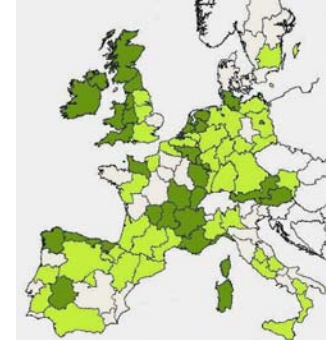


# Sustainable options for grassland-based dairying in the northwest of Europe



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# Overview – grassland and WFD

Defining the problems – nitrate leaching

Grazing and risk of nitrate leaching

Climatic conditions and soil texture

Options: Grazing, cutting or forage maize

Ploughing of grassland

White clover

Summary and conclusions



# Permanent grassland

Important land use in many regions of NW Europe



Water resources – catchment scale

Environmental Schemes (REPS)

Soil organic matter / soil erosion

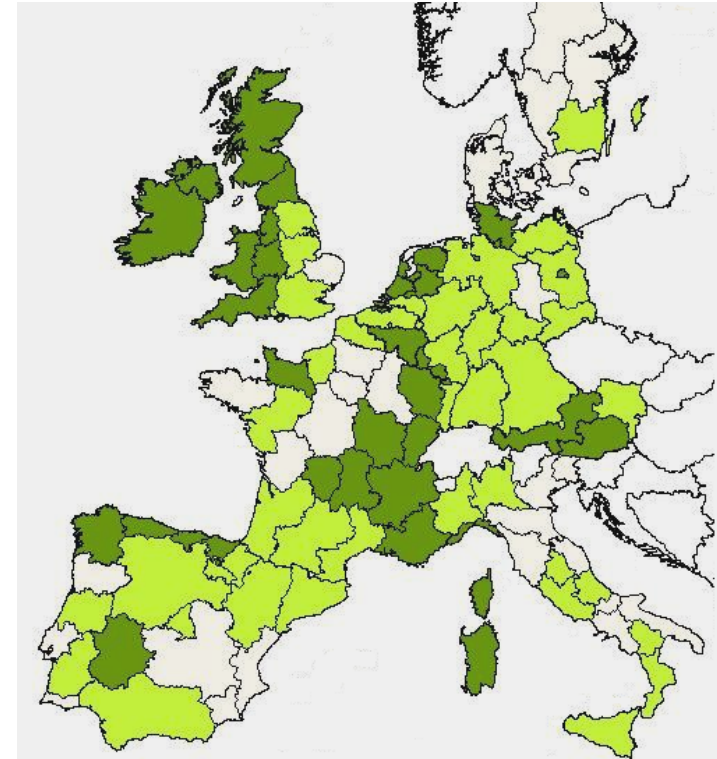
Lower gaseous emissions

Biodiversity

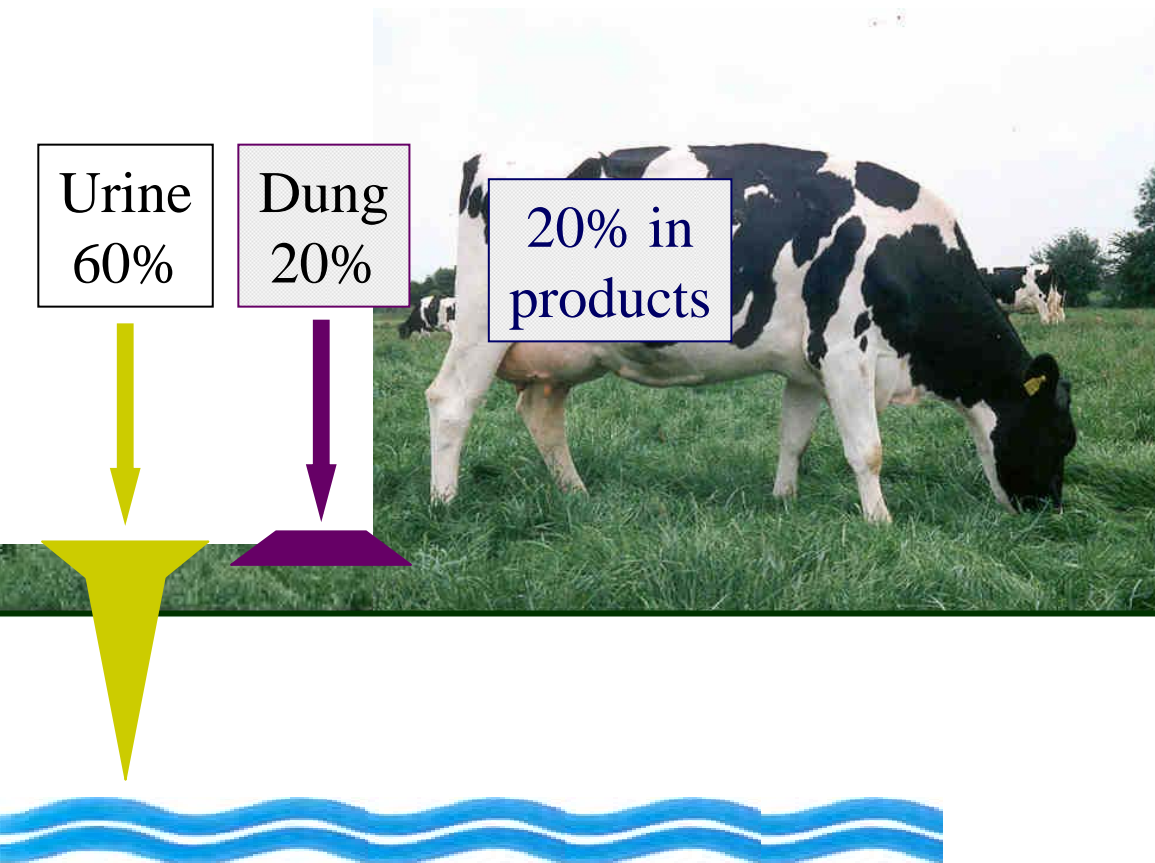
Animal welfare – grazing

Pesticides & agri-chemicals

Landscapes / tourism



# Grazing and nitrate leaching

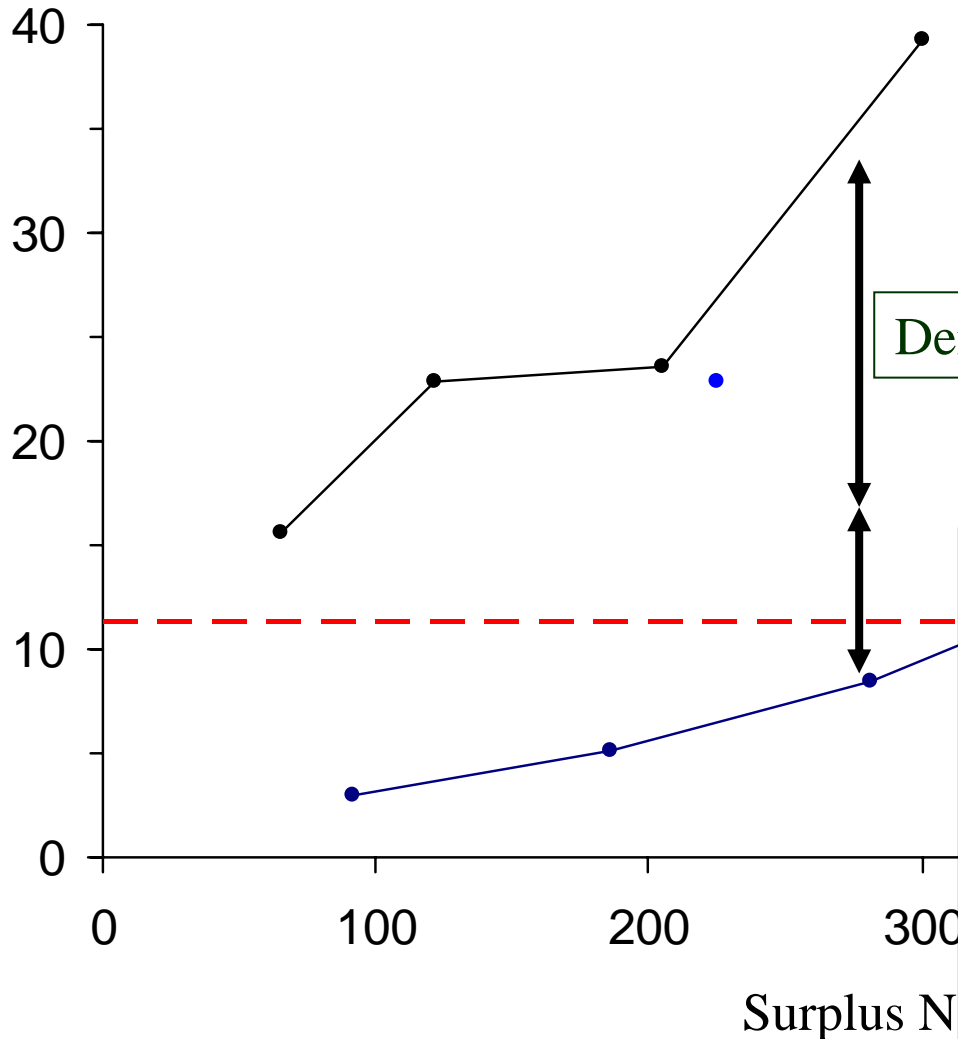


Intensive Grassland  
High fertilizer N inputs  
High N conc. in grass  
High N conc. in urine  
Localized deposition  
Inefficient recycling  
Losses on vulnerable soils

# Surplus N and nitrate-N conc. in grassland (grazing-only)

(from Wachendorf *et al.*, 2004 & Watson *et al.* 2000)

Nitrate-N  
(mg l<sup>-1</sup>)



