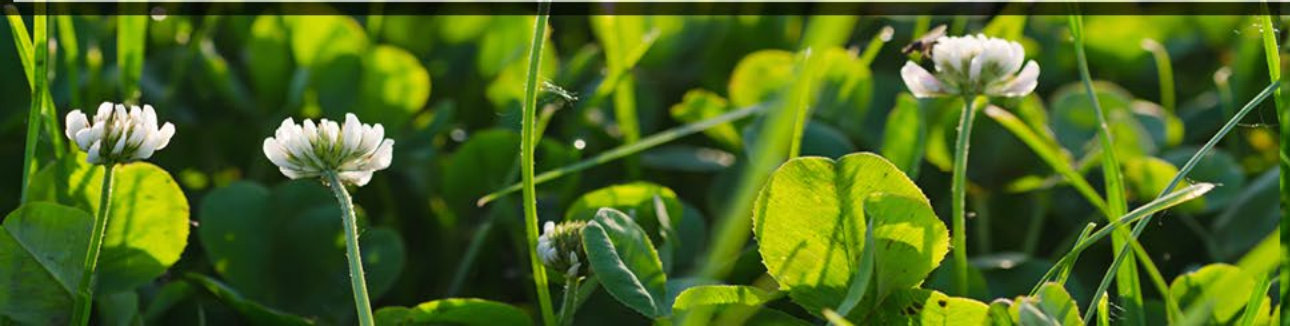



AgriSearch NI
Driving Excellence & Innovation

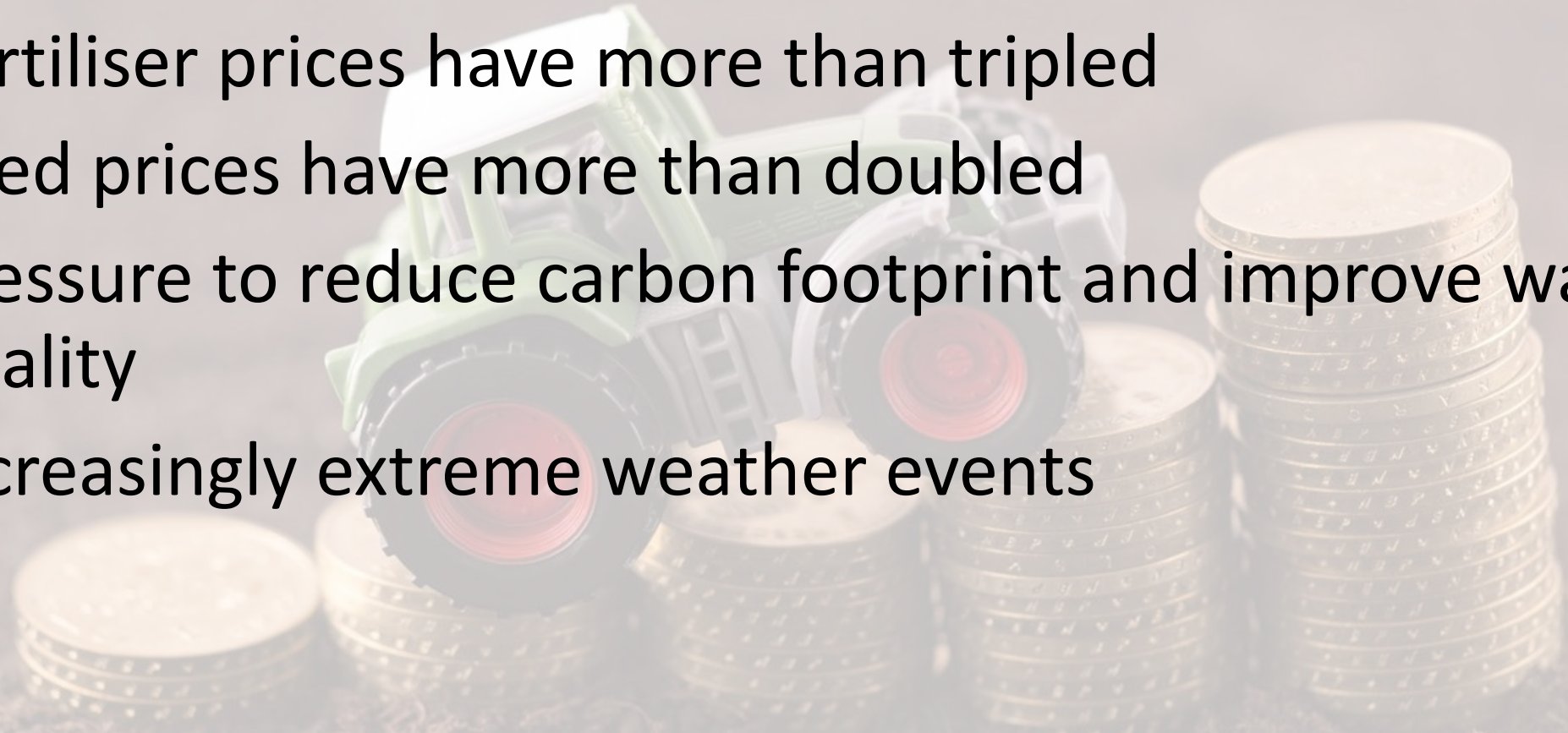
Capitalising on Clover Seminar

1st December 2022 at 7:30pm
Glenavon Hotel, Cookstown
Speakers: Liz Genever and James Humphreys




A time of challenge and change

- Fertiliser prices have more than tripled
- Feed prices have more than doubled
- Pressure to reduce carbon footprint and improve water quality
- Increasingly extreme weather events



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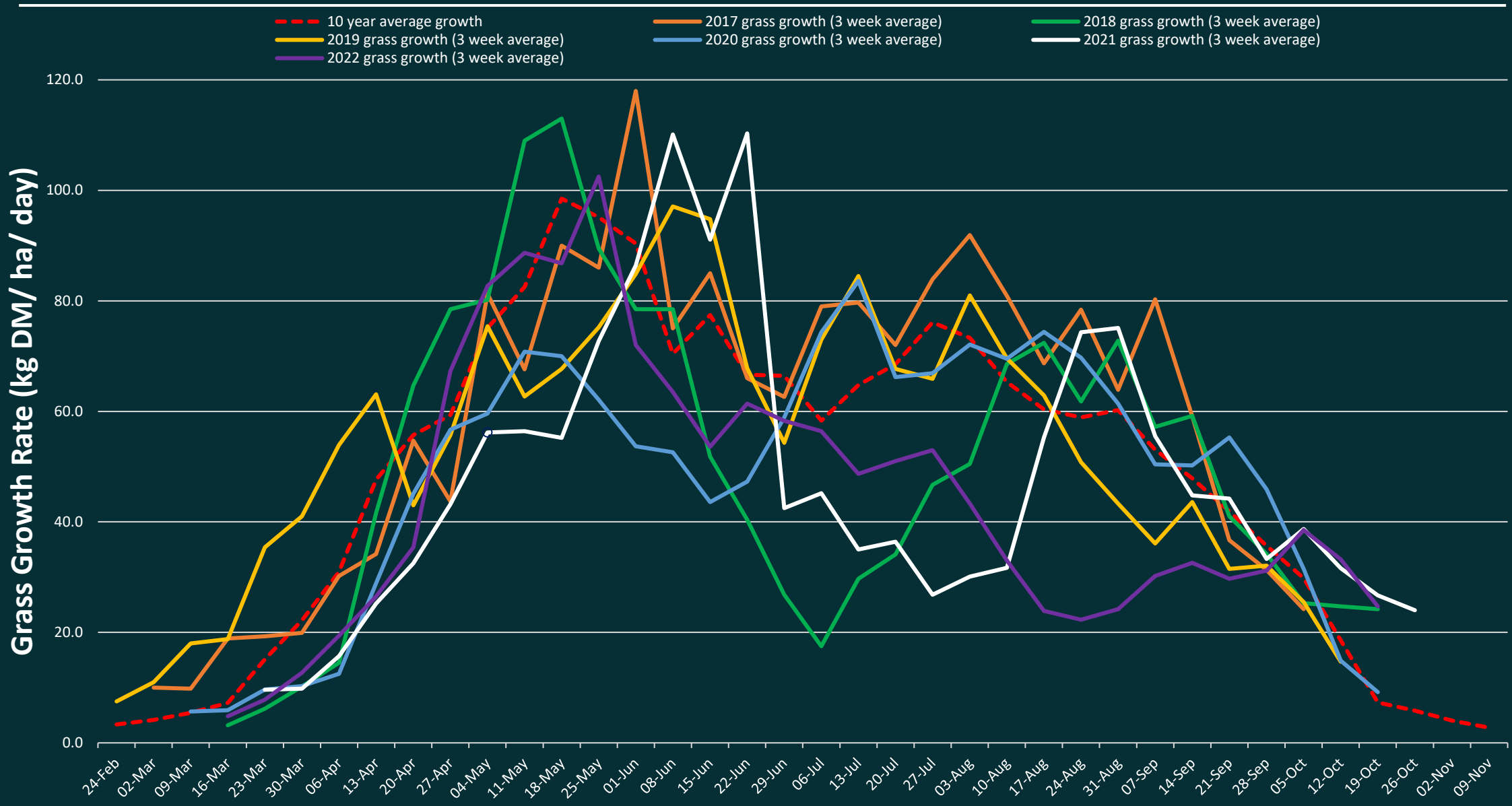

Clover – underappreciated plants & an opportunity missed

- Most farms have built up a dependence on the use of manufactured fertiliser
- Clover management skills have been lost
- Despite repeated evidence that clover can grow good yields of high quality forage, adoption remains low
- Many farmers are convinced that they cannot grow clover on their farms

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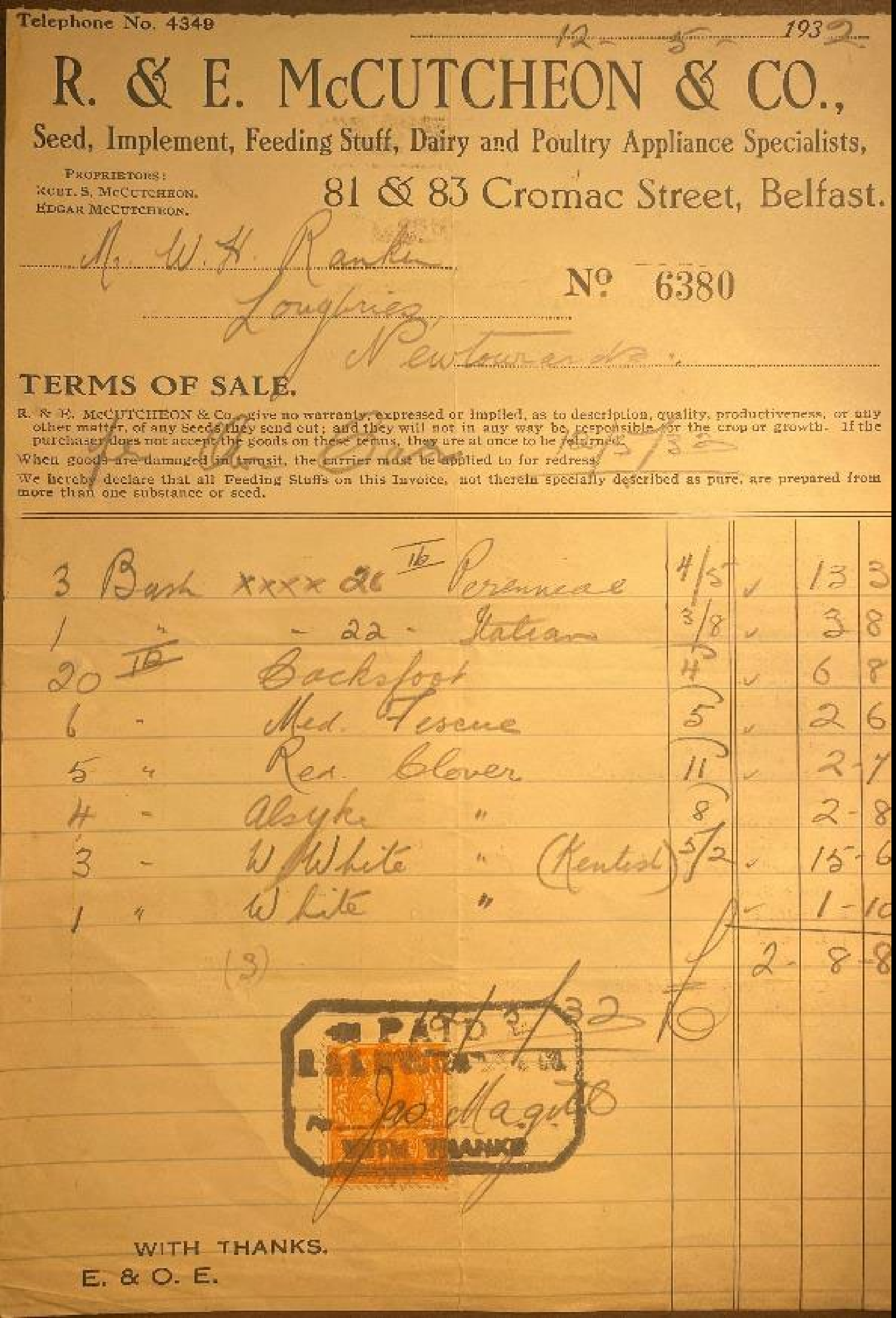

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Experience of previous generations lost

- 3 Bushels, 26lb Perennial Ryegrass
- 1 Bushels, 22lb Italian Ryegrass
- 20lb Cocksfoot
- 6lb Meadow Fescue
- 5lb Red Clover
- 4lb Alsike Clover
- 3lb Wild White (Kentish) Clover
- 1lb White Clover

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Why capitalise on clover?

