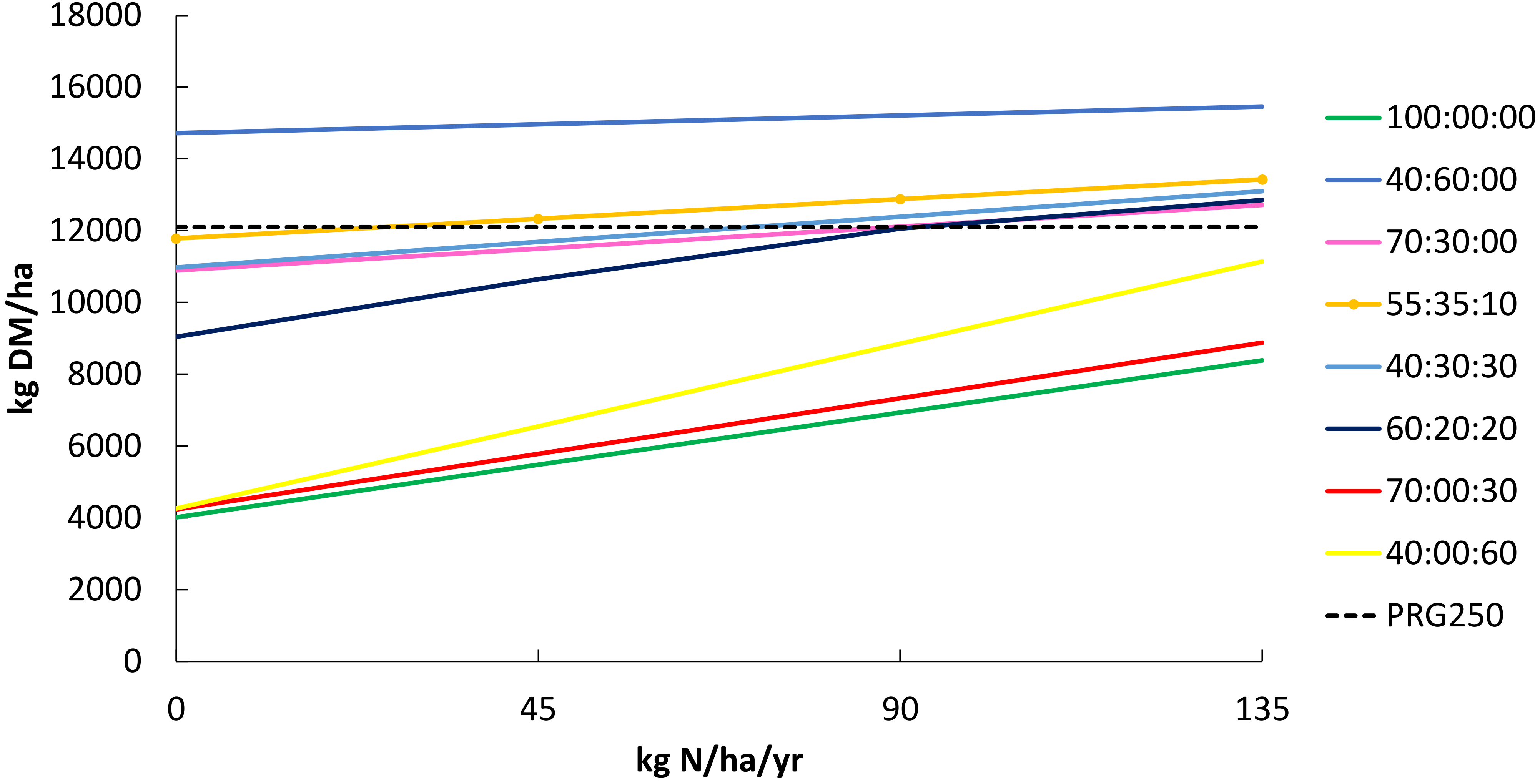
- Small number (3+) species representing different plant functional groups
- Niche complementarity
- Facilitation

Smartgrass
Biodiversity for production

- 112 plots established in 2013
- 1-9 species from 3 functional groups (included in different proportions)
- Four levels of N : 0, 45, 90, 135 kg N/ha/yr
- Conventional control: PRG 250 kg N/ha/yr
- DM yield, invertebrate diversity, persistence

UCD DUBLIN

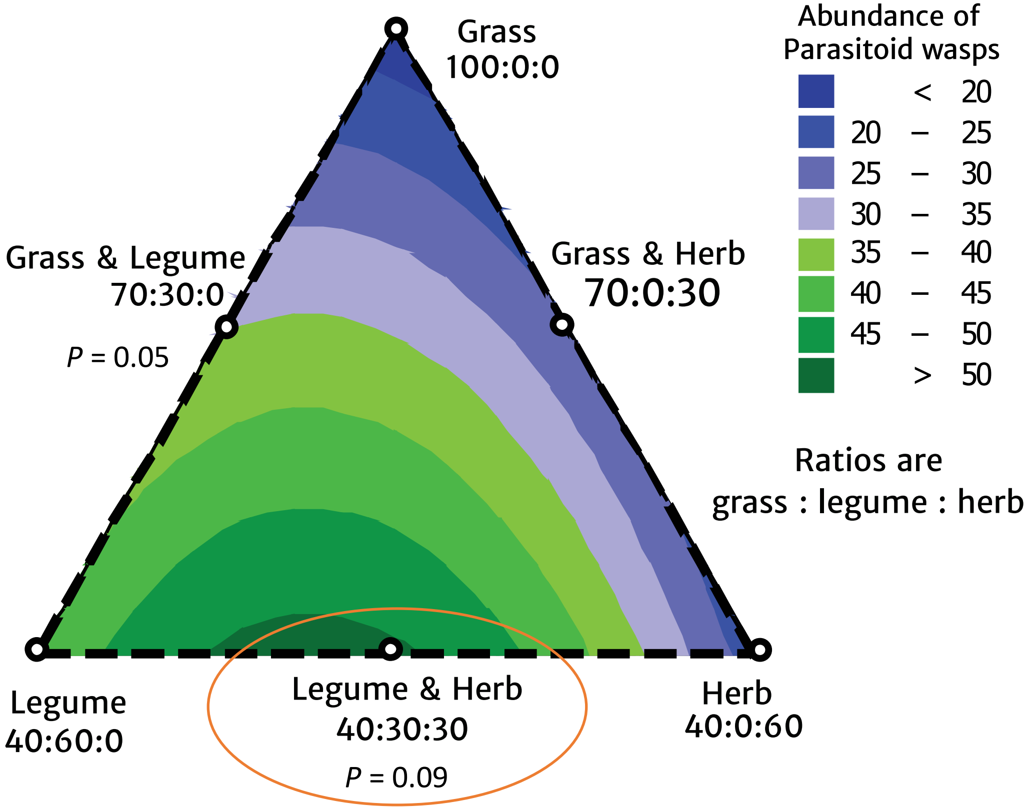
Effect of N on annual herbage production (kg DM/ha)



