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QUEEN'S UNIVERSITY BELFAST
ESTD1845

Multi-Species Swards Science & Practice

28th June 2023

Department of Agriculture, Environment and Rural Affairs
www.daera-ni.gov.uk

The European Agricultural Fund for Rural Development: Europe investing in rural areas

rural Development Programme

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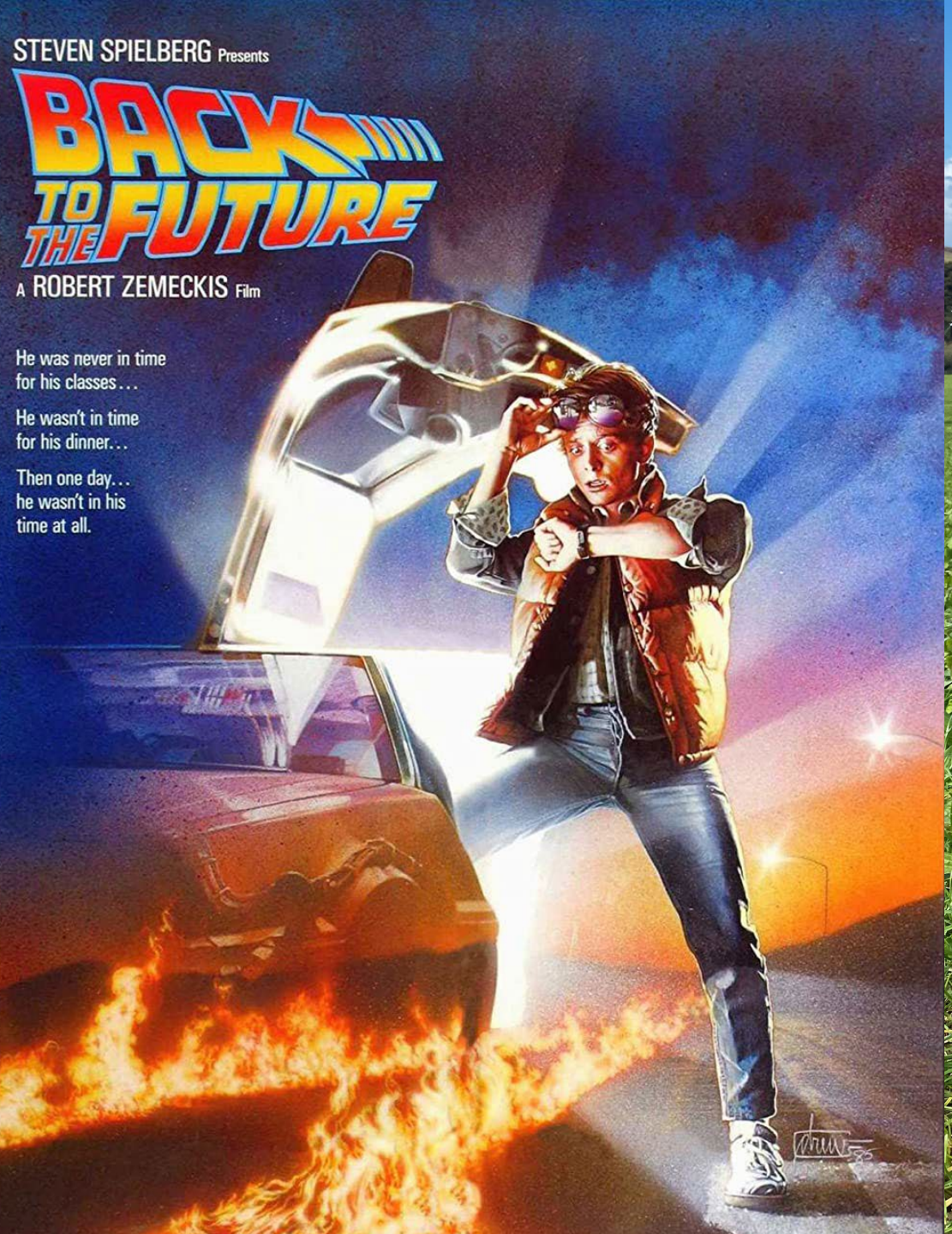

Multi-Species Swards – an old technology for a new challenge?

Experiment carried out on a farm in County Down in 1914 on 1 acre sown out with:

Species	Rate (lb)	Rate (kgs)
Perennial Ryegrass	28	12.7
Cocksfoot	4	1.8
Timothy	4	1.8
Fescue	5	1.4
Meadow Fox Tail	3	1.4
Perennial Red (Red Clover)	3	1.4
Wild White Clover	4	1.8
Total	**51**	**23.1**

Cost 43/0
£203.89 (in today's money)

Species	Rate (lb)	Rate (kgs)
Perennial Ryegrass	50	22.7
Red Clover (Crimson Clover)	4	1.8
Total	**54**	**24.5**

Cost 14/6
£68.75 (in today's money)

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	Multi Mix	PRG & RC	Difference
Yield of Hay in 1915	56 cwt - 1 qtr - 0 lb (2.86t)	44 cwt - 0 qtr – 14 lb (2.24t)	12 cwt - 0 qtr - 16 lb (0.62t) 27.5%
Sheep Liveweight Gain			
1915 aftermaths	125 lb	116 lb	9 lb
1916 grazing	420 lb	298 lb	122 lb
1917 grazing	707 lb	444 lb	263 lb
1918 grazing	374 lb	204 lb	170 lb
Total weight of mutton	**1626 lb (738kg)**	**1062 lb (482 kg)**	**564 lb (256kg) 53.1%**
1919 Field ploughed & sown with oats			
Yield of grain	33 cwt (1.68t)	26 cwt (1.32t)	7 cwt (0.36t) 26.9%
Yield of straw	35 cwt (1.78t)	20 cwt – 3 qtr – 21 lb (1.06t)	14 cwt – 0 qtr – 2lb (0.71t) 66.8%

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	Units	Price per Unit s/d	Total £-s-d
Difference in mutton value	564 lb	0/9 per lb (£7.84/kg today)	£9-8-0
Difference in hay crop	12 cwt - 0 qtr - 16 lb	3/0 per cwt (£278/t today)	£1-16-5
Difference in grain	7 cwt	16/3 per cwt (£1,526/t today)	£5-13-9
Difference in straw	14 cwt	5/0 per cwt (£467/t today) [£70 4x4 round bale)	£3-10-0
Total Difference			**£20-8-2 (£1,935 today)**
Difference in Cost of Seed			£1-8-6
Net benefit of "good" mixture			**£18-19-8 (£1,800 today)**
Benefit seen over 5 years so value of land was increased by £3-15-11 per acre (£360 today)			

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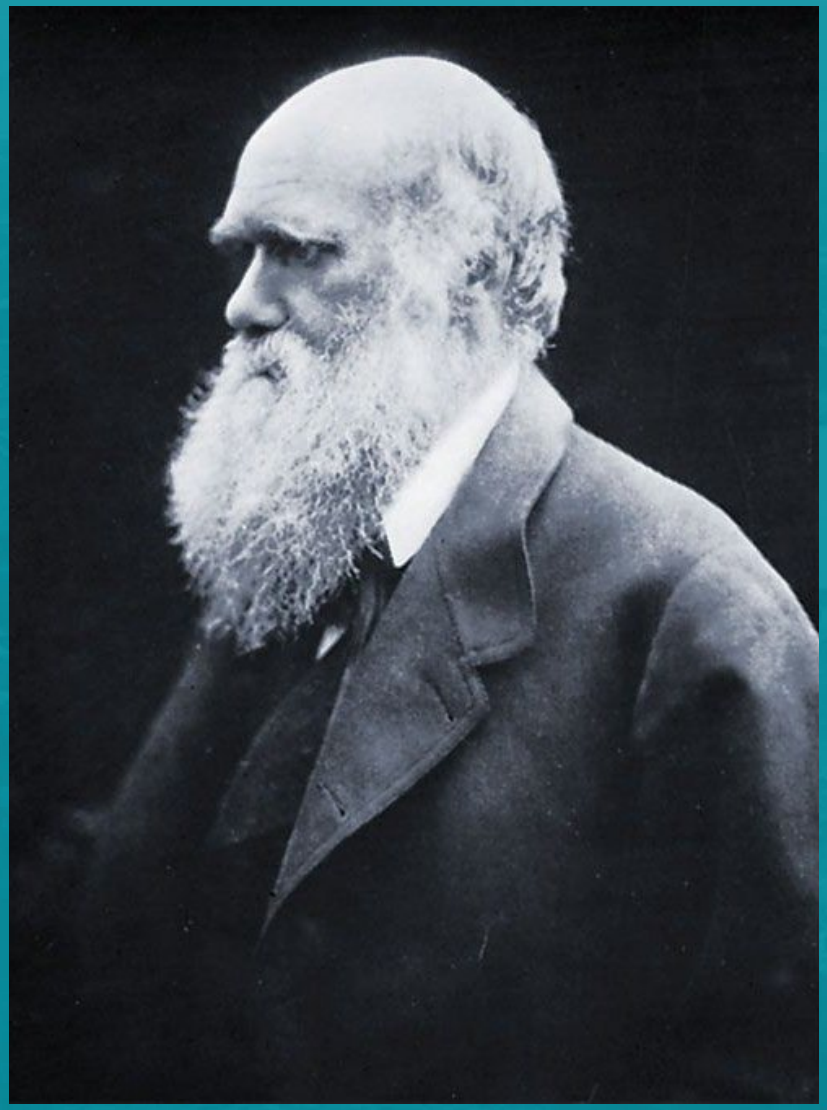
Strength in Diversity

- Charles Darwin identified over-yielding Darwin & Wallace (1858)
- Like heterosis in breeding the yield of a multi-species sward is greater than the average of the species when grown as a mono-culture.
- However, with the advent of the modern perennial ryegrasses & modern fertilisers nothing could keep up with them.
- PRG became dominant



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So why even consider moving away from PRG monocultures or PRG & White Clover?

- PRG is a thoroughbred, it needs fed & watered
  - Increasing cost of manufactured fertiliser
  - Increased incidence of more extreme weather events
- PRG gets easily stressed, lowering grass quality
- A monoculture can be a green desert
- Biodiversity brings resilience

- Optimisation / resilience versus maximisation

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Acknowledgements

- The SUPER-G Horizon 2020 project for starting us on this journey
- DAERA & EU / EAFRD for funding this project
- Our six farmers for their unbridled enthusiasm and commitment and taking a leap of faith with us.
- AFBI & QUB Colleagues

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rural Development Programme

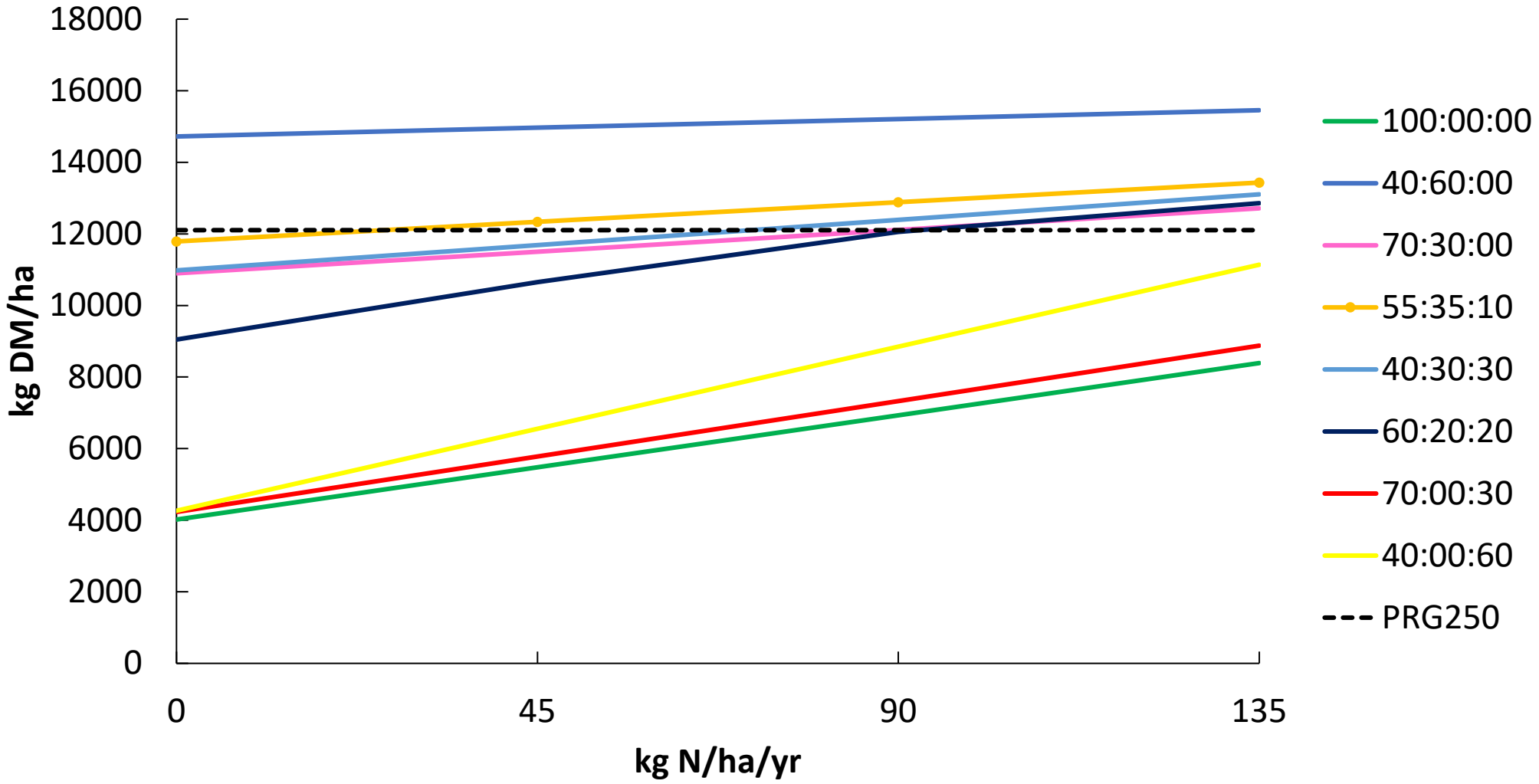
Multispecies Swards as a Biological Tool to Enhance Sustainability of Ruminant Production Systems

Associate Professor Helen Sheridan
School of Agriculture and Food Science, UCD.
helen.sheridan@ucd.ie