- Reduce costs
- Grow more protein at home
- Improve soil health & biodiversity
- Lower carbon footprint

60% of farmers expressed an interest in establishing clover in autumn “rising costs” survey

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Developing a blueprint for low emissions pasture-based dairy farming

James Humphreys, Dan Barrett, Imelda Casey

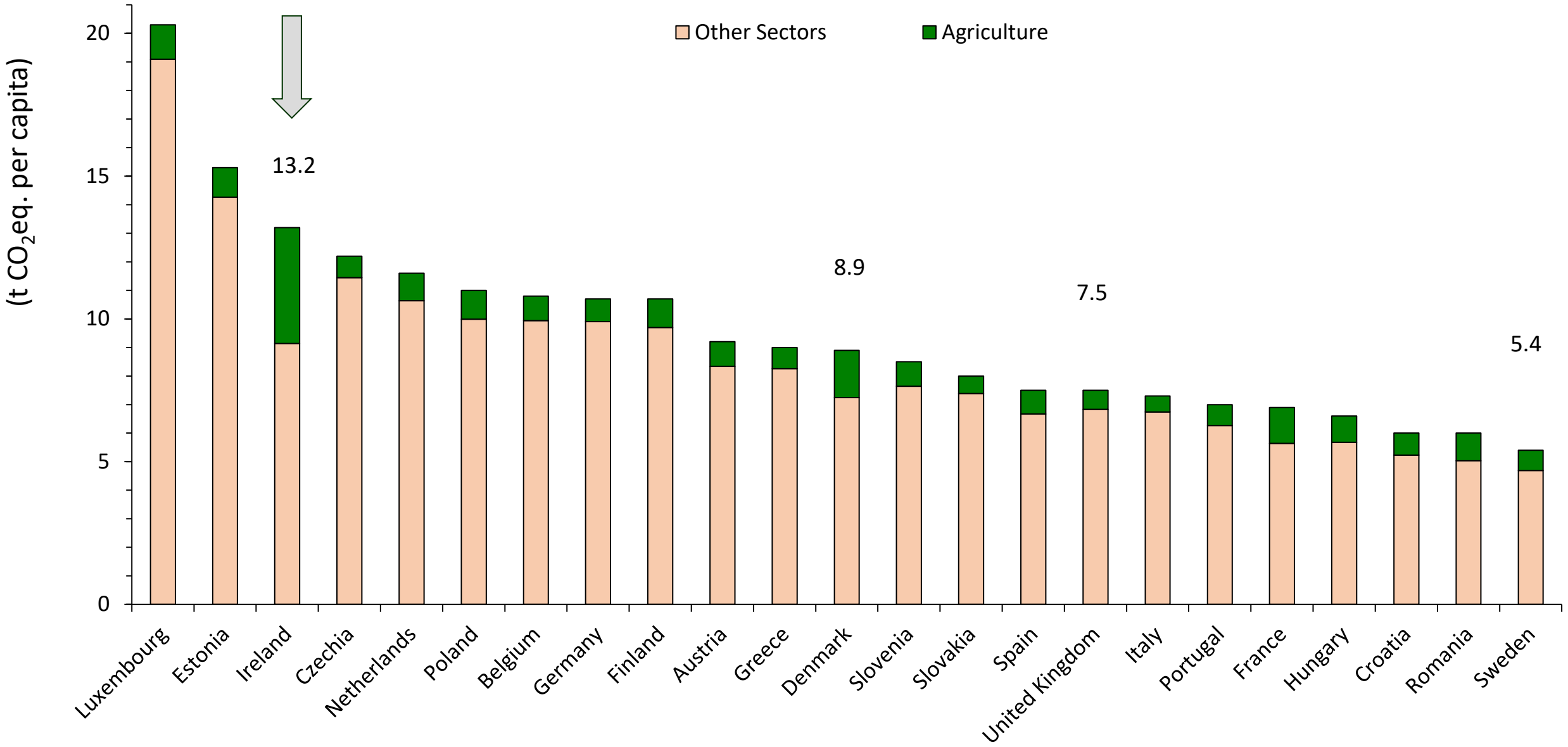
Marion Sorley, Owen Cashman, Emma Buckley

Teagasc
Agriculture and Food Development Authority

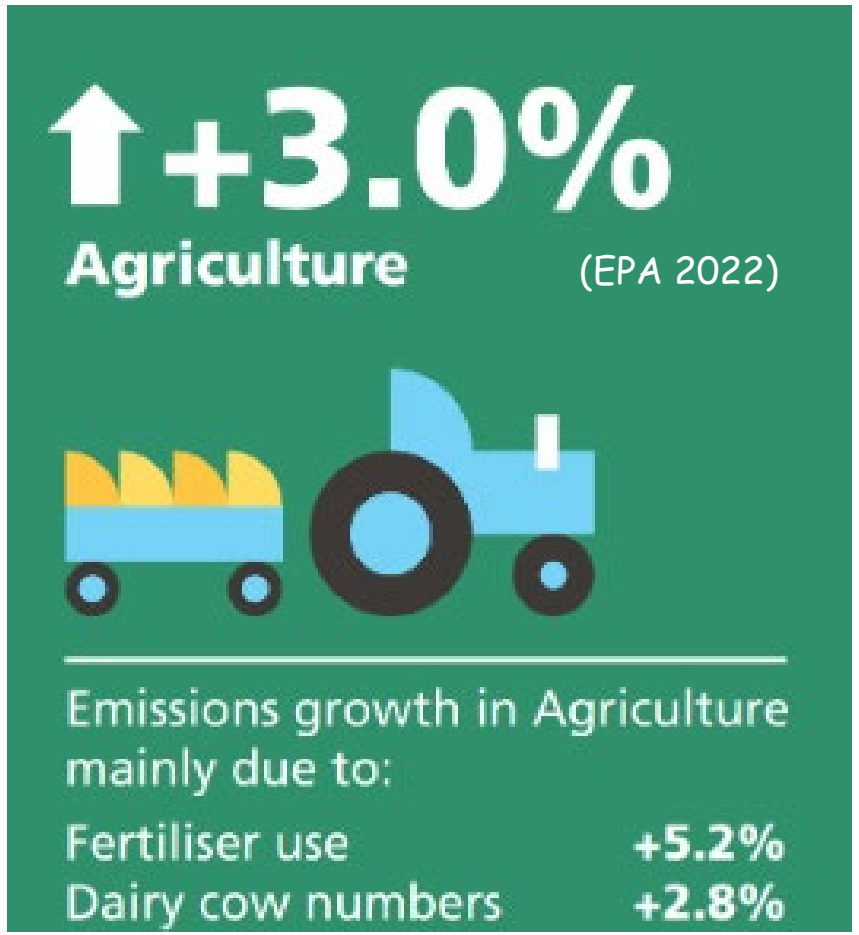
SETU
Ollscoil Teicneolaíochta an Oirdheiscirt
South East Technological University

