Efficient use of N on grassland

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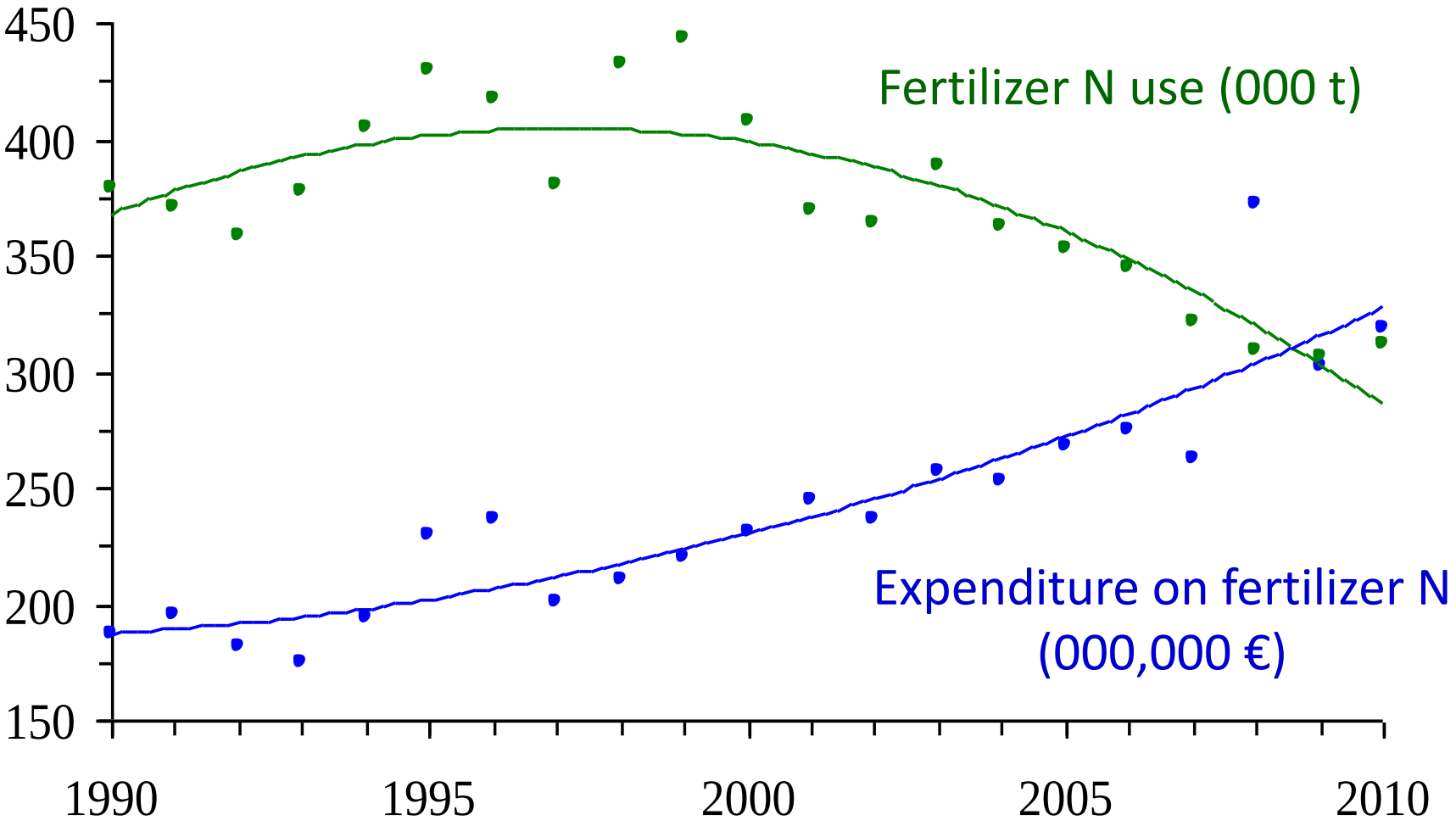
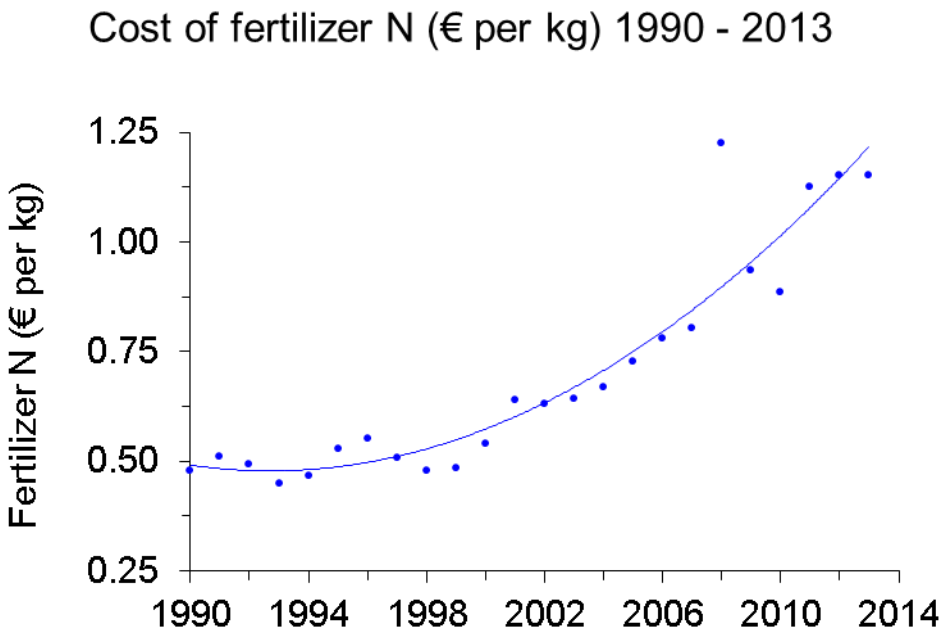
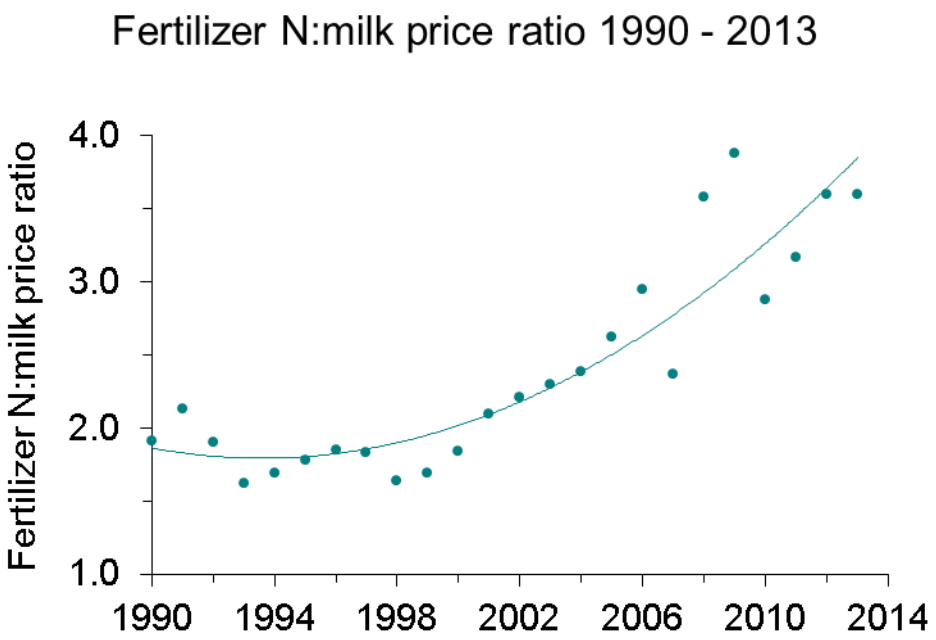
Annual Fertilizer N use and expenditure on fertilizer N in Ireland