Karkendamm, NW Germany

Soil: Sand

Drainage: 205 mm yr<sup>-1</sup>

Denitrification

CENIT, Northern Ireland

Soil: Sandy clay loam

Drainage: 420 mm yr<sup>-1</sup>

Denitrification

Nitrate (NO<sub>3</sub>) reduced to N<sub>2</sub> or N<sub>2</sub>O

Heavy textured soils

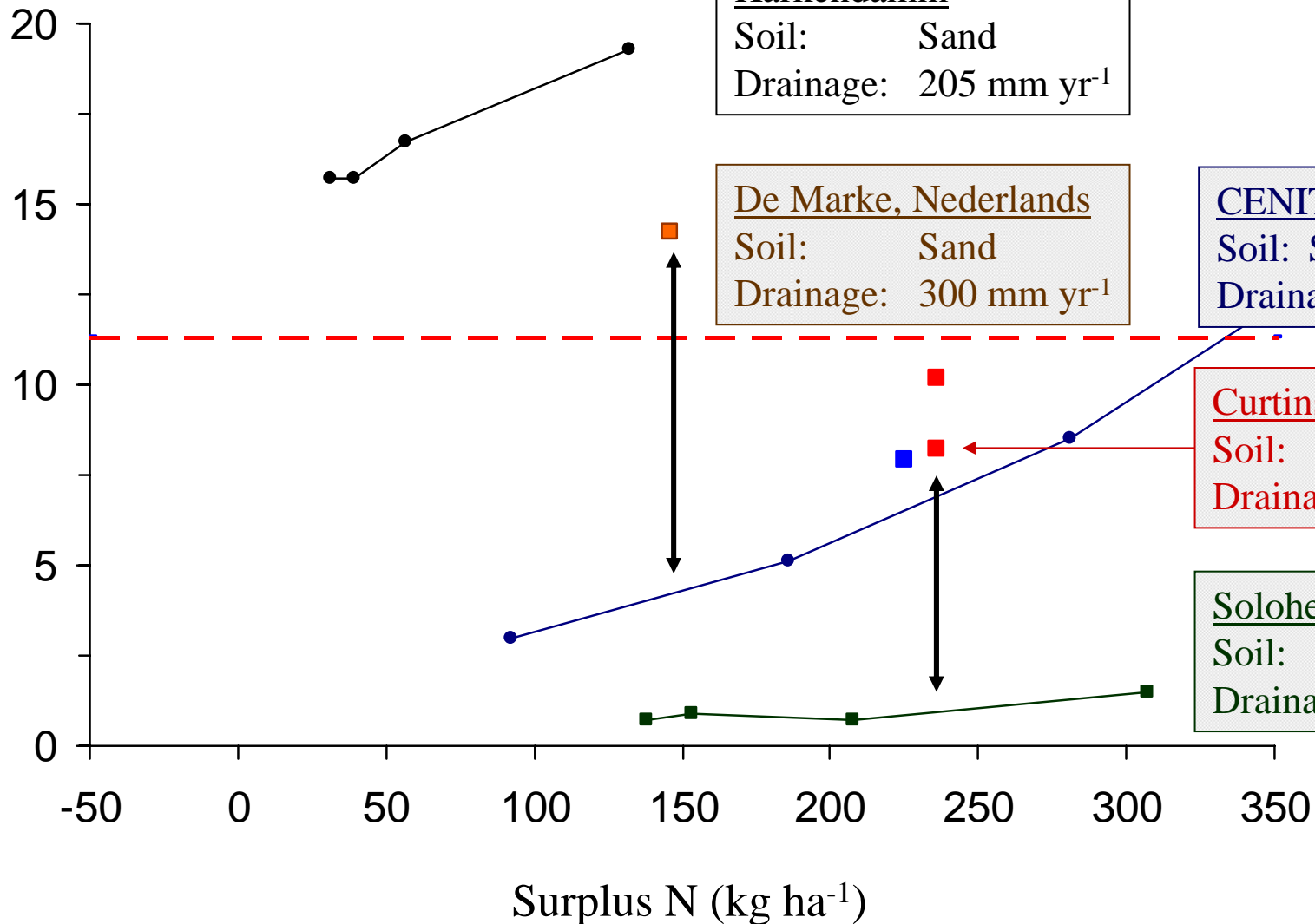
Anaerobic soil conditions (wet)

High soil organic matter

Typical of permanent grassland

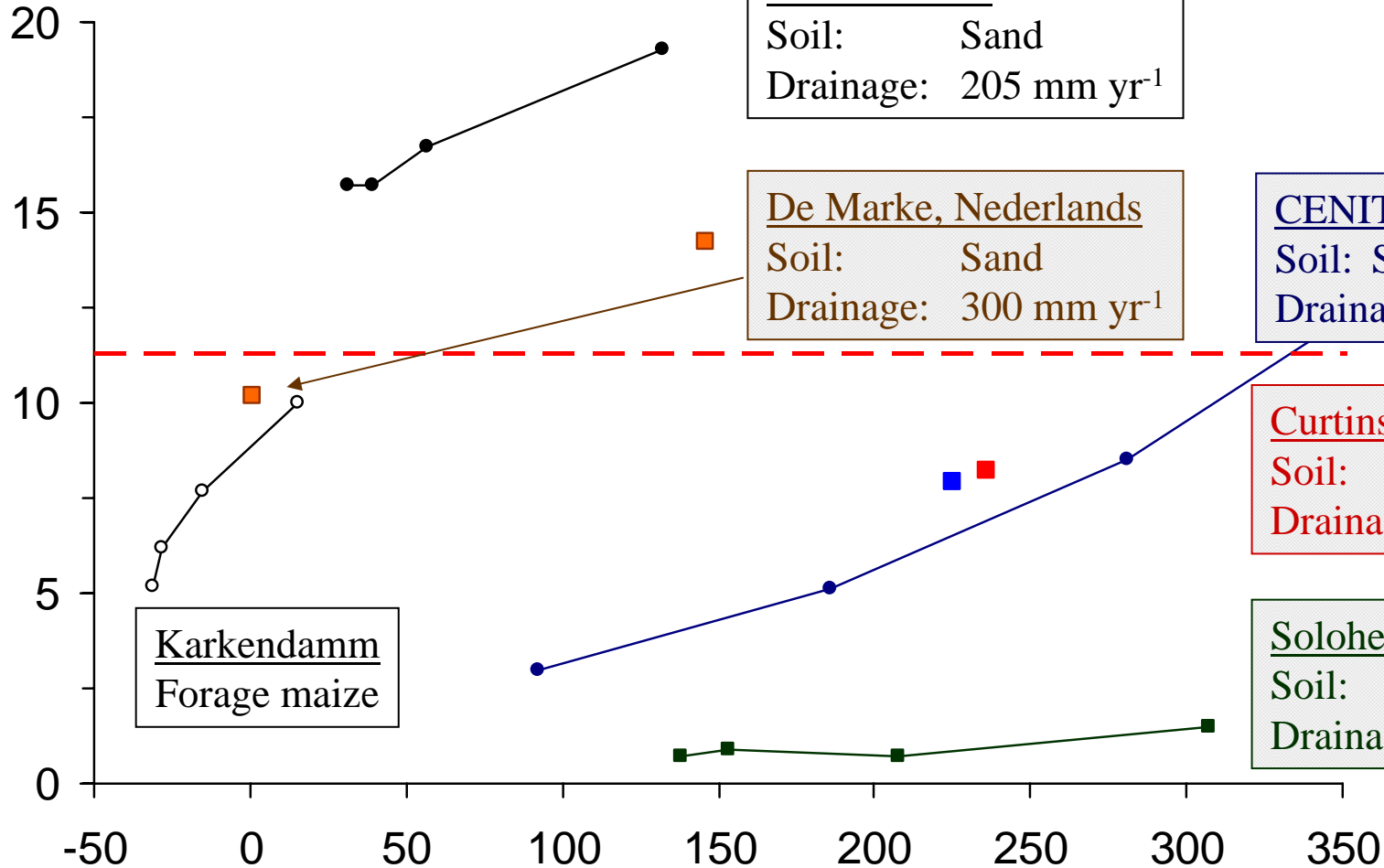
# Surplus N and nitrate-N conc. in grassland (grazing + cutting)