Smartgrass
Biodiversity for production

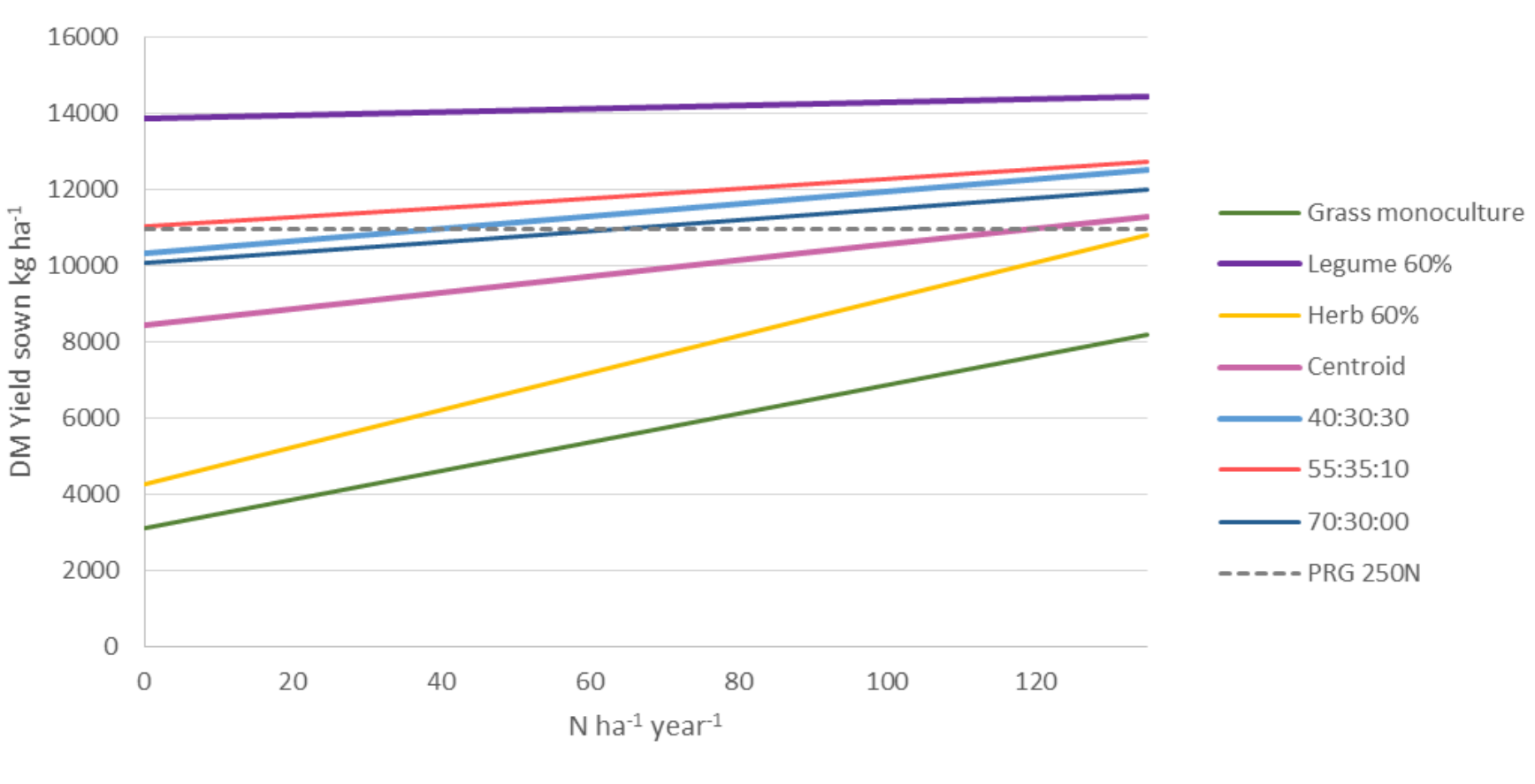
- 112 plots established in 2013
- 1-9 species from 3 functional groups (included in different proportions)
- Four levels of N : 0, 45, 90, 135 kg N/ha/yr
- Conventional control: PRG 250 kg N/ha/yr
- DM yield, species persistence, invertebrate diversity

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

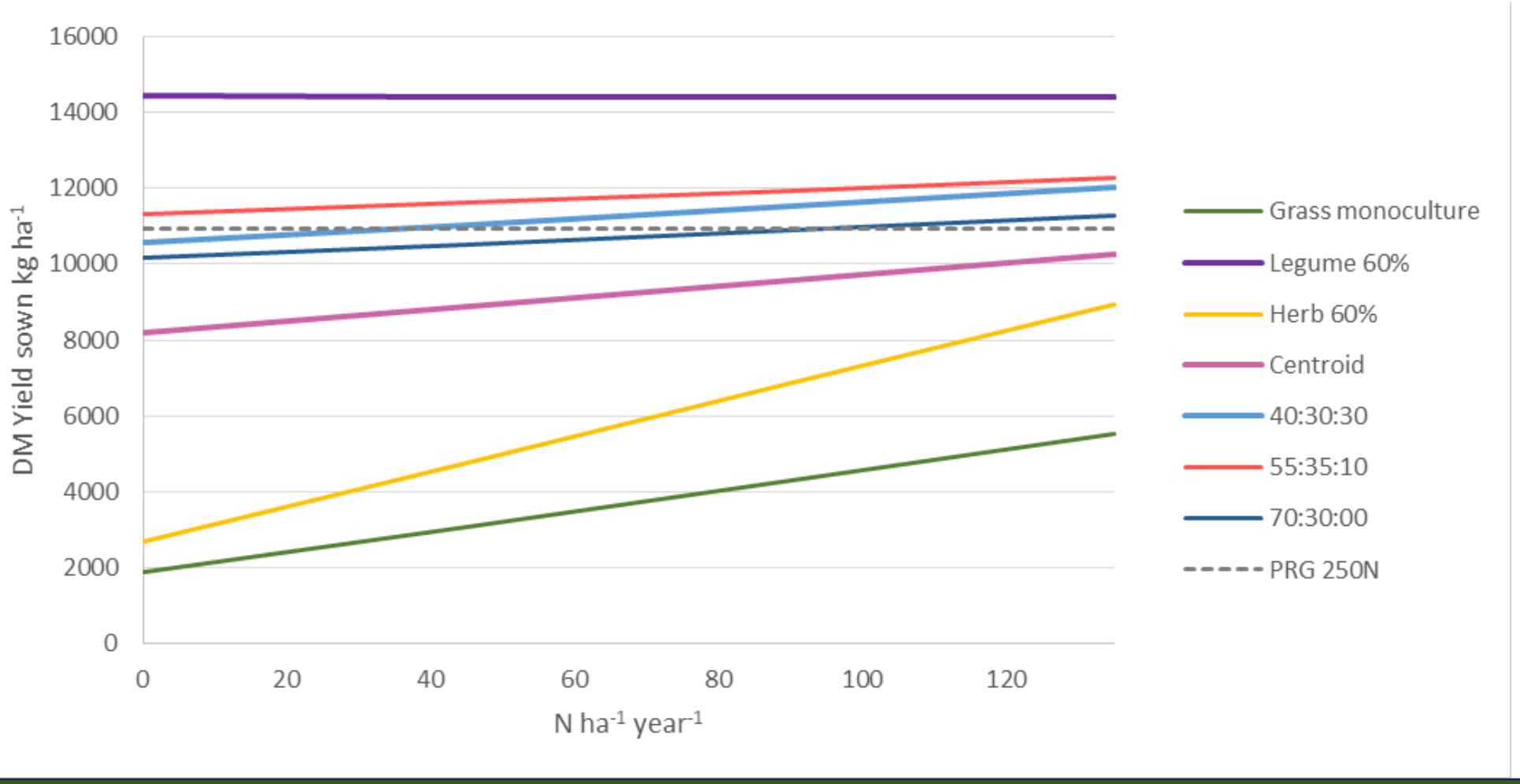


Grace (2018)