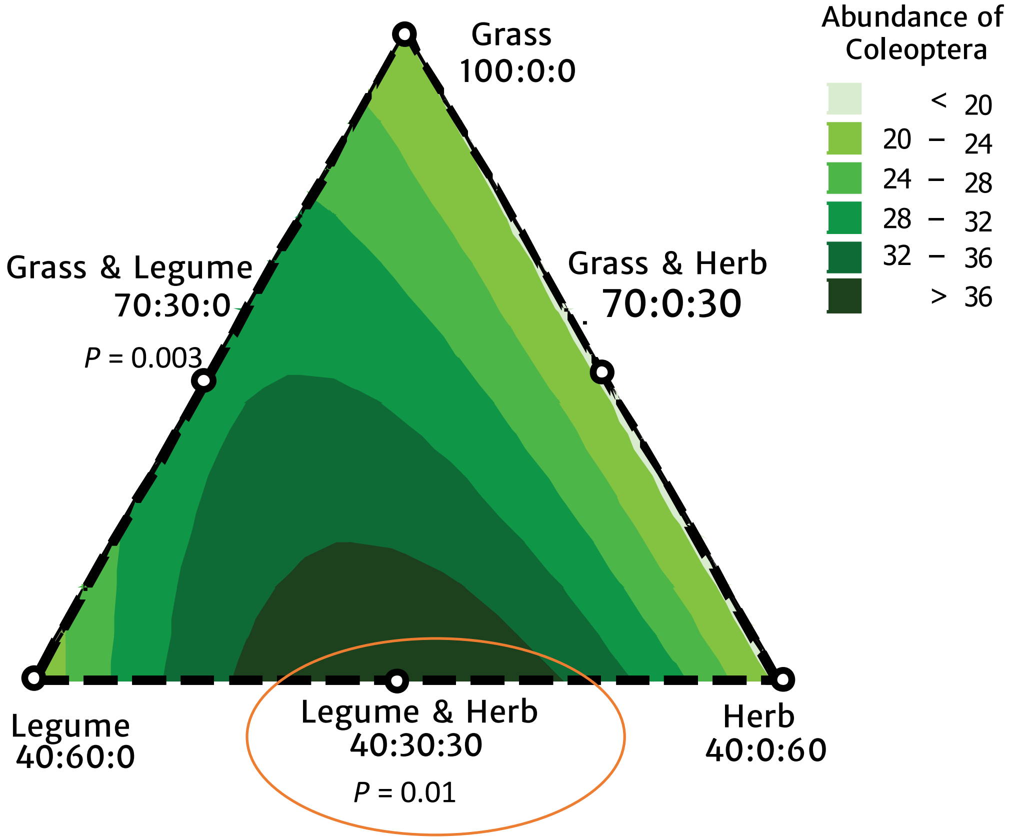
Grace (2018)