Nitrate-N  
(mg l<sup>-1</sup>)



# Surplus N and nitrate-N conc. in grassland (grazing + cutting & forage maize)

Nitrate-N  
(mg l<sup>-1</sup>)



Karkendamm  
Soil: Sand  
Drainage: 205 mm yr<sup>-1</sup>

De Marke, Nederlands  
Soil: Sand  
Drainage: 300 mm yr<sup>-1</sup>

CENIT, N. Ireland  
Soil: Sandy clay loam  
Drainage: 420 mm yr<sup>-1</sup>

Curtins, Ireland  
Soil: Sandy loam  
Drainage: 460 mm yr<sup>-1</sup>

Solohead, Ireland  
Soil: Clay loam  
Drainage: 485 mm yr<sup>-1</sup>

Karkendamm  
Forage maize

Surplus N (kg ha<sup>-1</sup>)

# Nitrate-N leaching losses from grassland

Large differences between locations

Climatic conditions – rainfall, effective drainage & soil moisture status

Soil texture: sand > sandy loam > sandy clay loam > clay loam

Grazing > grazing + cutting > forage maize > cutting only

On sand soils: low nitrate losses from cut grassland and maize

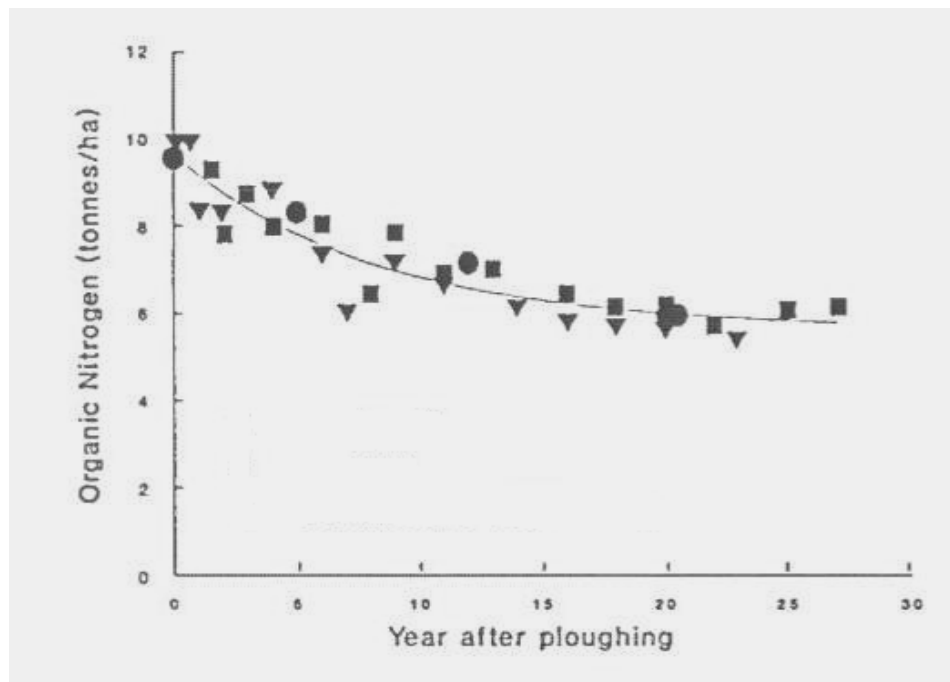
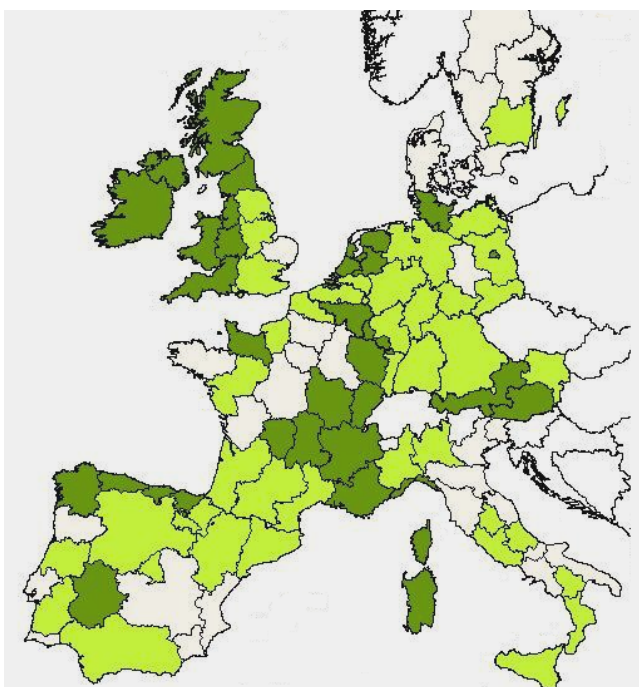
Maize should be followed by winter cover crop