DM yield stability – 2014

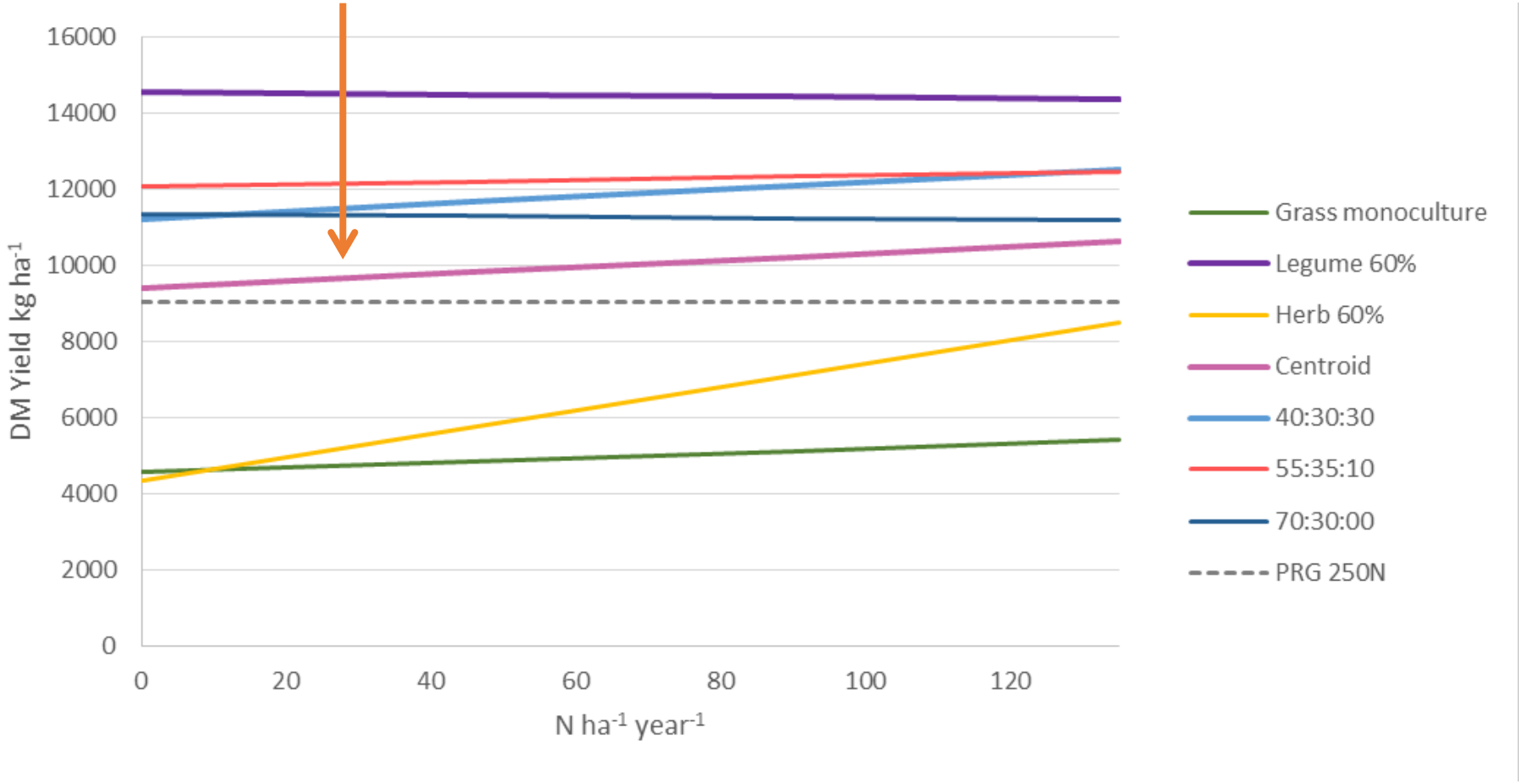


DM yield stability - 2015

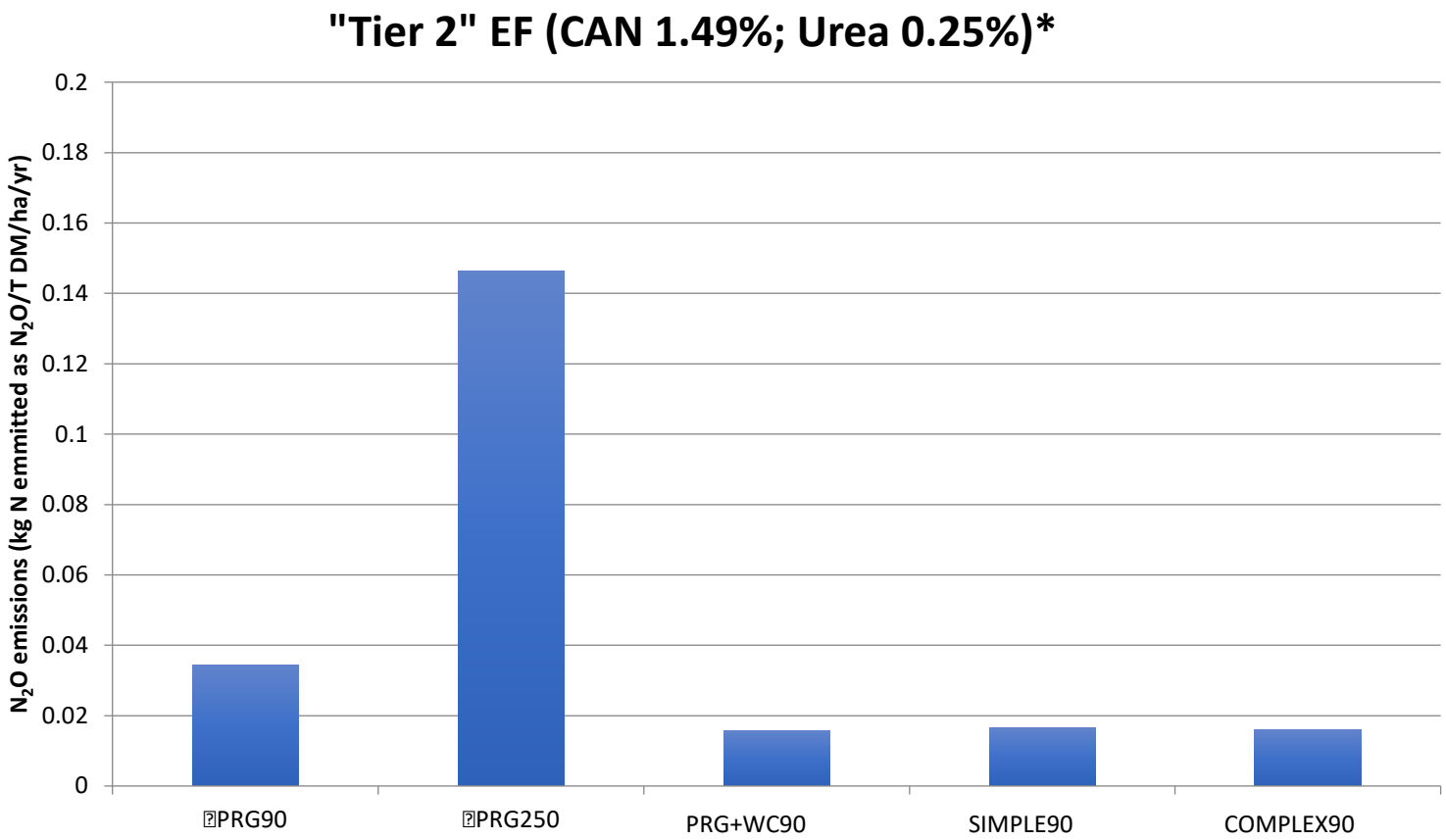


DM yield stability - 2016

PRG yield dropped from 11 t/ha to 9 t/ha



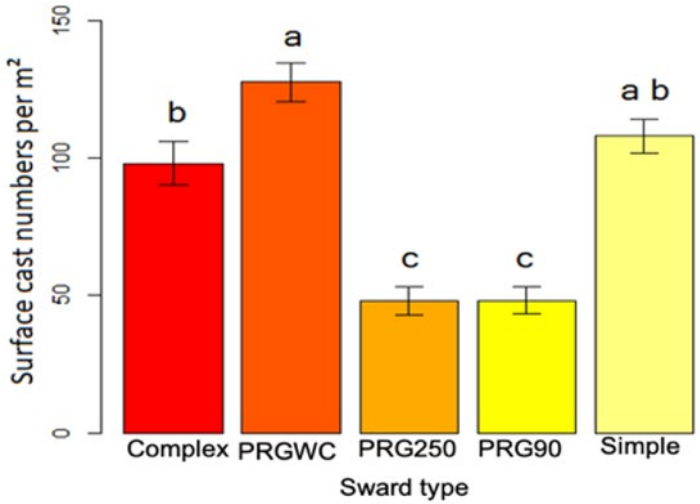
Estimated impact on N_2O emissions



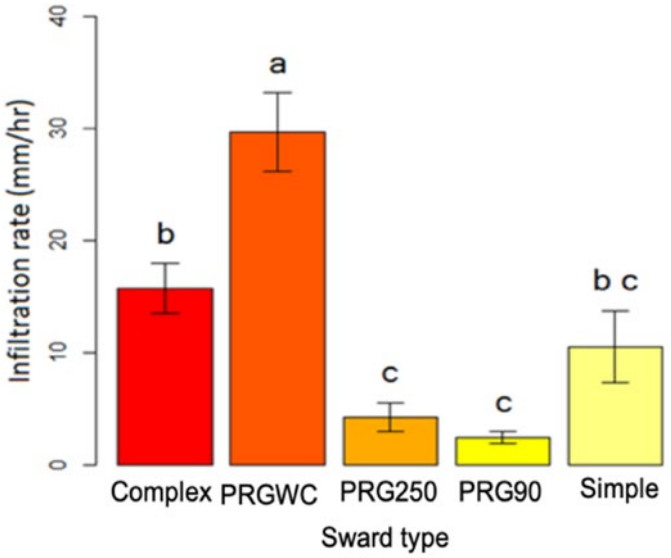
Murphy et al., 2018

* Harty, M. A., Forrestal, P. J., Watson, C. J., McGeough, K. L., Carolan, R., Elliot, C., ... & Lanigan, G. J. (2016). Reducing nitrous oxide emissions by changing N fertiliser use from calcium ammonium nitrate (CAN) to urea based formulations. Science of The Total Environment, 563, 576-586.

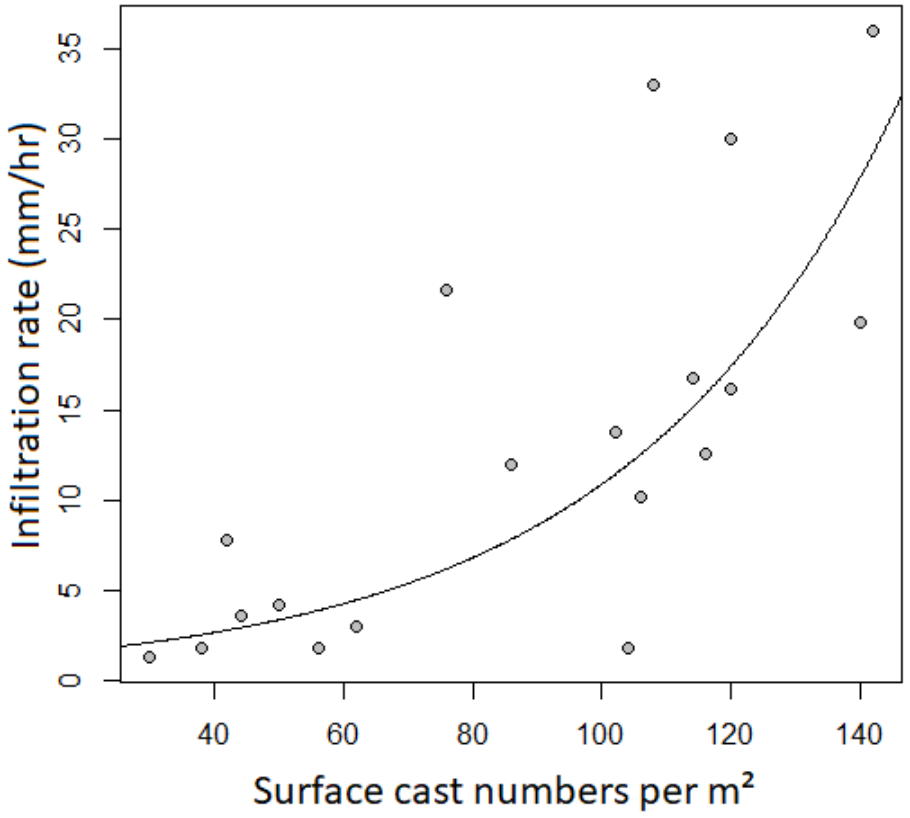
Earthworm surface casts



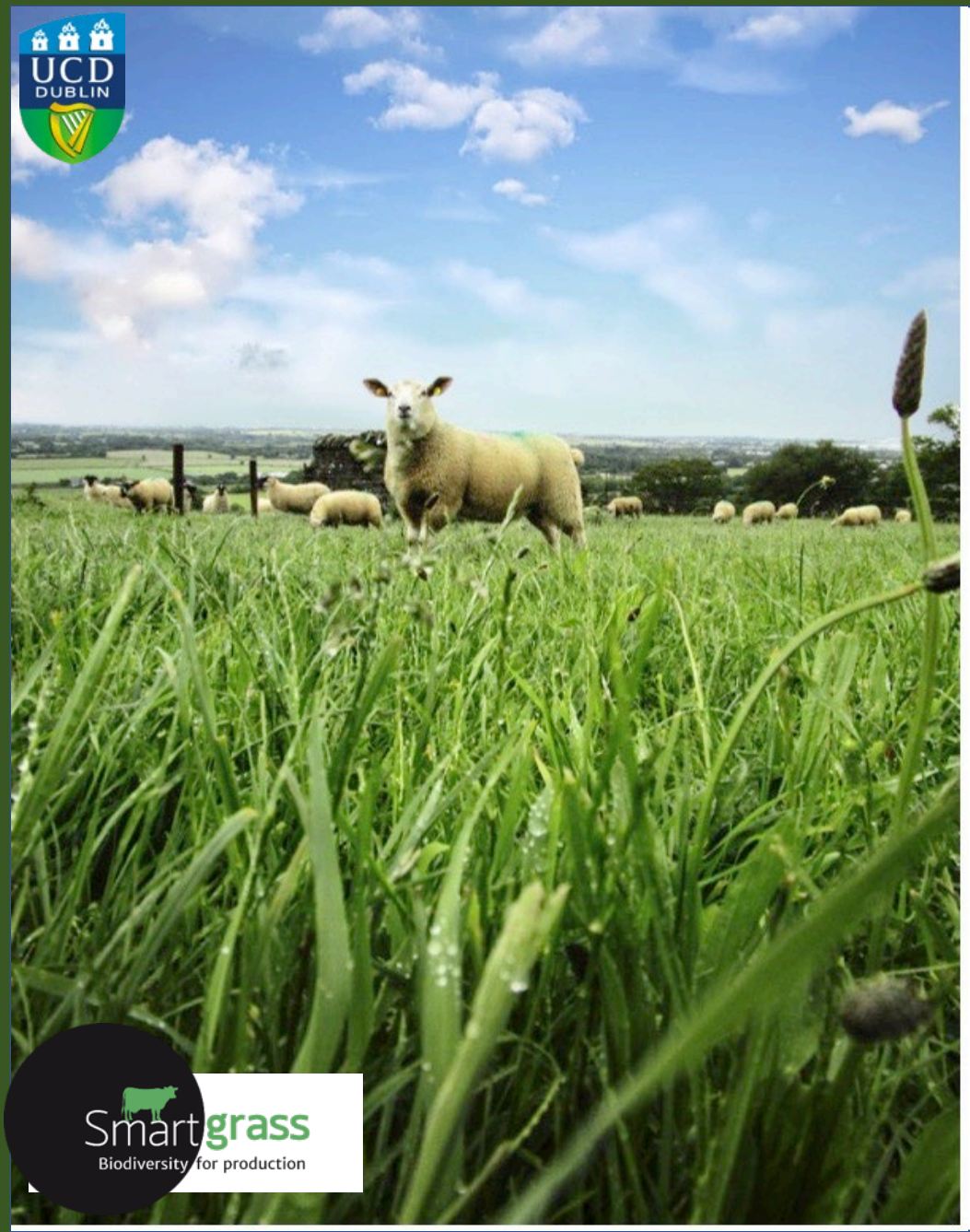
Water infiltration rates



Relationship between earthworm casts and water infiltration



Shnel et al. (2021)

