DEFRA Funded –

Urea vs Ammonium nitrate

New data for grass and winter cereals from Rothamsted, IGER, SAC and ADAS

Agronomic efficiency of urea is compromised by loss of N to atmosphere

Urea breaks down rapidly in the soil and is subject to losses via Volatilisation.

The process of Volatilisation is caused by the hydrolysis of urea, releasing Ammonia gas.

Conditions that increase N loss from urea:

- Light, high pH soils
- Very dry or water logged fields
- High soil temperature (e.g. 15 ºC) and windy conditions
- Poorly structured / capped soils

“Best Option for the environment and farming remains AN”, Says fertiliser research

Defra press release - Date 4th October 2006

Current Emission factors used by UK Government to calculate N losses as ammonia (% N loss from applications of fertilisers)

Fertiliser	Grass	Arable
UREA	23%	11.5%
Ammonium Nitrate	1.6%	0.8%

Grass experiments 2004/05

Ist cut only

0 – 240 kgN/ha, split mid-Feb/mid-March and late-March/early-April

IGER Rowden
IGER De Bathe
SAC Crichton Royal Farm
ADAS High Mowthorpe

Winter cereals experiments 2004/05

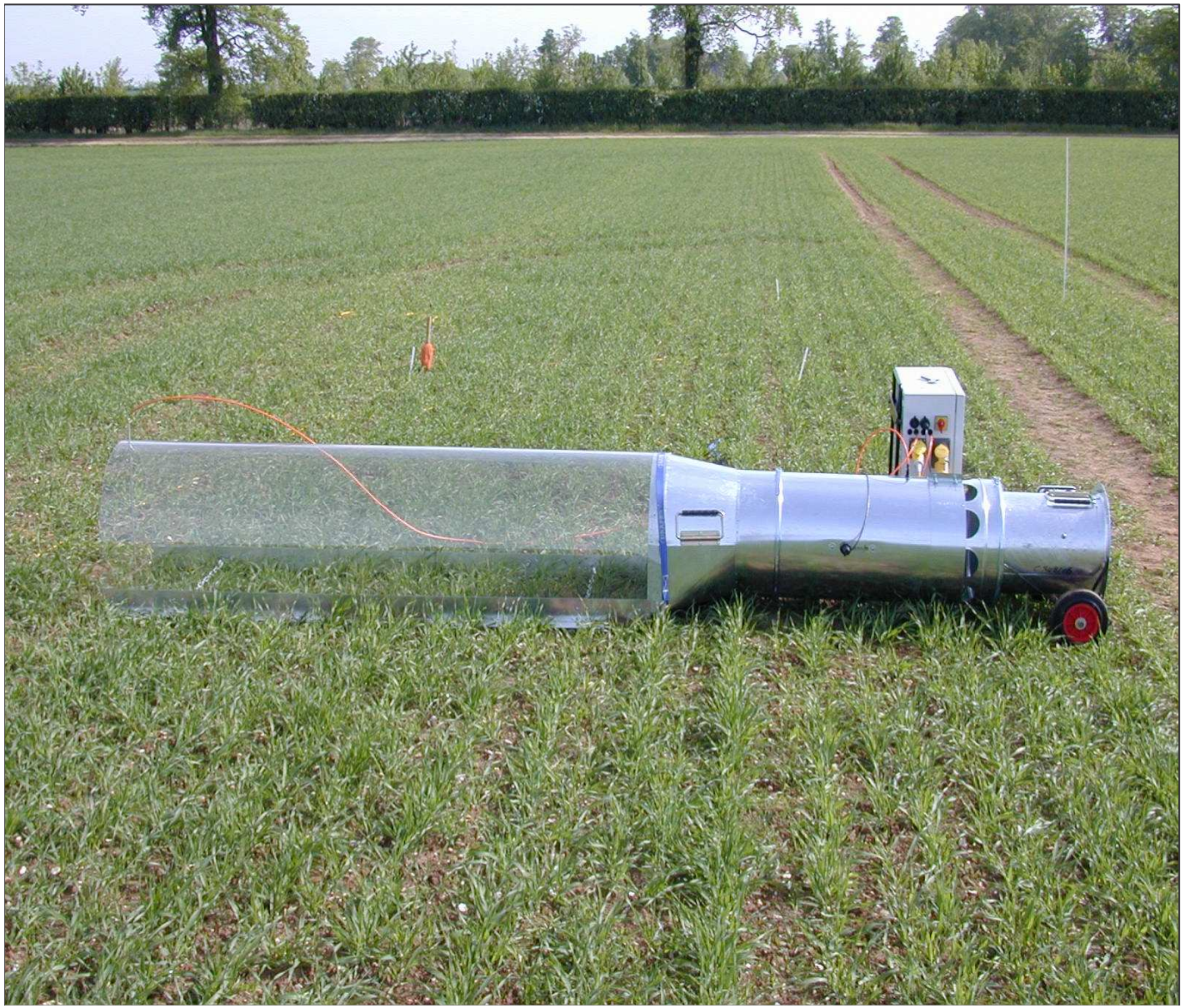
Mostly wheat (some barley)