Denitrification on heavy wet permanent grassland soils



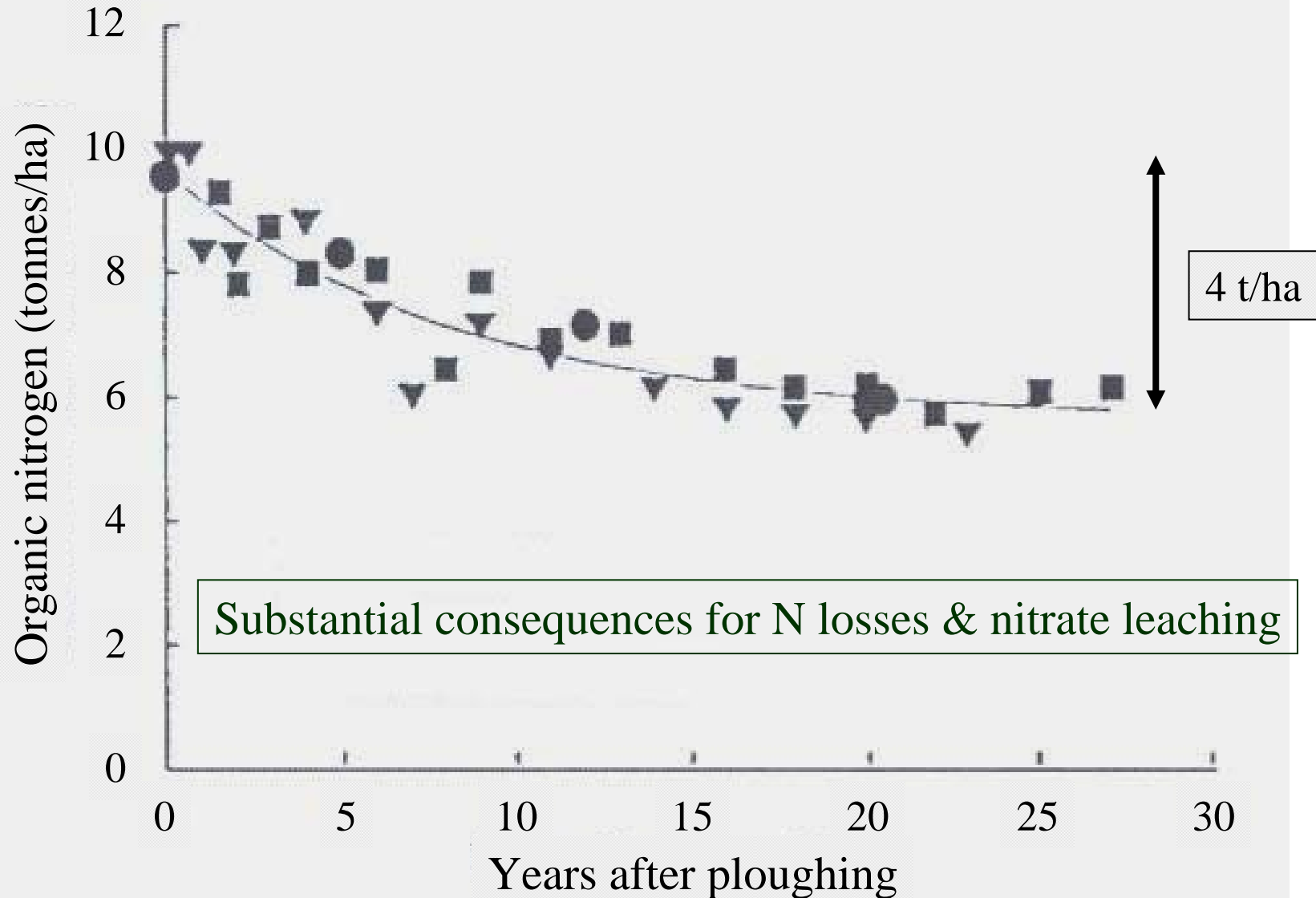


# Ploughing Grassland



# Loss of organic N after ploughing permanent grassland

(from: Whitmore *et al.*, 1992)



## Solohead Farm

Soil:	Clay loam
Drainage:	485 mm yr <sup>-1</sup>
Groundwater depth:	1 to 3 m bgl
Organic matter:	13.1%
Total N in topsoil:	11 t ha <sup>-1</sup>

Low nitrate leaching losses

High SOM = high denitrification

Winter grass growth +N uptake

**High N release after ploughing**

## De Marke Farm

Soil:	Sand
Drainage:	300 mm yr <sup>-1</sup>
Groundwater depth:	1 to 3 m bgl
Organic matter:	4.8%
Total N in topsoil:	4.1 t ha <sup>-1</sup>