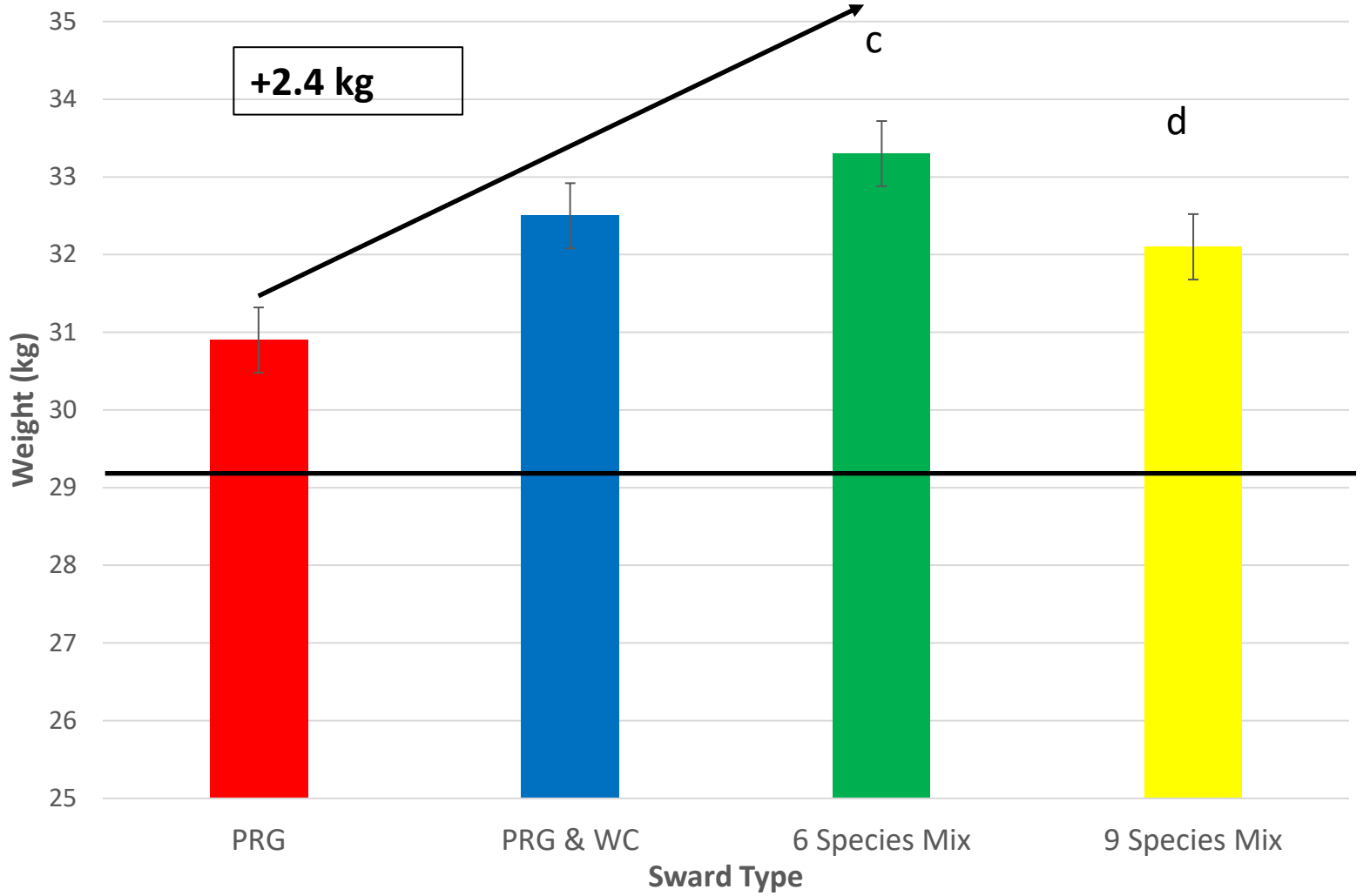


Farmlet Experiment at UCD Lyons Farm

- 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

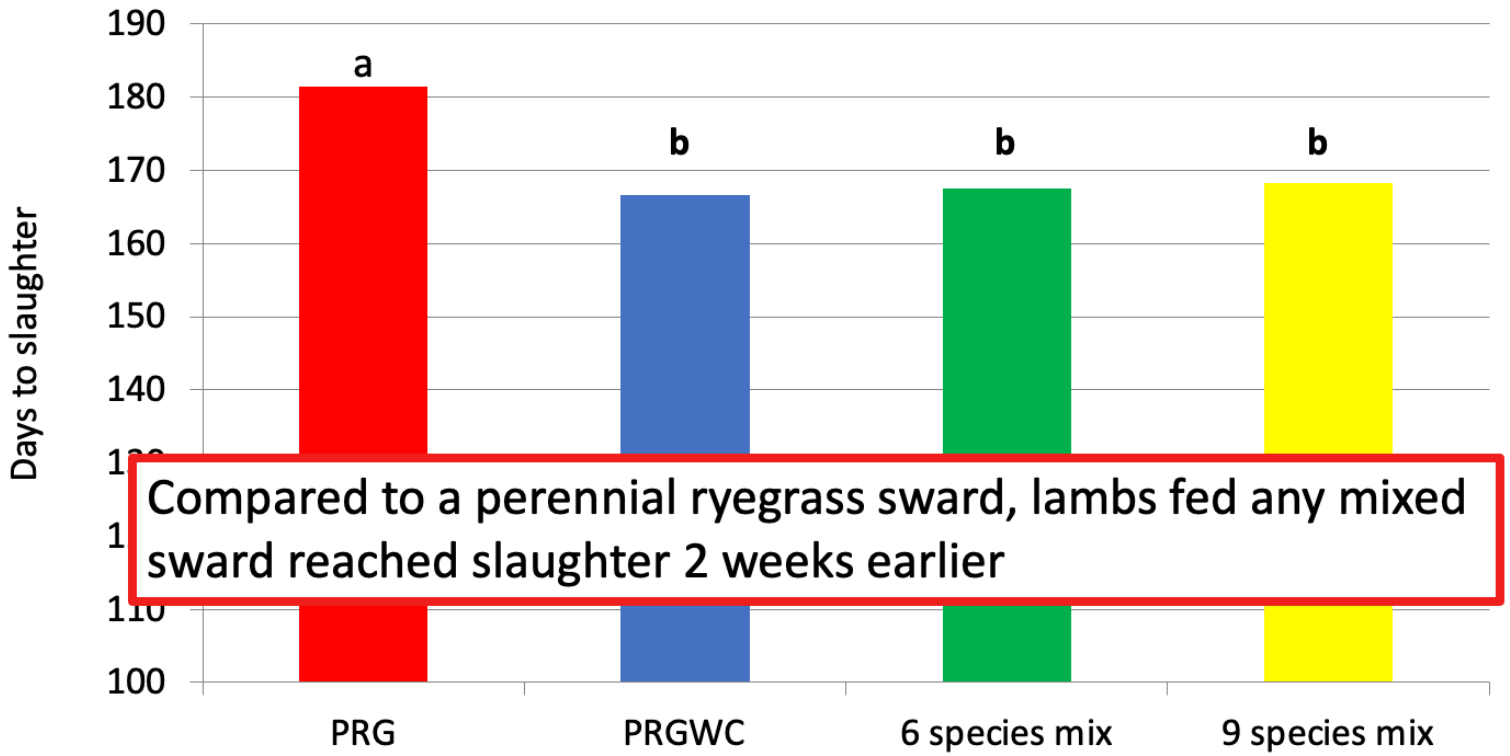
The effect of sward type on lamb weaning weights



Grace et al., 2018

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

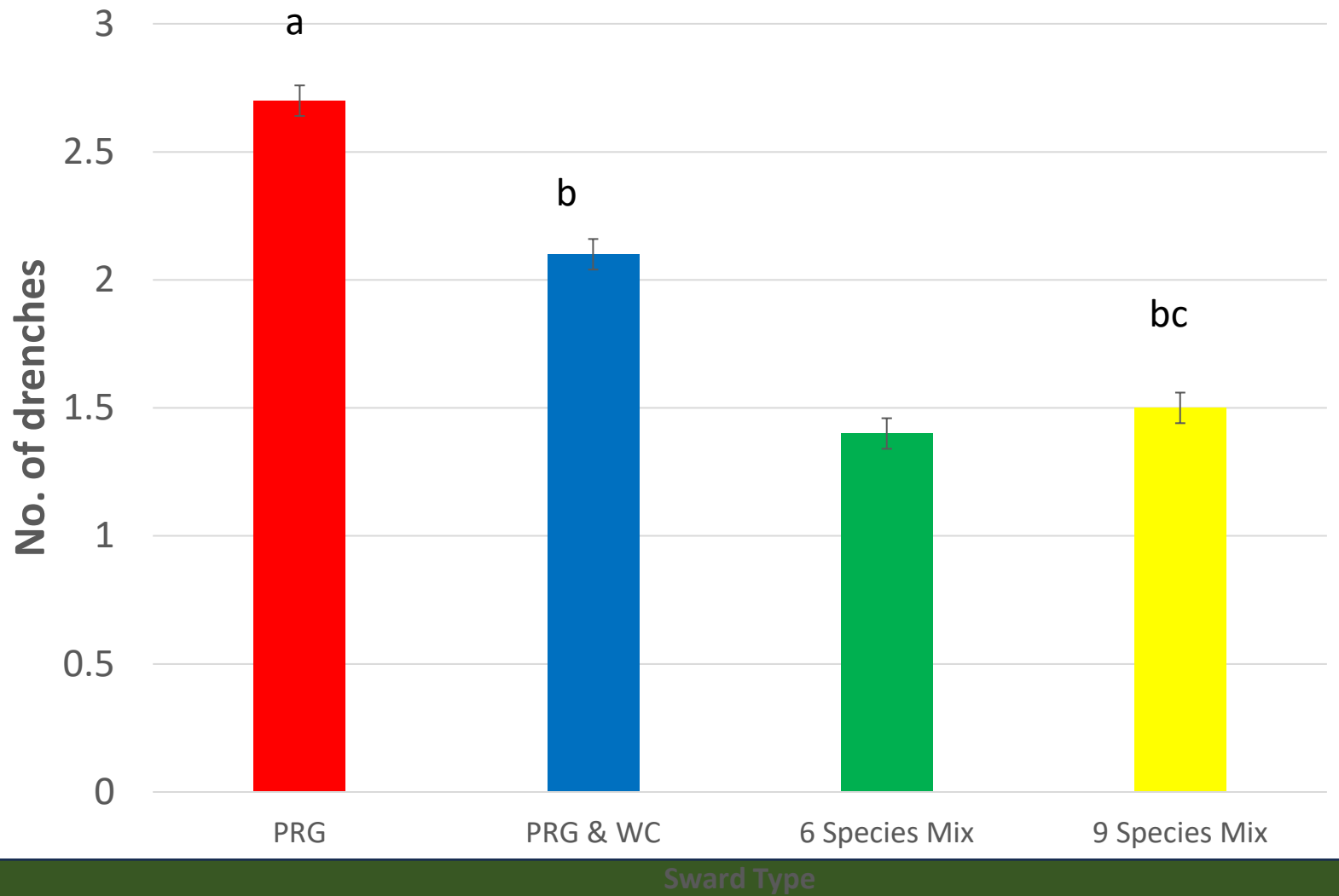
P < 0.05



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

Grace et al., 2019

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



Grace et al., 2019

Time

Long term grassland platform

▼ Greenhouse Gas Emissions

▲ Soil Health

▲ Water Quality

▲ Biodiversity

▲ Profitability

▲ Grazing Animal Health & Performance

▲ Food Quality

▲ Pasture Performance & Resilience

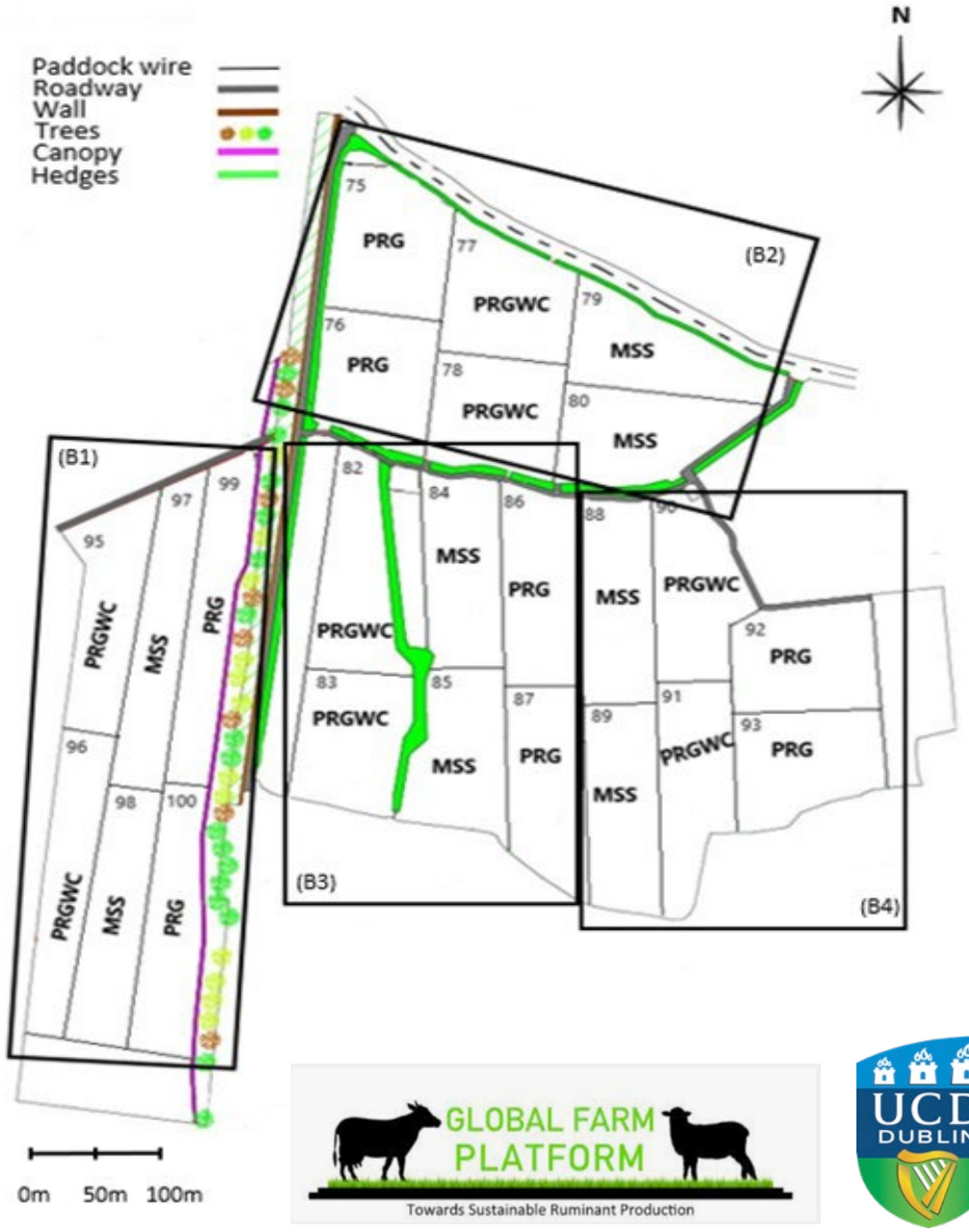
▲ Carbon Sequestration

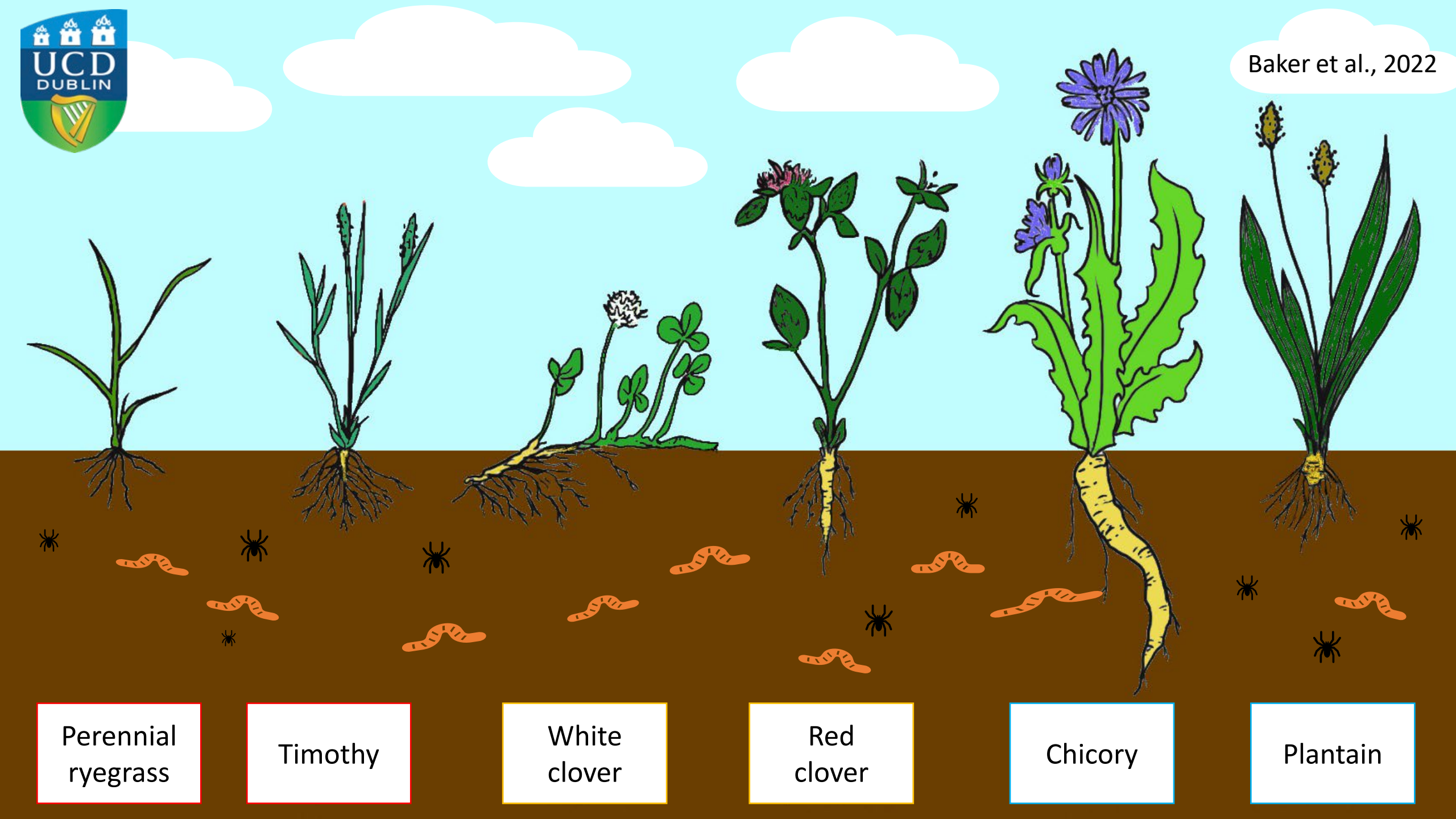
▲ Smart Agriculture

UCD DUBLIN

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
- Target
  - PGHM 1200 – 1800 kg DM/ha
  - PGSH 4cm v's 6cm MSS