Cost of fertilizer N in Ireland 1990 to 2013





Overview

The fate of N in the soil

Rainfall and evapo-transpiration

Sunlight and soil temperature

Meeting sward requirements

Stocking rates and application patterns

Making use of white clover on farms



The fate of N in the soil

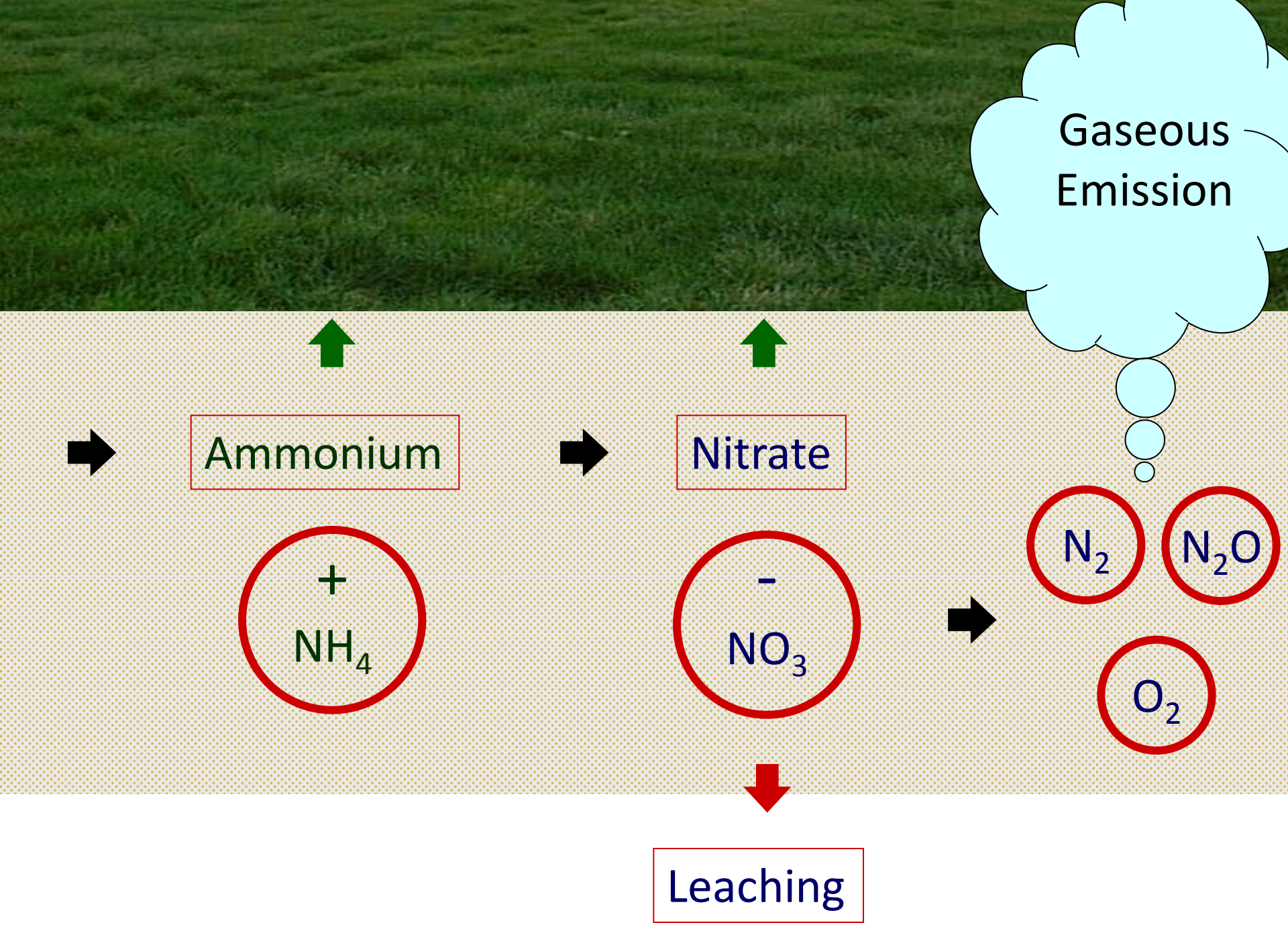



(1) Uptake by the grass sward

(2) Leached from the soil

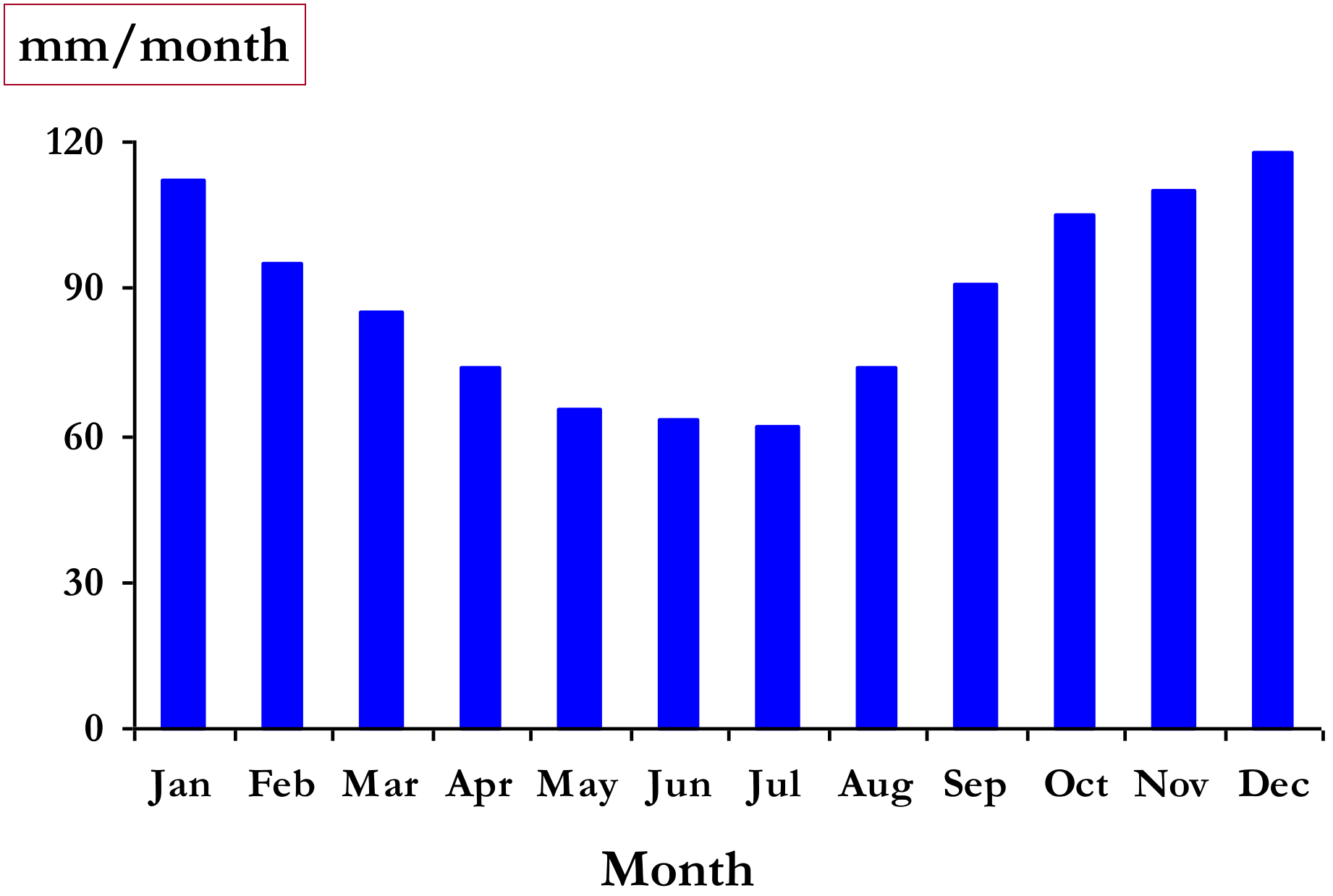
(3) Denitrified from the soil

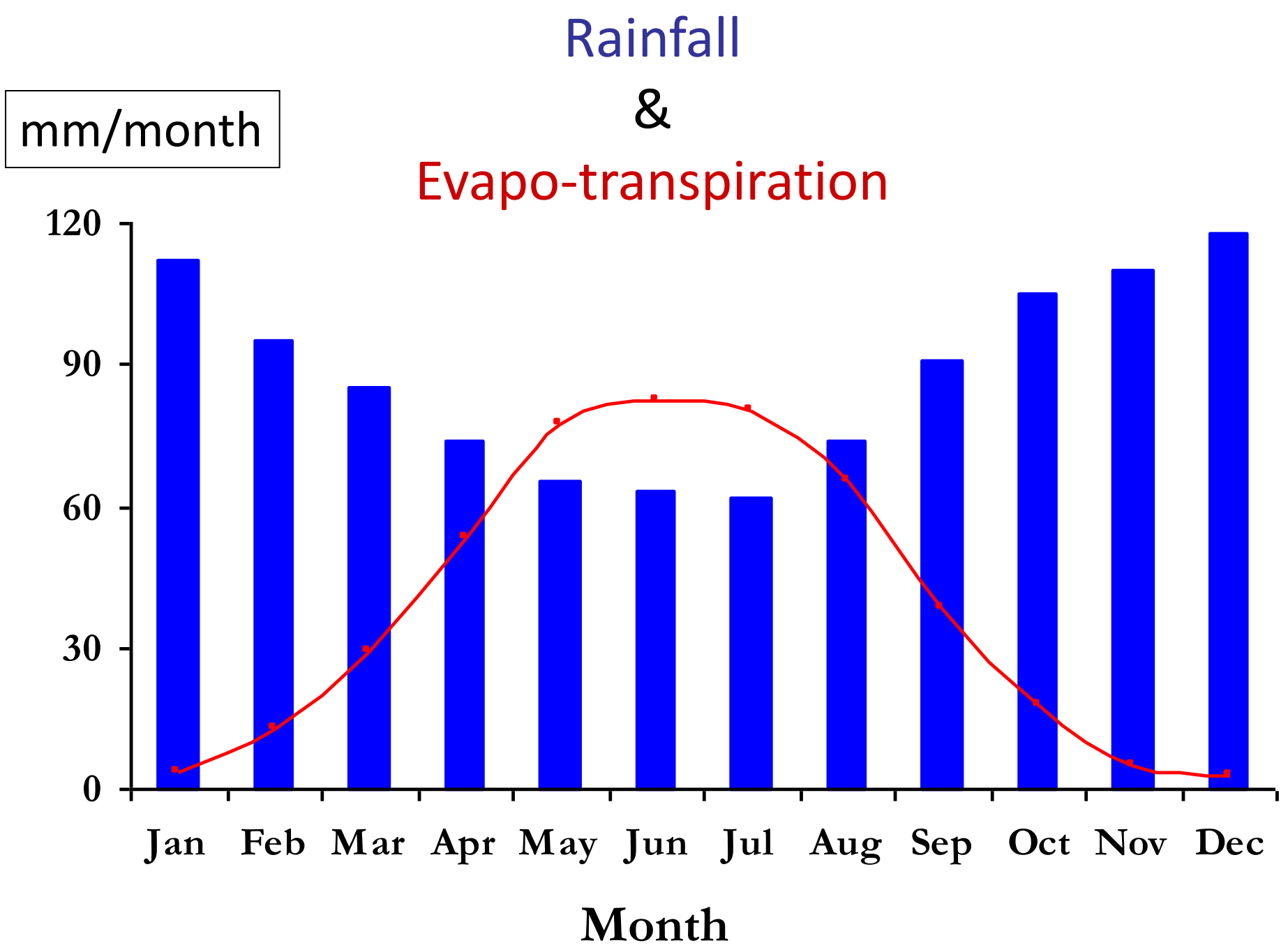
5 to 8 Weeks

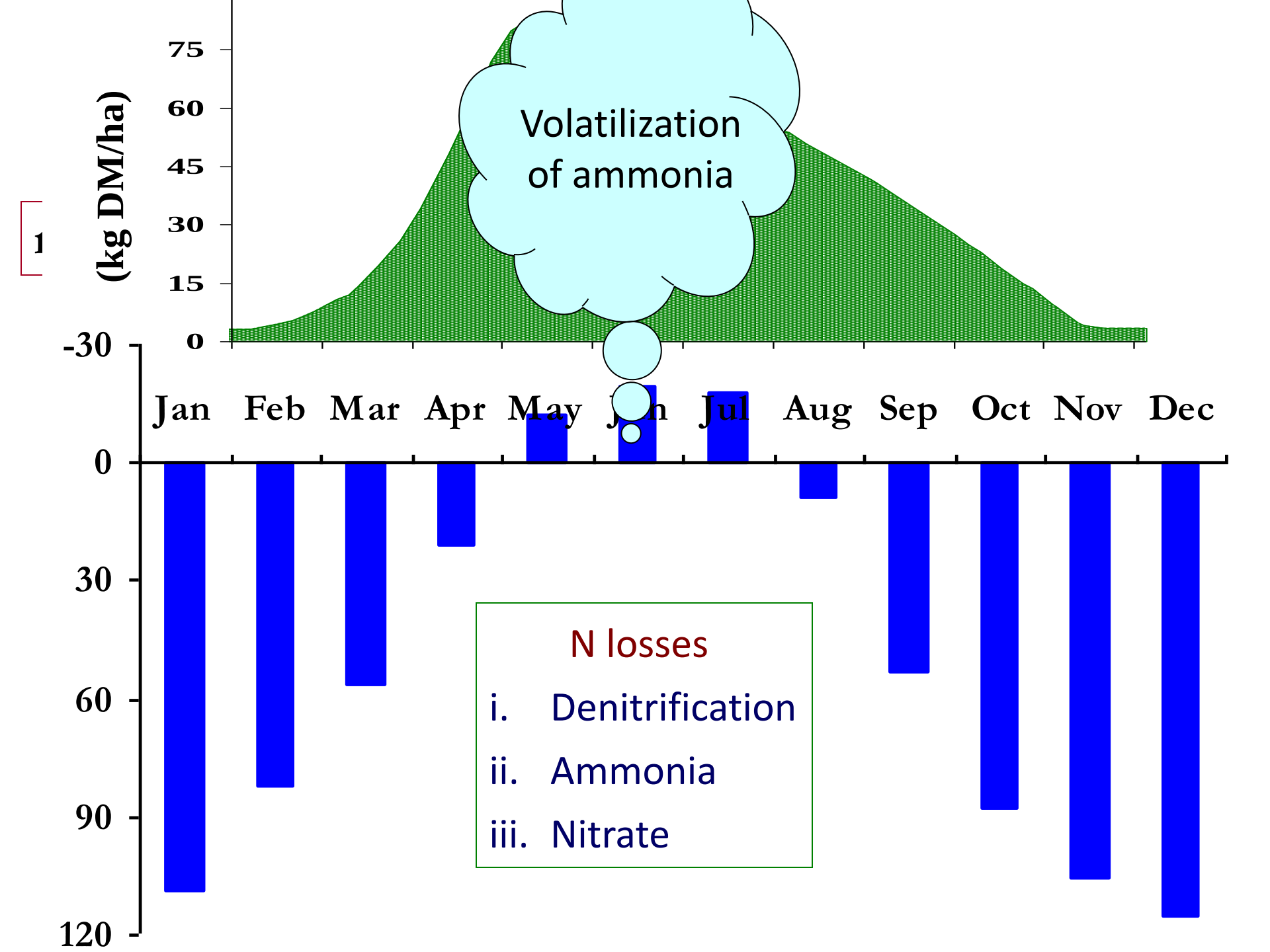