**High risk of nitrate losses**

Need to avoid grazing

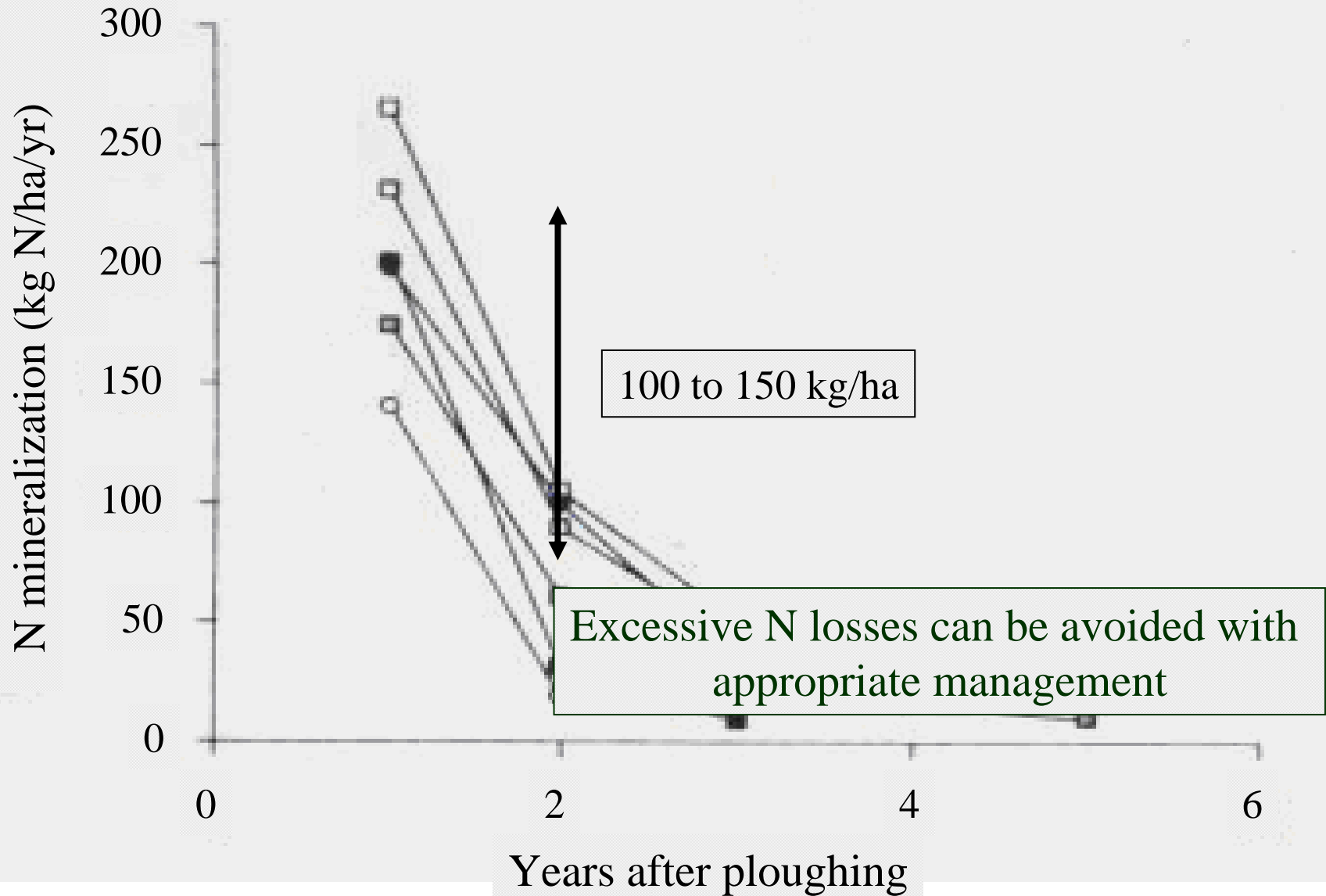
Cut grassland and forage maize

Low N release after ploughing

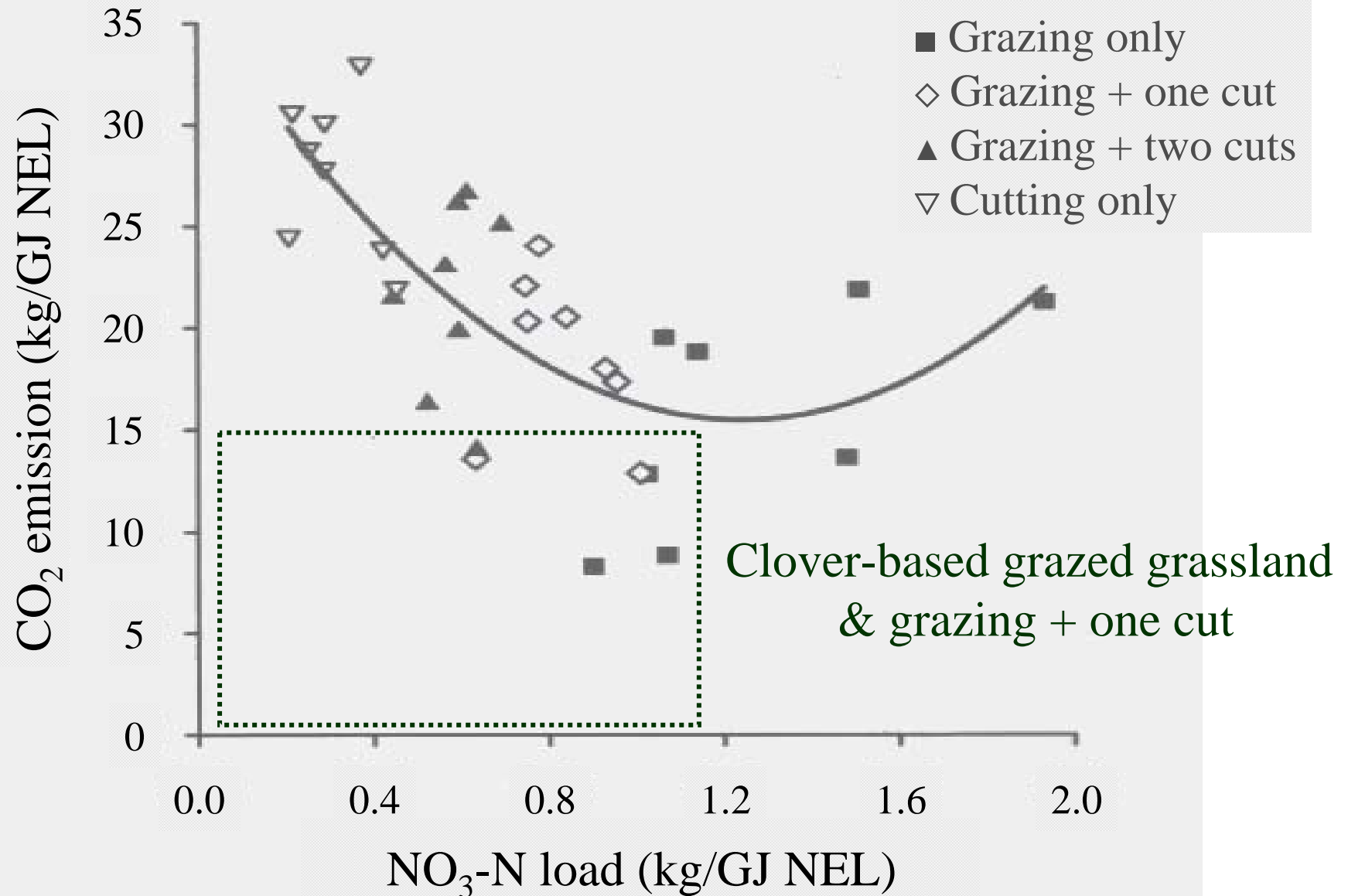


# Mineralization of N after ploughing temporary grassland

(from: Vertès *et al.*, 2007)