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

Greenhouse gas emissions per capita in selected European countries

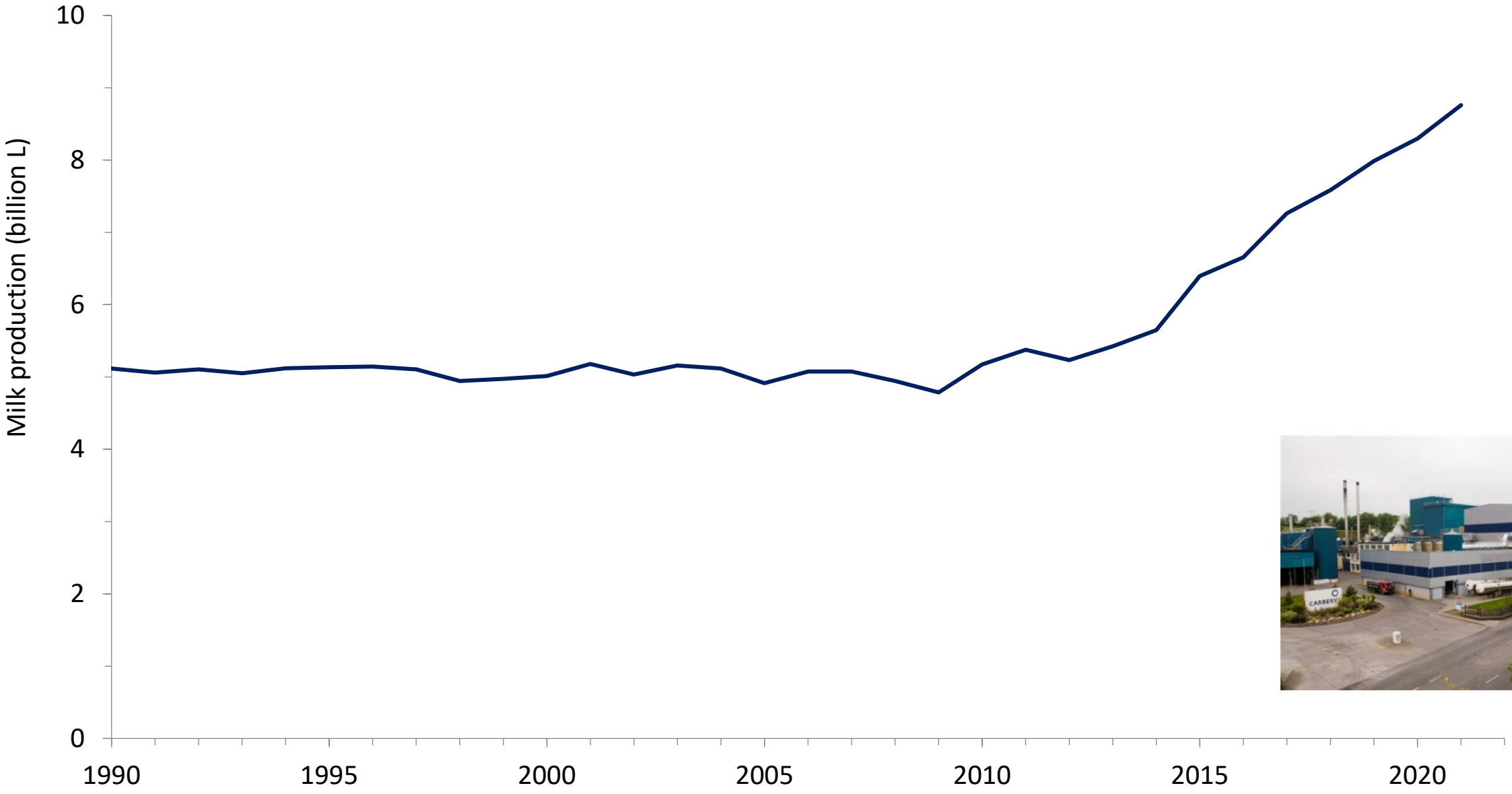


Background

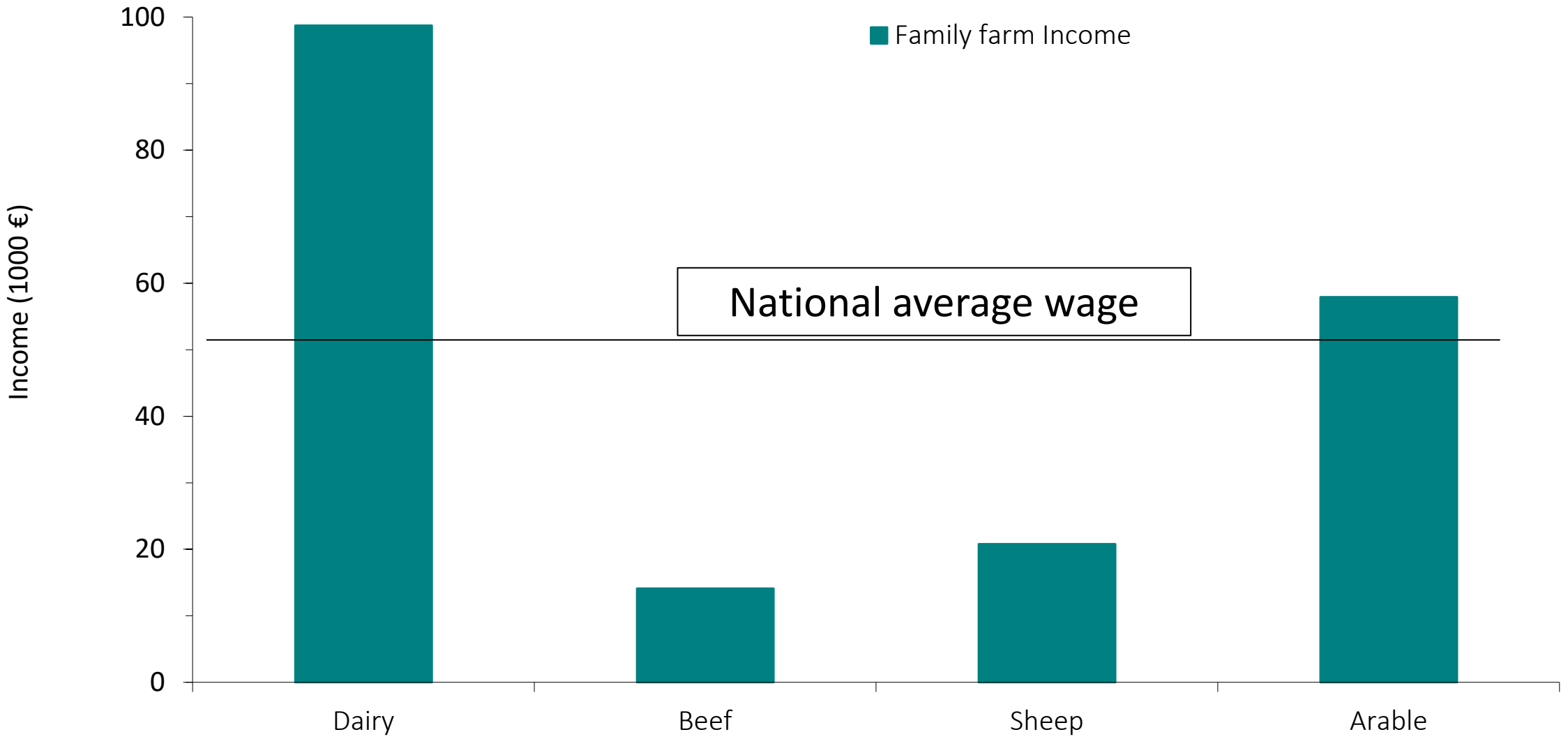


Agriculture and Food Development Authority

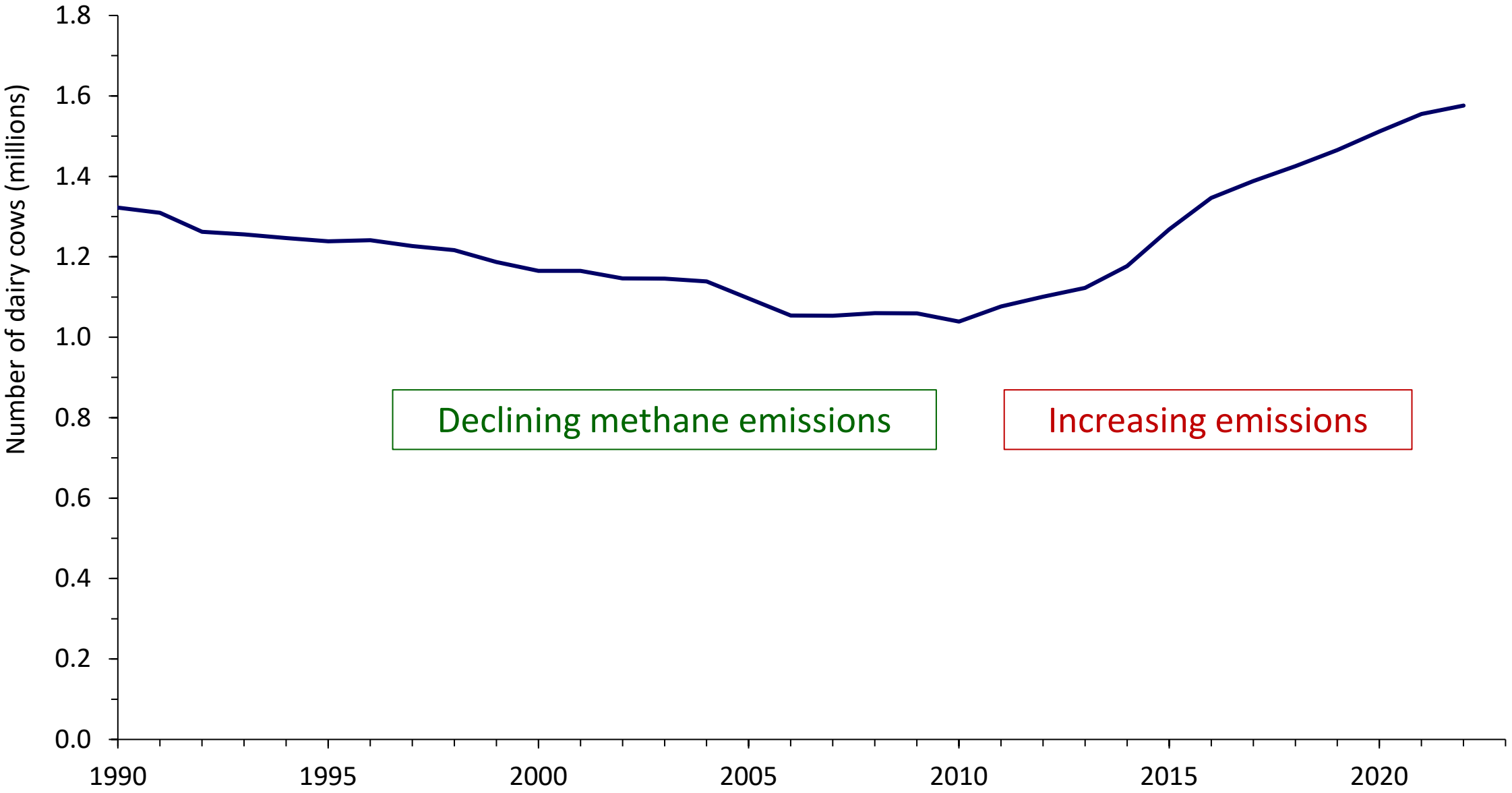
Milk production (billion L) in Ireland 1990 to 2021



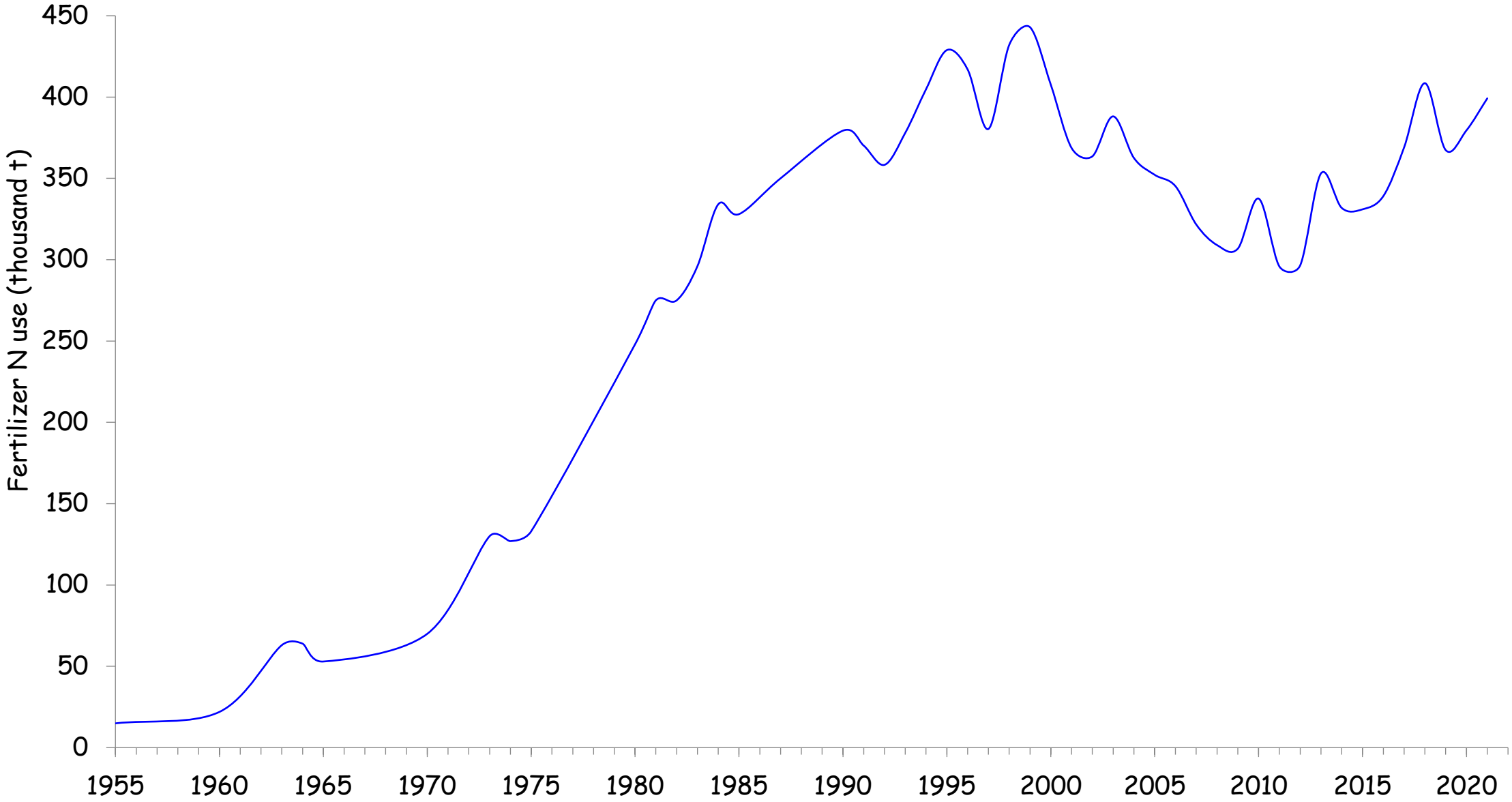
Family farm income and direct payments on Irish farms (Teagasc National Farm Survey 2021)



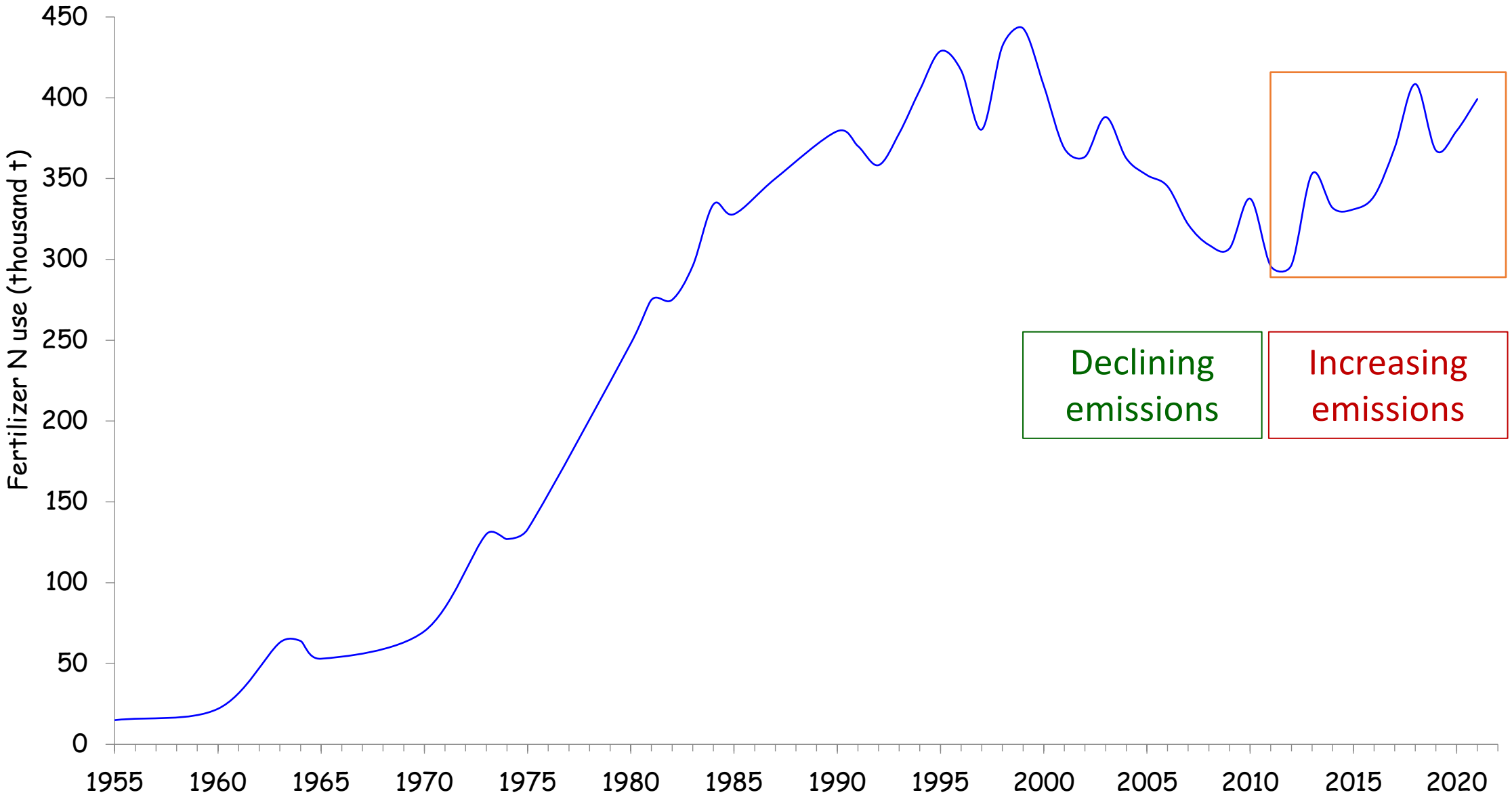
Number of dairy cows in Ireland 1975 to 2021 (millions)