0 – 340 kgN/ha, split:

I	40 kg late-Feb/early-March
II	Rest equal split GS 30/31, and
III	GS 32

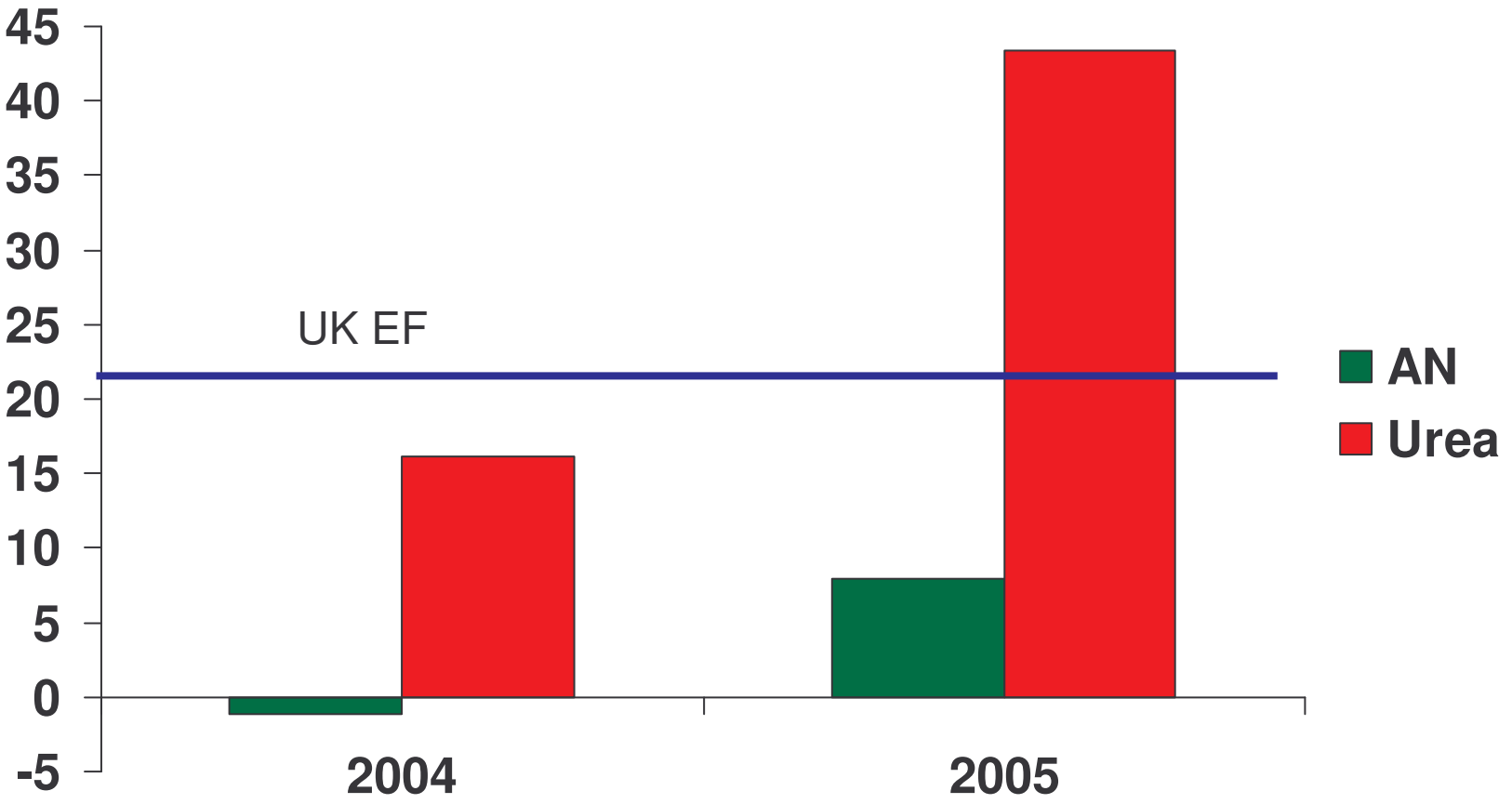
Rothamsted Harpenden
ADAS Rosemaund
ADAS Terrington
ADAS High Mowthorpe
ADAS Boxworth
ADAS Gleadthorpe
SAC Bush