Gaseous Emission
Ammonium
Nitrate
+
NH_4
-
NO_3
N_2
N_2O
O_2
Leaching

Rainfall & Evapo-transpiration

Rainfall

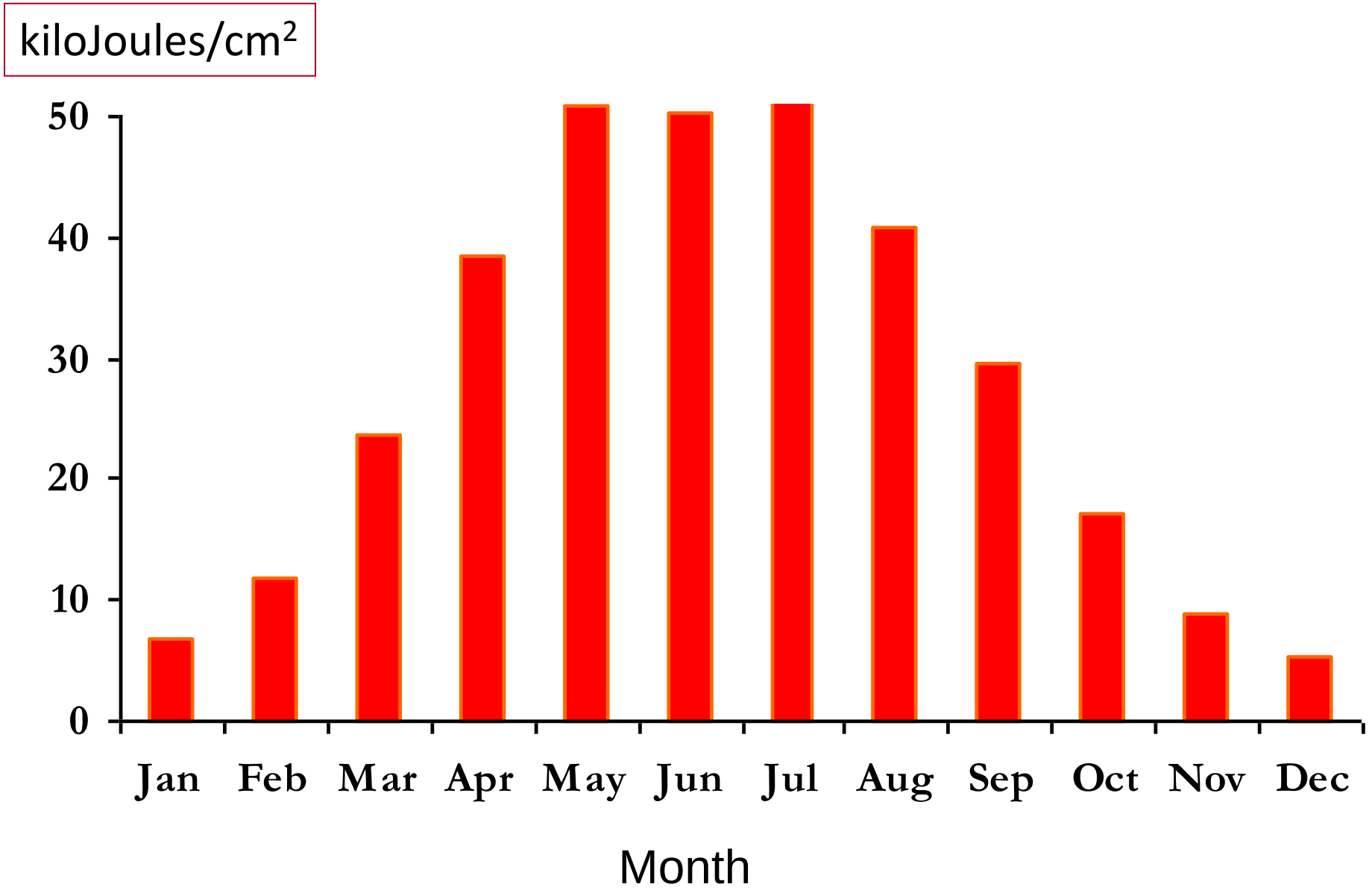

mm/month
120
90
60
30
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


Rainfall
&
Evapo-transpiration
mm/month
120
90
60
30
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

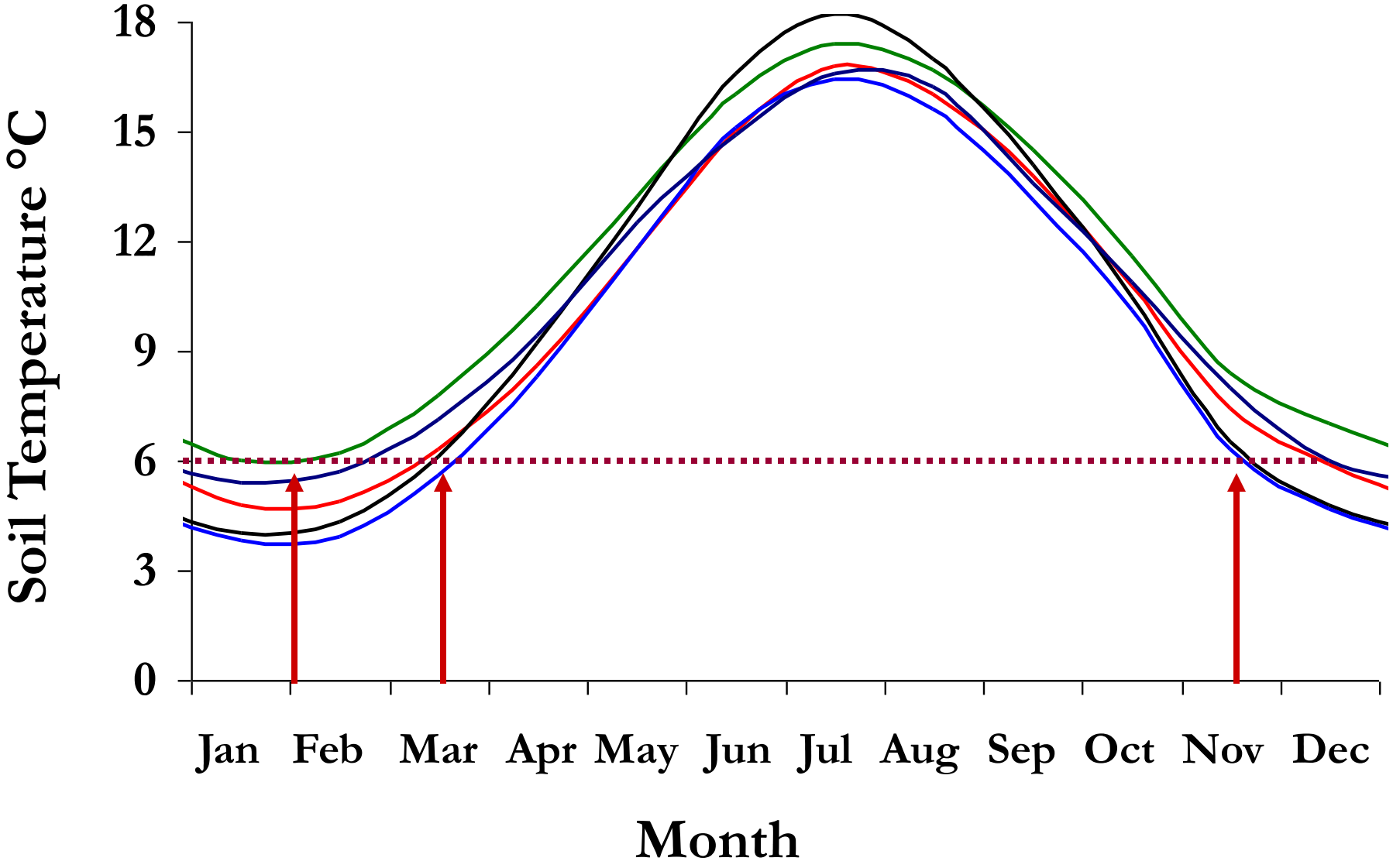

(kg DM/ha)
75
60
45
30
15
0
-30
Volatilization of ammonia
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0
30
60
90
120
N losses
i. Denitrification
ii. Ammonia
iii. Nitrate