Insect abundance

Parasitoid wasps

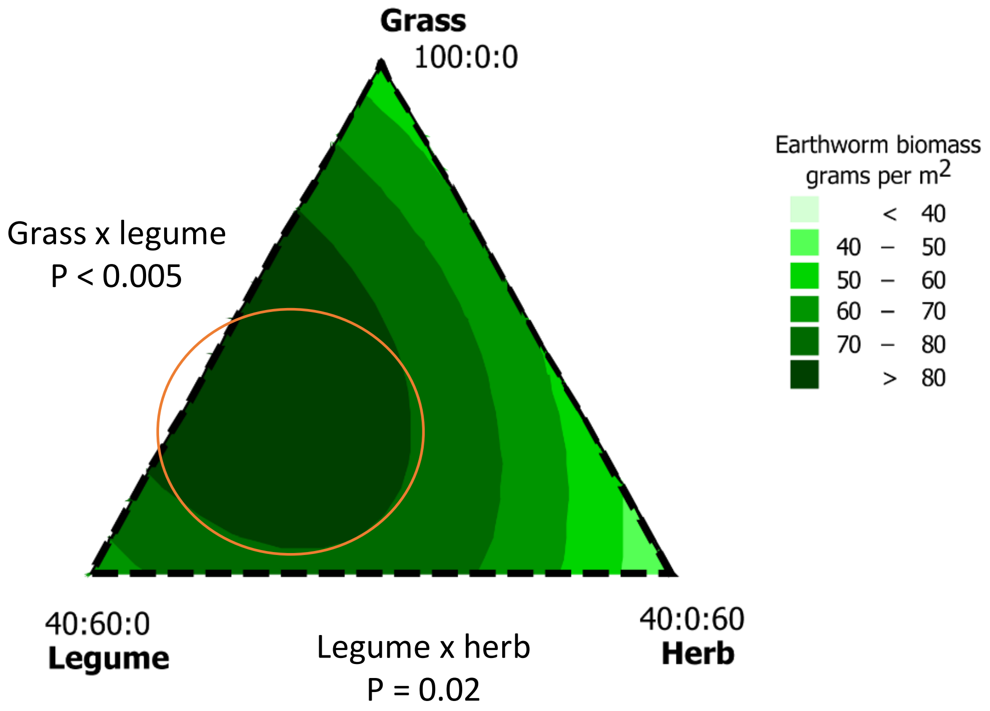


Beetles

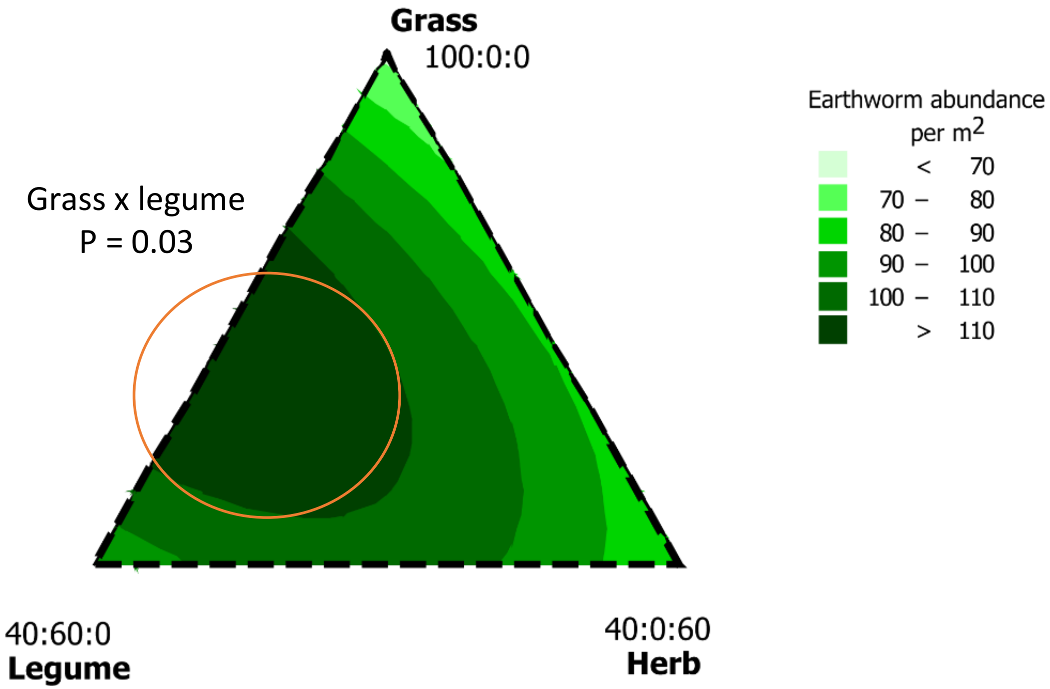


Earthworms

Biomass of 80 g m^{-2} = **800 kg ha^{-1}**

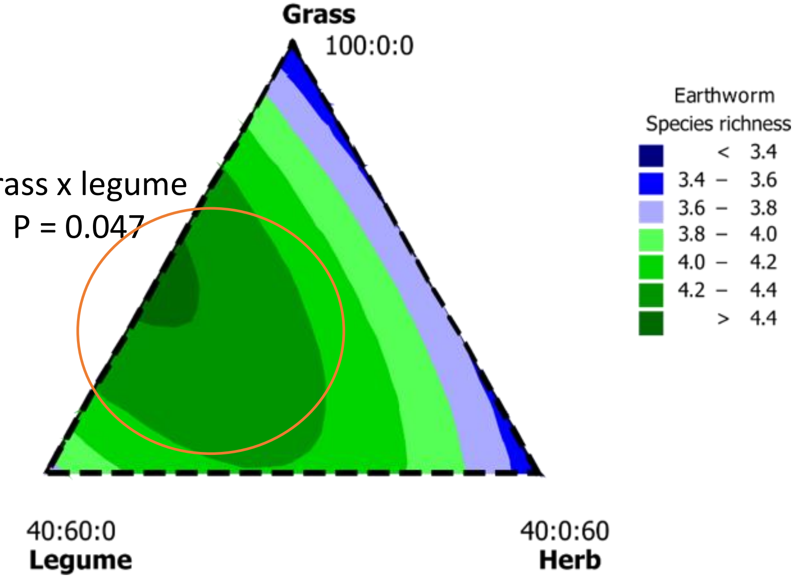


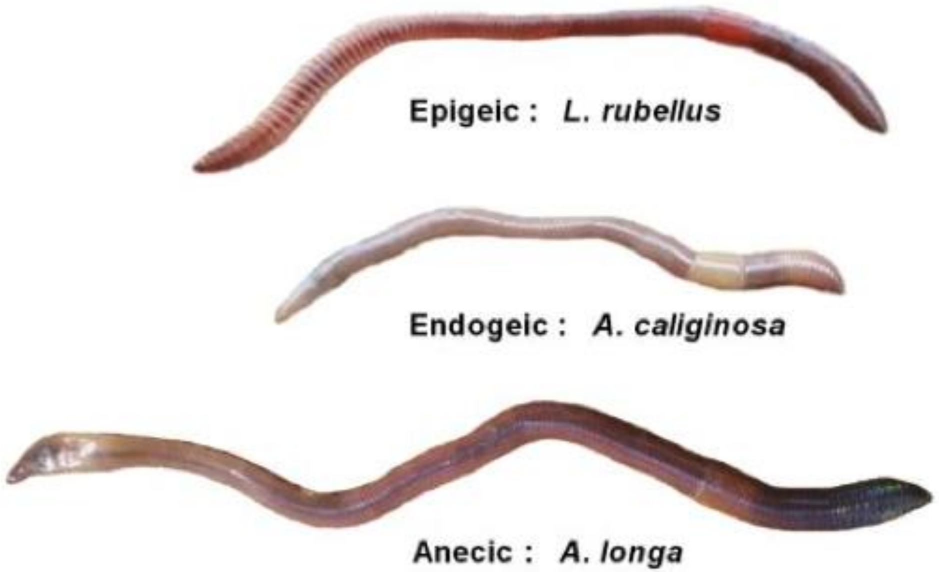
Abundance of 110 m^{-2} = **1.1 million ha^{-1}**