Ammonia measurements – wind tunnels



- **Small plots, 21 m x 2 m**
- **3 replicates of each treatment**
- **Windtunnels moved daily**

Ammonia emissions from grass (average % N applied – 2004 and 2005)

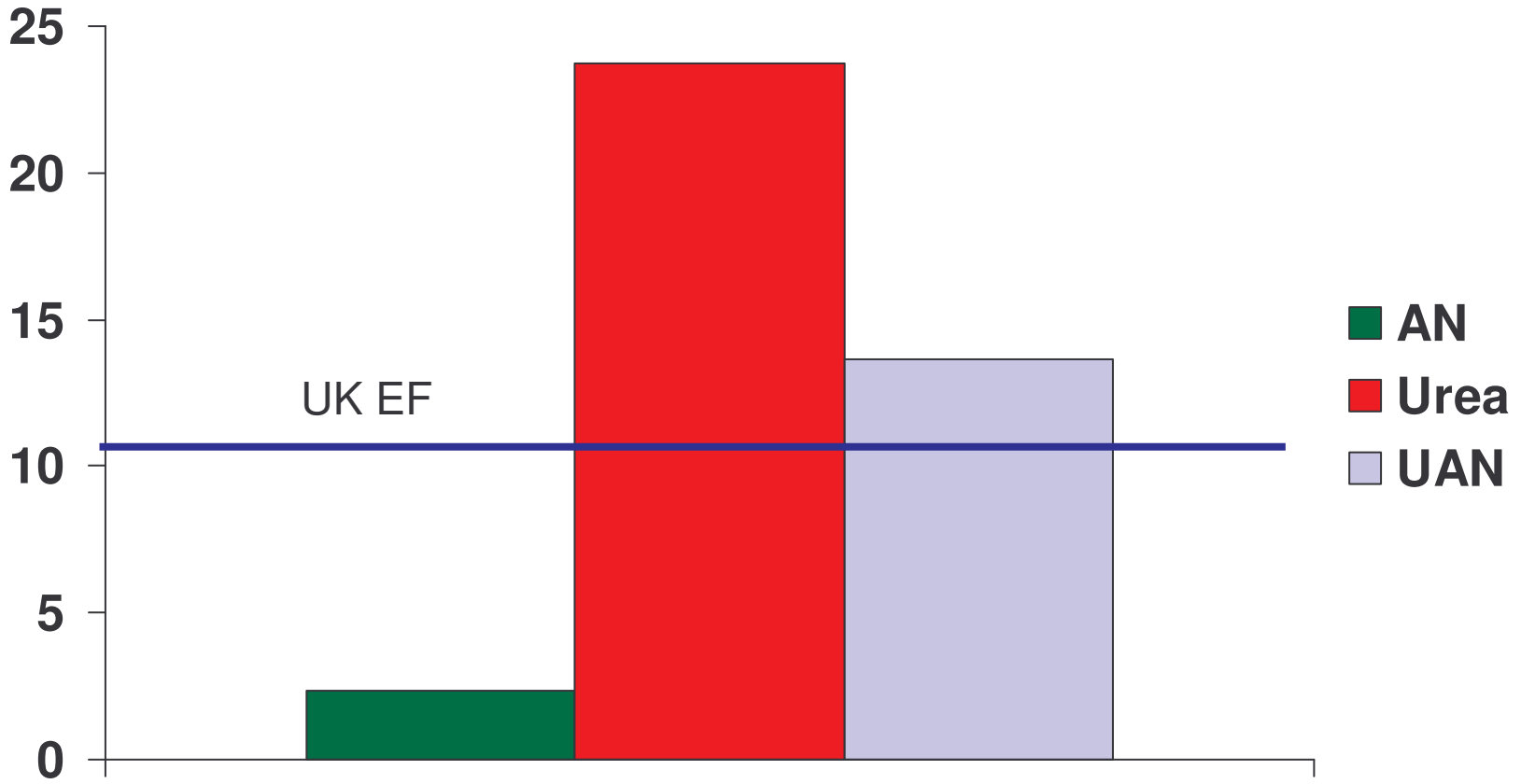


Average of three sites per year

Ammonia emissions from grass 2004 and 2005 (detail - % of N applied)