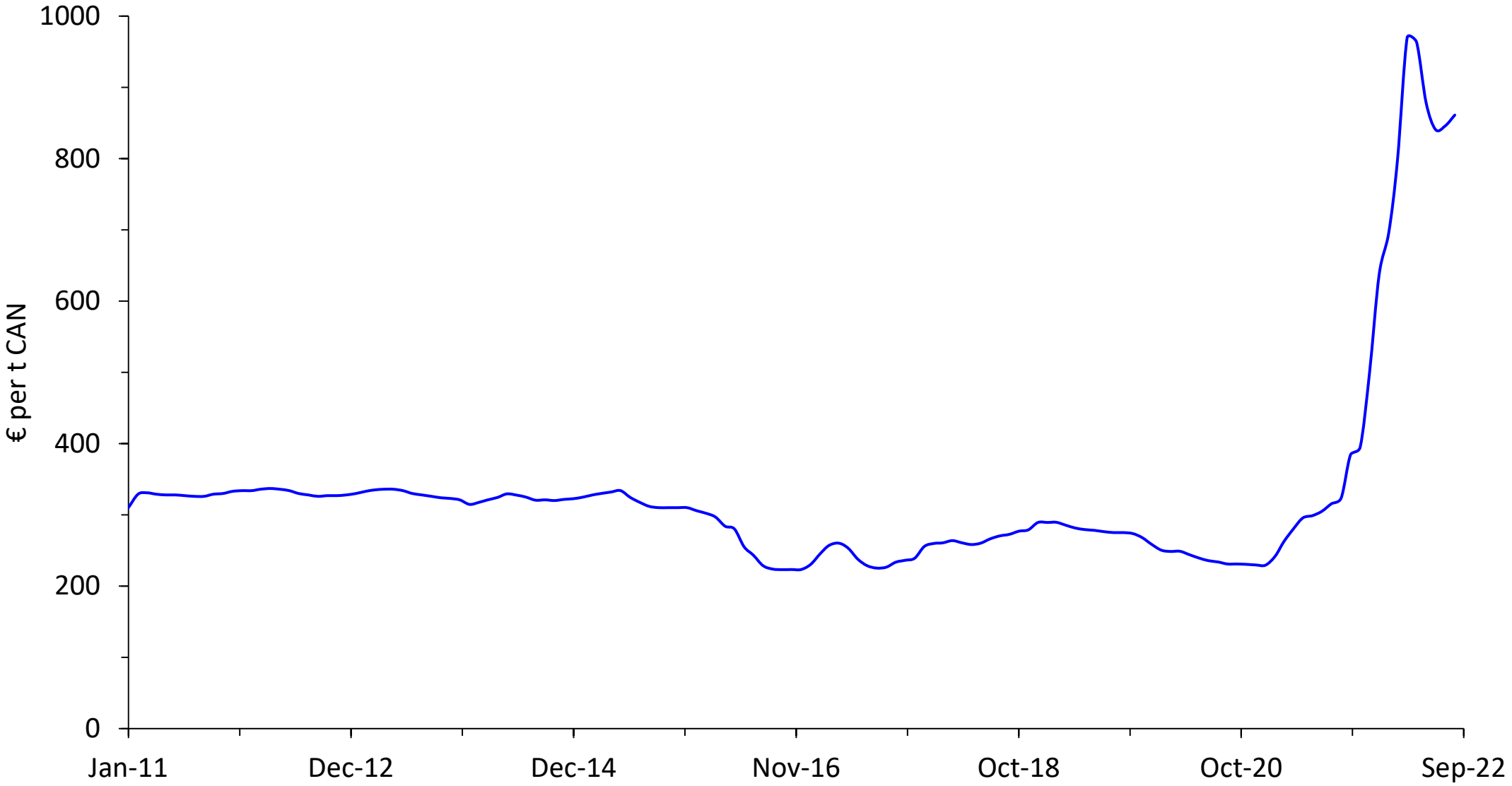
National fertilizer N use since 1955



National fertilizer N use since 1955



Cost of Calcium Ammonium Nitrate (CAN) 2011-2022



EUROPEAN UNION GREEN DEAL

GOAL: EU TO BE CLIMATE NEUTRAL BY 2050

FARM TO FORK TARGETS

FERTILISER USE DOWN 20%

ANTIMICROBIALS USE IN ANIMALS DOWN 50%

PESTICIDE USE DOWN 50%

BIODIVERSITY TARGETS

HIGH DIVERSITY LANDSCAPE TO BE 10% OF FARMING LAND

ORGANIC PRODUCTION TO BE 25% OF FARMING LAND

FARMERS TO GET INCOME FROM CARBON SEQUESTRATION

Clover Research at Solohead Research Farm

Optimum management of **white clover**-based systems

Environmental impact of clover-based systems

- N and C cycling
- Nitrate leaching
- Greenhouse gas and ammonia emissions
- Soil carbon storage

Lowering emissions from dairy farms

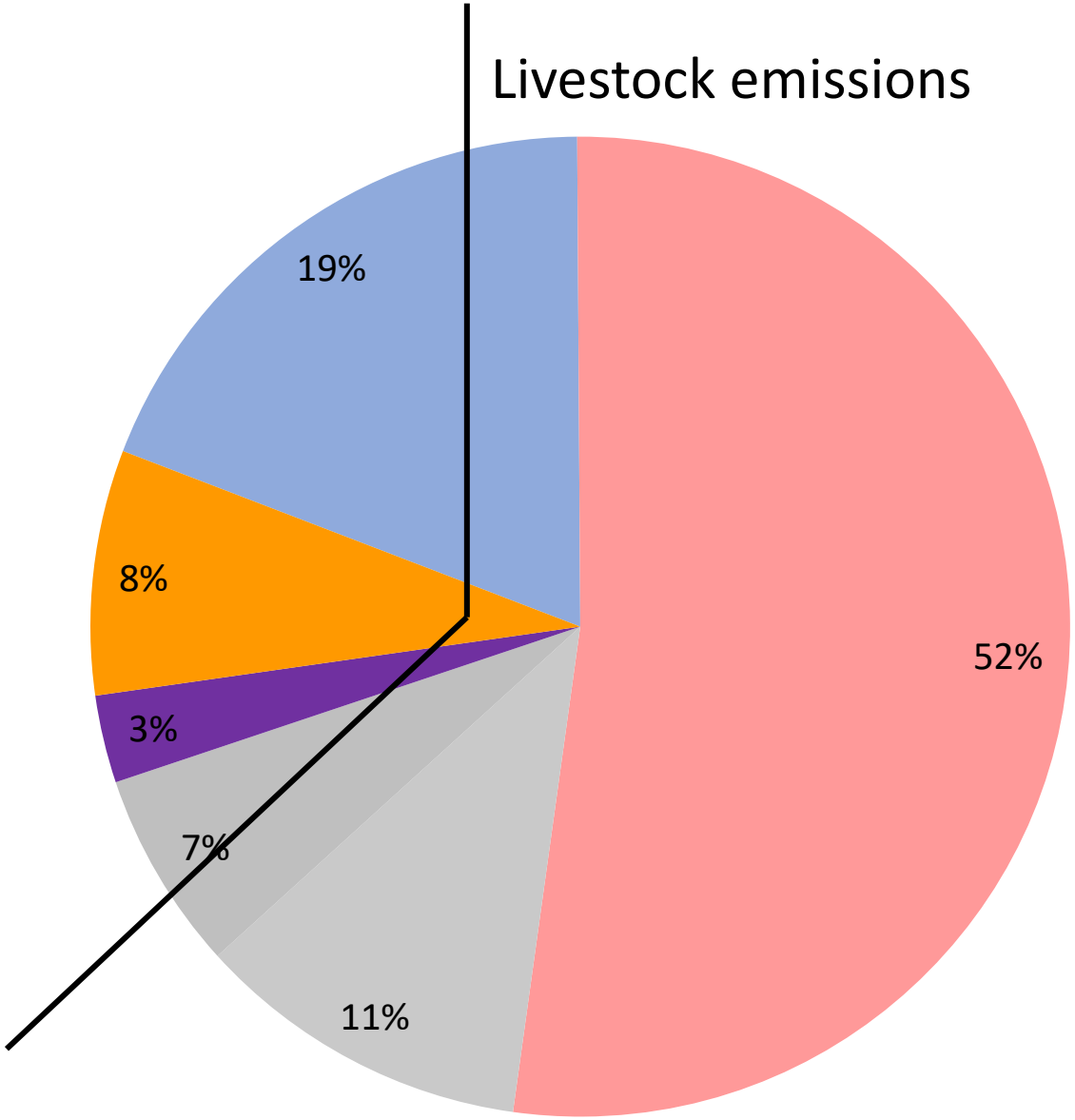
Extensive dairy production
Lower stocking density
Lower emissions per ha
Lower output per ha
Lower return on land/capital
Higher emissions per unit product

Lowering emissions from dairy farms

Extensive dairy production
Lower stocking density
Lower emissions per ha
Lower output per ha
Lower return on land/capital
Higher emissions per unit product

Sustainable intensification + Offsetting
Regional or national scale approach

Greenhouse gas emission profile on dairy farms



Stocking rate (LU/ha)	2.42
Fertilizer N (kg/ha)	272
C footprint (kg $CO_{2eq.}$/L)	1.18

- Fertiliser N
- Enteric Fermentation
- Excreta
- Other
- Fuel
- Concentrate

Objectives

Lower GHG emissions from dairy farms

Assess the impact on production and profitability

"Off the shelf" technologies

White and red clover

Protected urea

Low emissions slurry spreading

High genetic merit cows (Economic Breeding Index)

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Agriculture and Food Development Authority

Characteristics of three dairy systems

2017-2021: Stocking Rate 2.5 cows/ha; 27 cows per system

System	FN-270	FN-105	FN-0
N fertiliser (kg /ha)	270	105	0
N fertiliser type	Urea and CAN	NBPT urea	
Clover contents (%)	11	23	30
Slurry application	Splash plate	Trailing shoe	Trailing shoe
Herd EBI (€)	165	165	195

Milk production 2017 - 2021

System	FN-270	FN-105	FN-0
Stocking rate (cows/ha)	2.5	2.5	2.5
Fertilizer N input (kg/ha)	275	96	0
Herd EBI (€)	165	165	195
Milk (kg/cow)	6,018	6,075	6,090
Fat (kg/cow)	280	278	284
Protein (kg/cow)	217	220	221
Solids (kg/cow)	496	498	505
Fat (%)	46.5	45.8	46.6
Protein (%)	36.0	36.2	36.3
Concentrate (kg/cow)	550	550	550

Pasture production and biological N fixation

System	FN-270	FN-105	FN-0	SEM & P-value
Pasture (t DM/ha)	15.7	15.2	15.1	0.15*
Clover (t DM/ha)	1.6	3.1	4.1	0.40*
N fixation (kg/ha)	20	164	267	35***

*** P < 0.001; * P < 0.05

Modelled scenarios 50 ha farm

System	FN-270	FN-105	FN-0
Fertiliser N (kg/ha)	270	105	0
Herbage production	15.7	15.2	15.1
Stocking rate (LU/ha)	2.56	2.47	2.45
Concentrate (kg/cow)	550	550	550

