Commercial dairy farming without fertilizer N?

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European Regional Development Fund
European Union
Dairy 4 future

How much fertilizer N?

Stocking rate: 1 cow/acre; 2.5 cows/ha

Recommendation	Fertilizer N (kg/ha)
Early 1990's	250 - 380
Mid 2000's	250 - 280
Current	150 - 250
Solohead 2020	100
Solohead 2023	<50

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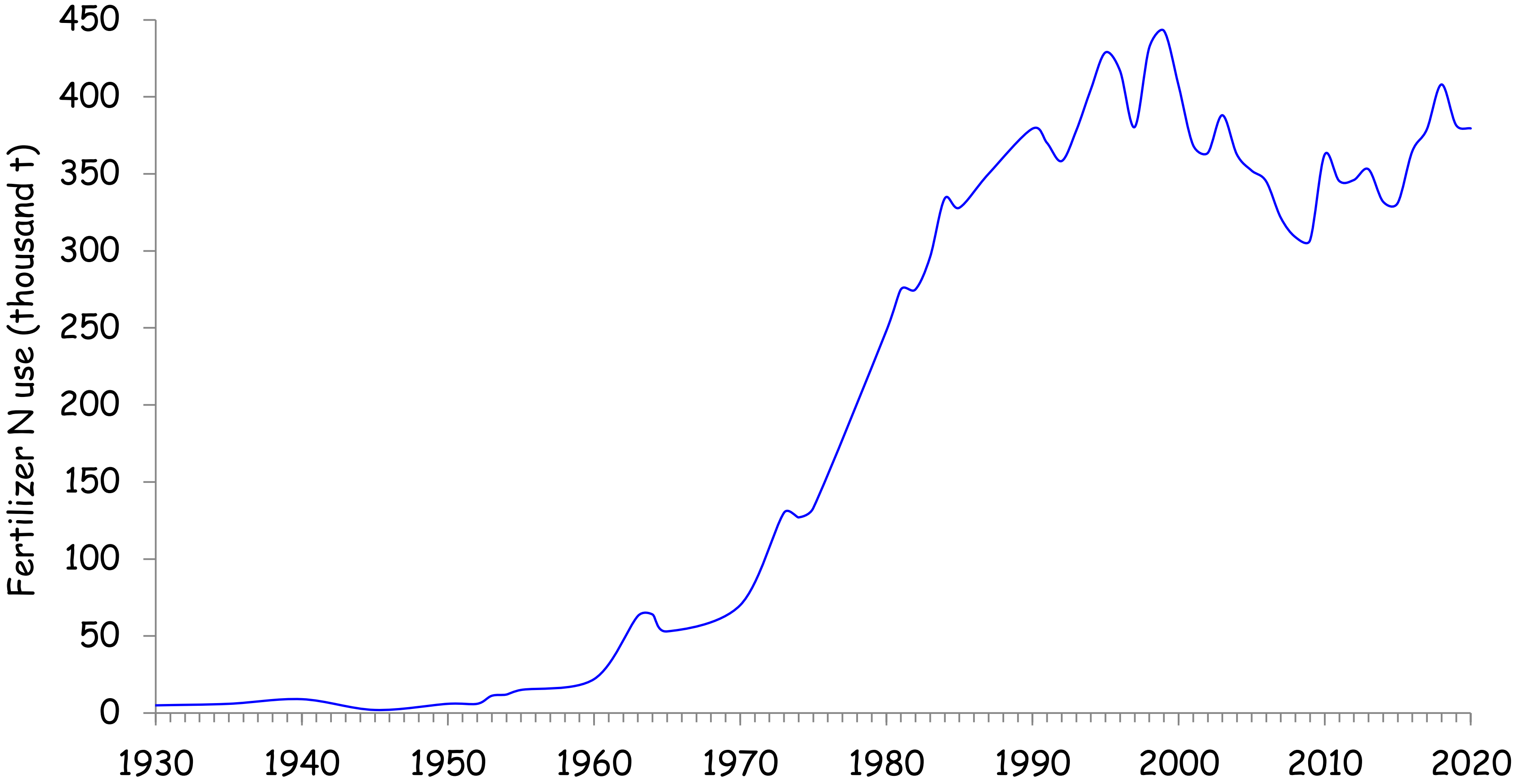
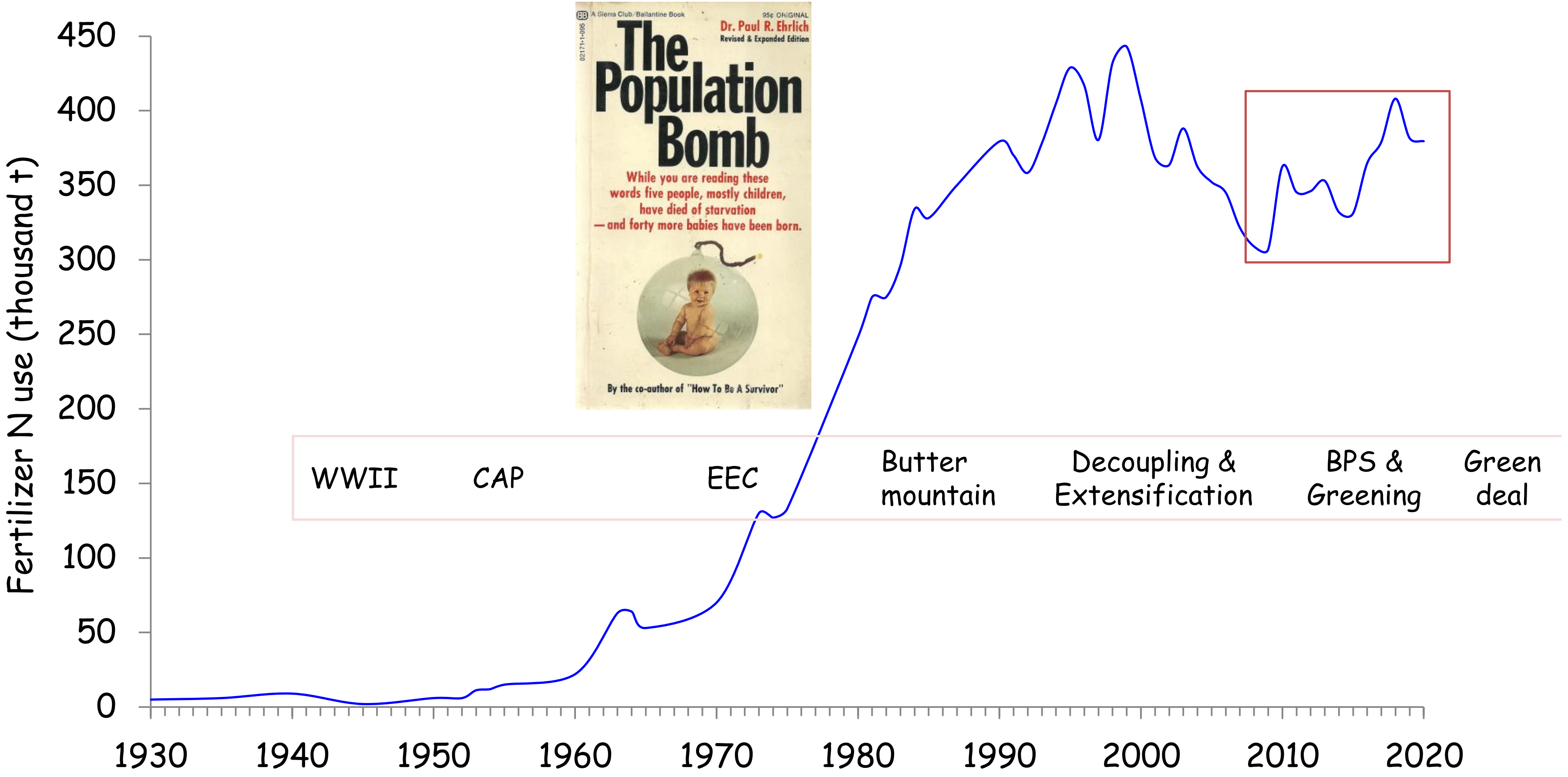
2019R521: Lowering the Carbon and Ammonia footprints of pasture-based dairy production