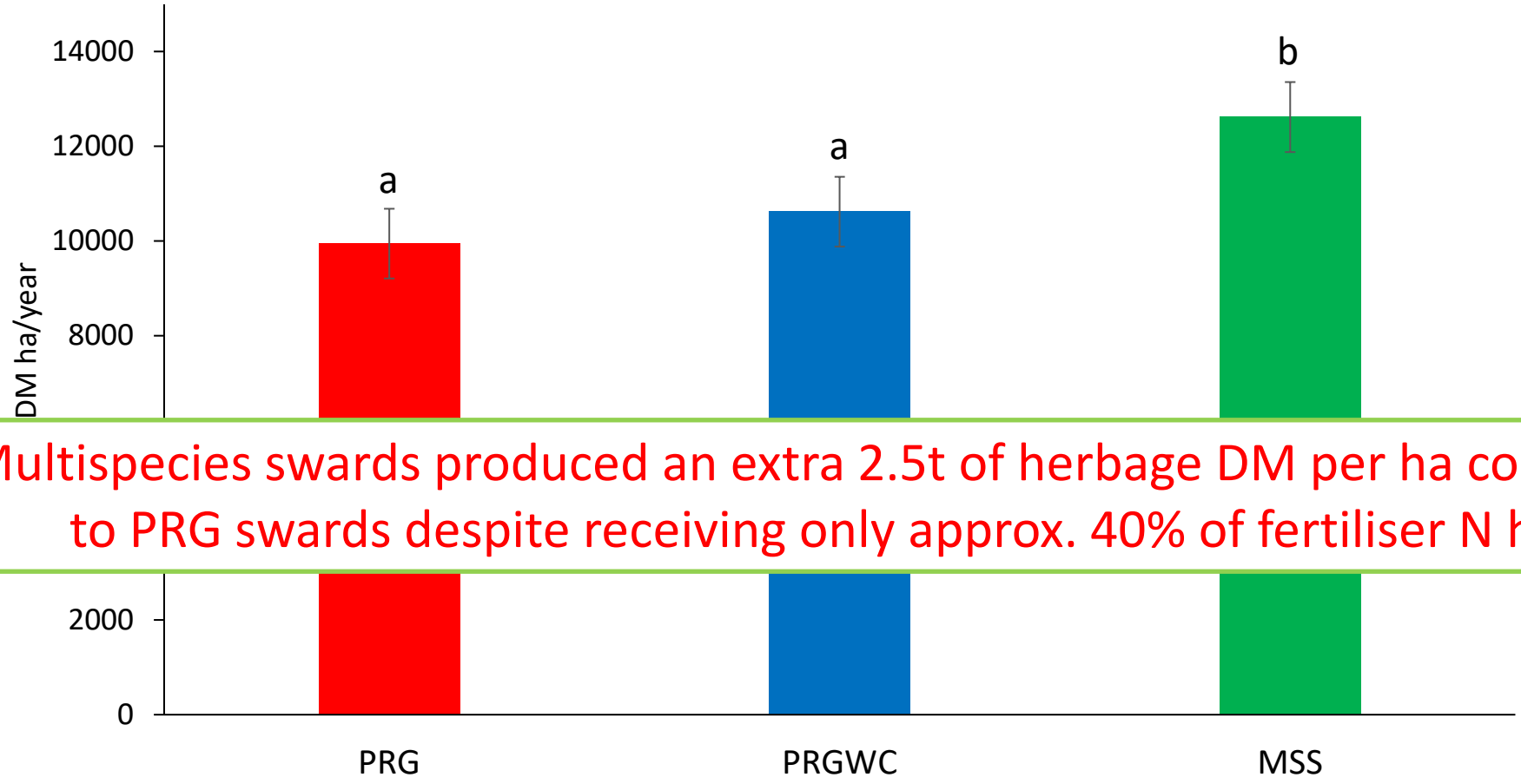

Baker et al., 2022
Perennial ryegrass
Timothy
White clover
Red clover
Chicory
Plantain

Sowing rates kg/ha

	PRG	PRGWC	MSS
PRG	37	33	13
Phleum pratense			3
Trifolium repens		5	5
Trifolium pratense			10
Cichorium intybus			3
Plantago lanceolata			3

PRG = AberGain & AberChoice; P. pratense = Presto & Winnetau; T. repens = Buddy & AberHerald; T. pratense = AberChianti & AberClaret; C. intybus = Puna II & Choice; P. lanceolata = Tonic & AgriTonic

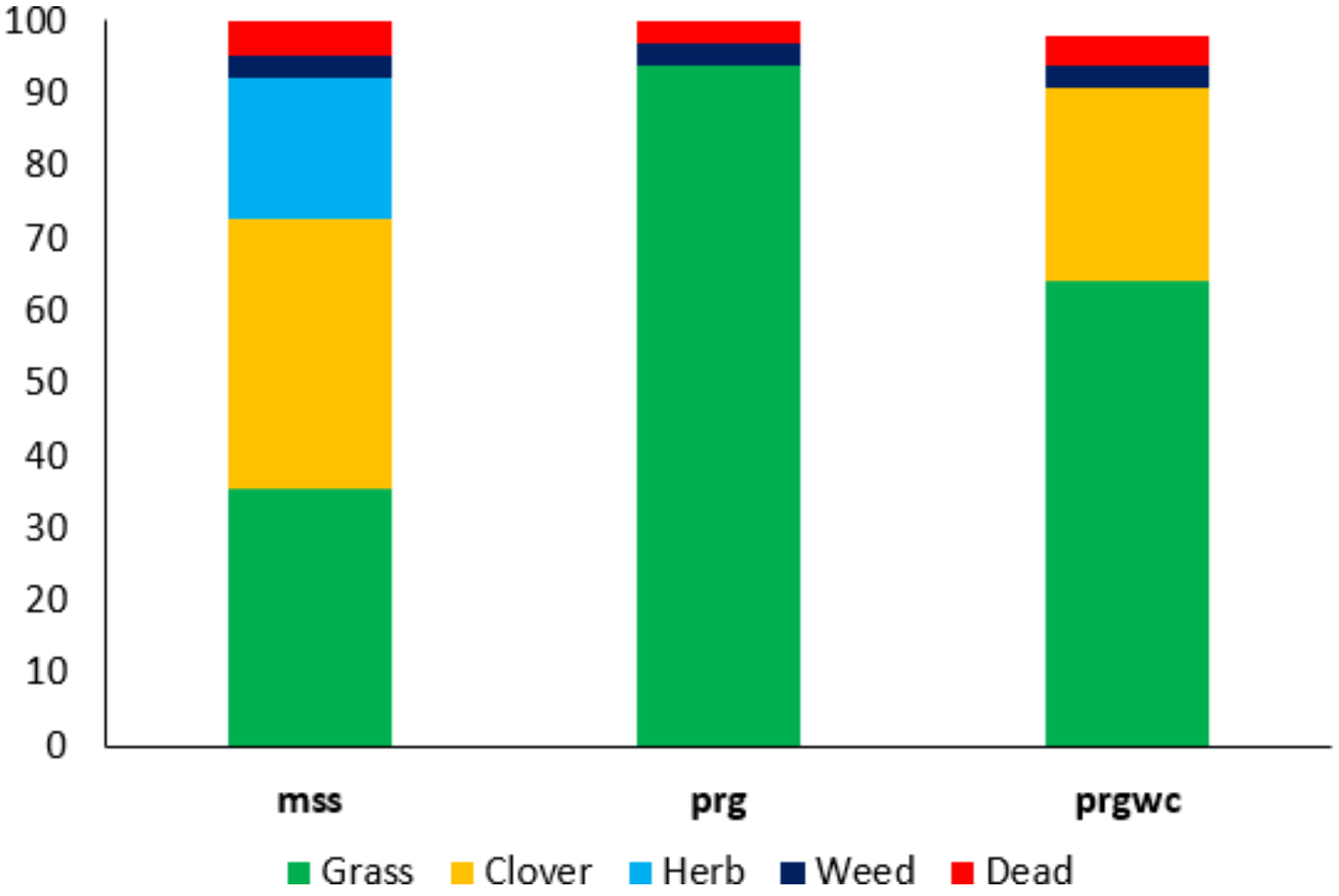
The impact of sward type on dry-matter production



Multispecies swards produced an extra 2.5t of herbage DM per ha compared to PRG swards despite receiving only approx. 40% of fertiliser N ha^{-1}

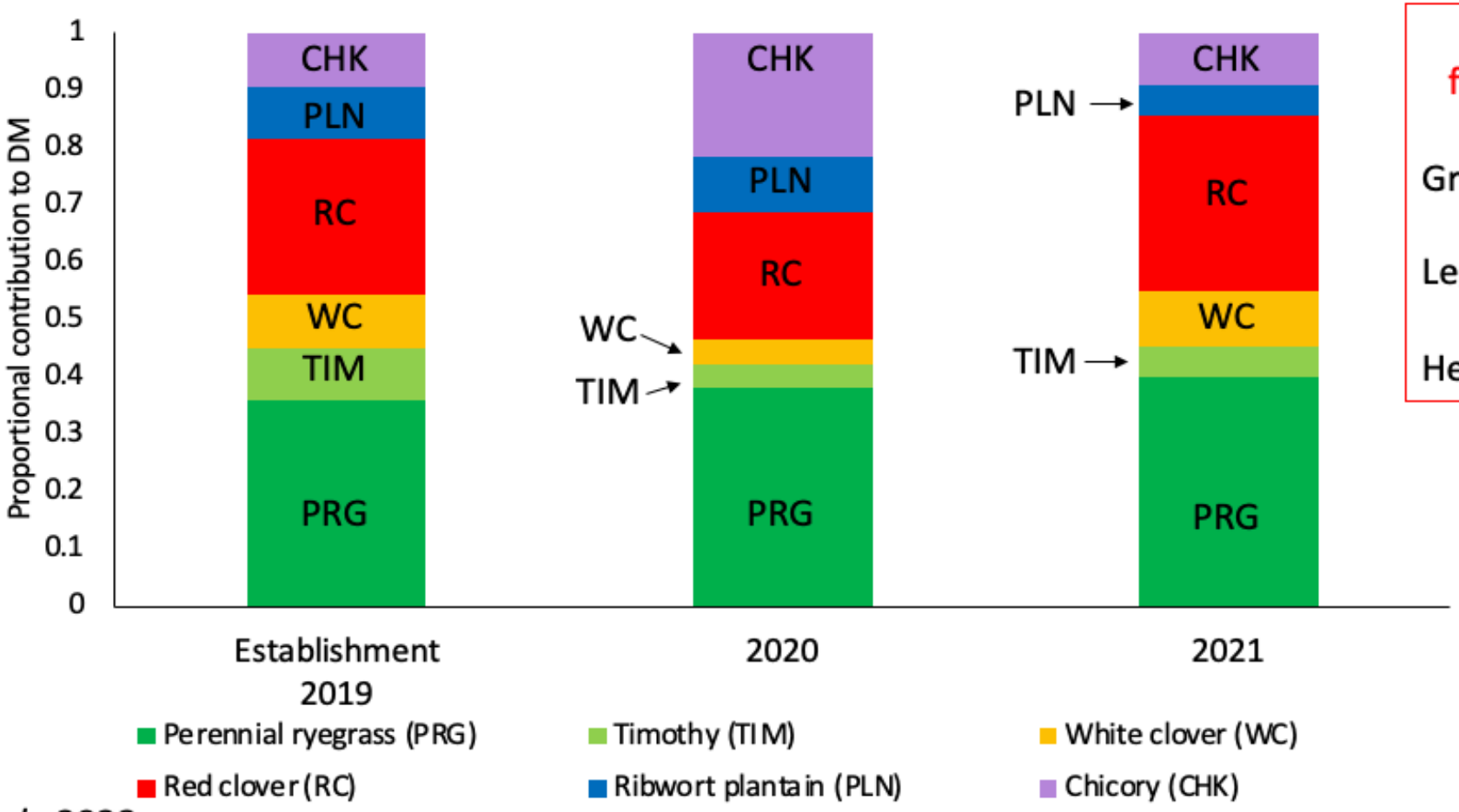
Baker *et al.*, 2023

Contribution of functional groups to yield 2020-2021



Baker et al., 2023

The sown species proportions of 2020 & 2021 compared to the actual sowing rate of each species in 2019.