Sunlight & Soil Temperature

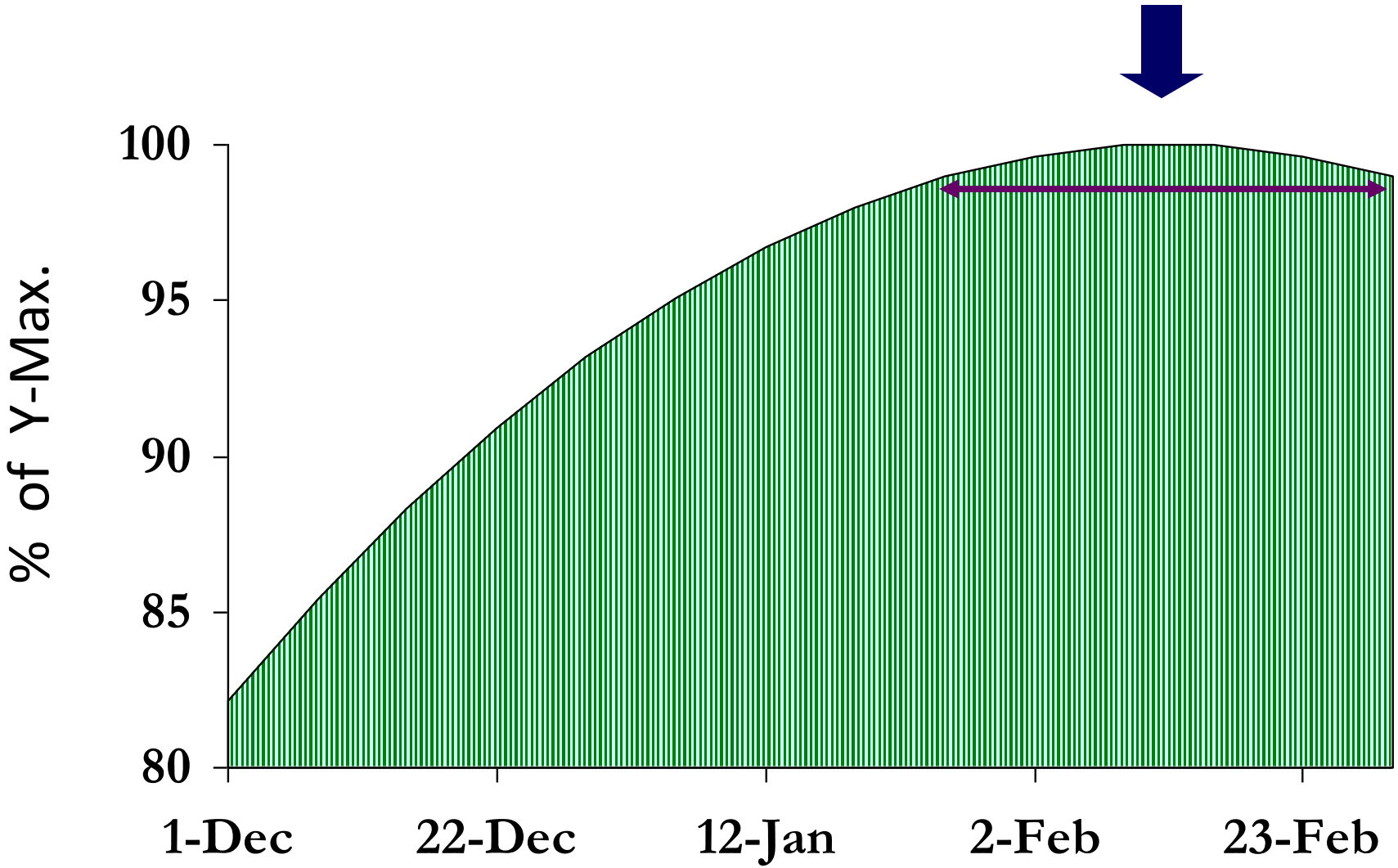
Global Solar Radiation (kiloJoules/cm^2)



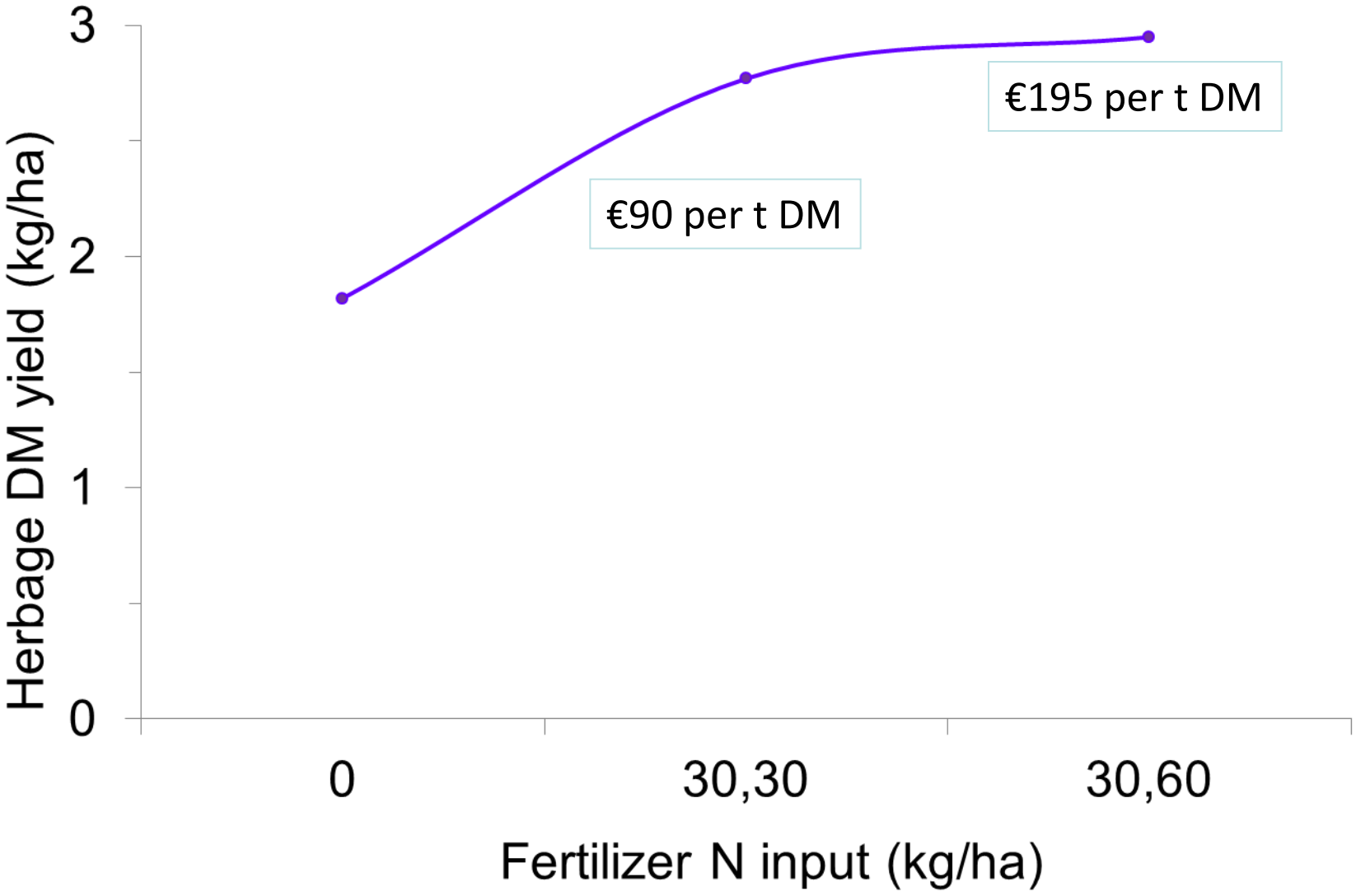
Soil Temperatures at 10 cm



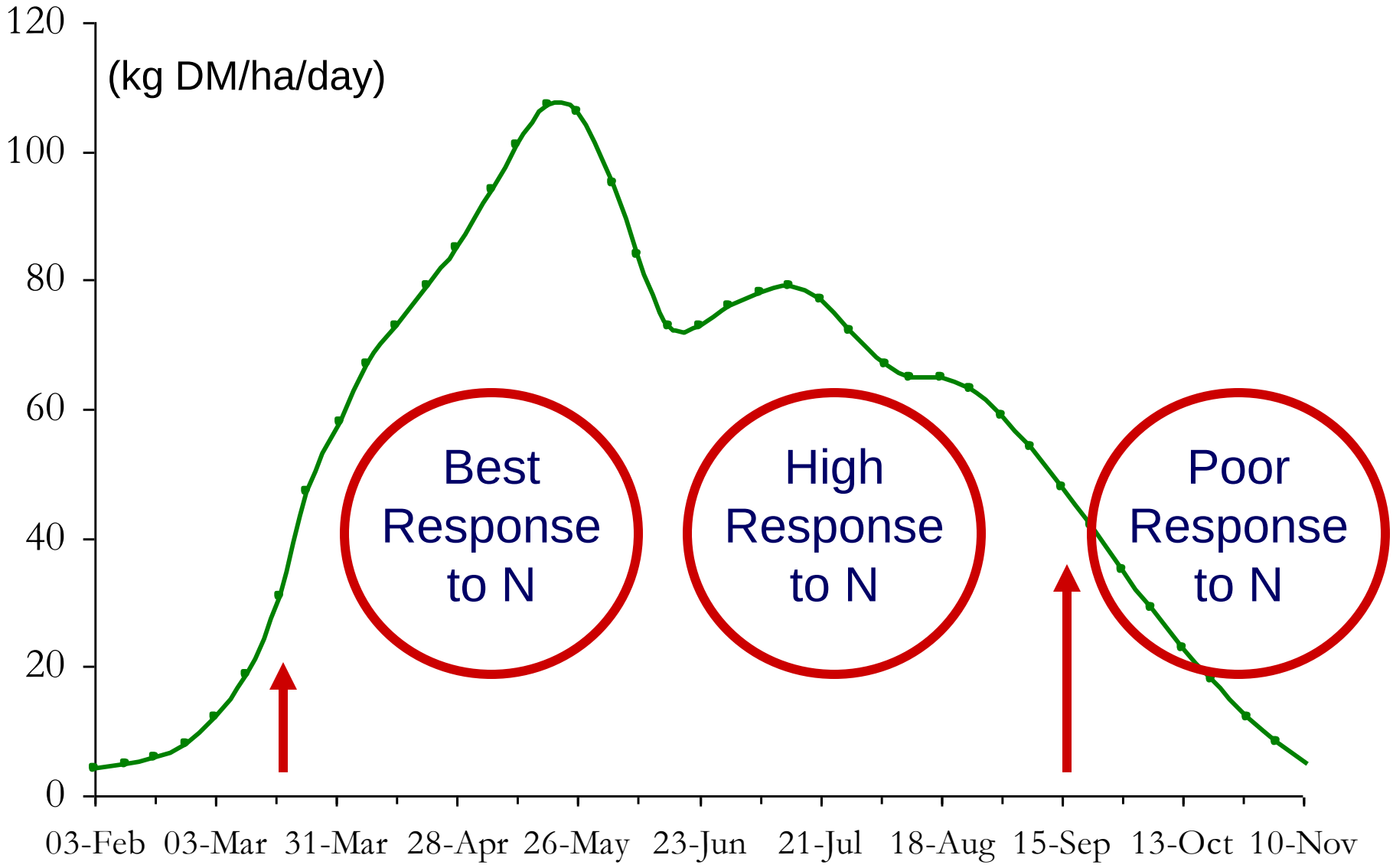
Response to fertilizer N during the Spring



Herbage production response to spring application of fertilizer N



Annual Grass Growth



Summary: Rainfall & Evapotranspiration

High risk of loss during the spring

Split application during the spring

30 kg N/ha during mid-Jan to end Feb.