Greenhouse gas & ammonia emissions & profitability

Fertilizer N (kg/ha)	FN-270	FN-105	FN-0
Stocking rate (LU/ha)	2.56	2.47	2.45
Herd EBI	165	165	195
Cows/farm	128	124	123
GHG (kg CO2eq./L)	0.88	0.75	0.69
GHG emissions (t/ha)	12.5	10.5	9.3
Ammonia (kg/t milk)	4.00	3.17	2.81
Relative GHG emissions (%)		-16	-25
Net margin (€ per ha)	1,513	1,584	1,733

Net margin on a 50 ha farm (heifers contract reared)

Fertilizer N (kg/ha)	FN-270	FN-105	FN-0
Stocking rate (LU/ha)	2.56	2.47	2.45
Herd EBI	165	165	195
Cows/farm	128	124	123
Total sales (€)	283,996	275,921	278,200
Fertilizer N (€)	12,967	4,055	0
Total variable costs (€)	97,599	89,142	83,980
Total Fixed costs (€)	110,751	107,583	107,550
Net margin (€)	75,646	79,196	86,670
Net margin (€ per ha)	1,513	1,584	1,733

Conclusions

Lower emissions and high net margins using existing technologies

Replacing fertiliser N with fixed N was the main mitigation technology

Lower stocking rate also lowered emissions

EBI, LESS and protected urea contributed to lower emissions

The challenge will be to get adoption of these technologies on farm

Optimum management of white and red clover on farms

Thank you

Five-week old white clover seedling

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Agriculture and Food Development Authority

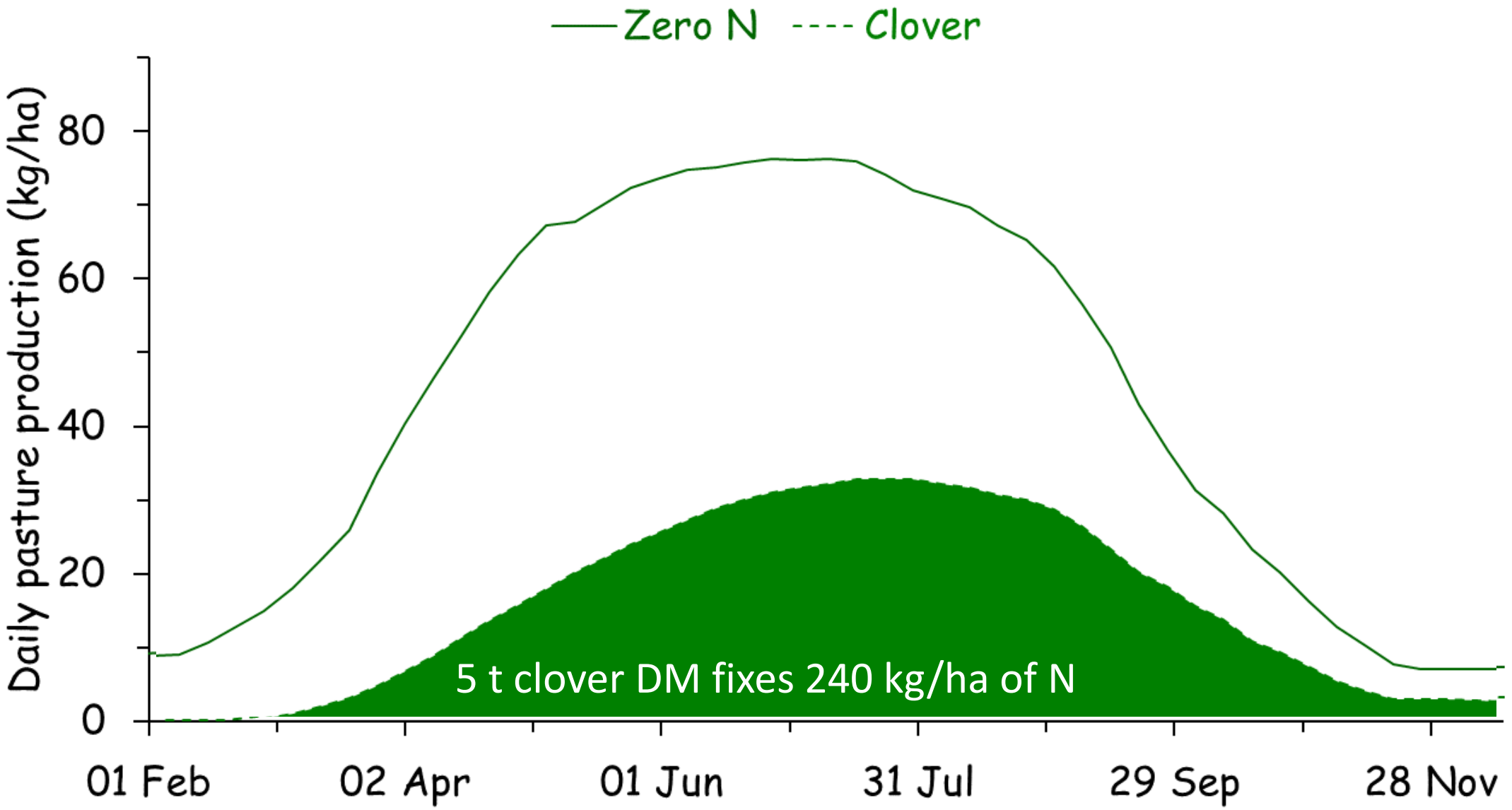
LoCAM-dairy project 2019R521

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

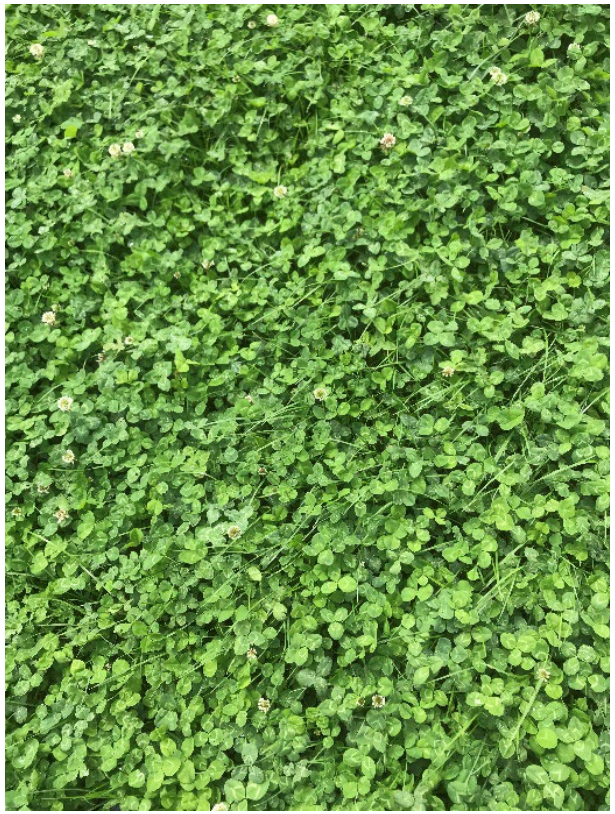
High pasture production without fertilizer N ?

48 kg N per t clover herbage DM

Target: 5 t/ha clover DM per year



How to grow 5 t/ha clover DM




Low risk conversion to clover

Reseeding

Post-emergence dock control

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Example of a seed mixture

Cultivar	Species	per ha
Astonenergy	Perennial ryegrass	20 kg
Milvus	Red clover	5 kg
Barblanca	White clover	2.5 kg
Coolfinn	White clover	2.5 kg

Example of a seed mixture

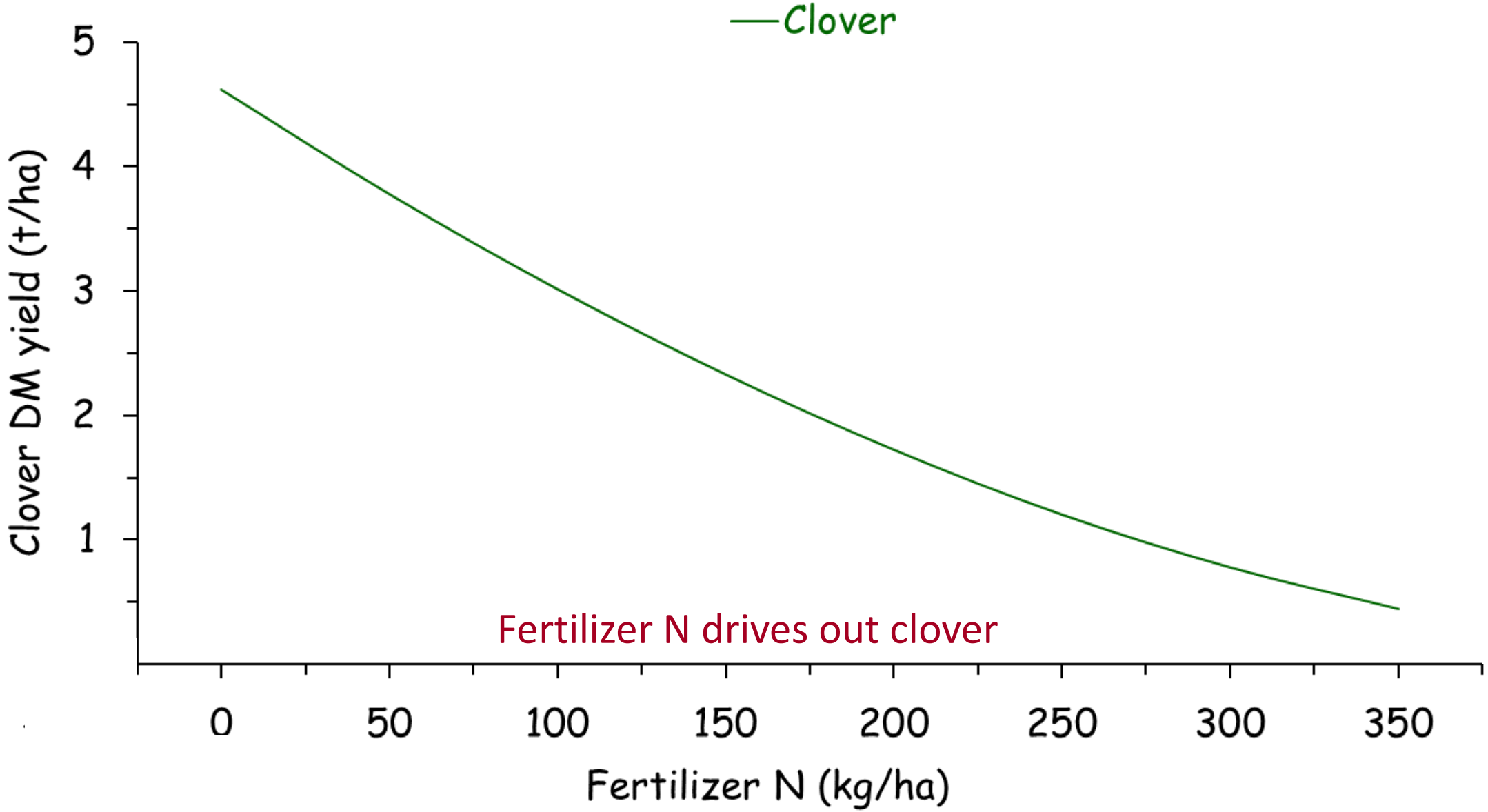
Cultivar	Species	per ha	
Astonenergy	Perennial ryegrass	20 kg	
Milvus	Red clover	5 kg	2.5 million
Barblanca	White clover	2.5 kg	7.5 million
Coolfinn	White clover	2.5 kg	