Teagasc 1361: Developing a blueprint for low or zero nitrogen fertilizer use for low-emissions pasture-based dairy farming

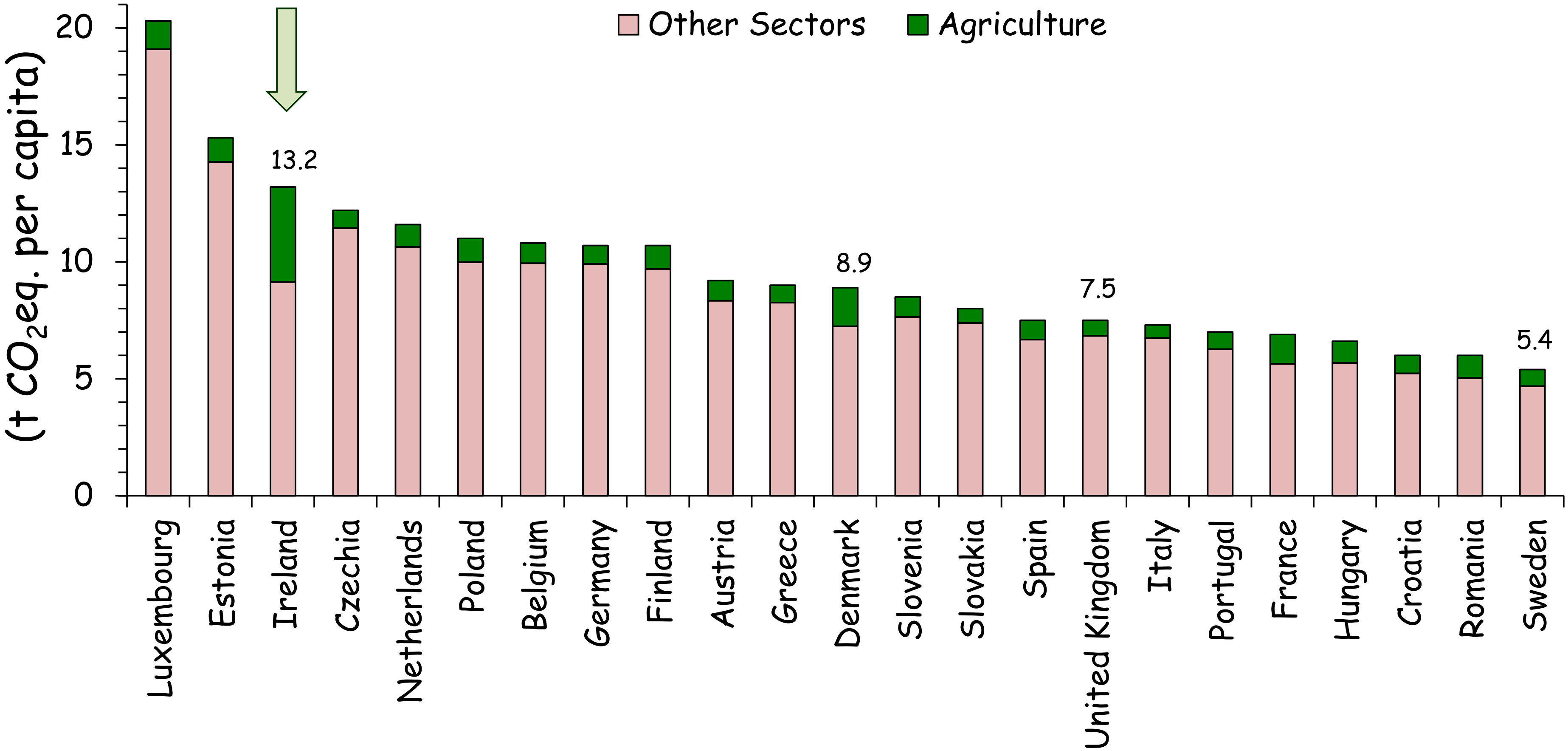
National fertilizer N use since 1930



National fertilizer N use since 1930

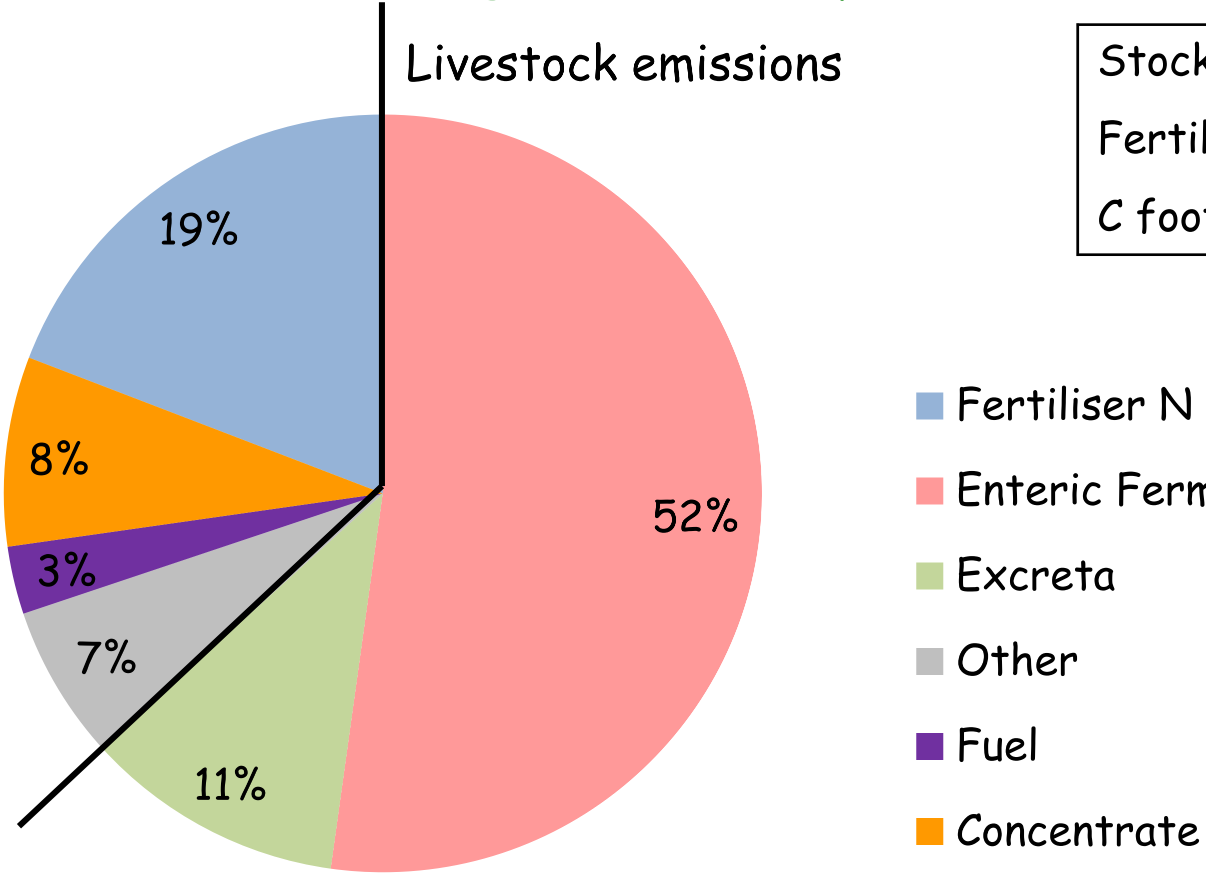


Greenhouse gas emissions per capita in selected European countries



Greenhouse gas emission profile on dairy farms

Stocking rate (LU/ha)	2.42
Fertilizer N (kg/ha)	272
C footprint (kg $CO_{2eq.}$/L)	1.05



Dairy systems research at Solohead Research Farm

2019R521: Lowering the Carbon and Ammonia footprints of pasture-based dairy production

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Solohead Research Farm 2000 to 2010

Clover-based versus N-fertilized grassland-based dairy production

No difference in profitability (Humphreys et al., 2012)

16% lower greenhouse gas emissions (Yan et al., 2013)

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The carbon footprint of pasture-based milk production: Can white clover make a difference?

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ABSTRACT

Carbon footprint (CF) calculated by life cycle assessment (LCA) was used to compare greenhouse gas emissions from pasture-based milk production relying mainly on (1) fertilizer N (FN), or (2) white clover (WC). Data were sourced from studies conducted at Solohead Research Farm in Ireland between 2001 and 2006. Ten FN pastures stocked between 2.0 and 2.5 livestock units (LU)/ha with fertilizer N input between 180 and 353 kg/ha were compared with 6 WC pastures stocked between 1.75 and 2.2 LU/ha with fertilizer N input between 80 and 99 kg/ha. The WC-based system had 11 to 23% lower CF compared with FN (average CF was 0.86 to 0.87 and 0.97 to 1.13 kg of CO_2-eq/

of the output of Irish agricultural commodities (Anonymous, 2011), GHG emissions from milk are important to policy makers. Tools are needed to assist with strategic policy development to enable the dairy sector to thrive while minimizing GHG emissions.

Life cycle assessment (LCA; ISO, 2006) has been developed to assess the environmental impact through the life cycle of products, from the "cradle" (production of raw materials such as iron ore) to the "grave" (the waste management of products after consumption). When applied to agricultural products, attention is often focused on "cradle to farm gate" because the greatest impact is found in the production stage (Schau and Fet, 2007). Because of global concerns about GHG emissions from livestock production, the LCA inter-

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An economic comparison of systems of dairy production based on N-fertilized grass and grass-white clover grassland in a moist maritime environment