Contribution of the 3 functional groups to DM

Grass : =

Legume: ↑

Herb: ↓

Baker *et al.*, 2023

SMARTSWARD Biodiversity for Production

The impact of sward type on animal liveweight at key stages of the production cycle

Stage of Production Cycle	PRG	PRGWC	MSS	SEM
Turnout weight (kg) first season	136	136	136	2.81
Housing date (kg) first winter	230	239	241	4.03
Turnout weight (kg) second season	321[a]	358[b]	369[b]	5.55
Housing date (kg) second winter	495[a]	536[b]	551[b]	4.61
Slaughter weight (kg)	629	629	629	5.32

P<0.05

Boland et al., 2022

The impact of sward type on animal slaughter parameters

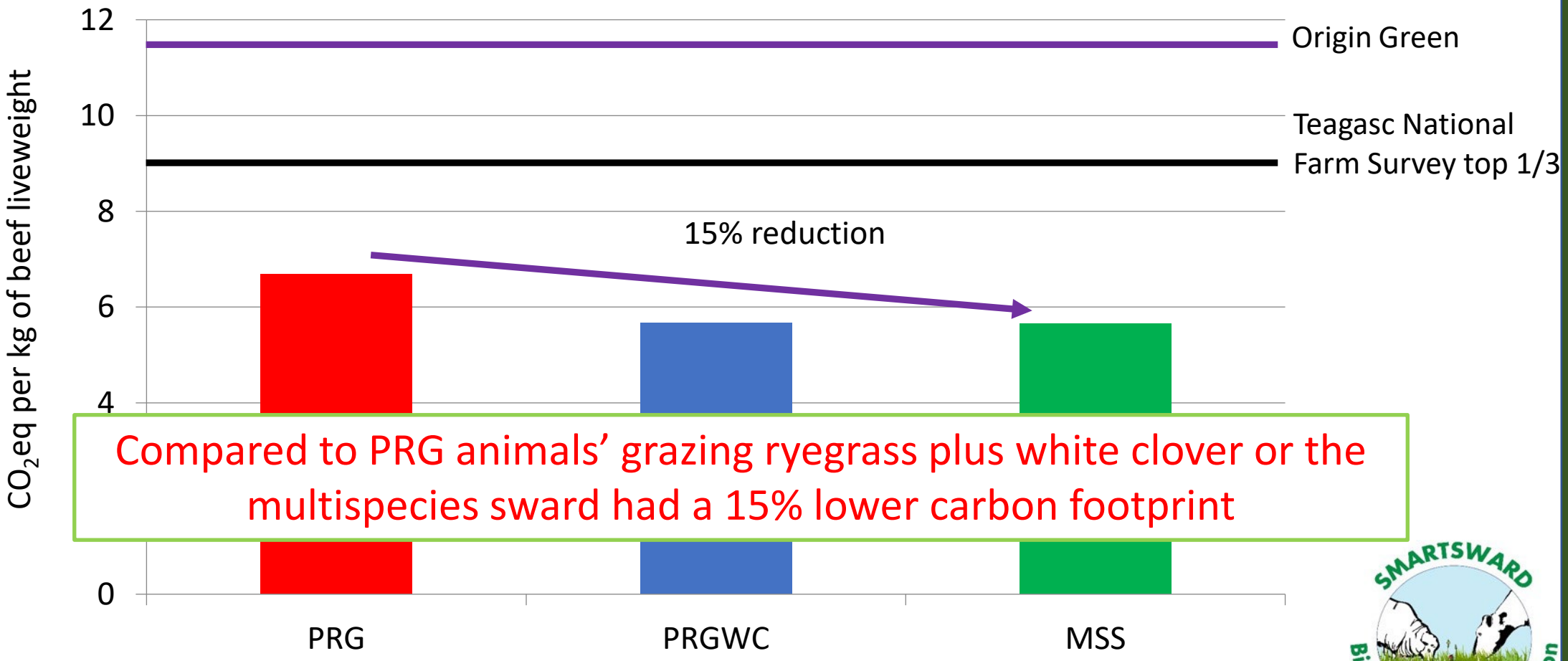
Slaughter parameter	PRG	PRGWC	MSS	SEM
Carcass weight (kg)	314	314	313	2.83
Kill out percentage (%)	51	51	51	0.21
Days to slaughter	524[a]	494[b]	490[b]	5.55

Compared to PRG animals' grazing ryegrass plus white clover or the multispecies sward reached slaughter weight at a younger age

Boland et al., 2022

P<0.05

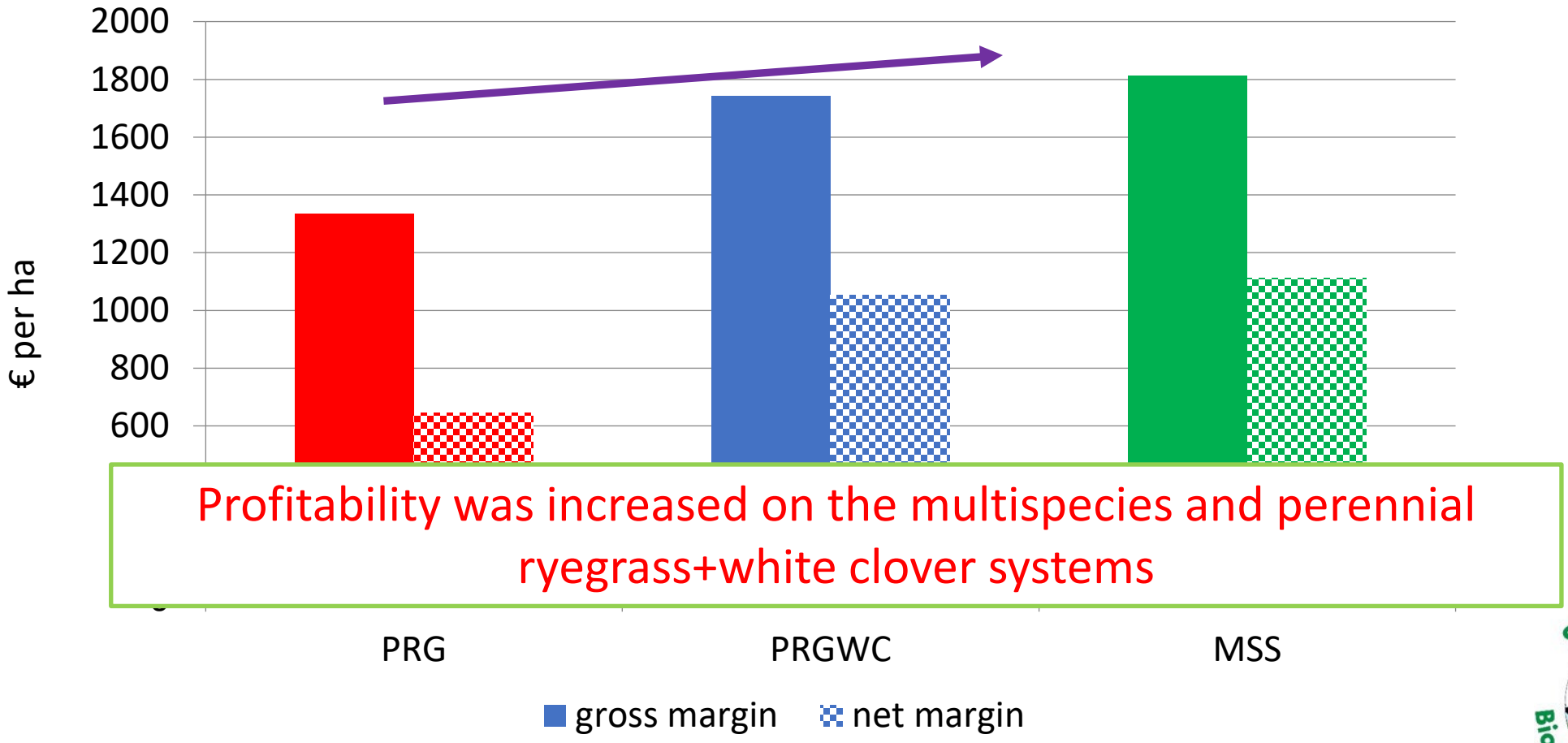
The effect of sward type on CO_2eq per kg of beef liveweight



Compared to PRG animals' grazing ryegrass plus white clover or the multispecies sward had a 15% lower carbon footprint

Boland et al., 2022

The effect of sward type on gross margin and net margin ha^{-1}



Profitability was increased on the multispecies and perennial ryegrass+white clover systems

Boland et al., 2022

Muscle fatty acid profile

C18:2*n*6*c*
C18:3*n*3
PUFAs
HP-PUFAs
n-6 FA
n-3 FA
PUFA : SFA
n-6 : *n*-3
HP-PUFA

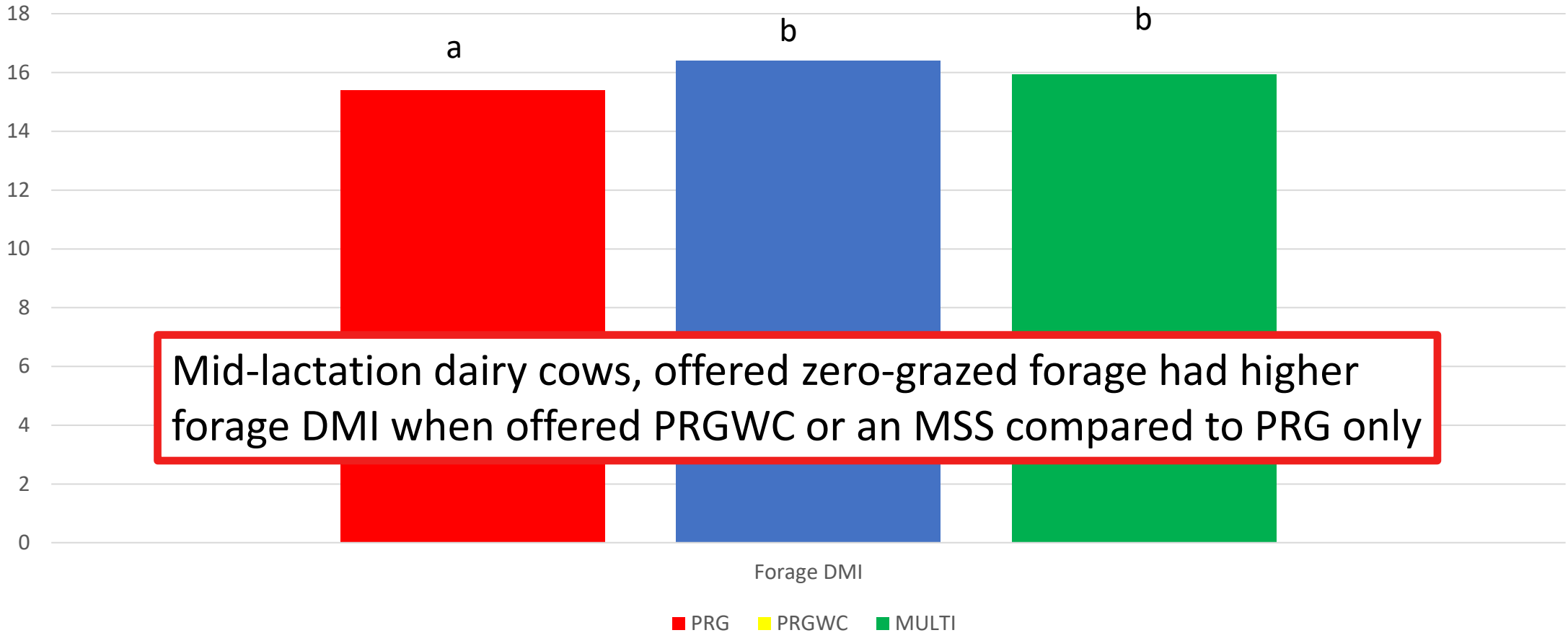
Impact of sward type on muscle fatty acid profile of beef

FA	PRG (n= 20)	PRG+WC (n=20)	MS (n=20)	SEM	p-value
C16:0	28.0	28.7	27.6	0.470	0.264
C16:1	4.4^{a}	4.0^{a}	3.4^{b}	0.139	**<0.001**
C18:0	14.0	14.3	15.1	0.318	0.052
C18:1*n*-9c	38.7^{a}	36.4^{b}	35.2^{b}	0.590	**<0.001**
C18:2*n*-6*c*	3.6^{b}	4.3^{b}	5.9^{a}	0.309	**<0.001**
C18:3*n*-3	0.8^{c}	1.1^{b}	1.6^{a}	0.057	**<0.001**
C18:2 *c*9 *t*11	0.2	0.3	0.3	0.014	0.152
C20:2	0.06^{b}	0.07^{b}	0.10^{a}	0.005	**<0.001**
C20:3*n*-6	0.3^{b}	0.4^{b}	0.5^{a}	0.039	**0.003**
SFA	45.8	47.0	46.4	0.627	0.391
MUFA	45.7^{a}	42.8^{b}	40.9^{b}	0.600	**<0.001**
PUFA	8.6^{b}	10.3^{b}	12.8^{a}	0.719	**0.001**
PUFA : SFA	0.2^{b}	0.2^{ab}	0.3^{a}	0.018	**0.003**
n-6	5.6^{b}	6.5^{b}	8.5^{a}	0.499	**0.001**
n-3	2.5^{b}	3.1^{ab}	3.7^{a}	0.213	**0.002**
n-6 : *n*-3	2.2^{ab}	2.1^{b}	2.3^{a}	0.039	**0.001**
HP-PUFA	4.5^{b}	5.3^{ab}	6.2^{a}	0.405	**0.014**

PRG = perennial ryegrass; PRG + WC = perennial ryegrass + white clover; MS = mixed sward.
SEM = pooled standard error of the means.
a,b,c different letters within a row indicate a significant difference (P<0.05).