Followed 6 to 4 weeks later by second application

Volatilization during summer $\rightarrow$ CAN (CAN-type fertilizers)

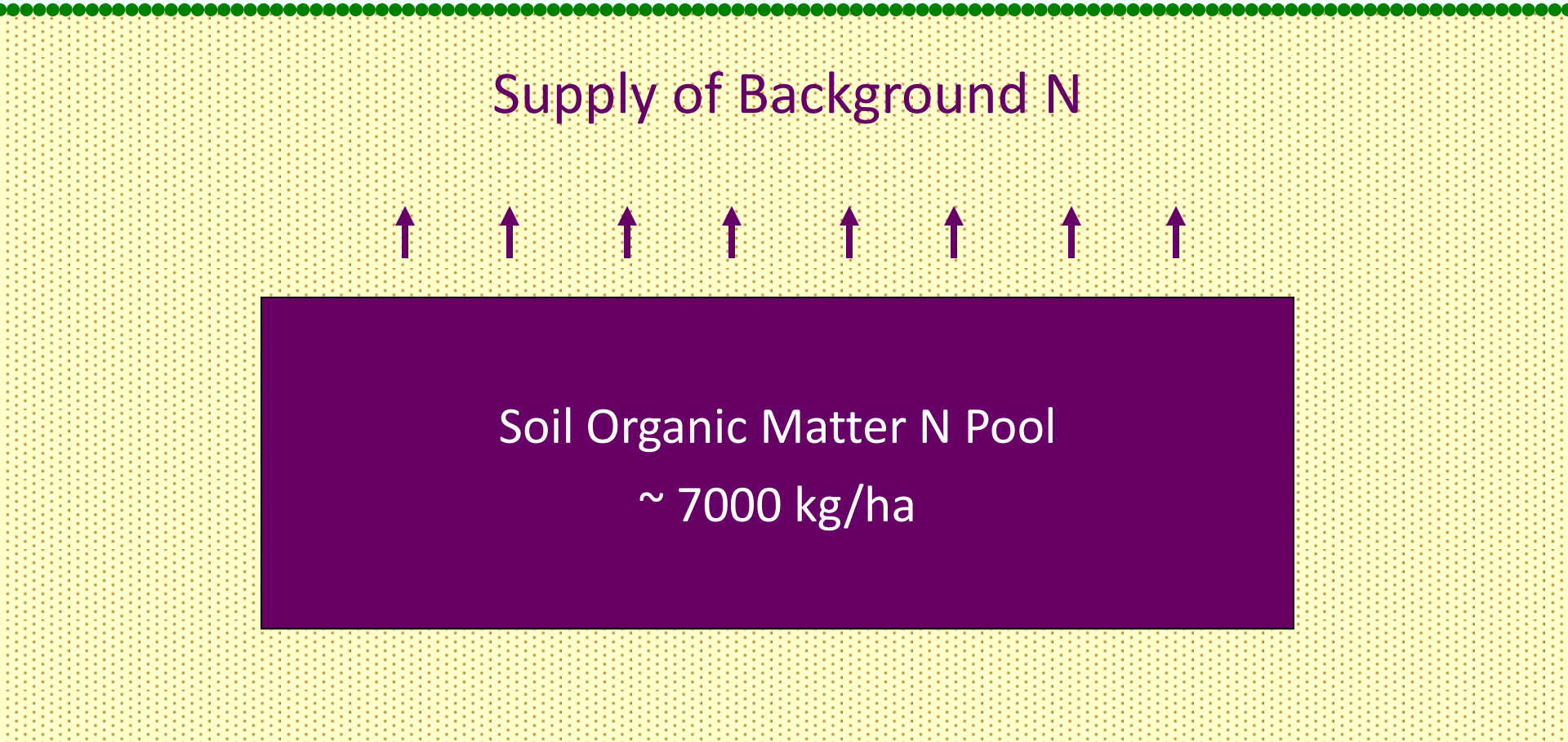
N retained in topsoil during summer months