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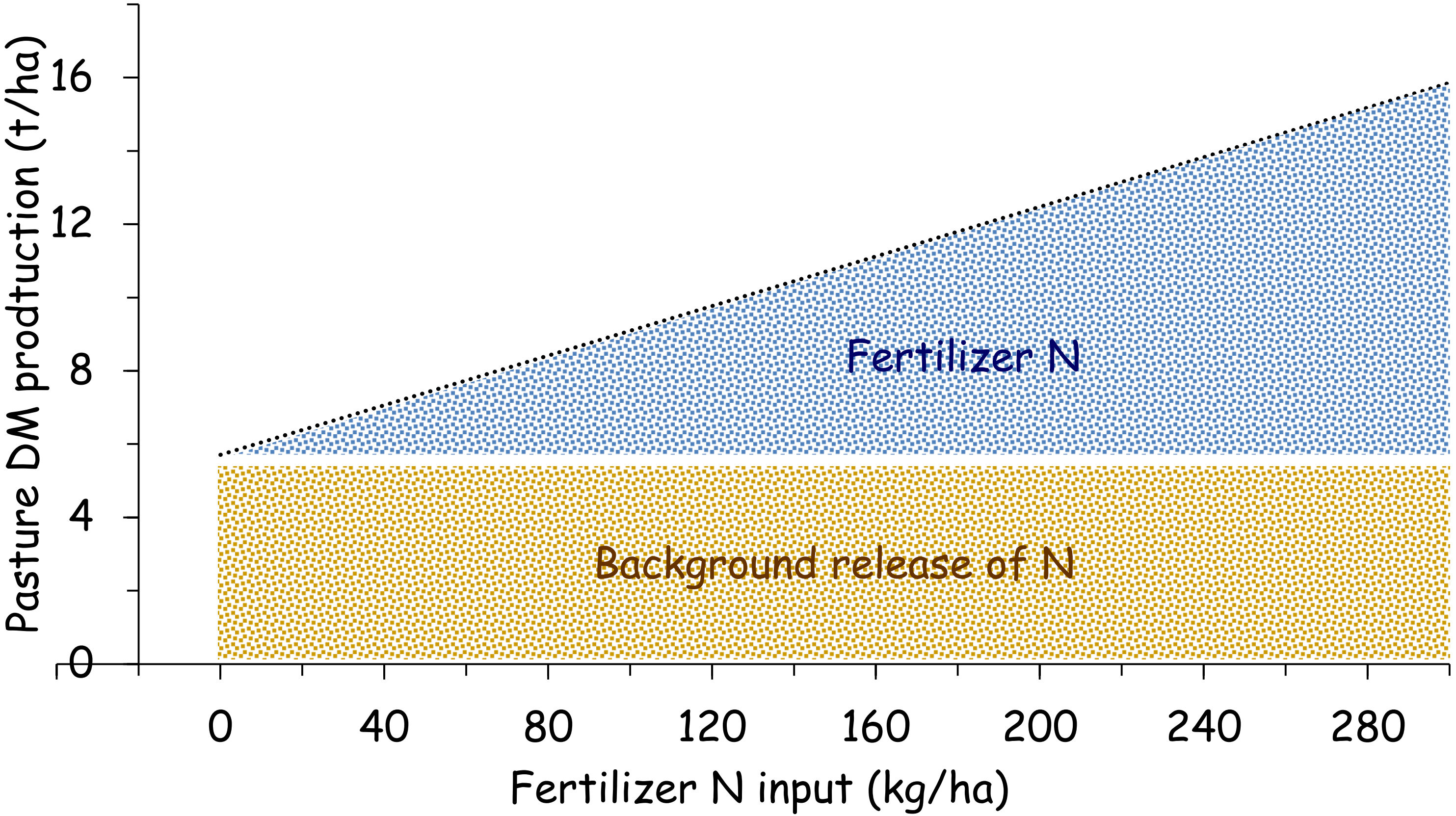
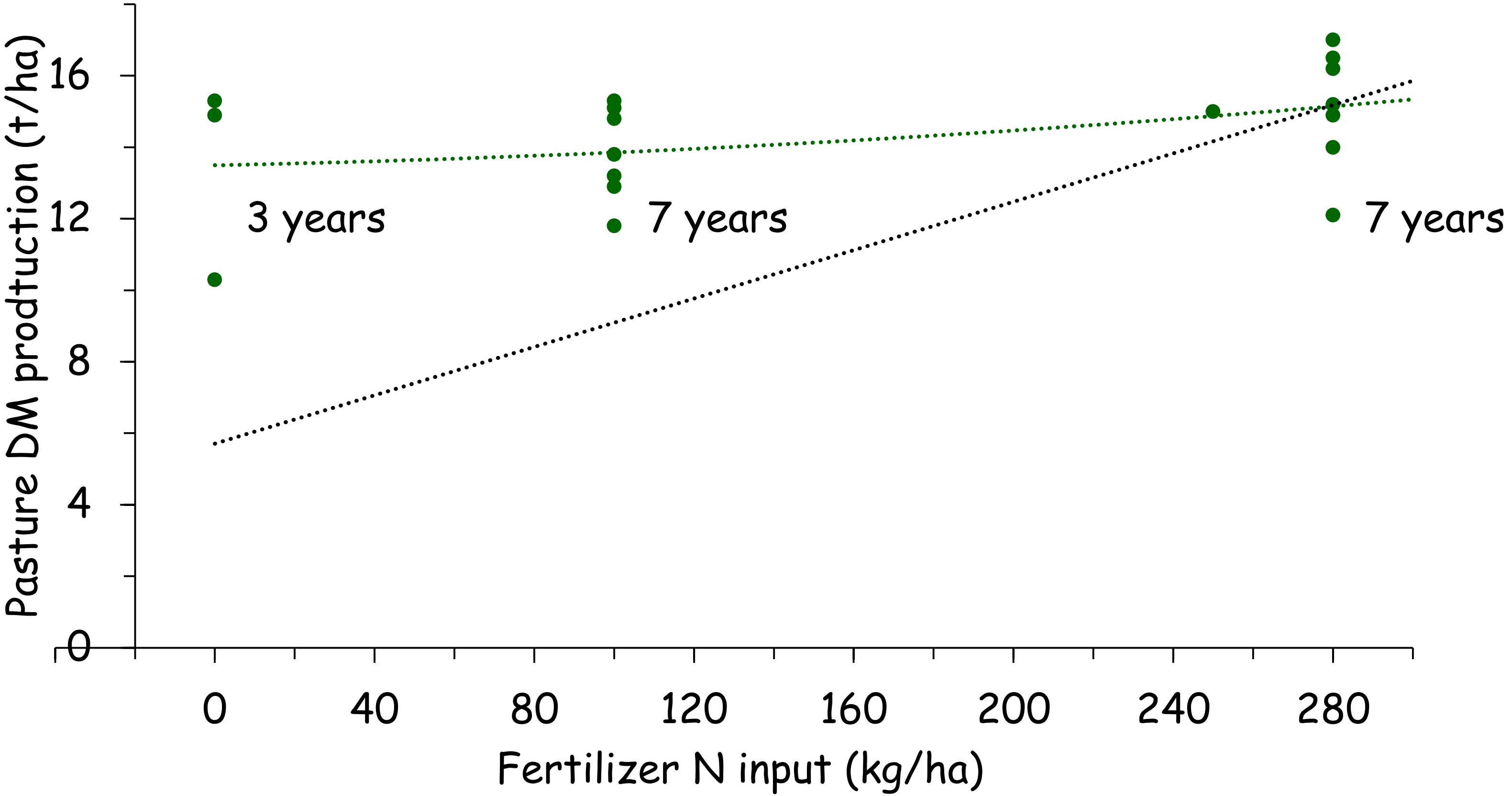
Fertilizer N input & pasture production