# Wider aspects of sustainability: GHG and nitrate leaching from grassland *(from: Wachendorf and Taube, 2005)*

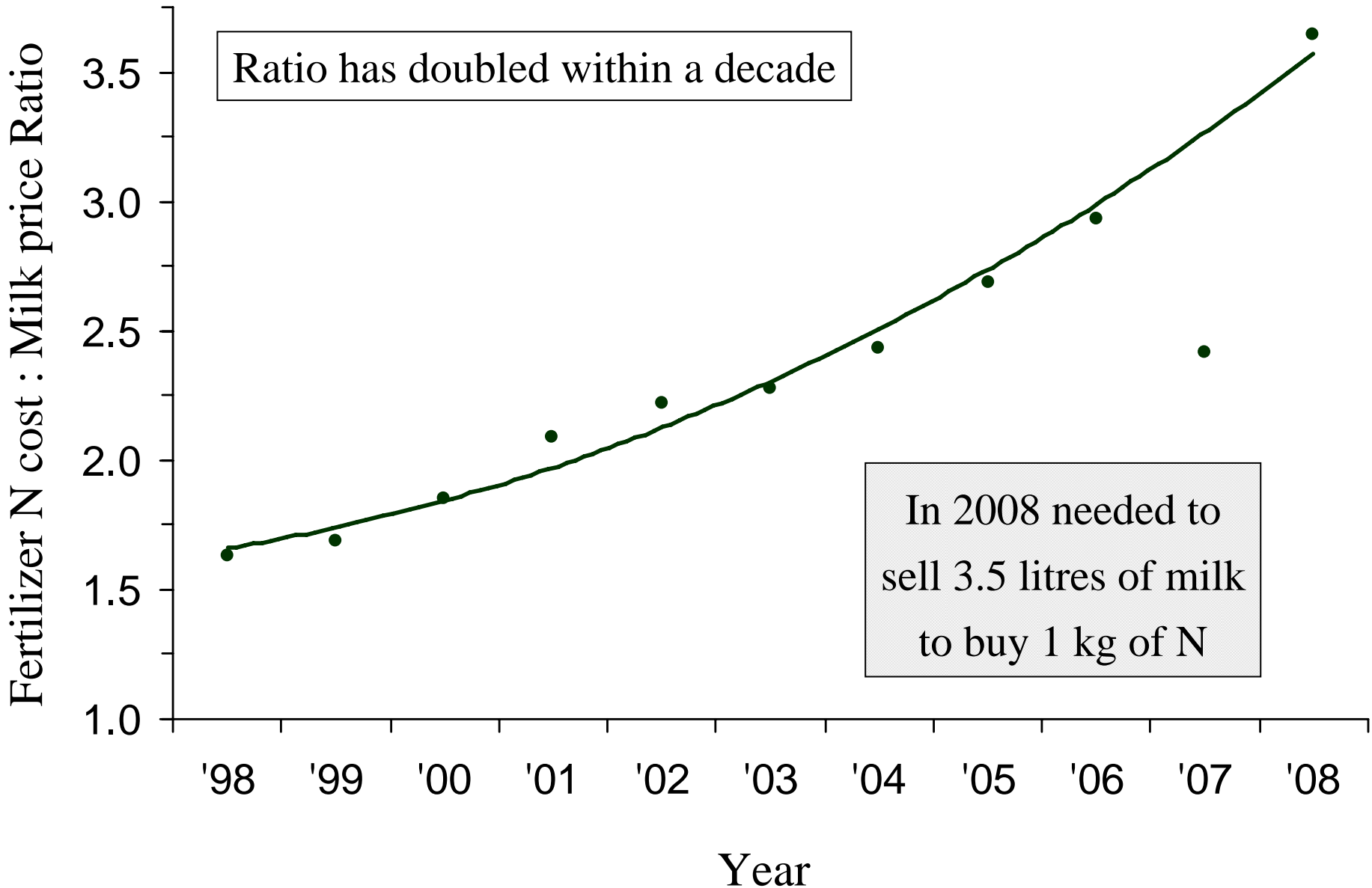




# White clover



# Fertilizer N cost : Milk price Ratio



# Profitability of different systems at Solohead

50 ha Farm	Clover-based system	Fertilizer based	Intensive system
Stocking rate (LU/ha)	2.2	2.2	2.5
Milk (litres/farm)	572,000	572,000	650,000
Milk			
Milk			
Total			
Fertil			
Total			
Gross Margin (€)	147,270	138,185	153,259
Total fixed costs (€)	54,340	54,340	61,750
<b>Net margin (excl. SFP) (€)</b>	<b>92,930</b>	<b>83,845</b>	<b>91,509</b>

Clover underpins similar profitability at lower stocking densities

Problem remains of inconsistent production from year to year

# Summary and Conclusions

Differences in risks between regions & locations within regions

Soil texture: sand > sandy loam > sandy clay loam > clay loam

Grazing > grazing + cutting > forage maize > cutting only

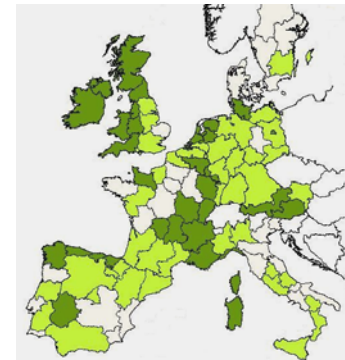
Ploughing permanent grassland – high nitrate losses to water