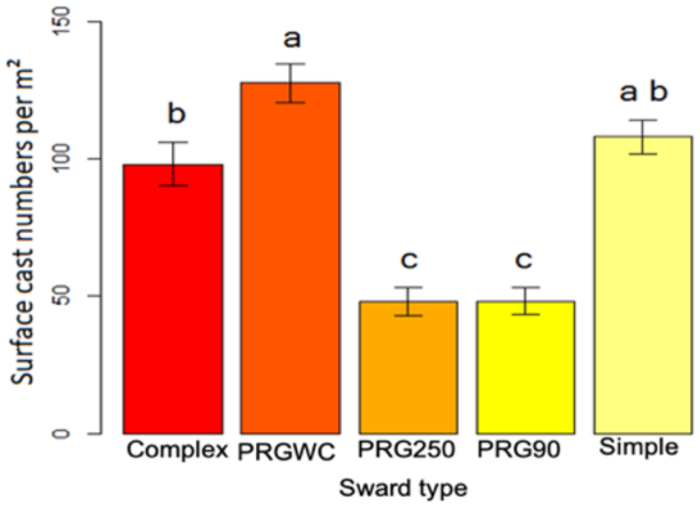
Earthworm species richness

Grass x legume
P = 0.047

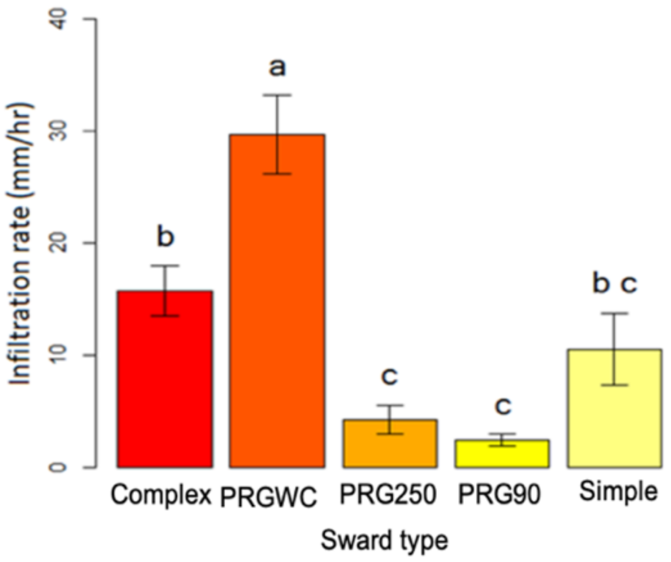




Earthworm surface casts

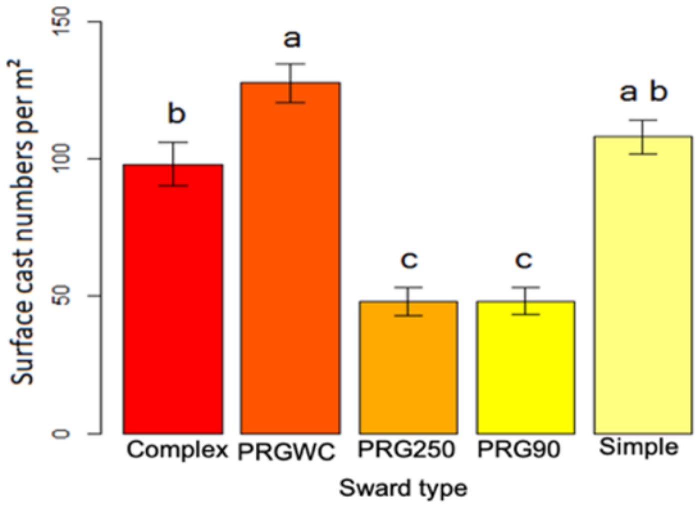


Water infiltration rates



Shnel et al. (under review)

Earthworm surface casts



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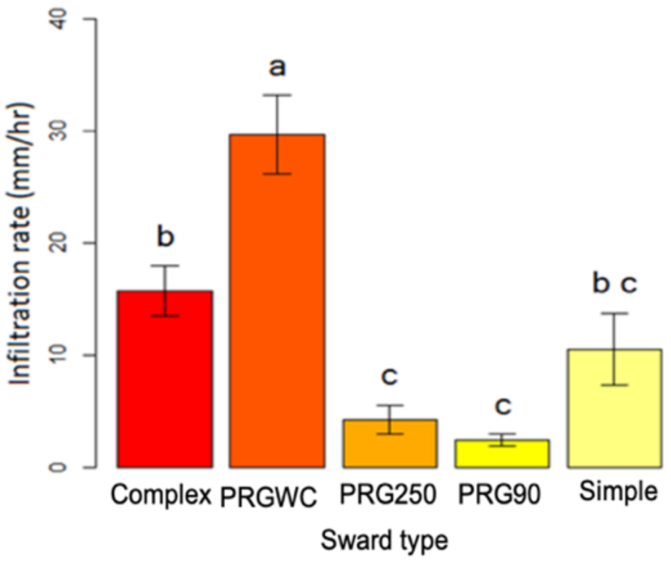
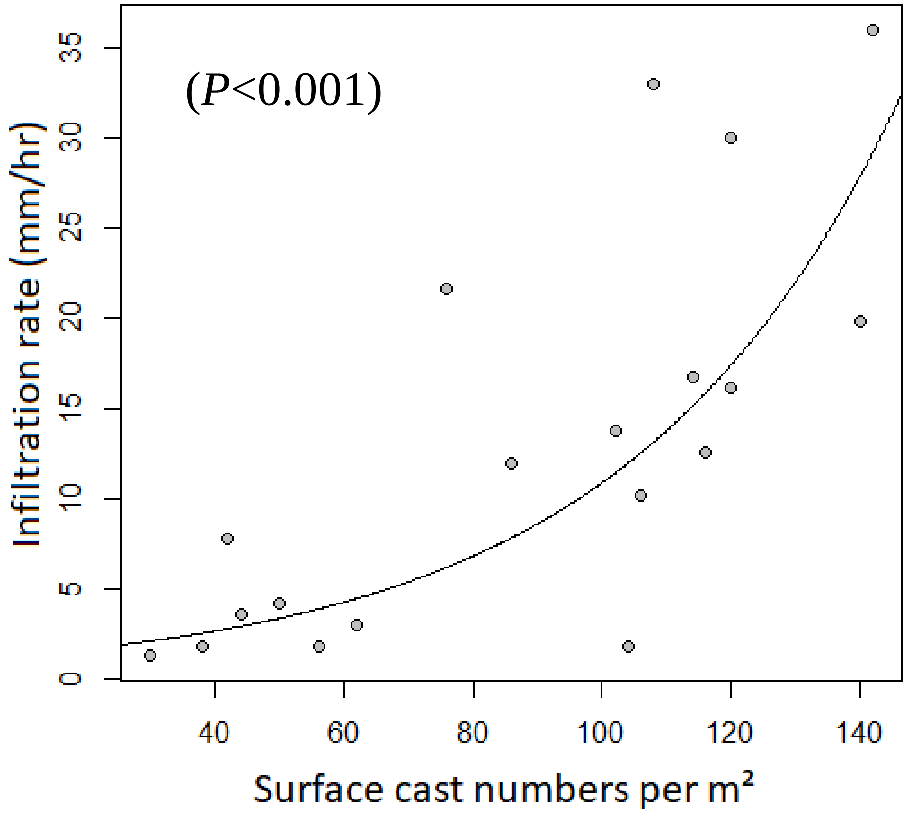