Six-week old white & red clover seedlings

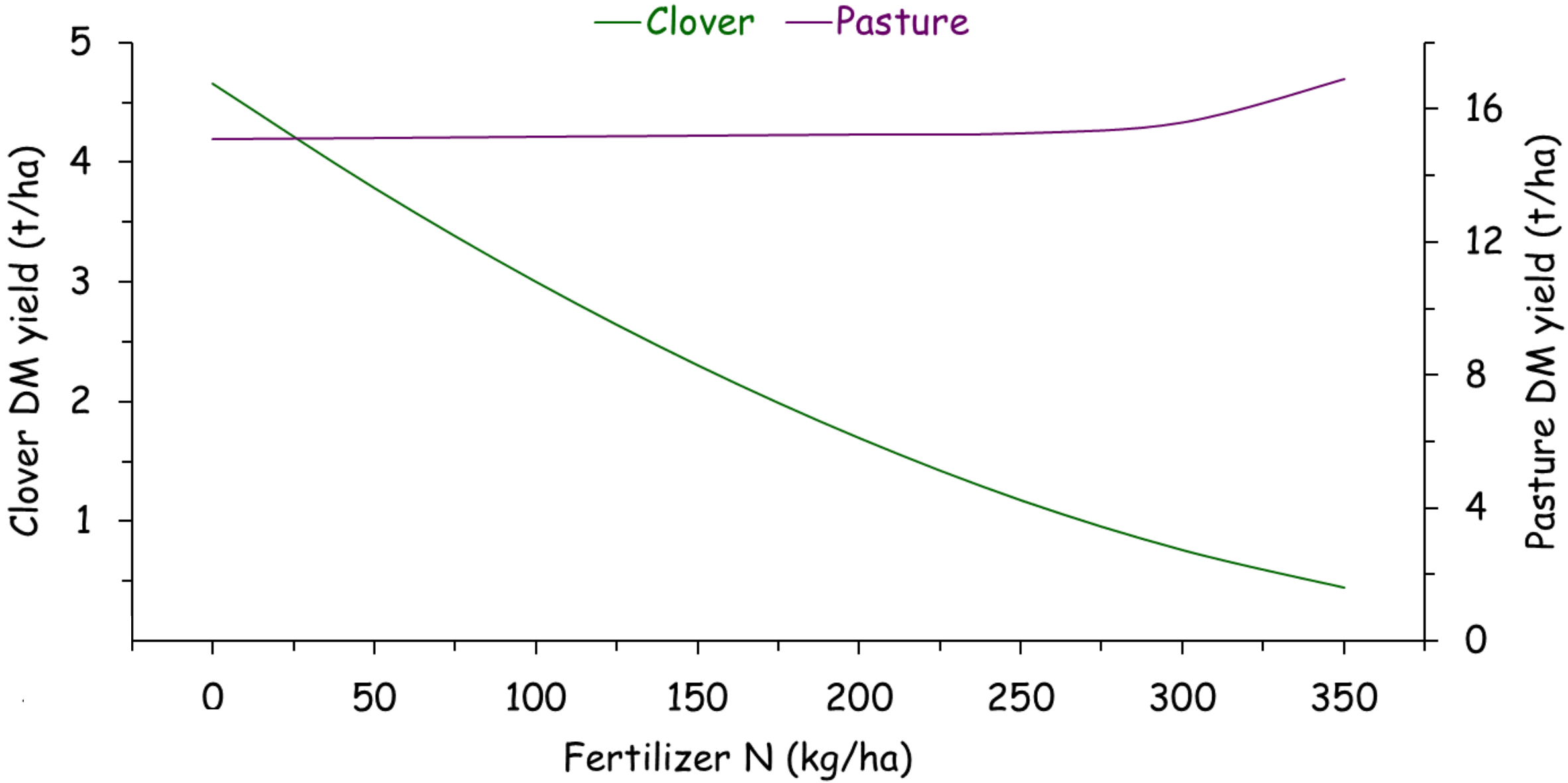
Fixes up to 225 kg/ha

after spring reseeding

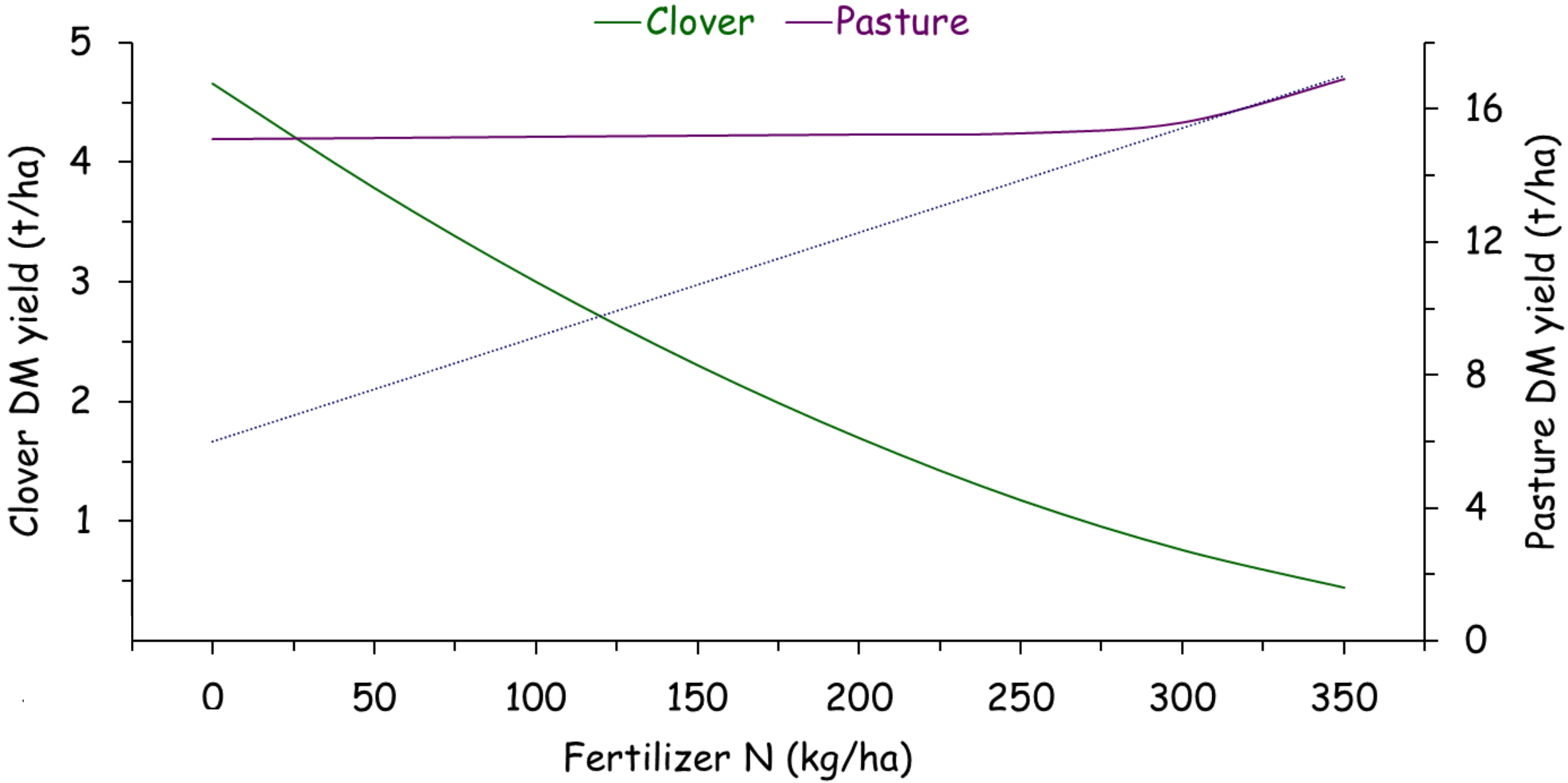
The effect of fertilizer N on clover production



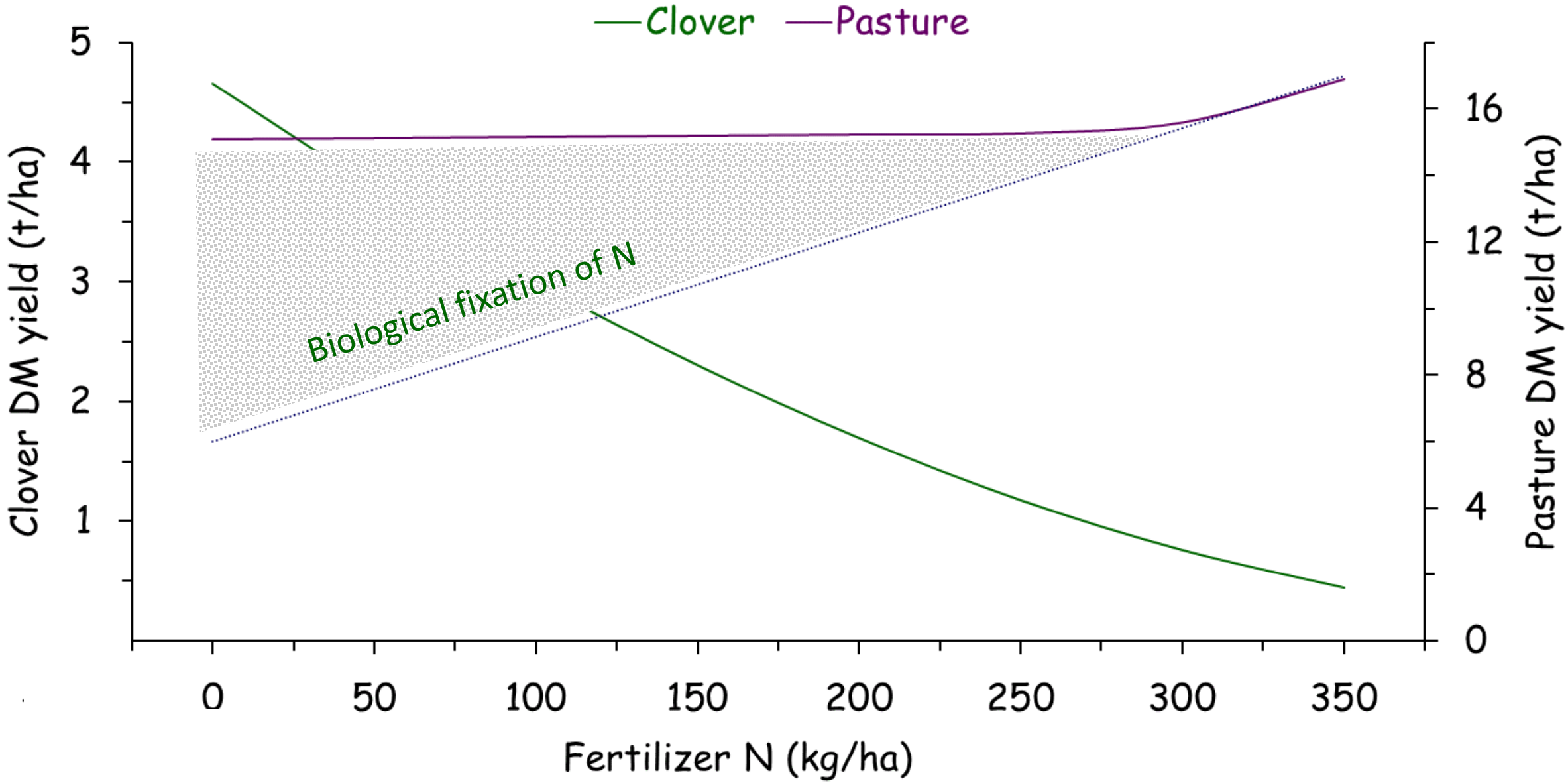
The effect of fertilizer N on clover and pasture production



The effect of fertilizer N on clover and pasture production



The effect of fertilizer N on clover and pasture production



Managing clover swards

Low fertilizer N input

Tight grazing <4 cm

Soil pH needs to be right: 6.5 – 7.0

Regular application of K and P

Increasing to 6 week rotations in the autumn

Low covers over the winter

Reseeding at ten-year intervals

Drainage of wet soils

Use silage harvests to increase clover contents

Final comments

Not more complicated than managing an N-fertilized system

Maximise clover production to maximise N fixation

Set up the farm for grazing to low residuals

Choice of cultivar during reseeding

Low covers over the winter

Improves profitability & lowers environmental footprints

Thank you

Five-week old white clover seedling

Teagasc
Agriculture and Food Development Authority

LoCAM-dairy project 2019R521

Department of Agriculture, Fisheries and Food
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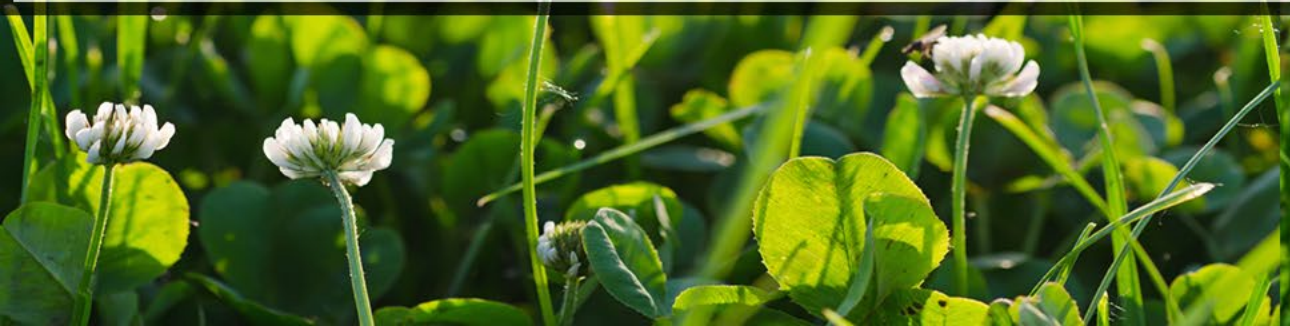



Using legumes in beef and sheep systems

Plan

- Why should we be interested in legumes?
- What legumes could work?
  - Pros and cons
  - Considerations
- Options to use legumes in beef systems
- Options to use legumes in sheep systems
- Summary

What is a legume?