Cease applying fertilizer N by mid-September

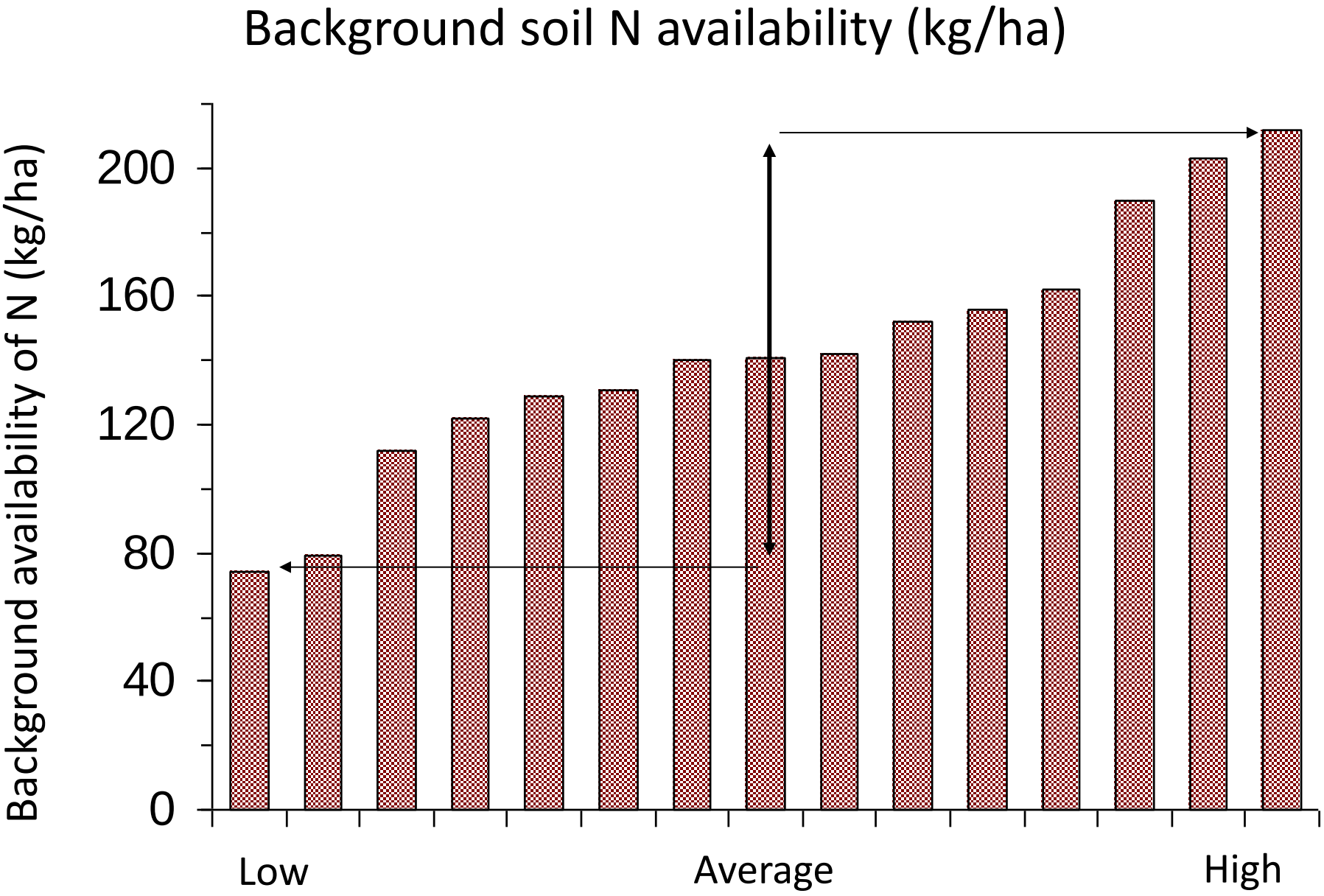
Meeting Sward Requirements

Net mineralization of soil organic matter N

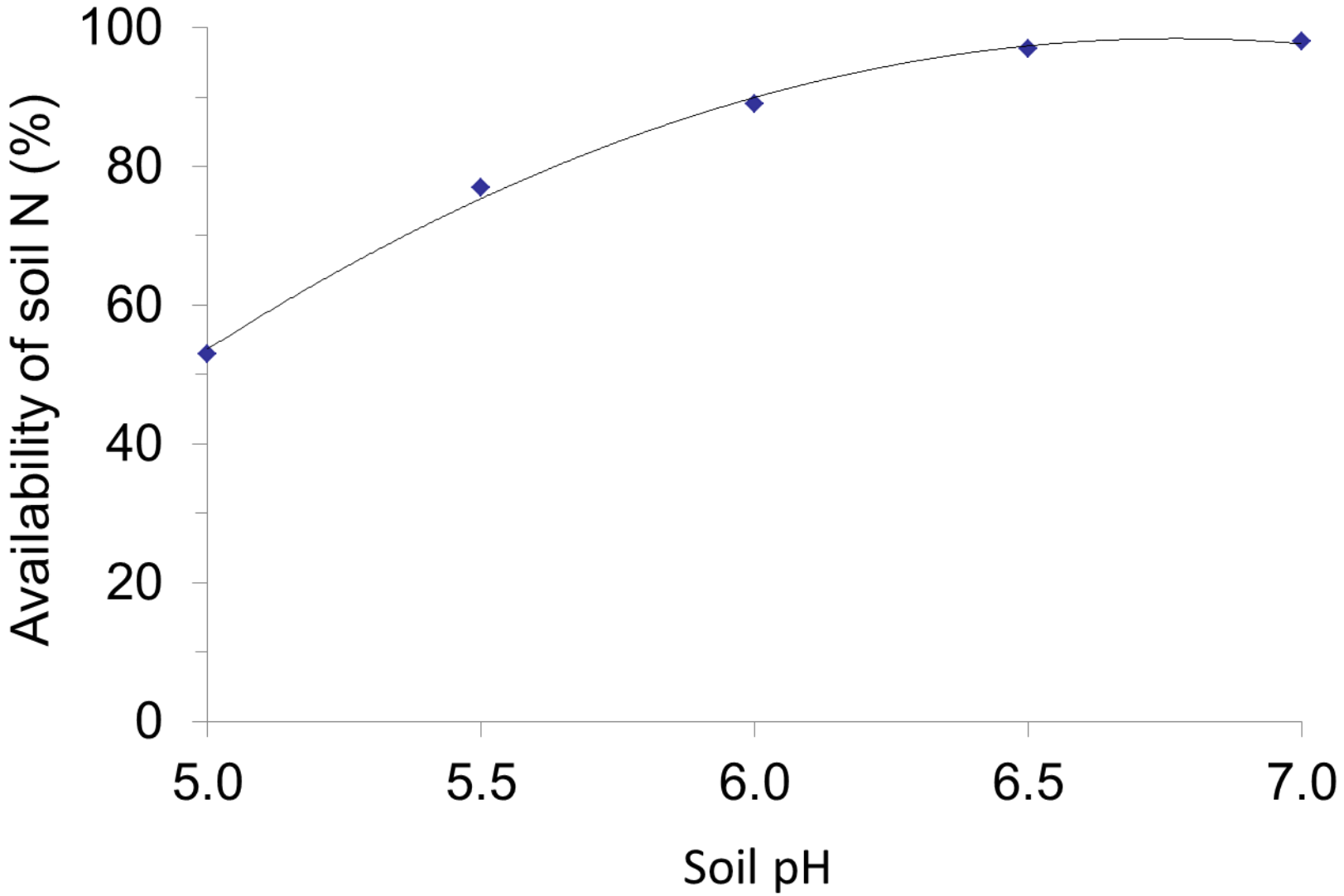
140 kg N/ha/year



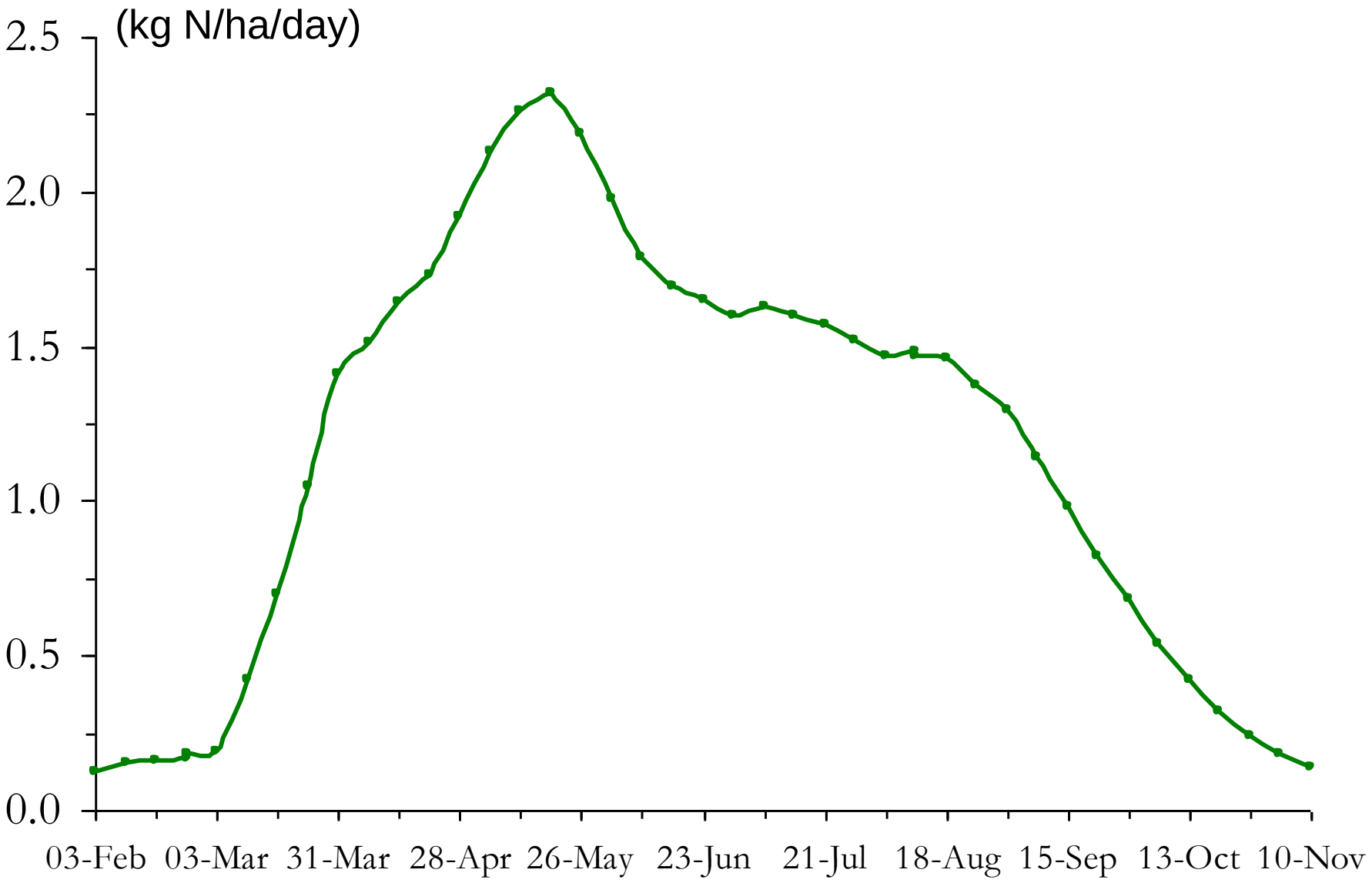
Factors affecting fertilizer N use on farms