Relationship between earthworm casts and water infiltration



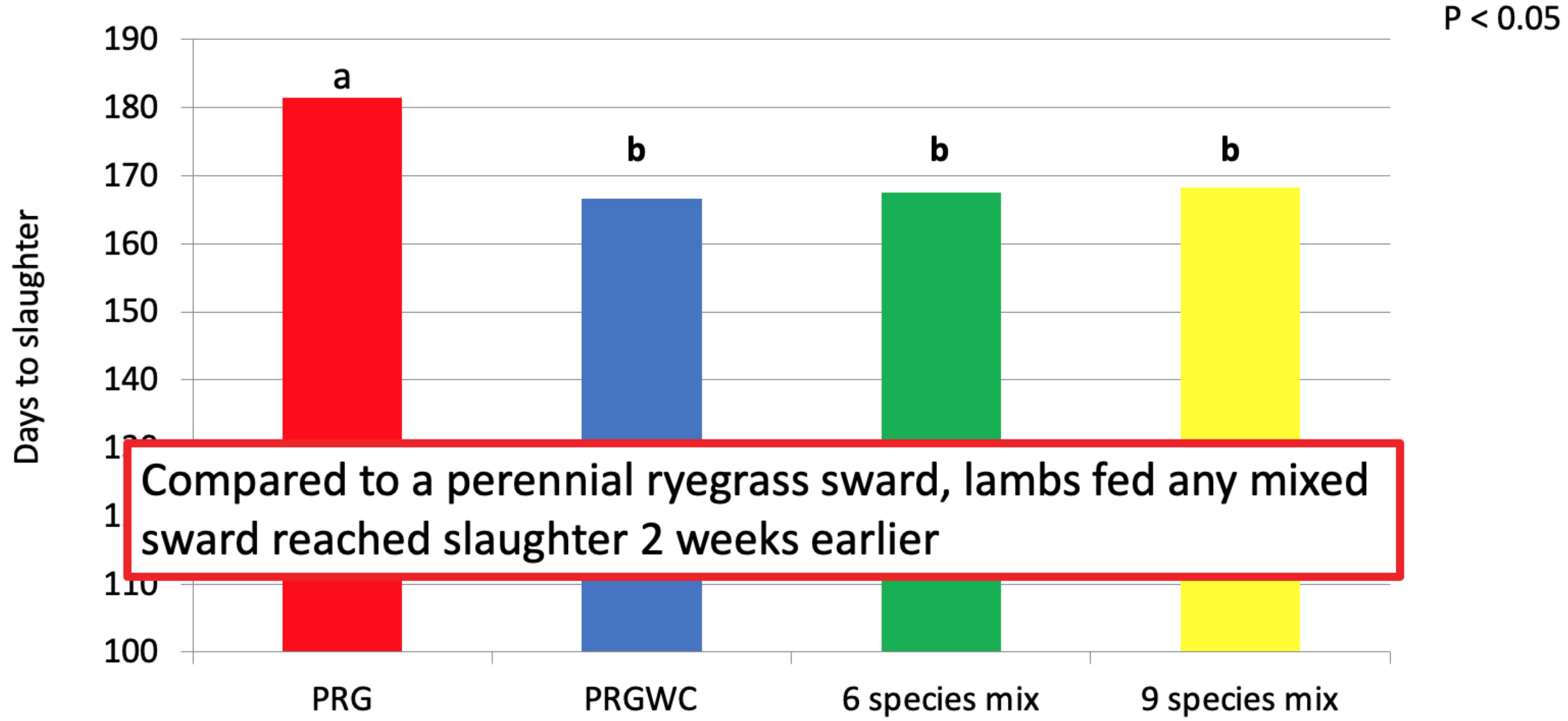
Shnel et al. (2021)

Farmlet Experiment at UCD Lyons Farm

- 4 sward types, randomised and replicated – 2015 & 2016
- 30 twin suckling ewes/treatment @ stocking rate of 12.5 ewes/ha repeated over 2 years
- Rotational grazed 5 paddocks/farmlet

  - PRG @ 163 kg N/ha/yr
  - PRG & WC @ 90 kg N/ha/yr
  - 6 species (2 x grasses + 2 x legumes + 2 x herbs) @90 kg N/ha/yr
  - 9 species (3 x grasses + 3 x legumes + 3 x herbs) @90 kg N/ha/yr

The effect of sward type on number of days required to reach target slaughter weight