Fertilizer N input & pasture production from clover-rich grassland

Systems-scale studies Solohead Research Farm



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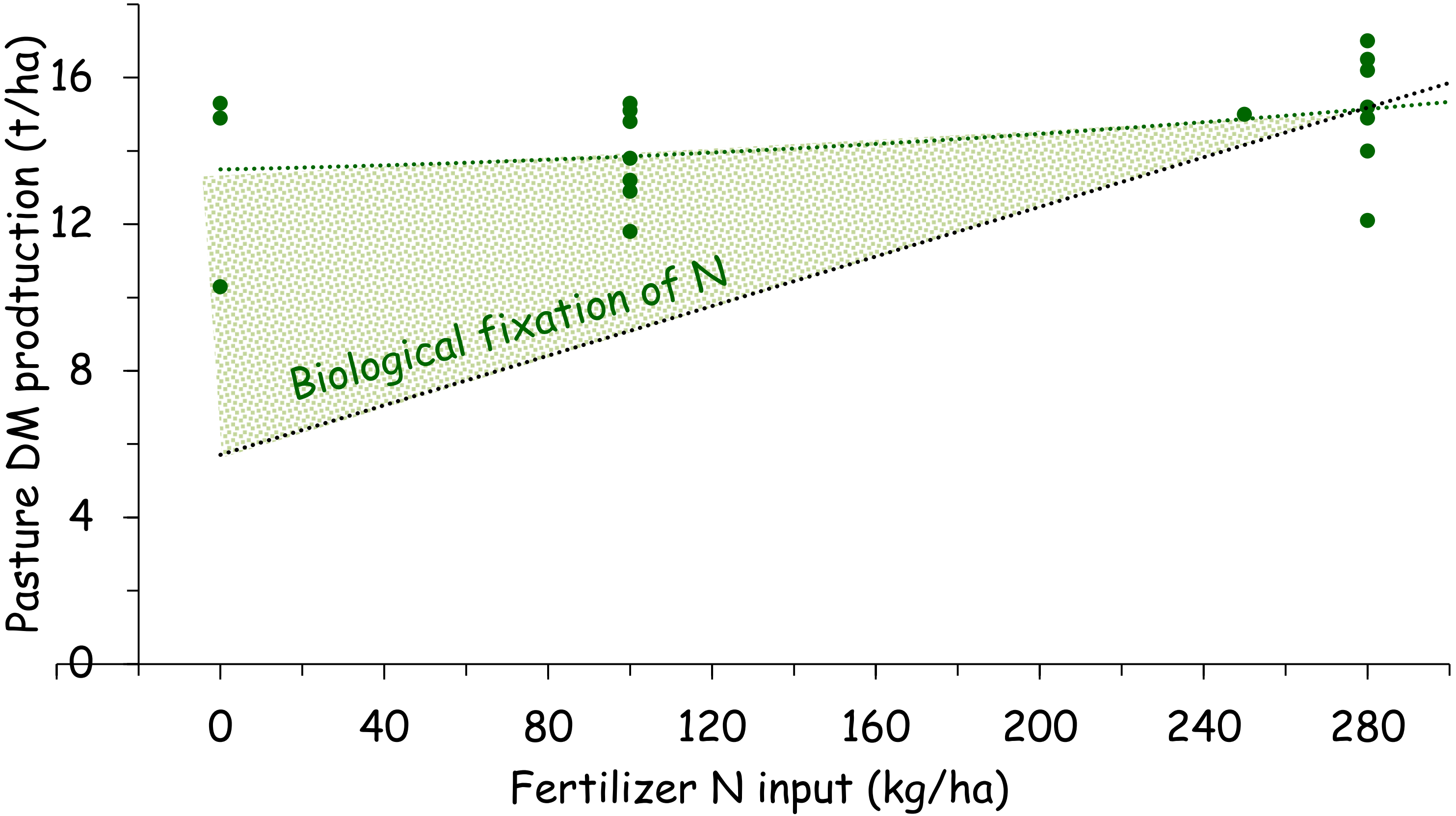