Kearns et al., 2023

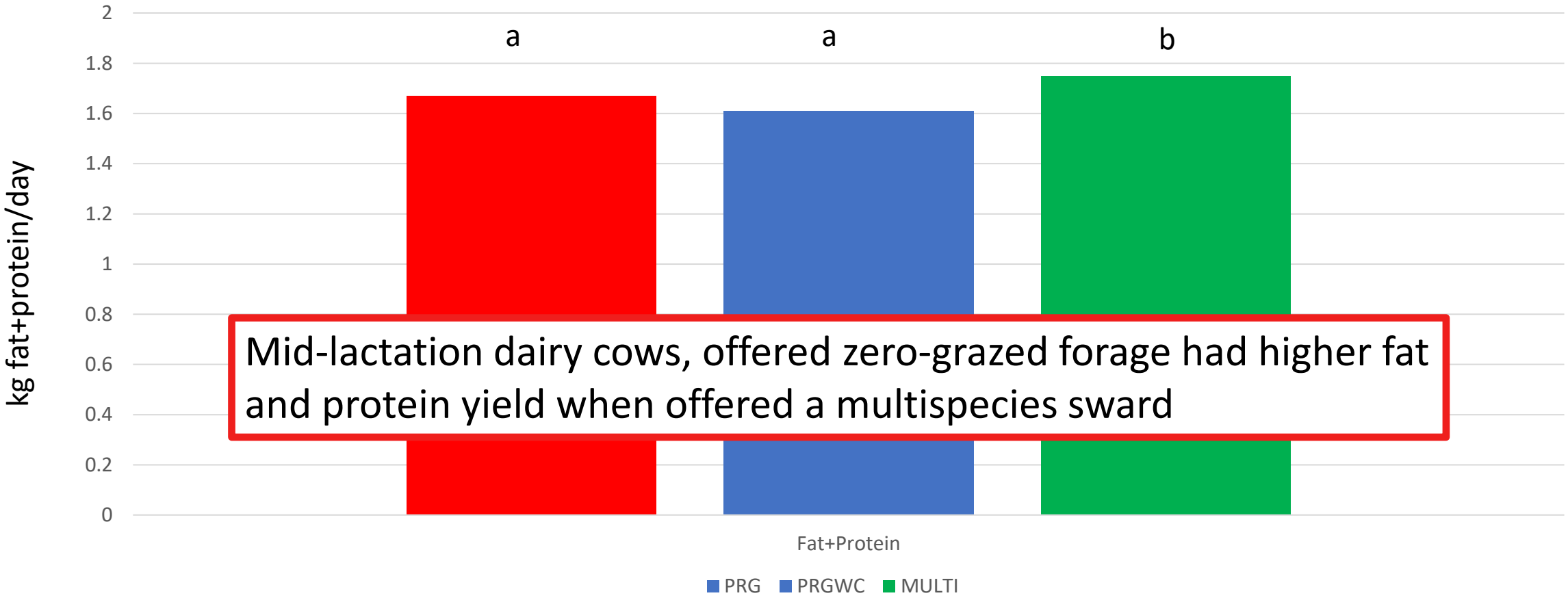
The effect of sward type on forage dry matter intake



Mid-lactation dairy cows, offered zero-grazed forage had higher forage DMI when offered PRGWC or an MSS compared to PRG only

McCarthy et al., 2021

The effect of sward type on kg fat and protein



Mid-lactation dairy cows, offered zero-grazed forage had higher fat and protein yield when offered a multispecies sward

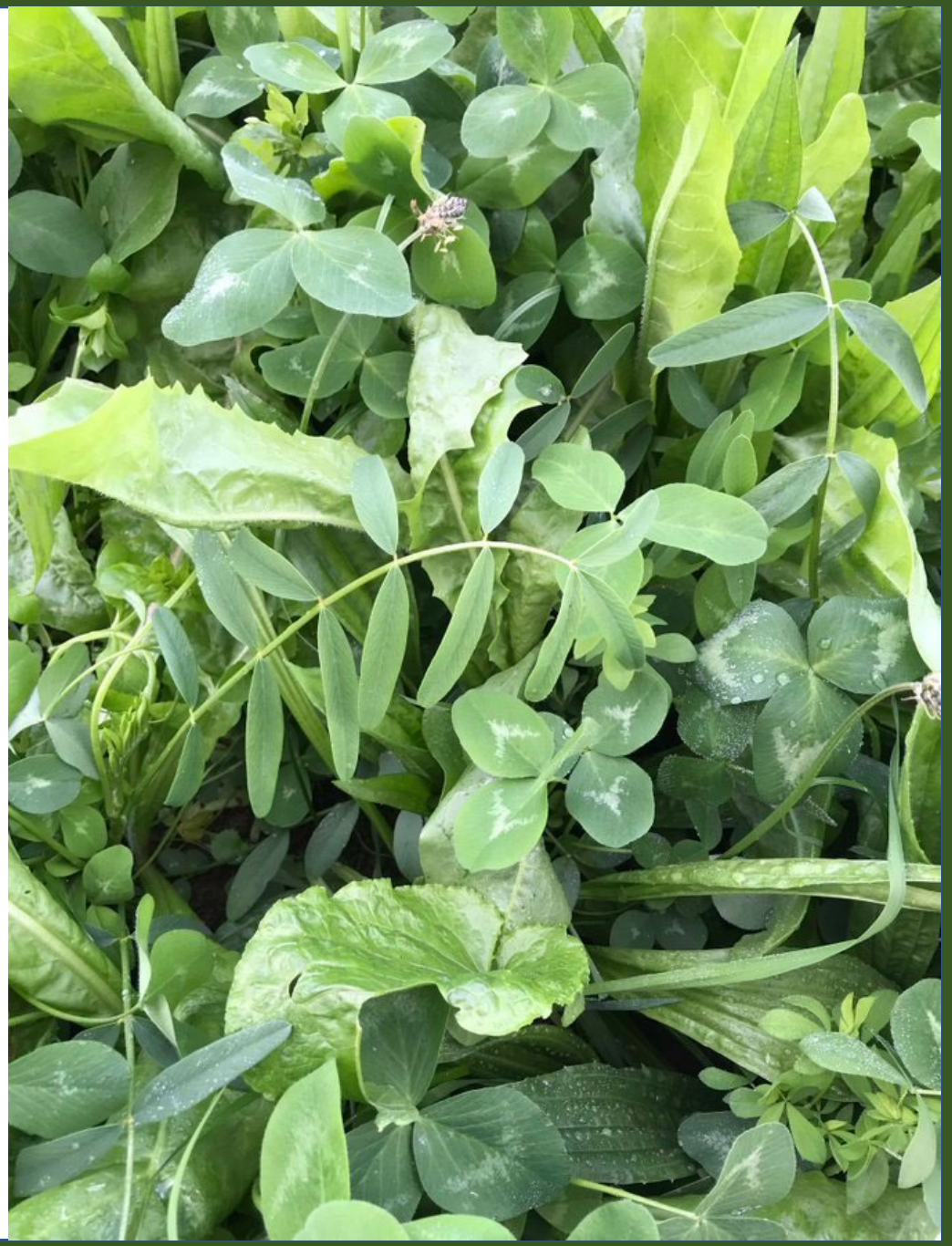
McCarthy et al., 2021

HEARTLAND

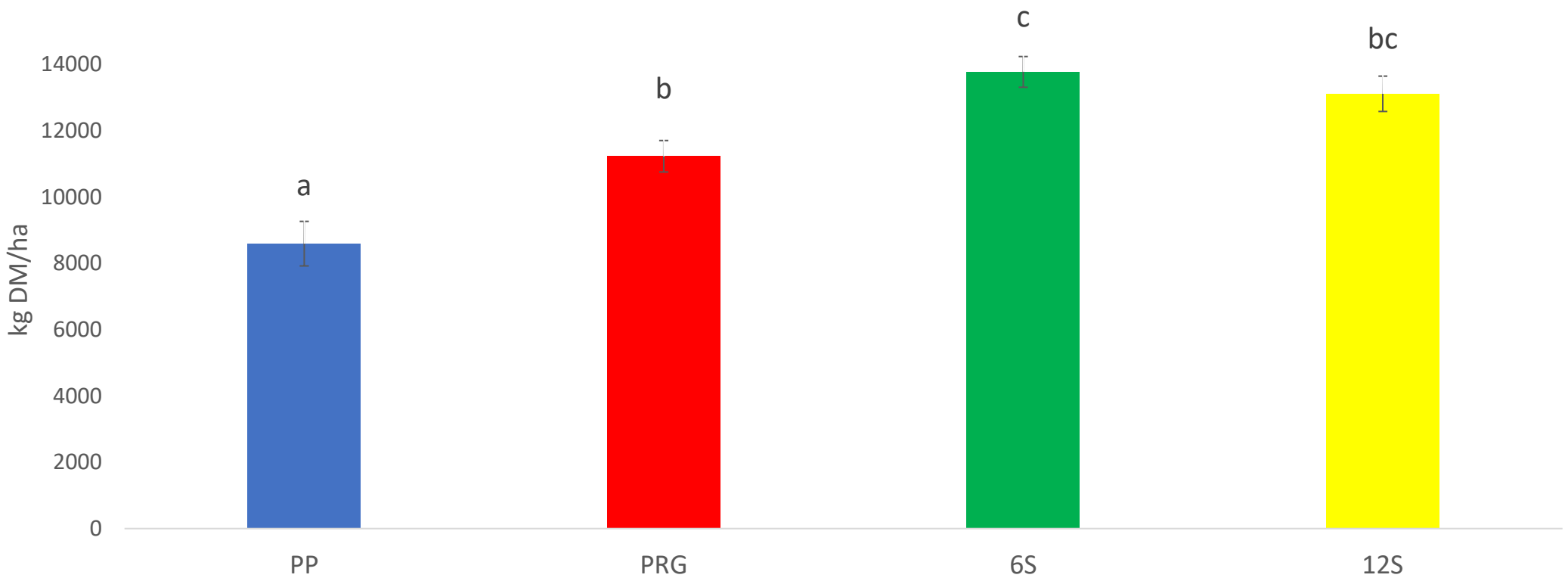
ONE HEALTH FROM SOIL TO SOCIETY

- 4 sward types
  - Perennial ryegrass (170 kg N/ha/yr)
  - Permanent pasture (135 kg N/ha/yr)
  - 6 species mix – PRG, Timothy, white & red clover, chicory, ribwort plantain (70 kg N ha/yr
  - 12 species mix - 6 species mix + cocksfoot, birdsfoot trefoil, sainfoin, yarrow, salad burnet and sheep's parsley (70 kg N/ha/yr)
- Co-grazed cattle & sheep
  - PGHM – 1500 v's 2500 kg DM/ha
  - PGSH – 4cm v's 6cm

UCD DUBLIN



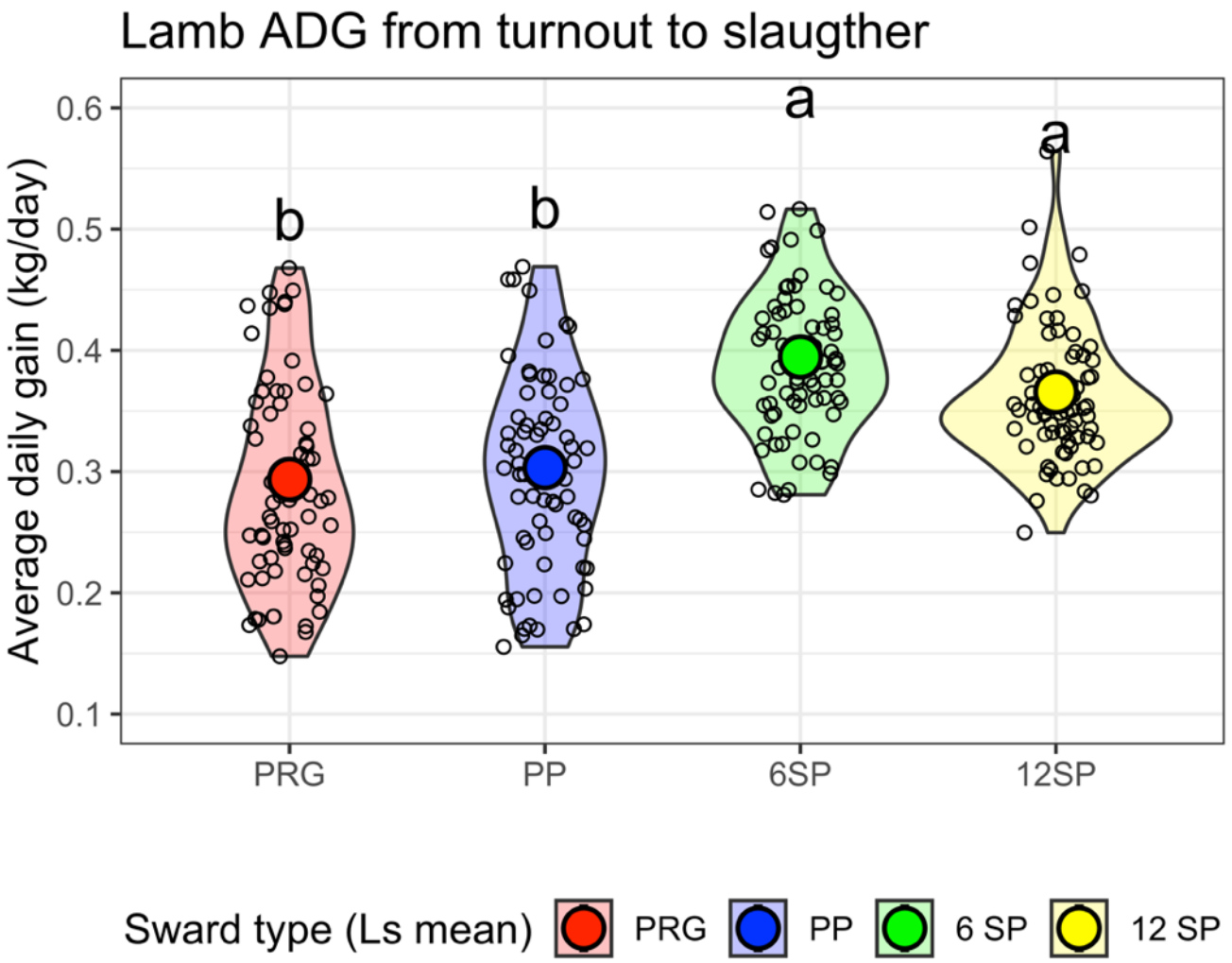
The effect of sward type on annual DM production



- PP had lower annual DM production compared to all other sward types ($P<0.05$).
- PRG had lower annual DM production to the 6S ($P<0.05$).
- Annual DM production from the 6S and 12S did not differ.