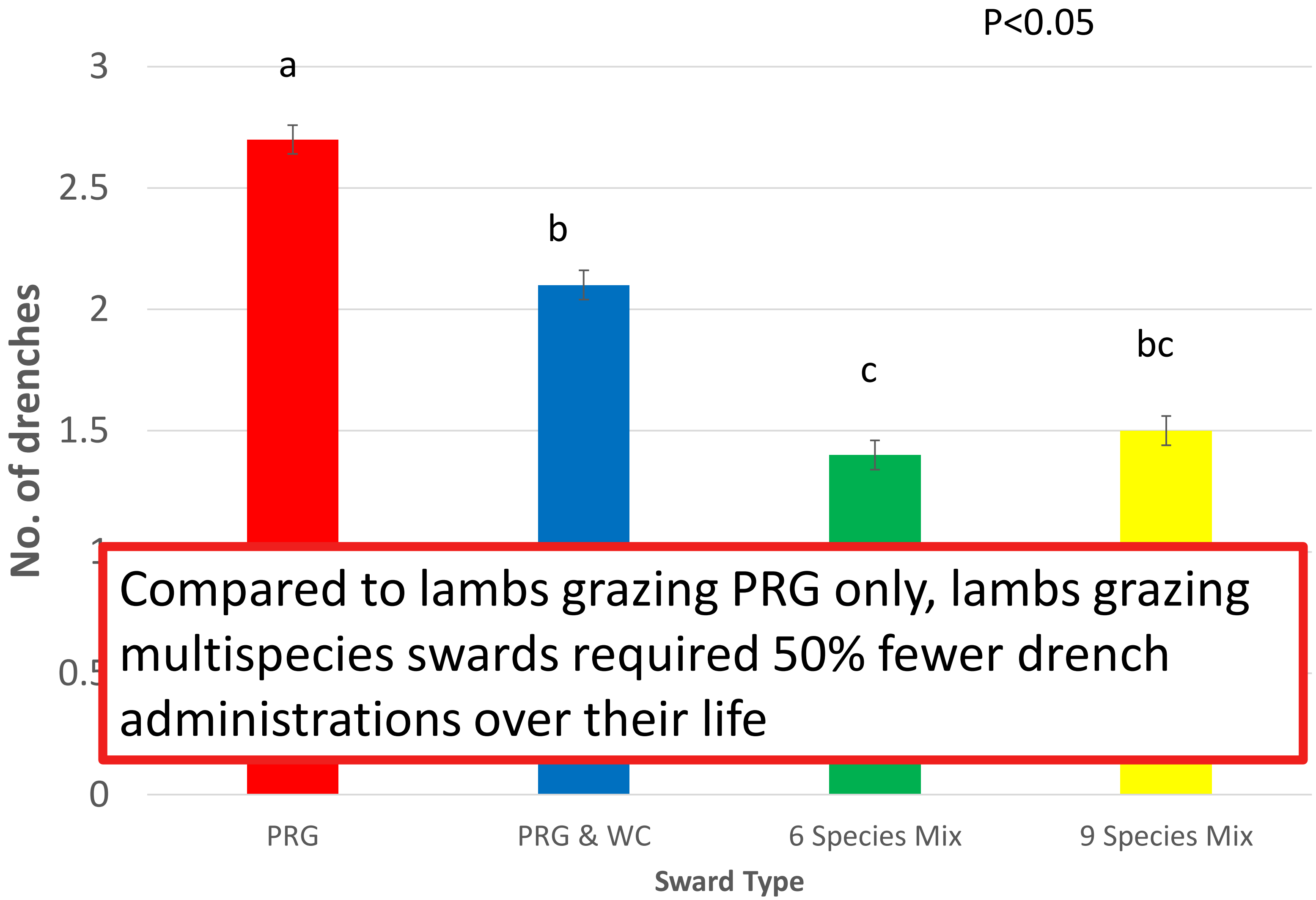


Compared to a perennial ryegrass sward, lambs fed any mixed sward reached slaughter 2 weeks earlier

Smartgrass
Biodiversity for production

Grace et al., 2019

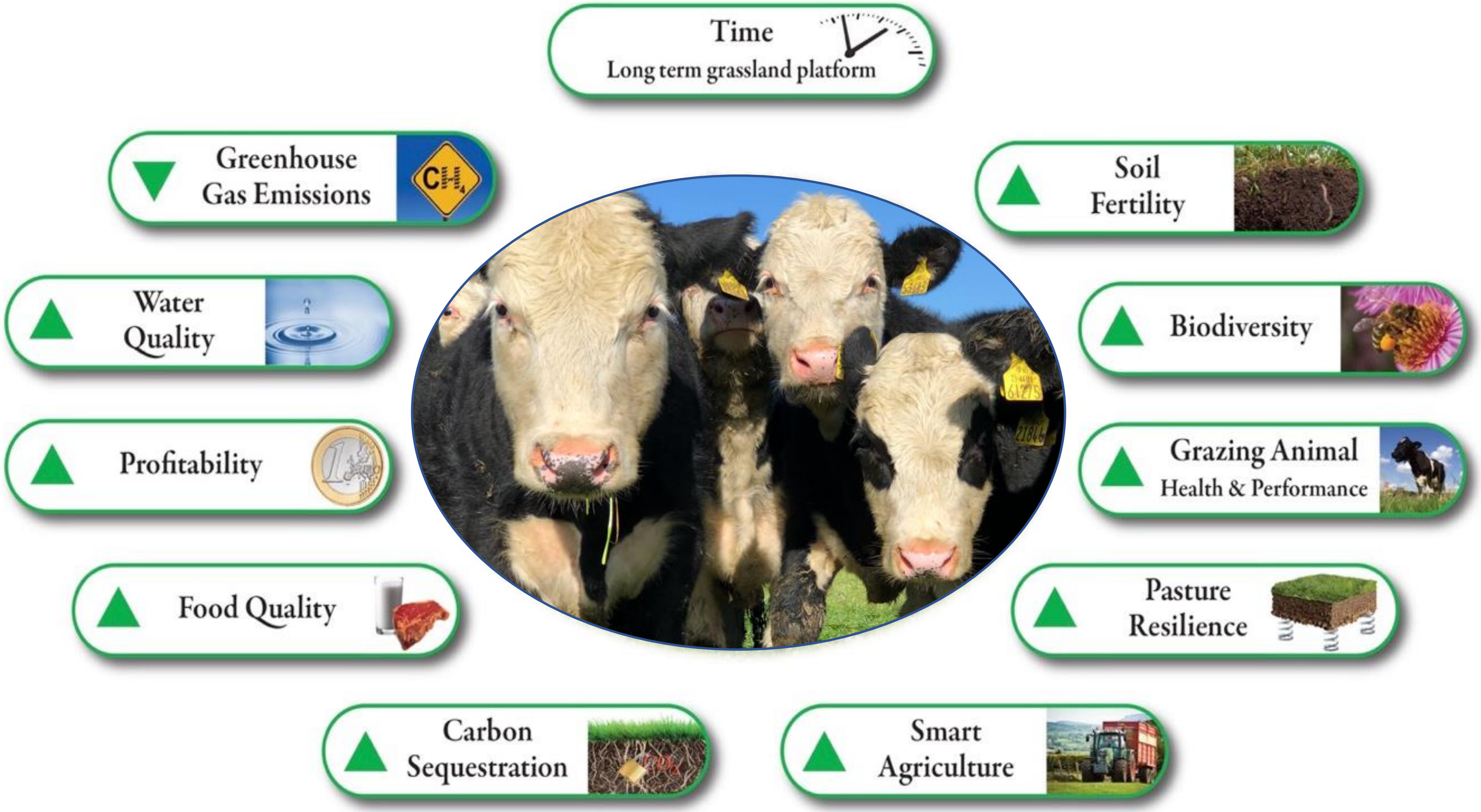
The effect of swards type on mean number of anthelmintic treatments required