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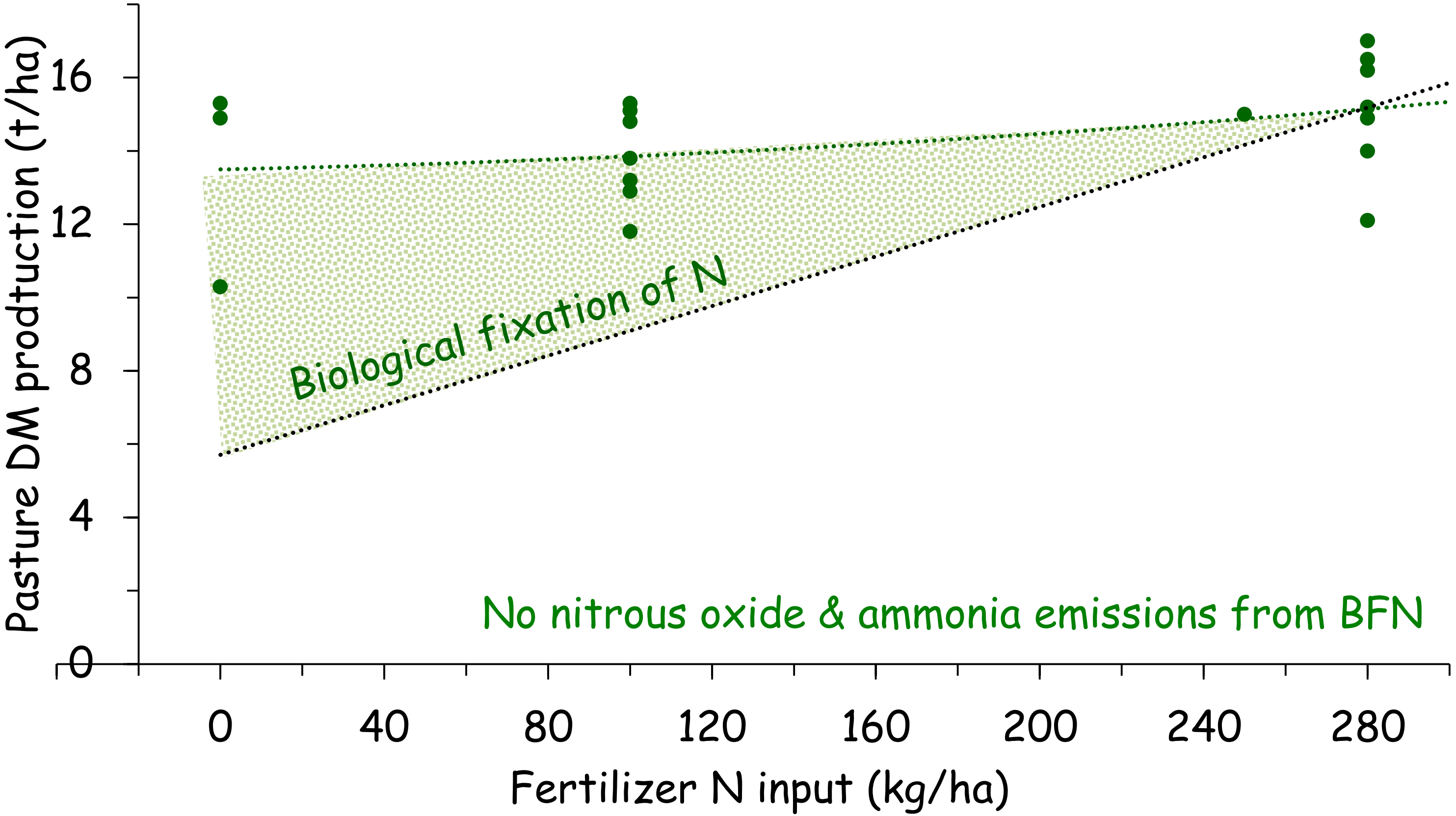