- **Beans**, soybeans, **peas**, chickpeas, peanuts, lentils, lupins, mesquite, carob, tamarind, **vetch**, **lucerne and clover**
- They form a symbiotic relationship with Rhizobium bacteria in the soil, which fix nitrogen from the air in exchange for feed and water
  - When nitrogen is limited, good air supply
  - pH of 6-6.5, P and K indexes of 2 and good Molybdenum levels

Why are we interested in legumes?

- High protein levels in silage
- Nitrogen fixation
- Improved liveweight gain
- Improves soil structure
- Different growth patterns
- Benefits the following crop
- More drought tolerant
- Sequestrates more carbon than grass
- Animal preference
- Used in diverse mixtures

Legumes

https://www.cotswoldseeds.com/seeds/21/legumes

LIZ GENEVER

Yield potential

Vetches

Red clover

Lucerne

Sainfoin

White clover

Crimson clover

Subterranean

Alsike clover

Balansa clover

Persian clover

Sweet clover

Birdsfoot trefoil

Berseem/ Egyptian clover

Yellow trefoil

Persistency

Vetch (*Vicia sativa*)

- Used on its own, or with forage rye or westerwolds for winter grazing

Pros	Cons
Fixes up to 200 kg of nitrogen	Drill in September Cultivate by May the next year
Winter-hardy annual	
Can make good silage with cereal companion	

Red clover (*Trifolium pratense*)

- Very useful for silage leys with some aftermath grazing
- Fit well into arable systems
- Crucial for organic systems

Pros	Cons
Fixes up to 250 kg of nitrogen	Persistency is reduced if grazed
New varieties can last 4-5 years	Can cause bloat and digestive upsets
Can make excellent silage and reduce bought-in proteins	

Lucerne (*Medicago sativa*)

- Very useful for silage leys with some aftermath grazing
- Fit well into arable systems
- Can be grazed

Pros	Cons
Fixes up to 250 kg of nitrogen	Persistency is reduced if grazed
Can last 4-5 years	Can cause bloat and digestive upsets
Can make excellent silage and reduce bought-in proteins	Need to have salt and fibre at all times

https://www.innovativefarmers.org/field-lab?id=2a12e37b-4a5d-ea11-8181-005056ad0bd4

Sainfoin (*Onobrychis viciifolia*)

- Useful for silage leys with some aftermath grazing
- Not much grown

Pros	Cons
Fixes 150-250 kg of nitrogen	Persistency is reduced if grazed
Mitigates bloat	Doesn't like heavy or acidic land
Can make excellent silage and reduce bought-in proteins	

White clover (*Trifolium repens*)

- Very versatile legume
- Different leaf size fits systems

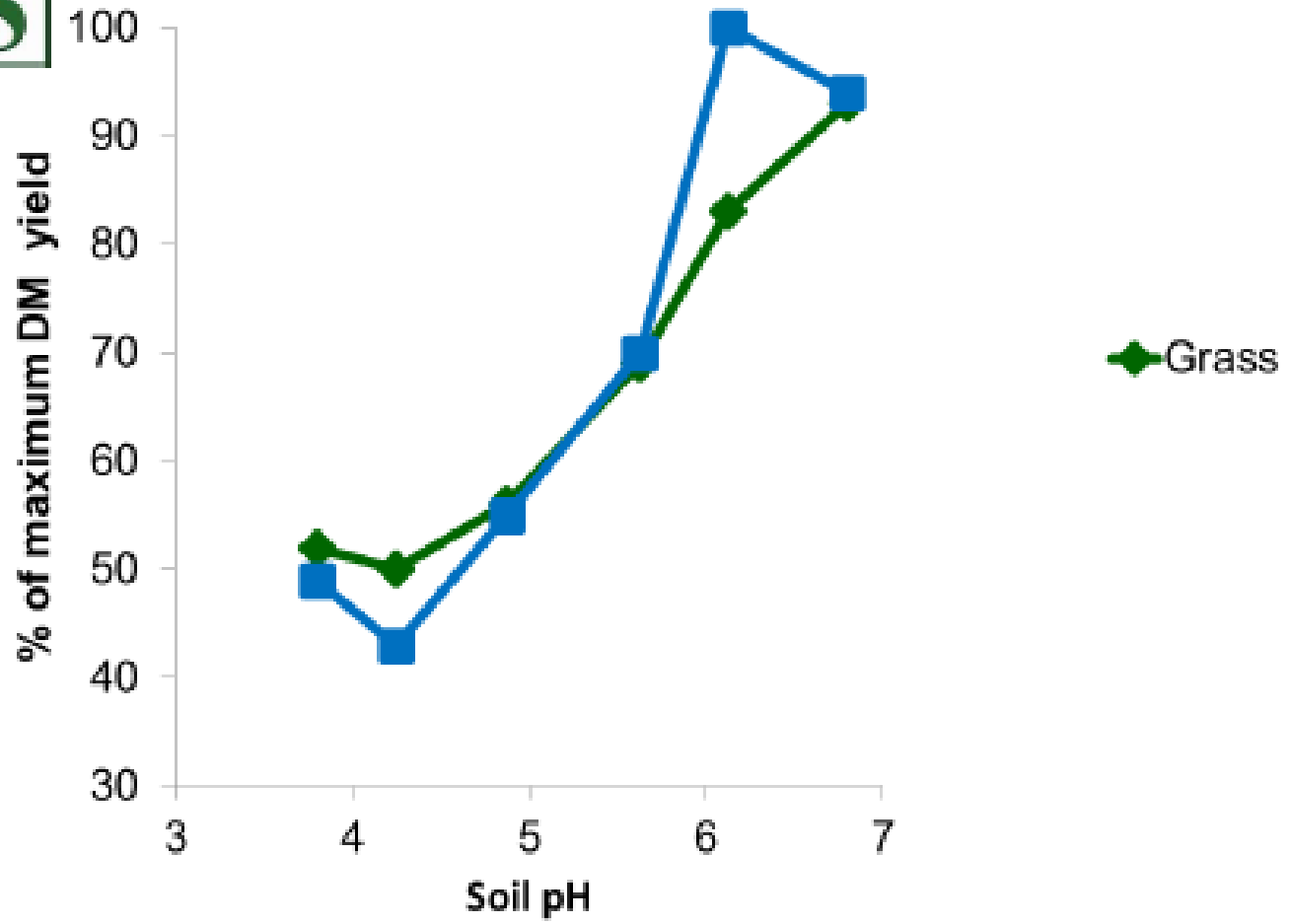
Pros	Cons
Fixes up to 150 kg of nitrogen	Yields less than red clover
Will last for years if managed well	Can cause bloat and digestive upsets
Can make excellent silage and reduce bought-in proteins	

Legume	How it can be used?	Considerations
White clover	Silage or grazing, can lasts for a long time	Bloat, needs careful grazing to avoid plant death, needs matching with appropriate grasses
Red clover	Silage or grazing, lasts over up to four years	Bloat, needs careful grazing to avoid plant death, needs matching with appropriate grasses
Annual clovers – crimson, berseem (Egyptian), trefoils, alsike	Silage or grazing leys, help with production in year one, earlier nitrogen fixation, more tolerant of poorer soils	Annuals
Subterranean clover	Dryland production systems	Not much grown in the UK (annual)
Lucerne	Silage or grazing, lasts over four years	Bloat, salt, well-drained land, high calcium requirement, weeds
Vetch	Cover crop, e.g. with oats and other species, or within diverse ley	Not grazing tolerant (annual)
Beans, peas or vetch	Bi-crop silage, e.g. with barley, alternative to maize	Harvest date, fits within rotation?

Considerations for establishment

- Soil test results are needed – what nutrients need to be applied?
- Soil structure check – what cultivations are needed?
- Good seedbed with very shallow drilling
  - Inoculation is needed for lucerne, may be for clovers in arable systems
- Overseeding is possible
  - Best in the summer with warm soils
  - 1.5 – 2.5 kg per acre depending on how established current sward
- Grazing rather than silage to ensure clover gets light
- Weed control

Soil pH and grass/clover growth



From Hopkins *et al.* (1990) Grass and Forage Science

Application of nitrogen

Table 3.12 Nitrogen recommendations for grass establishment

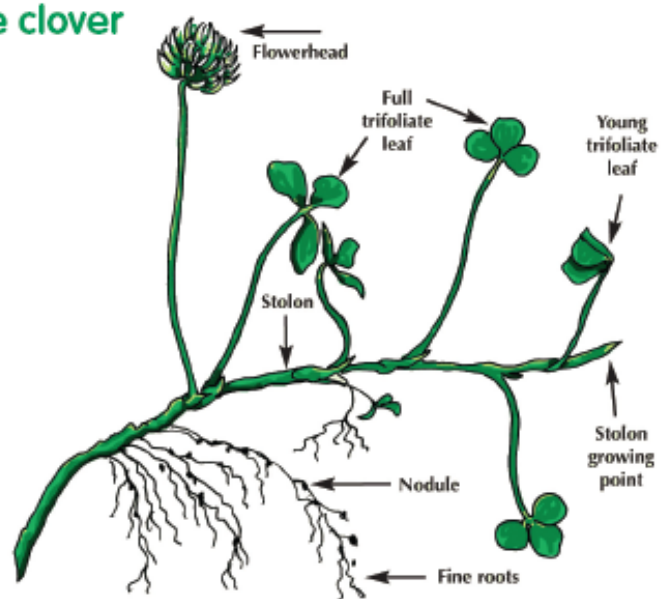
	Soil Nitrogen Supply (kg N/ha)		
	Low	Moderate	High
Spring sown (April–June)	60	60	60
Summer or autumn sown (July to mid-October)	30–50[a]	0–30[a]	0
Grass and clover swards	0	0	0

a. Nitrogen is important when rapid grass growth is needed, e.g. when seedbed conditions are suboptimal; or seed is sown late. Nitrogen should not be applied where it will stimulate weed growth (e.g., in weedy stubbles) or seedling competition (e.g., direct-drilled into an existing sward). Be aware of NVZ closed periods.

For spring-sown swards, deduct the amount of nitrogen applied for establishment from the first season's grazing or silage/hay requirement.

White clover

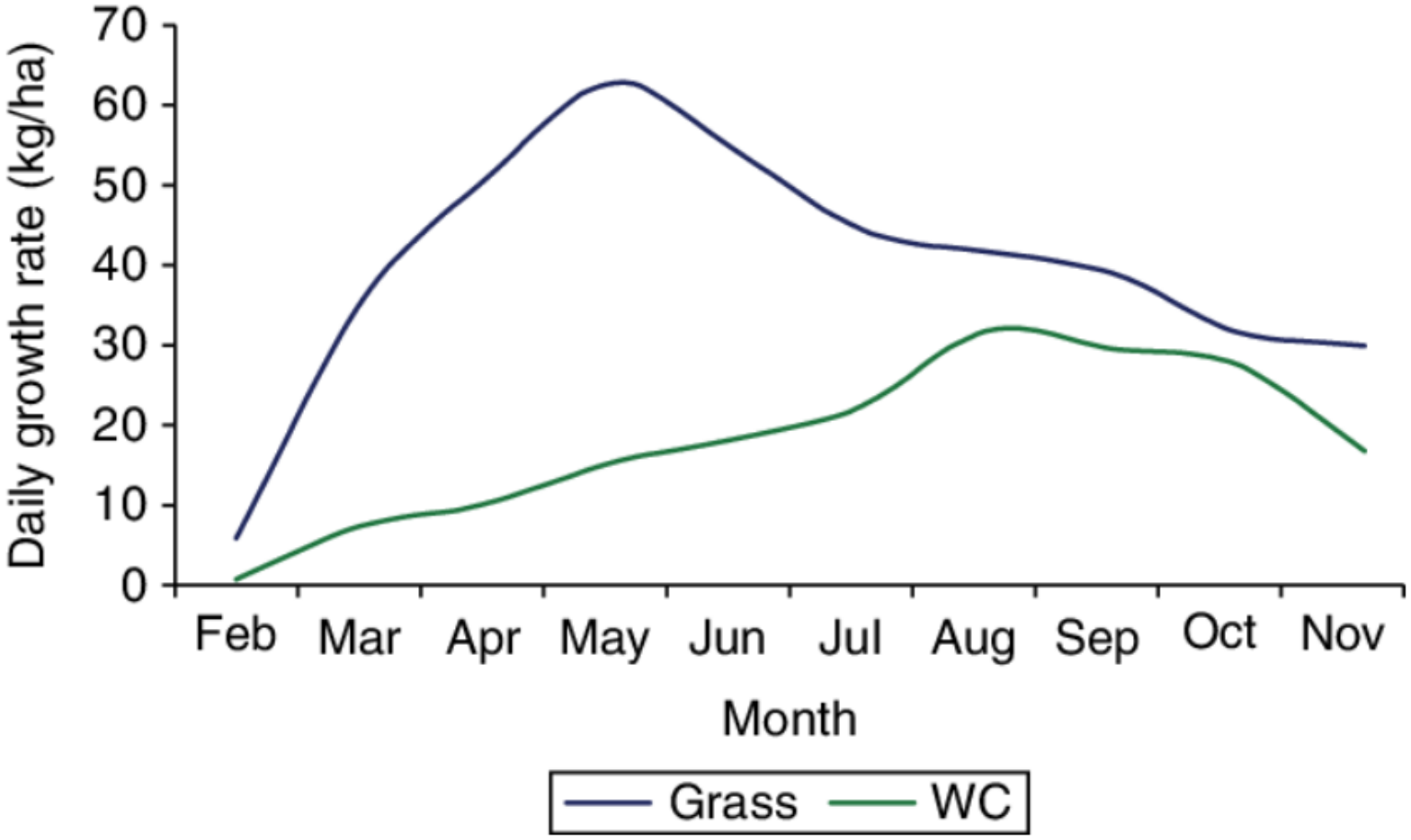
White clover



Leaf type	Leaf area*	Uses
Small	Less than 700mm²	Continuous sheep grazing
Medium	700-1000mm²	Rotational sheep grazing Continuous cattle grazing Cutting
Large	More than 1000mm²	Cutting Rotational cattle grazing