Compared to lambs grazing PRG only, lambs grazing multispecies swards required 50% fewer drench administrations over their life

Grace et al., 2019

UCD Lyons Long Term Grazing Platform

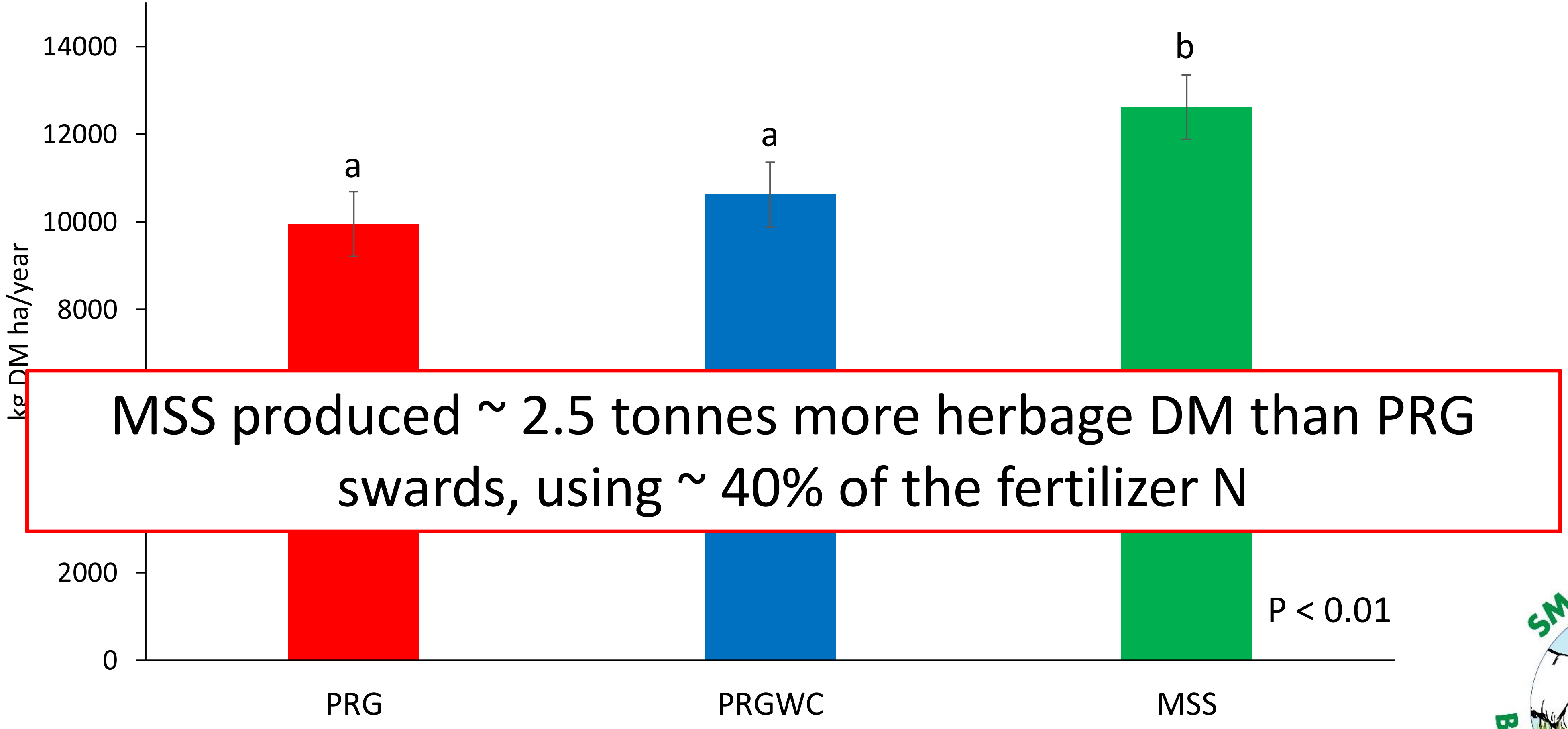


GLOBAL FARM PLATFORM
Towards Sustainable Ruminant Production

UCD Lyons Long Term Grazing Platform

- 3 farmlets established 2019 (8ha each)
  - PRG – 205 kg N/ha
  - PRG and white clover - 90 kg N/ha
  - MSS - PRG, Timothy, white clover, red clover, chicory and ribwort plantain - 90 kg N/ha
- Stocked @ 2.5 LU/ha – dairy calf to beef

The impact of sward type on dry-matter production (2-year average 2020 – 2021)



MSS produced ~ 2.5 tonnes more herbage DM than PRG swards, using ~ 40% of the fertilizer N

Baker *et al.*, 2022

The impact of sward type on animal slaughter parameters

Slaughter parameter	PRG	PRGWC	MSS	SEM
Carcass weight (kg)	314	314	313	2.83
Kill out percentage (%)	51	51	51	0.21
Days to slaughter	524[a]	494[b]	490[b]	5.55