Site	2004		2005	
	AN	UREA	AN	UREA
Crichton	-1	12		
Rowden (Feb)	0	26	13	58
Rowden (March)	-3	10		
De Bathe			10	43
Mowthorpe			0.4	30

Ammonia emissions from winter cereals (average % N applied - 2004/05)



Average of ten sites

Ammonia emissions from winter cereals 2004 and 2005 (detail – % of N applied)

Site	AN	UREA	UAN
Rothamsted	2	10	9
Terrington	4	10	19
Boxworth	3	27	14
Rosemaund	5	23	13
High Mowthorpe	2	33	17
Gleadthorpe	1	35	10
Boxworth	10	18	18
Terrington	2	19	11
Rothamsted	2	43	20
Bush	2	19	5

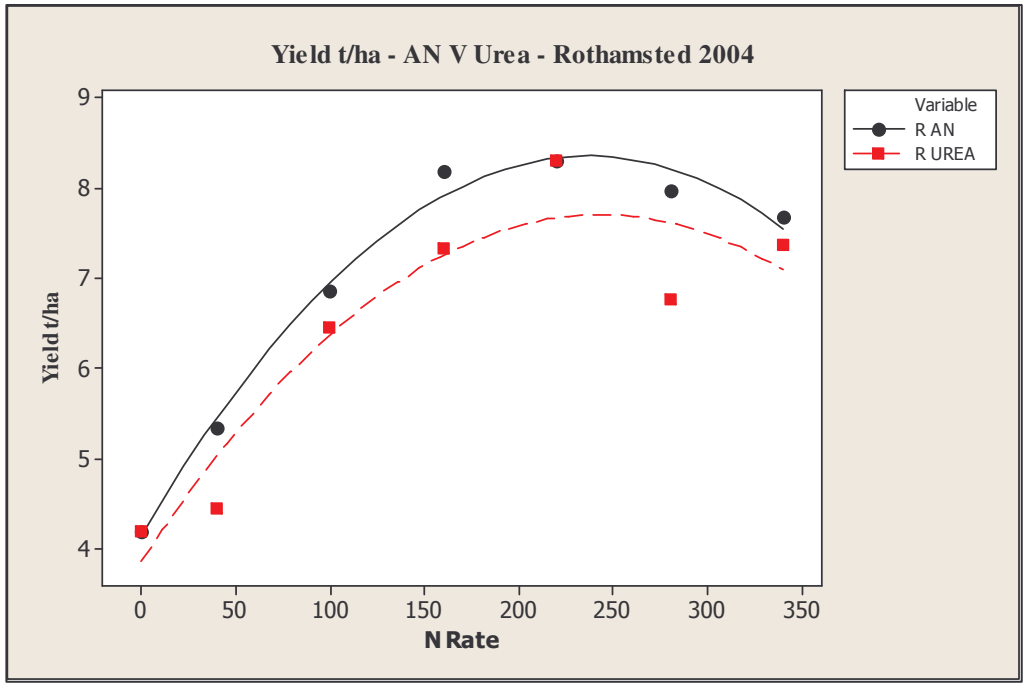
Current Emission factors used by UK Government to calculate N losses (Need for change?)

Fertiliser	Grass	Arable
UREA	23% 26%	11.5% 24%
Ammonium Nitrate	1.6% 3.0%	0.8% 3.0%

Main practical conclusion

To get the same yield and protein quality, you need to put on 20% more urea N than ammonium nitrate N