*See Recommended Grass and Clover Lists

Different growth habit



Source: White Clover Supported Pasture-based Systems in North-west Europe, Legumes in cropping systems

Impact of companion grass on white clover yield and contribution under silage management

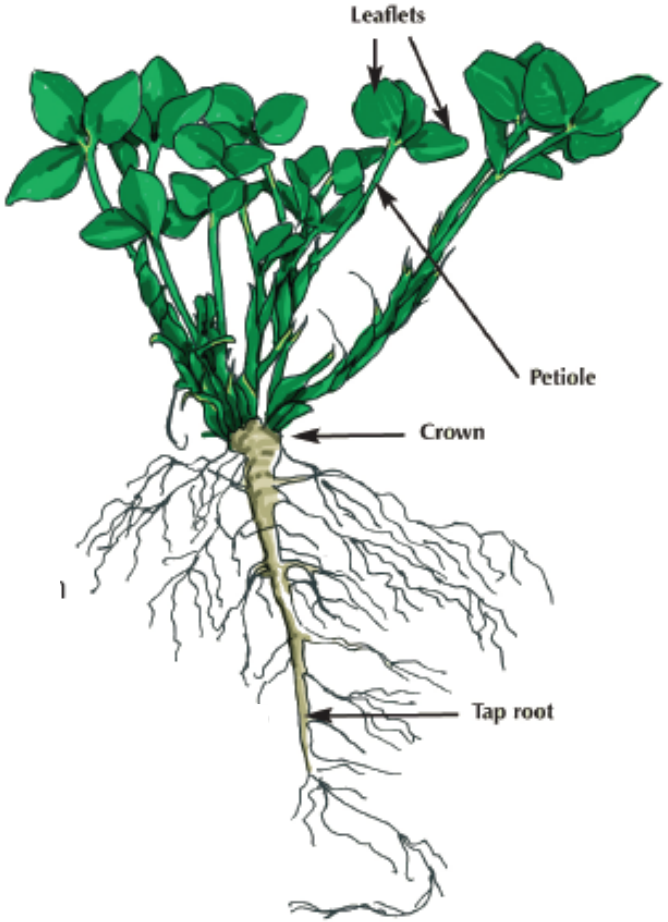
Companion grass	Grass + clover yield (t DM/ha)	Clover yield (t DM/ha)	Clover contribution (%)
Cocksfoot	13.9	4.0	29
PRG	13.9	5.9	42
PRG (T)	13.9	6.4	46
Timothy	13.8	7.4	53

(T) = Tetraploid cultivar

Management for white clover

- They form a symbiotic relationship with Rhizobium bacteria in the soil, which fix nitrogen from the air in exchange for feed and water
  - When **nitrogen is limited**, good air supply
  - pH of 6-6.5, P and K indexes of 2 and good Molybdenum levels
- Not under-grazed in late spring/summer (light)
- Not over-grazed in winter (stolon damage)

Red clover



Breeding ewes on red clover

- Innovative Farmers Field lab (tupping 2021) showed that red clover within a diverse sward had no negative impact on 3 out of 4 farms involved, with most reporting a higher scanning percentage
  - Mating Sheep On Red Clover Swards Field Lab

- Need to think about ewe lambs or any sheep grazing high red clover swards for long periods of time
  - Not very likely in the UK

How to use legumes in beef systems

- Careful to avoid over grazing in winter and under-grazing in the summer
- Need to think about transition to clover-rich swards, plus oil in the water, long fibre available, salt

Group	Spring	Summer	Autumn	Winter
Suckler cows		Used to tidy up pasture for grazing cattle	Used to tidy up pasture for grazing cattle	Thinner cows on better silage
Growing cattle	Turnout to grass with low levels of clover	- Grazing clover and grass leys - Monitor for bloat as clover levels are increasing	Monitor performance as clover levels will be dropping	Fed high clover silage to reduce need for supplements
Finishing cattle				

How to use legumes in sheep systems

Group	Spring	Summer	Autumn	Winter
Ewes and lambs	- Triplets or young sheep lambing on red clover swards - White clover in swards	- Red clover area shut up for silage cut, or used for high priority groups - White clover levels building		Minimal grazing of high clover swards Red clover silage being fed to ewes to reduce the need for supplements Lambs on vetch-based cover crop
Lambs			Weaned onto high clover leys	
Dry ewes			- Thinner ewes being used to tidy up pastures. - Care around red clover levels?	

Summary

- Clovers need to play an important part in every beef and sheep systems
  - They do make management more challenging, but need to think about impact of under- and over-grazing

- Other specialist legumes have a place, but need to plan how they fit into the rotation and how they are going to be grazed or used

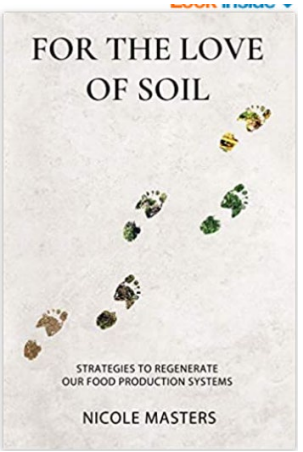
Let's talk about fungi

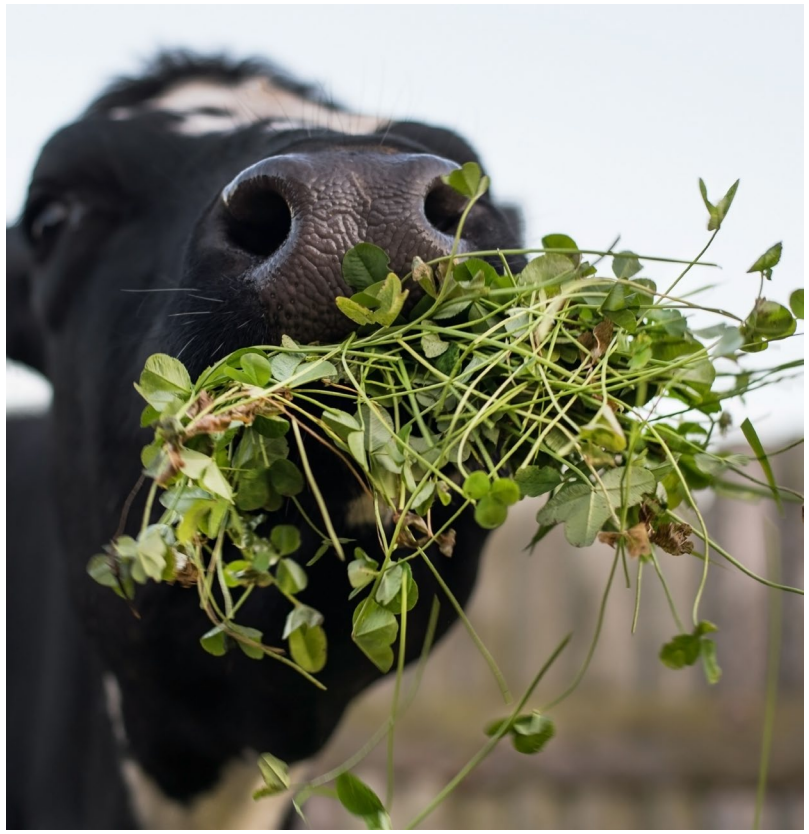
- Ideal cropping soils have a bacteria to fungi ratio of 1:1
  - Less than 1 – annual weeds, brassicas, more bare soil
  - More than 1 – bushes, shrubs,

- Fungi makes nutrients more available from across the soil profile – provides plants with P, Zn and N in exchange for sugars
  - Other soil life (protozoa and nematodes) eat bacteria and release the nutrients

- What kills fungi?
  - Cultivations, nitrogen fertiliser, weed killers

- Bacteria dominant soils have nutrient lock-up




Discussion Session

AgriSearch NI
Driving Excellence & Innovation

Recommended List of Red Clover Varieties 2021/2022

		Diploids									Tetraploids			
	Mean of G varieties	Merviot	Lemmon	AberClaret	AberChianti	Harmonie	Metis	Discovery	Sinope	Fearga	Amos	Maro	Atlantis	Magellan
Recommended List status		S	G	G	S	G	G	G	PG	PG	G	G	G	G
Conservation: management														
Total yield: 1st harvest year (% of 12.34t DM/ha)	100	105	100	103	92	99	92	103	101	103	103	102	103	99
Total yield: 2nd harvest year (% of 13.07t DM/ha)	100	98	98	105	97	99	94	101	101	108	102	99	103	100
Total yield: 3rd harvest year (% of 9.73t DM/ha)	100	87	101	109	109	101	96	94	102	109	96	96	105	106
Total yield: mean (% of 11.91t DM/ha)	100	97	100	105	99	100	94	100	101	106	101	99	104	101
Seasonal growth: 1st harvest year														
1st cut (% of 5.06t DM/ha)	100	112	101	99	85	100	95	105	110	95	105	102	103	98
Protein content %: 1st cut	17.8	17.1	17.5	17.0	17.1	18.2	17.4	16.2	17.9	17.1	18.1	17.9	17.8	18.0
Agronomic characters														
Ground cover % (1st harvest year)	68	66	68	66	68	71	69	62	63	64	70	66	70	69
Ground cover % (2nd harvest year)	56	45	57	56	60	60	58	46	55	59	56	50	57	57
Ground cover % (3rd harvest year)	49	35	52	51	60	55	50	41	46	51	45	38	51	53
Year First Listed		1980	2003	2010	2011	2012	2016	2016	2018	2018	2005	2010	2011	2014
Breeder		ILVO	ILVO	IBERS, Aberystwyth	IBERS, Aberystwyth	Nord. Pflan/ DSV	DLF Seeds A/S	INRA	DLF Seeds A/S	Teagasc, Eire	Slechtitelská stanice, The Czech Republic	LSPB	Nord. Pflan/ DSV	Nord. Pflan/ DSV
Agent		Limagrain UK Ltd	Barenbrug UK Ltd	Germinal	Germinal	DSV	DLF Seeds Ltd	Barenbrug UK Ltd	DLF Seeds Ltd	Goldcrop Ltd	DLF Seeds Ltd	Limagrain UK Ltd	DSV	DLF Seeds Ltd
Number of trials for yields														
1st harvest year		19	17	17	17	17	12	12	6	9	19	17	17	17
2nd harvest year		20	16	16	16	16	11	11	5	8	20	16	16	14
3rd harvest year		17	13	13	13	13	8	8	5	5	17	13	13	11

Recommended List of Red Clover Varieties 2022/2023

Good for cutting and finishing stock in the autumn.

	Conservation management						
Variety	**Yield of 1st cut** in 1st harvest year *Average = 100 at 5.20t DM/ha*	**Total annual yield** *Average = 100 at 11.69t DM/ha*	**Crude protein %** *in 1st cut of 1st harvest year*	**Crude protein %** *in 2nd cut of 2nd harvest year*	**Crude protein %** *in 2nd cut of 3rd harvest year*	**Ground cover %** *2nd harvest year*	Suitable for my farm ✔
Diploids							
Merviot	112	96	17.1	19.3	19.0	47	
Lemmon	100	99	17.6	19.2	19.8	60	
AberClaret	98	104	17.0	18.2	18.7	59	
Harmonie	99	98	18.3	19.6	20.1	64	
Sinope	104	100	17.8	19.2	-	57	
Fearga	91	105	17.1	18.3	18.6	58	
Ganymed	104	106	16.5	18.1	19.0	60	
Tetraploids							
Amos	101	99	18.1	20.2	19.9	57	
Maro	101	96	18.0	19.5	19.7	50	
Atlantis	101	102	17.8	20.6	19.7	60	
Magellan	99	102	18.0	19.9	19.9	60	