Shackleton et al., 2022

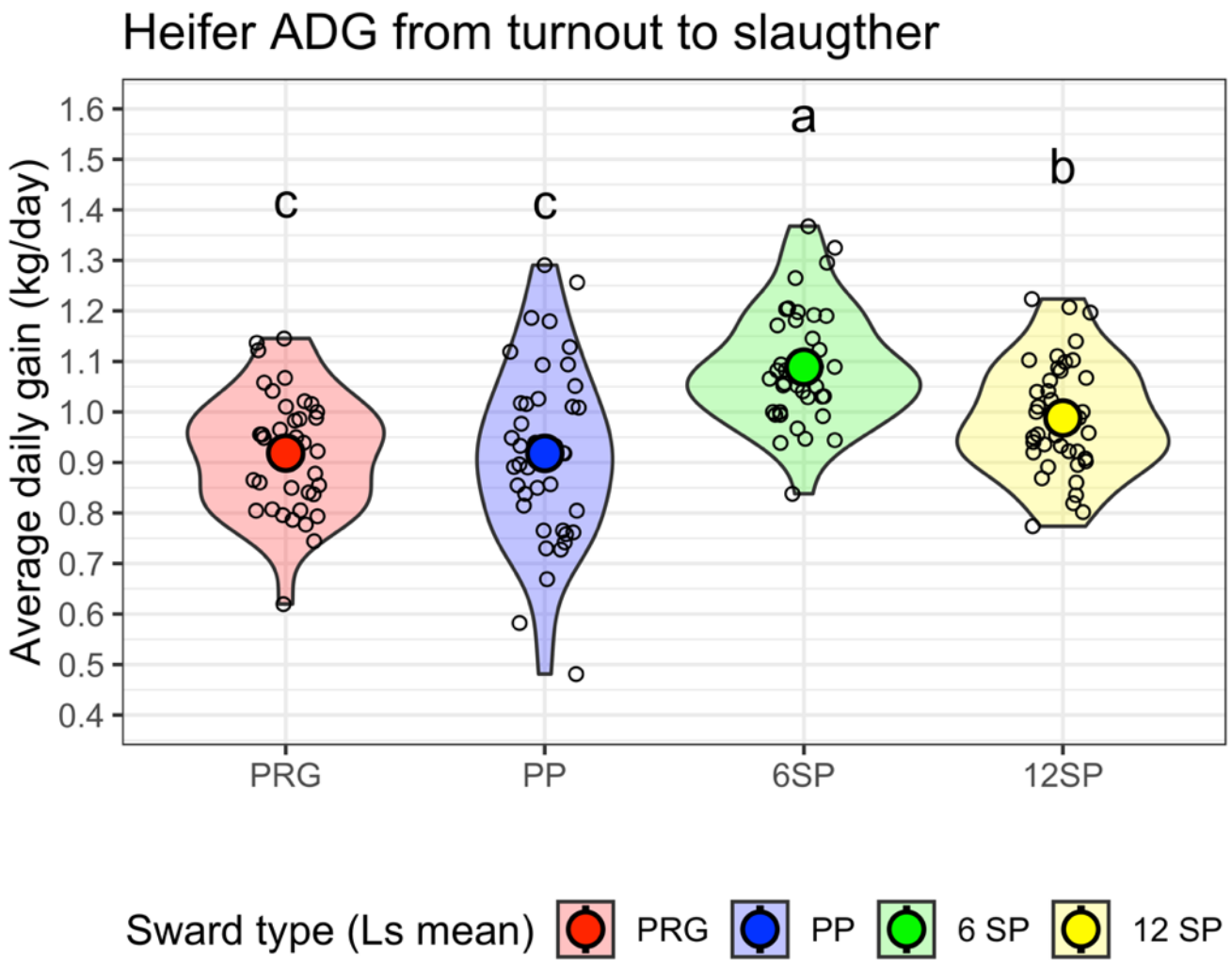
The effect of sward type on lamb ADG from turnout to slaughter



Lambs grazing the **6 SP** and **12SP** had a **30%** and **21%** increased ADG respectively compared to the **PRG** and the **PP**.

(Beaucarne et al., 2022)

The effect of sward type on heifer ADG from turnout to slaughter



(Beaucarne et al., 2022)

Heifers grazing the **6SP** had a **17%** greater **ADG** compared to the **PRG** and **PP** swards and **10%** greater than the heifers grazing the **12SP**.

Findings:

- Increased herbage DM production
- Decreased fertilser N ha^{-1}
- Enhanced animal performance
- Improved animal health
- Reduced GHG emissions
- Indications of enhanced biodiversity
- Enhanced economic performance

Challenges:

- Management
- Herb persistence – sward rejuvenation
  - Establishment within existing permanent grassland
- Weed control
- Possibility of bloat

UCD Lyons Long Term Grazing Platform

Time
Long term grassland platform

Greenhouse Gas Emissions

Soil Health

Water Quality

Biodiversity

Profitability

Grazing Animal Health & Performance

Food Quality

Pasture Performance & Resilience

Carbon Sequestration

Smart Agriculture

@SMARTSWARD1

UCD DUBLIN

GLOBAL FARM PLATFORM
Towards Sustainable Ruminant Production


Prof. Tommy Boland, Dr Bridget Lynch, Dr Alan Kelly, Dr Paul Murphy, Prof. Olaf Schmidt, Prof. Alex Evans, Dr Rochelle Fritch, Dr Saoirse Tracy, Dr Cornelia Grace, Dr Jean Kennedy, Dr Shona Baker, Fionnuala Godwin, Asaf Shnel, Jane Shackleton, Gaspard Beaucarne Dr Kate McCarthy, Prof. Frank Monahan.
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An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

SMART SWARD
Biodiversity for Production

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Department of Agriculture, Food and the Marine

HEARTLAND
ONE HEALTH FROM SOIL TO SOCIETY

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Invertebrate diversity

Plant diversity

Fertiliser effects

Multi4More

Promoting sustainable and efficient agricultural practices that enhance the productivity of Irish agriculture

Multisite experiment

Knowledge transfer

Ovine grazing experiment

Legacy effects

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

Department of Agriculture, Environment and Rural Affairs
Sustainability at the heart of a living, working, active landscape valued by everyone

Teagasc
Agriculture and Food Development Authority

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Supported by:

GOLDCROP

Germinal
Sowing future seeds

DLF

Multi-Species Swards for Beef and Sheep

A European Innovation Partnership (EIP) Project

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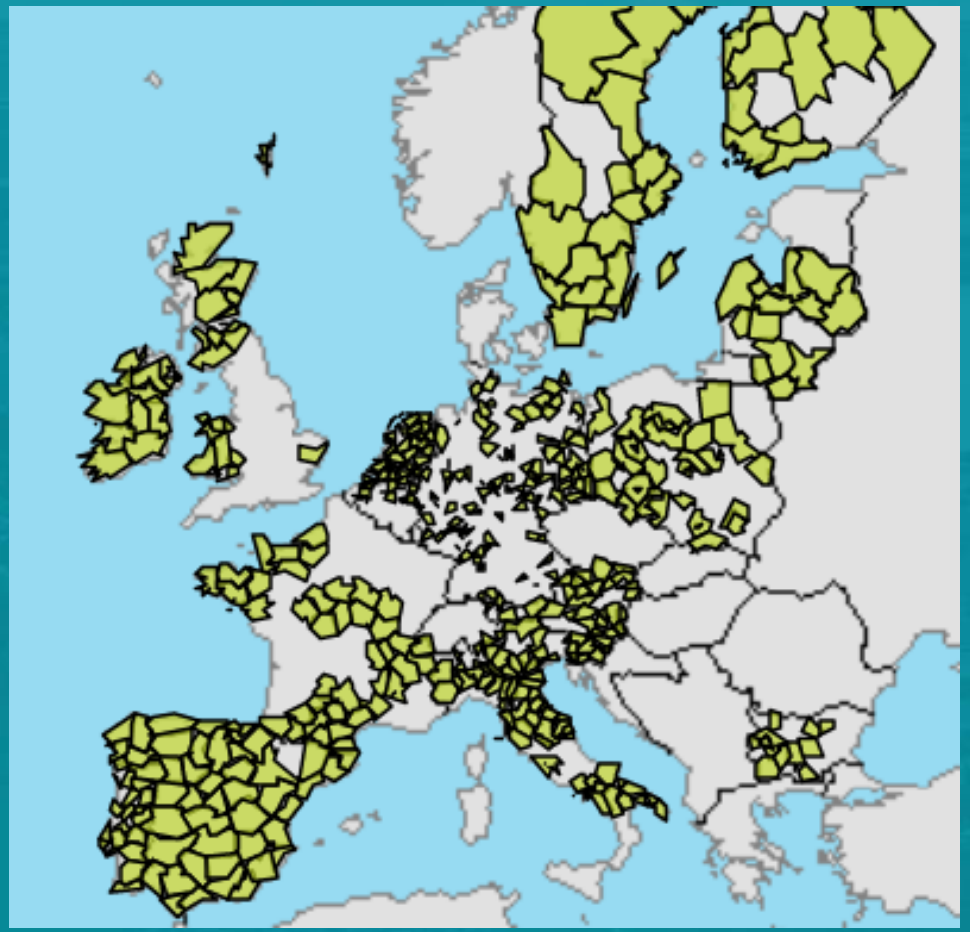
EIP - Agri

- Designed to bring farmers, researchers and advisors together to help NI farmers innovate and address specific opportunities and challenges
- Jointly funded by the European Agricultural Fund for Rural Development and DAERA
- Seven projects were funded – of which ‘MSS for Beef and Sheep’ was one
- Started November 2020 & concludes June 2023



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Project Group

- Dale Orr – Strangford, Co. Down
- Sam Chesney – Kircubbin, Co. Down
- Paul Turley – Downpatrick, Co. Down
- Roger & Hilary Bell – Kells, Co. Antrim
- Crosby Cleland – Saintfield, Co. Down
- Andrew Clarke/Wayne Acheson – Cookstown, Co. Tyrone

- AFBI – Dr David Patterson, Dr Francis Lively and Dr Denise Lowe
- QUB – Prof Nigel Scollan & Prof Mark Emmerson
- AgriSearch – Project Lead

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Project Aims

- To investigate the feasibility and practicality of incorporating multi-species swards on Northern Ireland commercial beef and sheep farms
- Significantly increase the knowledge of MSS establishment, management and use specific to Northern Ireland
- To assess impact of MSS incorporation on animal performance and the wider environment
- To determine prospects for success of widespread MSS incorporation on NI farms
- Share all project activity and results

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Project Activity - Establishment

2021 - MSS established

- 37ha (92ac) across 20 fields
- Variety of establishment methods – including stale seed bed method and stitching in
- Wide range of seed mixes selected – 6 species up to 18 species

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Project Activity - Establishment

Grasses

- PRG
- Cocksfoot
- Timothy
- Meadow Fescue
- Tall Fescue

Legumes

- White Clover
- Red Clover
- Alsike Clover
- Sweet Clover
- Sainfoin
- Birdsfoot trefoil

Herbs

- Plantain
- Chicory
- Burnet
- Yarrow
- Sheeps parsley
- Ribgrass Forage Herb
- Knapweed Wildflower

Project Activity – Sward Management

Fertiliser

- All farms reduced their use of chemical Nitrogen significantly or entirely

Production

- Total production comparable to PRG swards
- Flatter growth curve across the season
- Coped well in drought conditions

Grazing regimes

- Some trial and error was required
- Extended rotation length and higher residuals vs PRG swards

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Project Activity – Animal Performance

- Reduced need for Anthelmintics observed on some farms
- Mixed results - Best when a batch grazed exclusively on MSS
  - Comparable DLWG with PRG Swards across the grazing season

	Cattle DLWG/kg PRG	Cattle DLWG/kg MSS
21/3 – 31/05	0.82	0.6
31/05 – 12/07	0.8	0.85
12/07 – 30/08	0.65	0.63
30/08 – 21/09	0.185	0.67
2022 Full Season Average	0.70	0.68

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Project Activity – Animal Performance

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- Mixed results - Best when a batch grazed exclusively on MSS
  - Comparable DLWG with PRG Swards across the grazing season

	MSS Lambs	PRG&WC Lambs
First 4 Weeks – DLWG	0.376 kg per day	0.304 kg per day
First 8 Weeks – DLWG	0.310 kg per day	0.280 kg per day
Average Slaughter Weight	42.86 kg	42.96 kg
Average Carcase Weight	19.95 kg	19.50 kg
Average Slaughter Age	167 days	196 days

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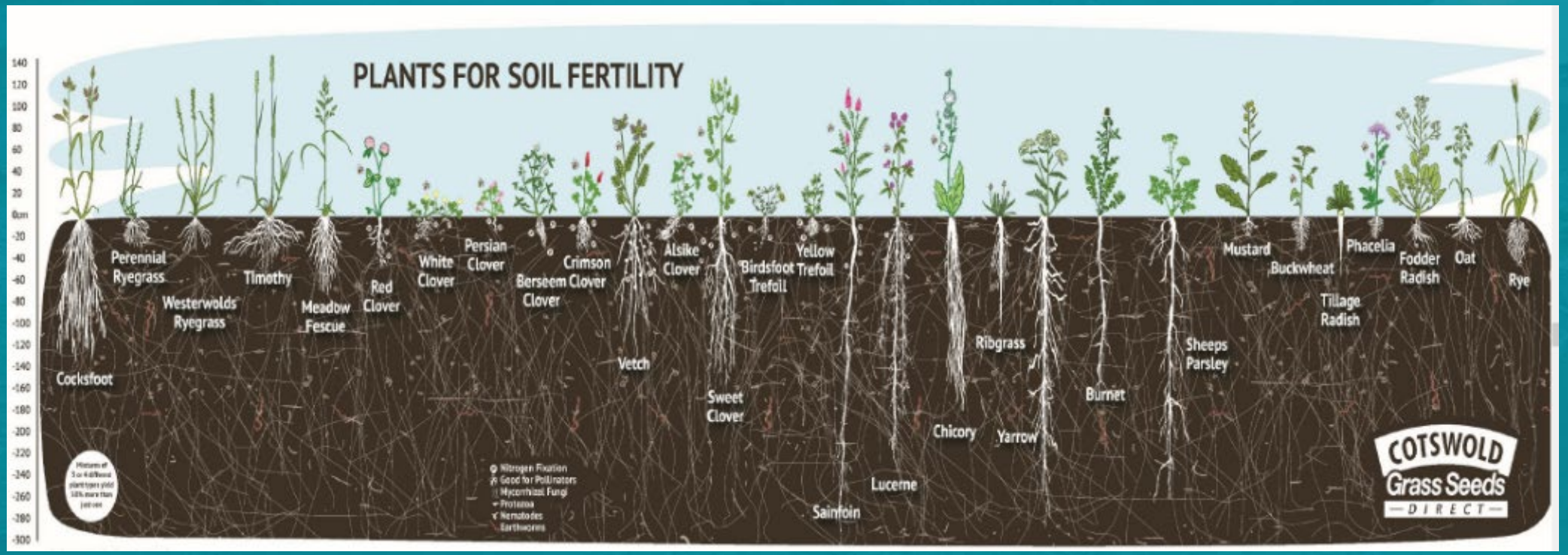
Project Activity – Soil and Biodiversity

- All participants noted obvious increased insect and bird activity
- Soil structure has improved in many cases
- Soil sampled in 2021 and 2023 - no notable changes to date across a range of trace elements



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Project Activity – Dissemination

- 3 x Farm Walks
  - Basics & Establishment
  - Sward Management
  - Animal Management & performance
- Private Farm Visits
- Webinar
  - Farmer Perspective - Establishment and Grazing
- Videos – YouTube
- Social Media Updates
- Study Tour
- Articles - Farming Press

Project Outcomes

- A huge amount of knowledge gained and shared
- The formation of the group has been invaluable for farmer support during the project
- No one size fits all – need to make choices suitable for your farming business
- Patience and a willingness to adapt required
- Research gaps still exist

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