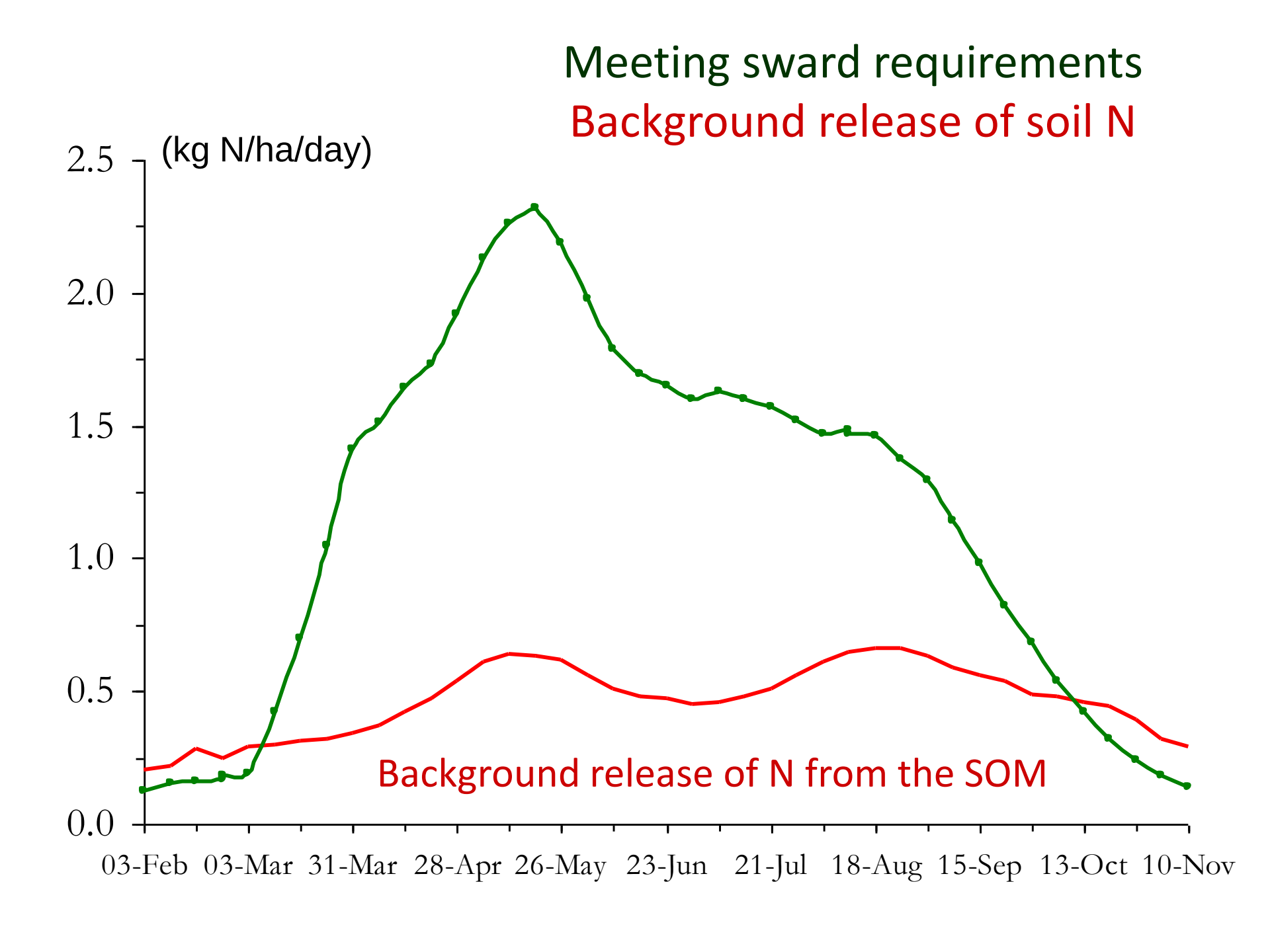


The impact of soil pH on availability of N in soil

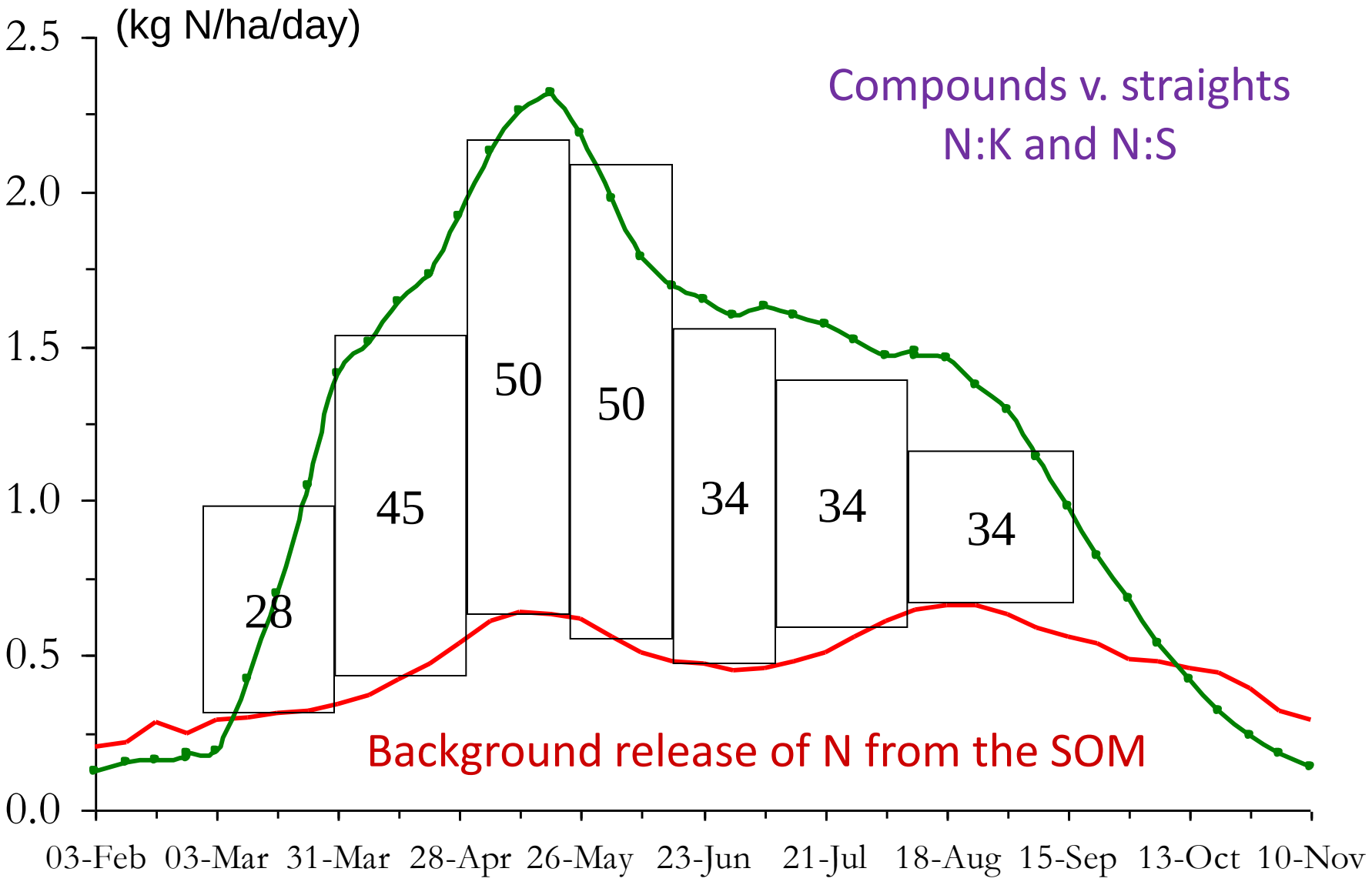


Meeting sward requirements




Meeting sward requirements
Background release of soil N
(kg N/ha/day)
2.5
2.0
1.5
1.0
0.5
0.0
Background release of N from the SOM
03-Feb
03-Mar
31-Mar
28-Apr
26-May
23-Jun
21-Jul
18-Aug
15-Sep
13-Oct
10-Nov

Matching supply with demand






Stocking Rates
&
Application Patterns



Whole farm stocking density	Area harvested for silage	
	First cut	Second cut
LU/ha	% of farm area	
2.6	43	35
2.5	45	33
2.4	47	26
2.3	49	20
2.2	51	12
2.1	53	5
2.0	55	0
1.9	54	0

Nitrogen application throughout the year

Recommended rates of fertilizer N for grassland during the year where approximately half of the farm is cut for first-cut silage and the amount of second cut is kept to a minimum (0 – 30% of the grassland area). Rates of fertilizer N are presented in kg per ha (units per acre in brackets)

Stocking rate (kg/ha organic N)	Jan/Feb	March	April	May	June	July	August	September	Total (kg/ha)	(u/ac.)
155 – 170	0	28 (23)	43 (35)	34 (28)	34 (28)		25 (20)		164	(133)
170 – 180	28 (23)	28 (23)	43 (35)	34 (28)	34 (28)		25 (20)		192	(156)
180 – 190	28 (23)	37 (30)	49 (40)	34 (28)	34 (28)		34 (28)		216	(175)
190 – 200	28 (23)	49 (40)	49 (40)	34 (28)	34 (28)	34 (28)		25 (20)	253	(205)
200 – 210	28 (23)	49 (40)	49 (40)	51 (41)	34 (28)	34 (28)		34 (28)	279	(226)
211 – 250	28 (23)	43 (35)	49 (40)	34 (28)	34 (28)	34 (28)		25 (20)	247	(200)

Table 2. Nitrogen fertilizer for different stocking rates on the area available for grazing during the year. Rates of nitrogen fertilizer are presented in kg per ha

Stocking rate (LU/ha)	Nitrogen fertilizer kg/ha		Stocking rate (LU/ha)	Nitrogen fertilizer kg/ha		Stocking rate (LU/ha)	Nitrogen fertilizer kg/ha			
Mid March	Jan/Feb	March	May & June	April	May	July & August	Jun	Jul	Aug	Sep
<1.2	0	28	<3.5	28	17	<2.00	17		17	
1.2 – 1.4	28	28	3.50 – 3.75	28	26	2.0 – 2.5	26		25	
1.4 – 1.6	28	38	3.75 – 4.00	38	34	2.5 – 3.0	34		34	
1.6 – 1.8	28	49	4.00 – 4.25	49	42	3.0 – 3.5	34	26		25
>1.8	28	49	>4.25	49	51	>3.5	34	34		34

Making efficient use of fertilizer N – Fertilizer N

Apply 23 units per acre in January/February (SR > 170 kg/ha)