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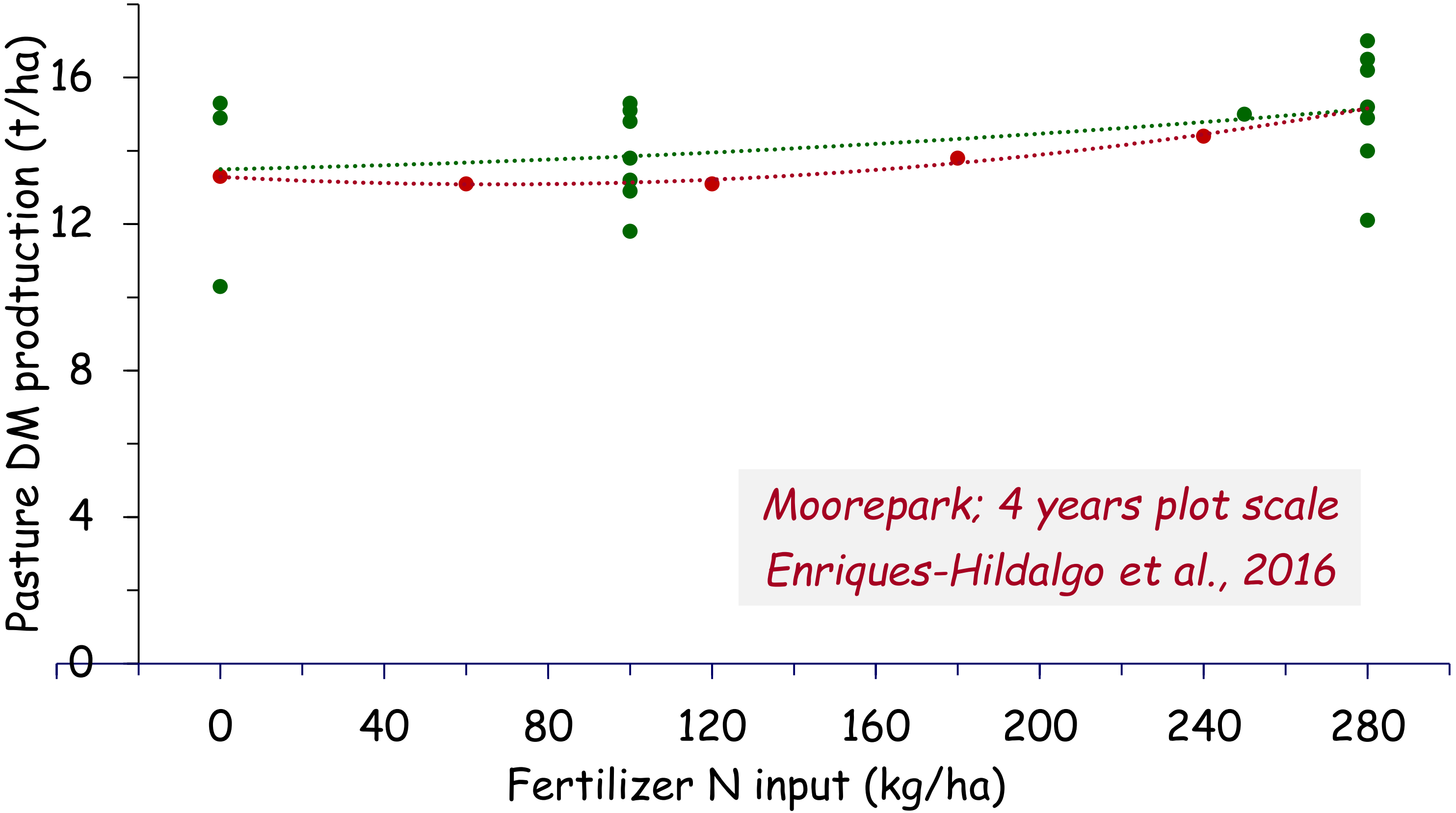

What can we do to lower emissions?

Improve soil fertility

Protected urea

White and red clover

Improve EBI

Sexed semen?

Low emissions slurry spreading (LESS)

Covered slurry storage

Greenhouse gas & ammonia emissions & profitability

Fertilizer N (kg/ha)	280	110	0
Stocking rate (LU/ha)	2.50	2.40	2.35
Herd EBI	165	165	195
Cows/farm	126	120	117
GHG (kg CO2eq./L)	0.88	0.75	0.69
Including sequestration	0.81	0.68	0.62
GHG emissions (t/ha)	12.3	10.1	9.5
Ammonia (kg/t milk)	4.00	3.17	2.81
Relative GHG emissions (%)	-16	-28	-34
Net margin (€ per ha)	1,402	1,552	1,650

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

Fertilizer N (kg/ha)	280	110	0
Stocking rate (LU/ha)	2.52	2.40	2.35
Herd EBI	165	165	195
Cows/farm	126	120	117
Milk sales (€)	250,894	240,467	239,932
Total sales (€)	275,443	263,859	262,842
Total variable costs (€)	97,709	83,224	77,428
Total Fixed costs (€)	107,635	103,050	102,875
Net margin (€)	70,098	77,585	82,540
Net margin (€ per ha)	1,402	1,552	1,650

Carbon & ammonia footprints at Solohead Research Farm

	Fertilizer N (kg/ha)	SR (LU/ha)	Milk sales kg MS	C footprint (t/ha)	C footprint (kg/L)	Ammonia (kg/ha)
2011-2013	195	2.10	39,500	9.7	0.82	36.5
2016	280	2.39	56,000	11.5	0.88	48.6
2017	242	2.55	60,000	11.4	0.85	49.3
2018	242	2.49	58,222	11.3	0.85	48.6
2019	224	2.47	57,842	11.0	0.84	45.9
2020	104	2.53	64,350	10.2	0.75	40.8

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2019	224	2.47	57,842	11.0	0.84	45.9
2020	104	2.53	64,350	10.2	0.75	40.8
Zero-FN	0	2.35	58,900	9.5	0.69	33.7

Managing clover swards

Low fertilizer N input

Tight grazing <4 cm

pH = 6.5 and regular applications of P & K

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

Concluding comments

Natural advantage in harnessing BNF in grassland

Solohead: High stocked system with low environmental footprints

Economically competitive system

Clover, LESS and protected urea to lower emissions

Achieving net zero emissions by 2050 is an enormous challenge

Policy, sustainable intensification of food production and offsetting

Marketing opportunities for food with low environmental footprints