Need regionally specific guidelines and regulations

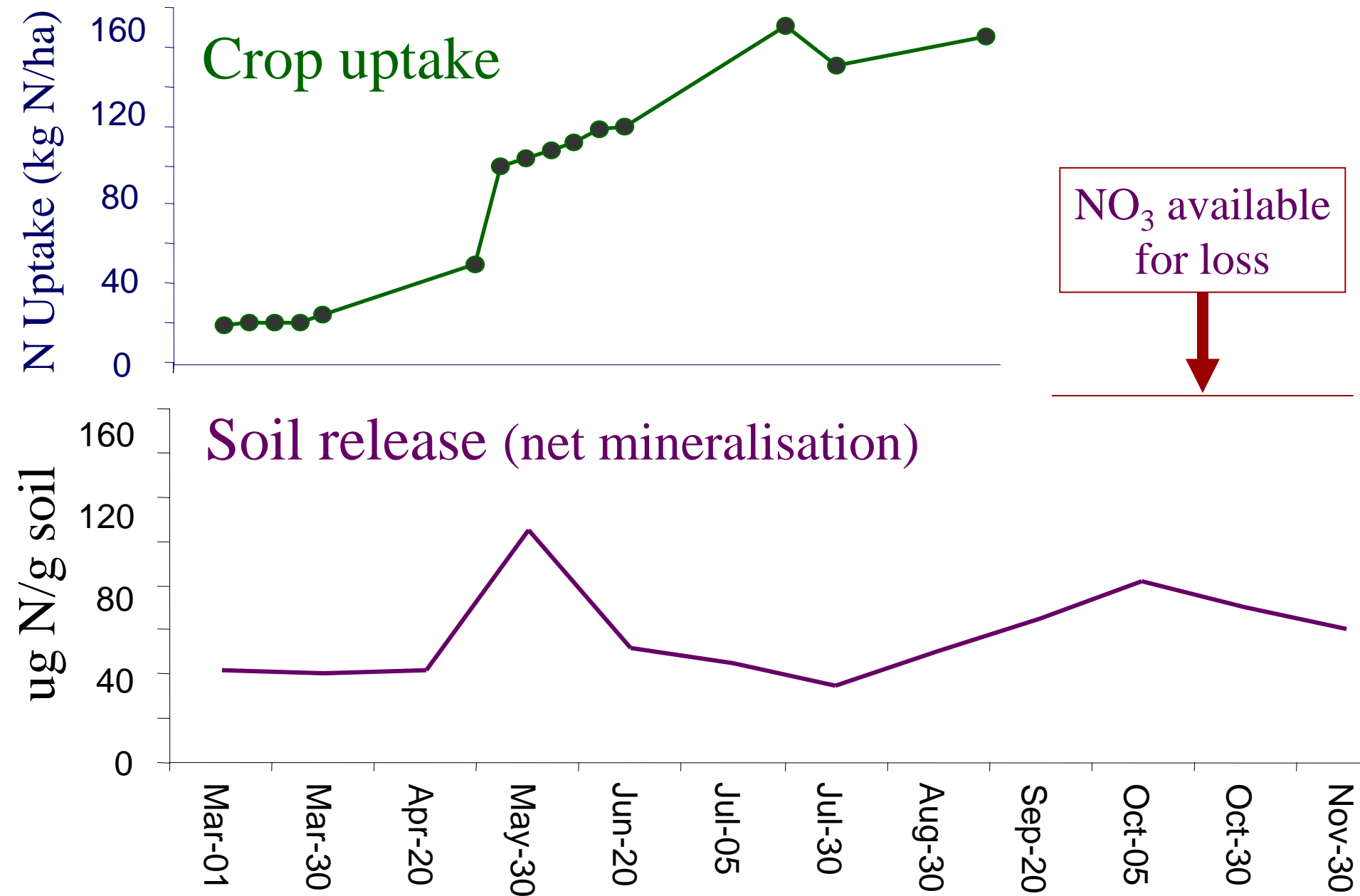
White clover – profitable at lower stocking densities

Other benefits of grazing: lowers costs, soil erosion, animal welfare...

Thank you



# Availability of soil N & uptake by maize



# Winter grass growth rates at different locations in Ireland

Location	Latitude Longitude	Altitude (m asl)	Period	Daily growth rate (kg DM ha <sup>-1</sup> )	Reference
Moorepark	52° 09' N 08° 15' W	46	1 Nov. 21 Mar.	<b>5.0</b>	Brereton <i>et al.</i> (1999)
Moorepark	52° 09' N 08° 15' W	46	20 Oct. 18 Mar.	<b>13.5</b>	O'Donovan <i>et al.</i> (2004)
Moorepark	52° 09' N 08° 15' W	46	10 Oct. 20 Feb.	<b>11.9</b>	Hennessy <i>et al.</i> (2006)
Grange	53° 31' N 6° 40' W	92	10 Oct. 20 Feb.	<b>6.1</b>	Hennessy <i>et al.</i> (2006)
Solohead	52° 51' N 08° 21' W	95	16 Oct 15 Mar.	<b>10.1</b>	Humphreys <i>et al.</i> (2008)

**Daily growth rate of 10 kg DM/ha = uptake of 50 kg N/ha over winter**

# Why has forage maize gained a bad reputation?

In the past – dumping of slurry – excessive N inputs

Grows best on light sandy soils – vulnerable to N leaching

Ploughing & cultivation – mineralization of N

Short growing season – no C residues returned to soil

Loss of soil organic matter and soil erosion (light soils)

Use of plastics and higher use of agri-chemicals than grassland

Cows confined indoors – losses of ammonia + animal welfare



# Animal Welfare: Cows prefer to be outdoors