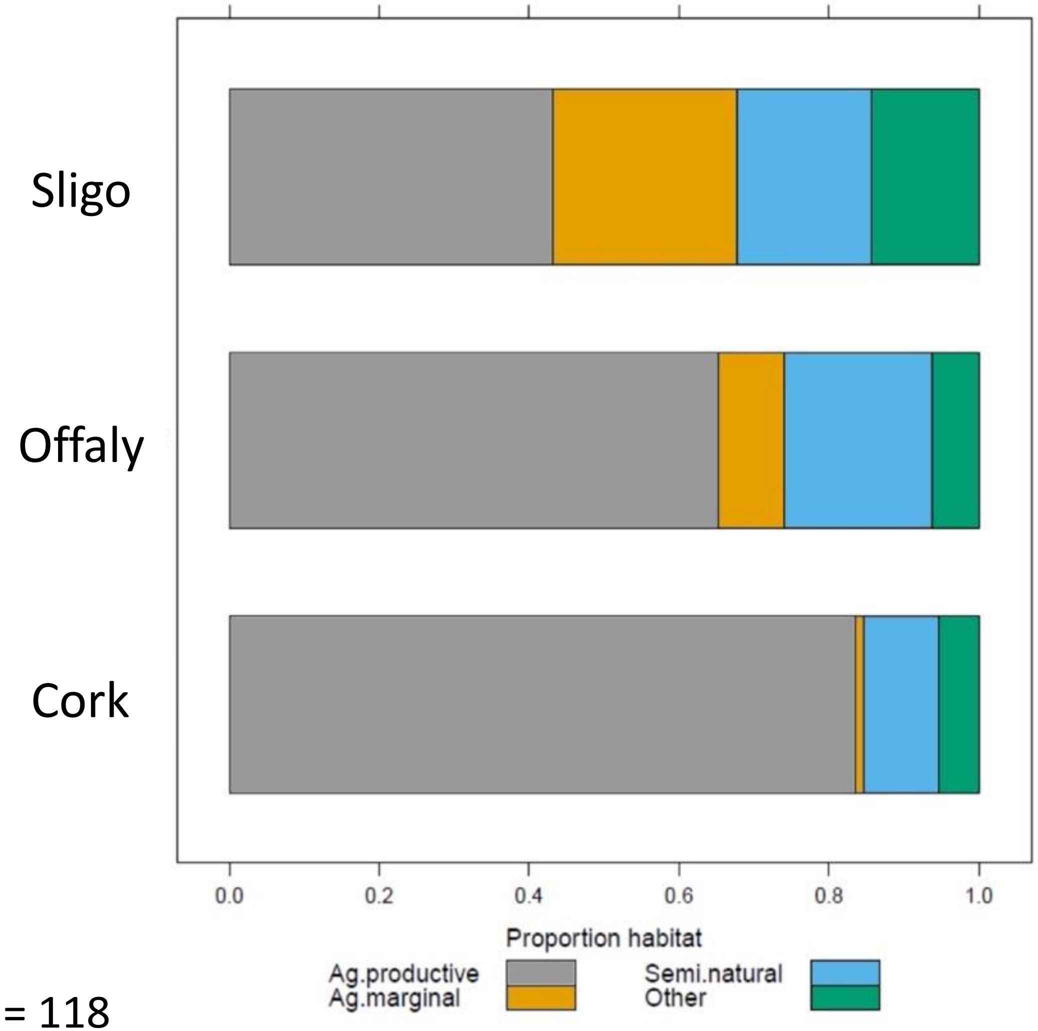
$P<0.05$

Boland et al., 2022

Current status farmland habitat area:

- Average farm area under semi-natural habitat area 13% (Sheridan *et al*., 2011, 2017)
- East Galway – average farm area ~ 15% (Sullivan *et al*., 2011)
- On more intensively managed farms (including tillage) ~ 10% (Larkin *et al*., 2019)
- Compares very favourably with some other countries
  - Netherlands 2.1 -5% (Manhoudt and de Snoo, 2003)
  - France 2-12% (Vereijken, 1995)
  - Poland 1-4% (Vereijken, 1995)

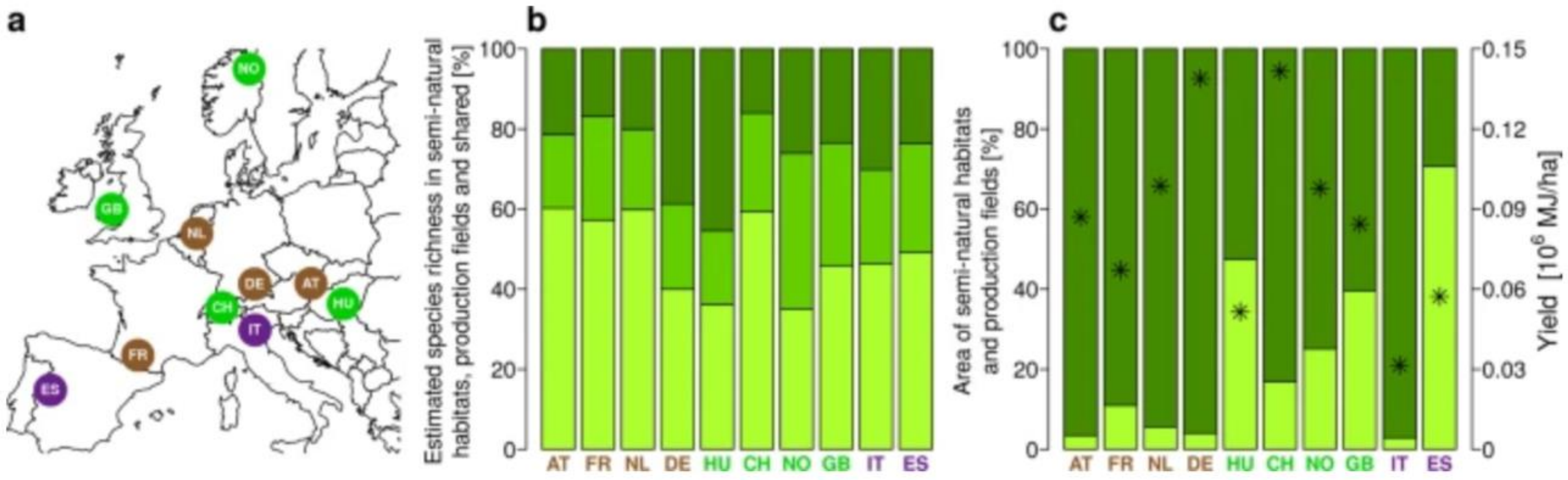
Farmland habitat type



n = 118
Region $p < 0.001$
System $p = 0.002$

Sheridan et al. (2017)

Fig. 1: Importance of semi-natural habitats for biodiversity in ten European farmland regions.



a Location of the study regions with dominant type of agricultural land use (brown: arable crops, mixed systems and horticulture, bright green: grassland, violet: permanent crops). **b** Proportions of summed vascular plant, earthworm, spider and bee species unique to semi-natural habitats (light green bars), shared by the semi-natural habitats and production fields (medium green bars) and unique to production fields (dark green bars) per region (per taxa separately in Supplementary Fig. 1). **c** Percentage of farm area occupied by semi-natural habitats (light green bars) and production fields (dark green bars) per region, and average yield (stars) over fields of sampled farms in the ten study regions.

Jeanneret et al., 2021.
https://www.nature.com/articles/s43247-021-00256-x

What can the Life Science Universities do?

- Education
  - Not just ‘nice to have’ – need to focus on relevance to everyday lives
  - Instill students with enthusiasm and hope
- Research
  - Inter-disciplinary
  - Long-term research programmes
- Outreach
  - Public engagement
  - ‘Walk the walk’ – lead by example