Follow up with more fertilizer N within 6 weeks – mid-March

Third application to coincide with closing for silage in April

Maximise stocking rate on grazing area during April to June

Make all or most silage as first-cut – minimise second-cut

Large area of farm available for grazing from June onwards

Start building covers during late July or early August

Last application during early September

Making use of white clover on Farms

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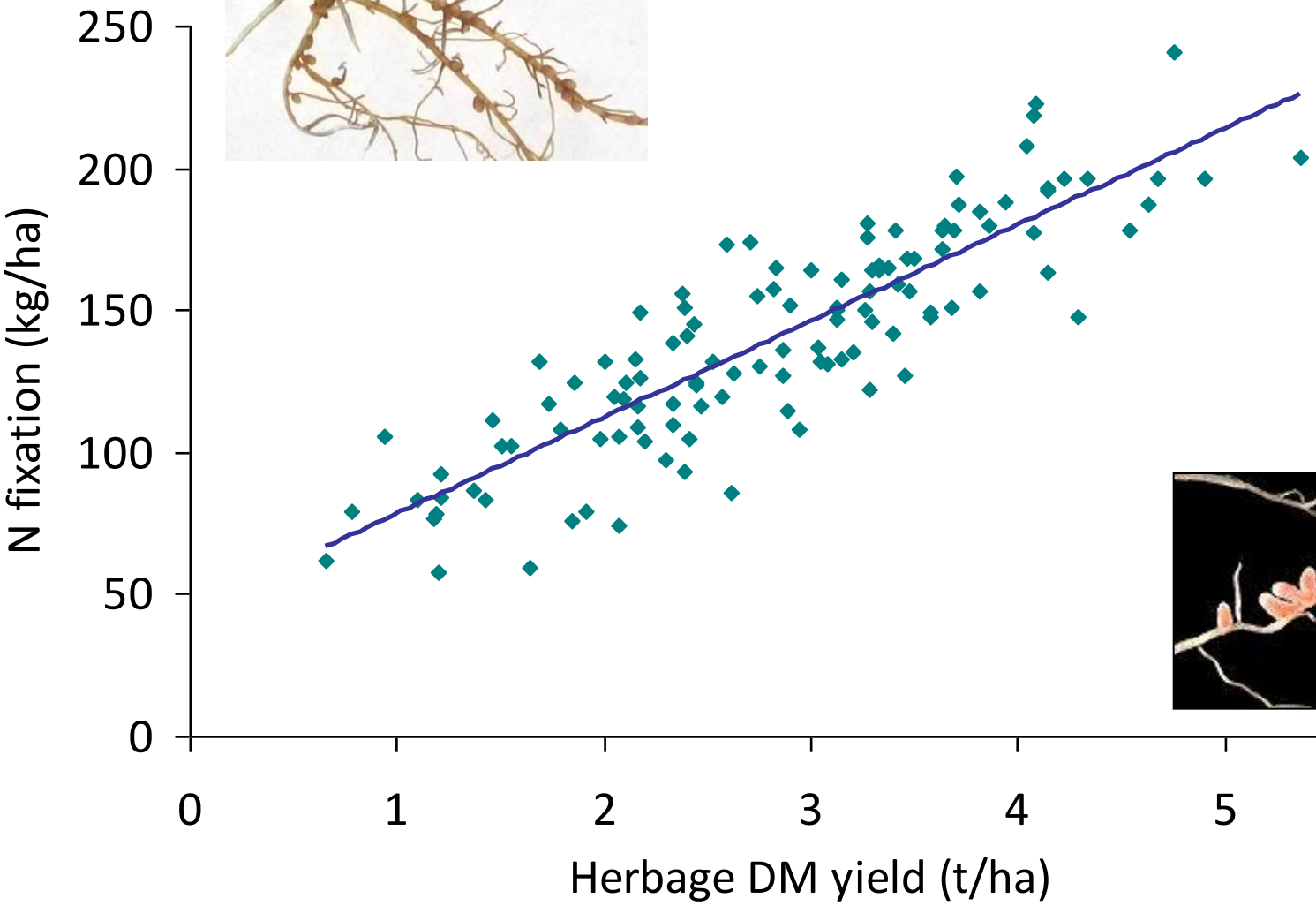
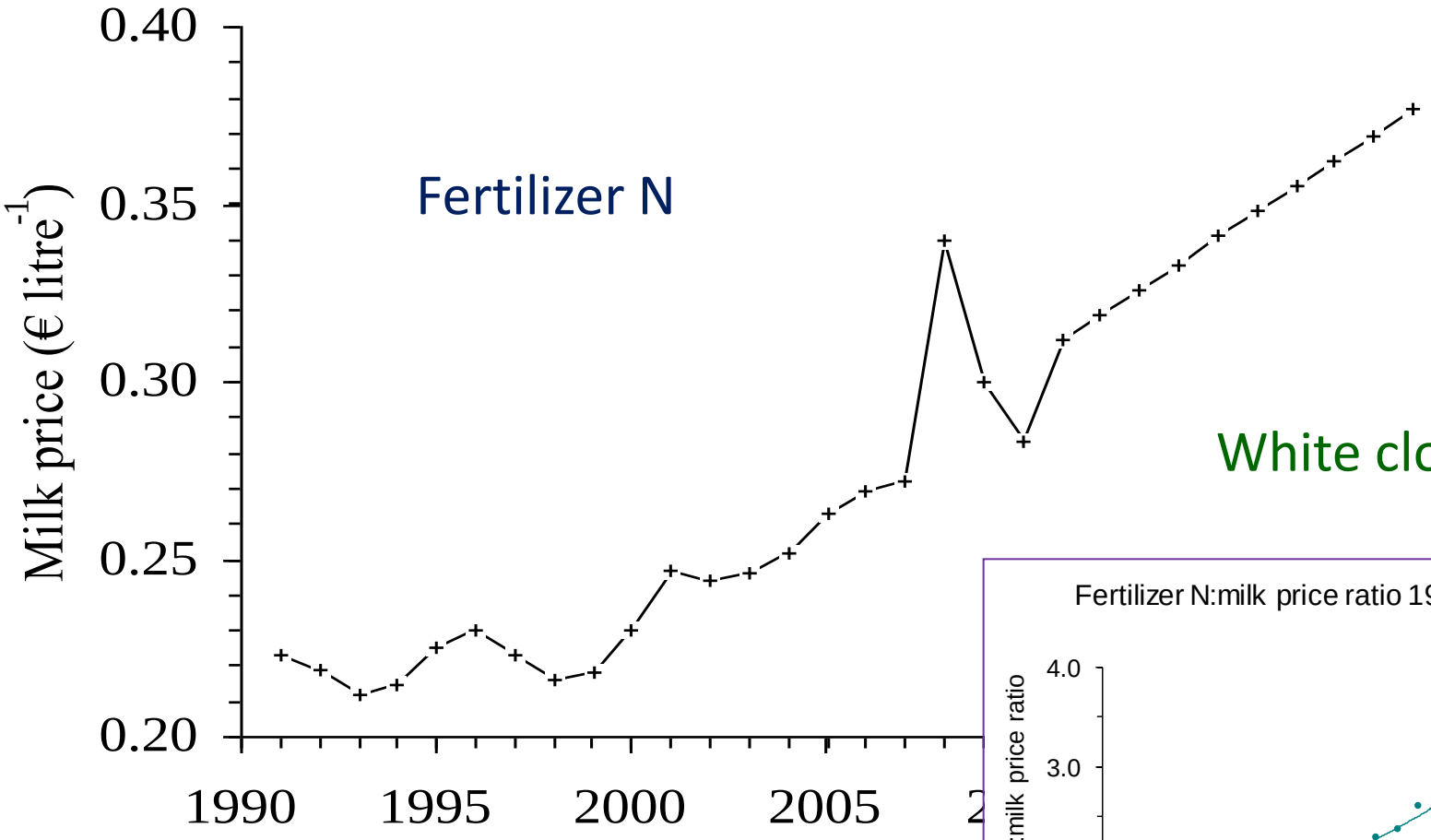
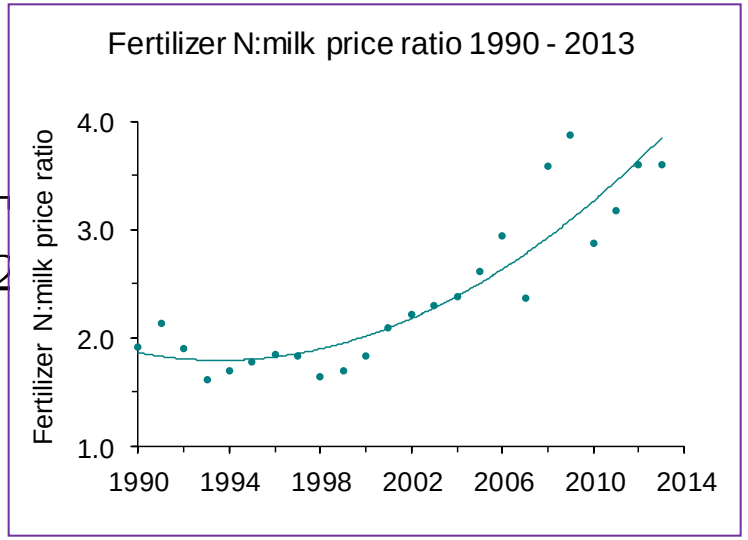
The relationship between white clover herbage yield and N fixation at Solohead Research Farm

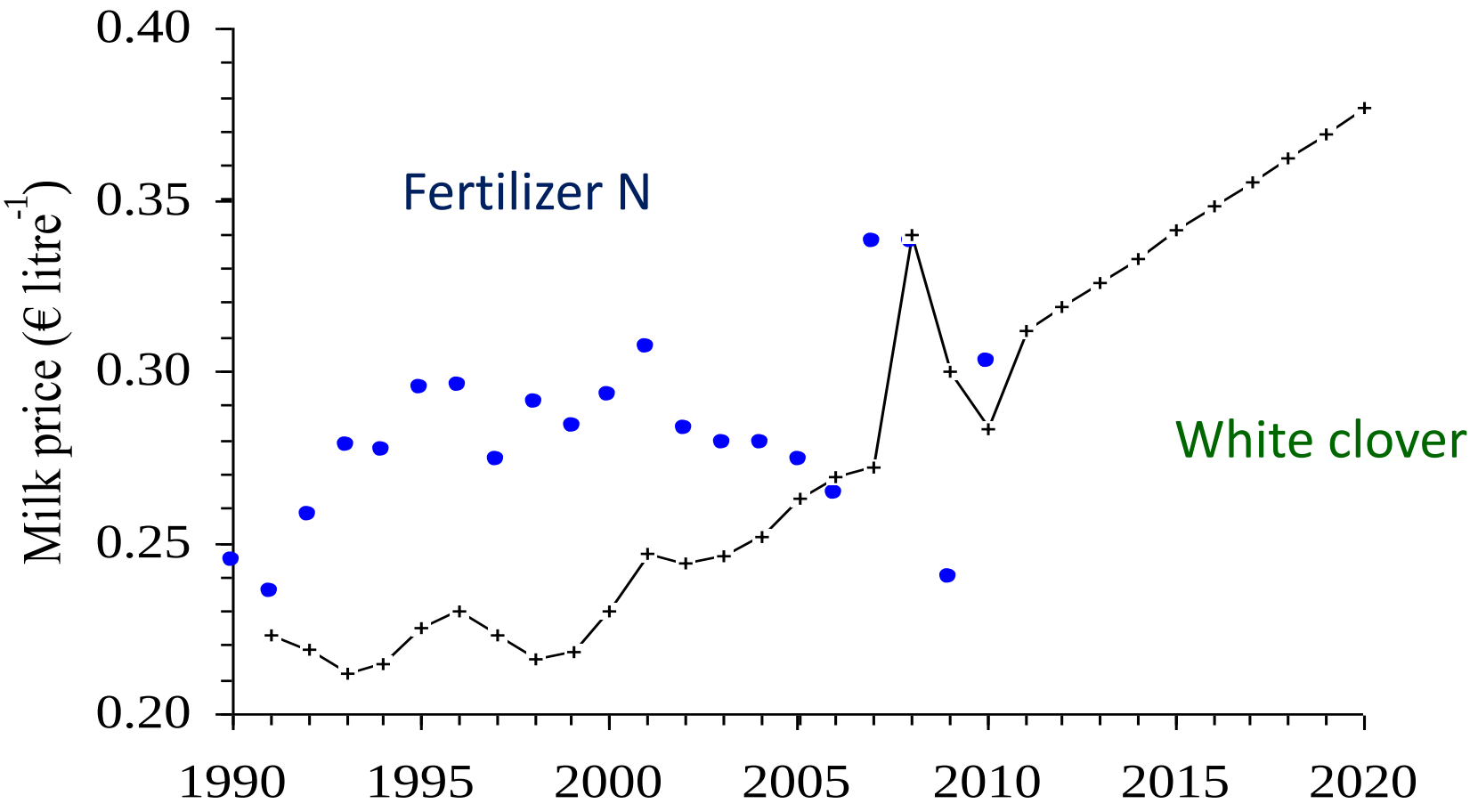


The milk price (+) at which the profitability of WC would have equalled FN between 1990 and 2010 and projected to 2020 based on the increase in fertilizer N price between 1997 and 2010 ($R^2 = 0.77$; $P < 0.001$)





Actual milk price (●) and the milk price (+) at which the profitability of WC would have equalled FN between 1990 and 2010 and projected to 2020 based on the increase in fertilizer N price between 1997 and 2010 ($R^2 = 0.77$; $P < 0.001$)



Making efficient use of fertilizer N – White Clover

Large potential to cut fertilizer N use of farms – can be halved

Biological N fixation = 100 to 200 kg per ha per year

Recommended for stocking rates up to 2.5 LU per ha

Low fertilizer N input and tight grazing are important

Introduce clover by reseeding, over-sowing & management

Suits farms where a long grazing season can be achieved

Sensitive to shading over winter and poaching damage

Bloat & dock control are not serious impediments

Two Farms – SR 2.2 cows/ha	Inefficient	Efficient
Soil pH	5.5	6.5
Slurry management	after silage & last grazing	Jan/Feb & March - silage
White clover content	None	~20%
Background N (kg/ha)	115	150
Available N slurry (kg/ha)	5	35
N fixed by clover (kg/ha)	0	120
Supply of non-fertilizer N (kg/ha)	120	305
Fertilizer N requirement (kg/ha)	275	90
Total soil N supply (kg/ha)	395	395
Cost of fertilizer (€/ha)	275	90
Cost on 50 ha farm (€)	13,750	4,500