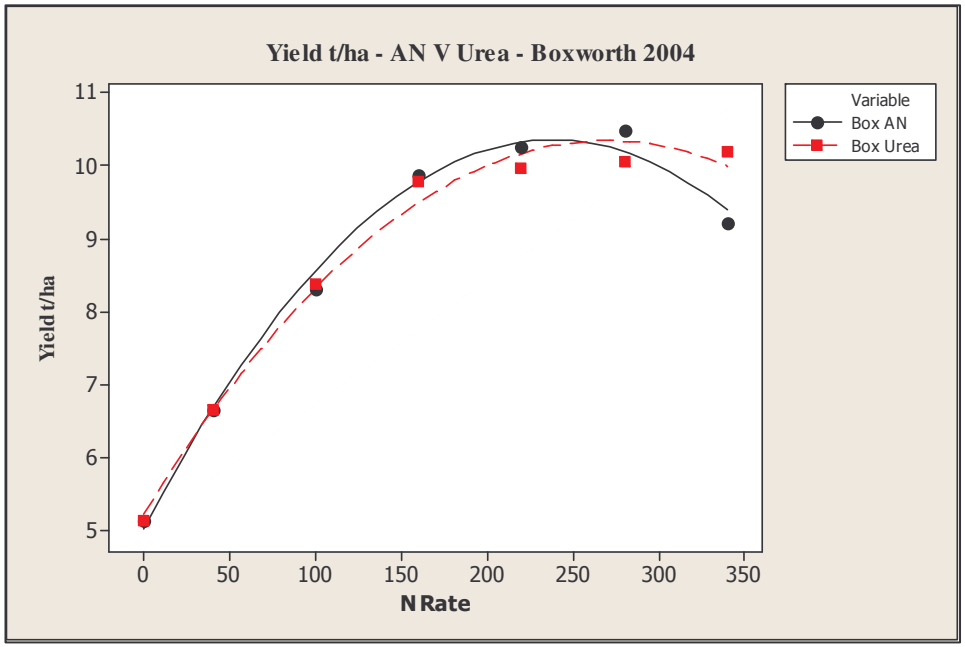
Rothamsted 2004



NH4 Losses %	AN Margin/N Cost £/ha	UREA-N Margin/N Cost £/ha	Difference £/ha
0	248.62	196.38	52.24
10	248.62	193.47	55.15
20	248.62	181.30	67.32
30	248.62	167.99	80.63
40	248.62	140.22	108.40
50	248.62	116.51	132.11

Optimum AN-N – 240kg/ha
Optimum UREA-N – 240kg/ha
Value of – 0N = £335/ha
Cost of – Urea-N = £86/ha
Cost of – AN - £110/ha

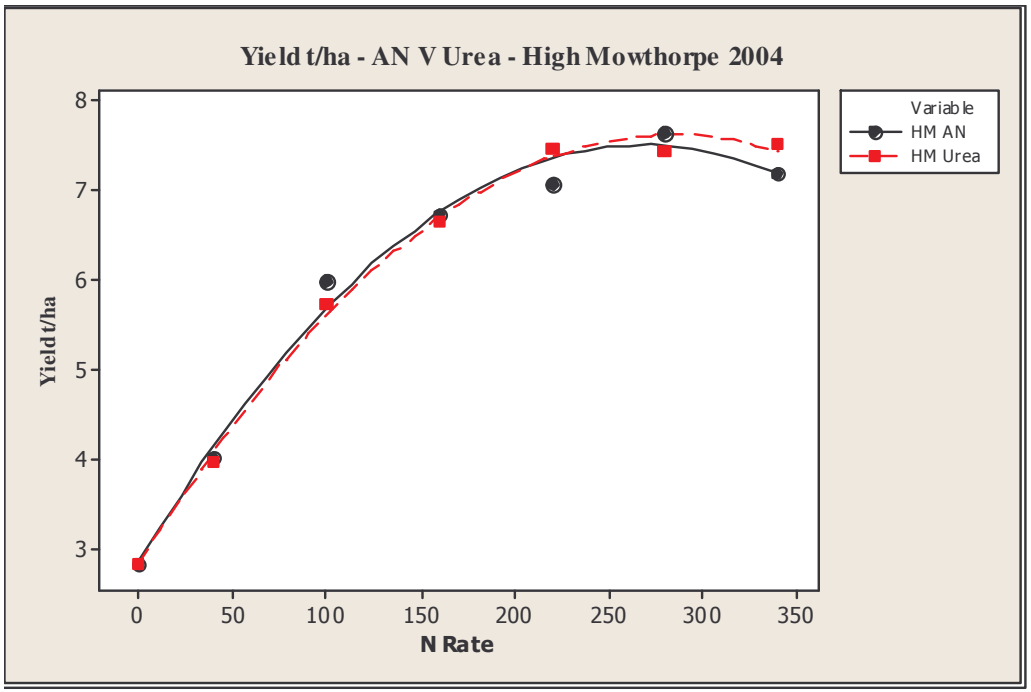
Boxworth 2004



NH4 Losses %	AN Margin/N Cost £/ha	UREA-N Margin/N Cost £/ha	Difference £/ha
0	308.08	319.10	-11.02
10	308.08	313.97	-5.89
20	308.08	304.94	3.14
30	308.08	283.01	25.07
40	308.08	250.99	57.09
50	308.08	159.25	148.83

Optimum AN-N – 240kg/ha
Optimum UREA-N –270kg/ha
Value of – 0N = £411/ha
Cost of – Urea-N = £97/ha
Cost of – AN - £110/ha

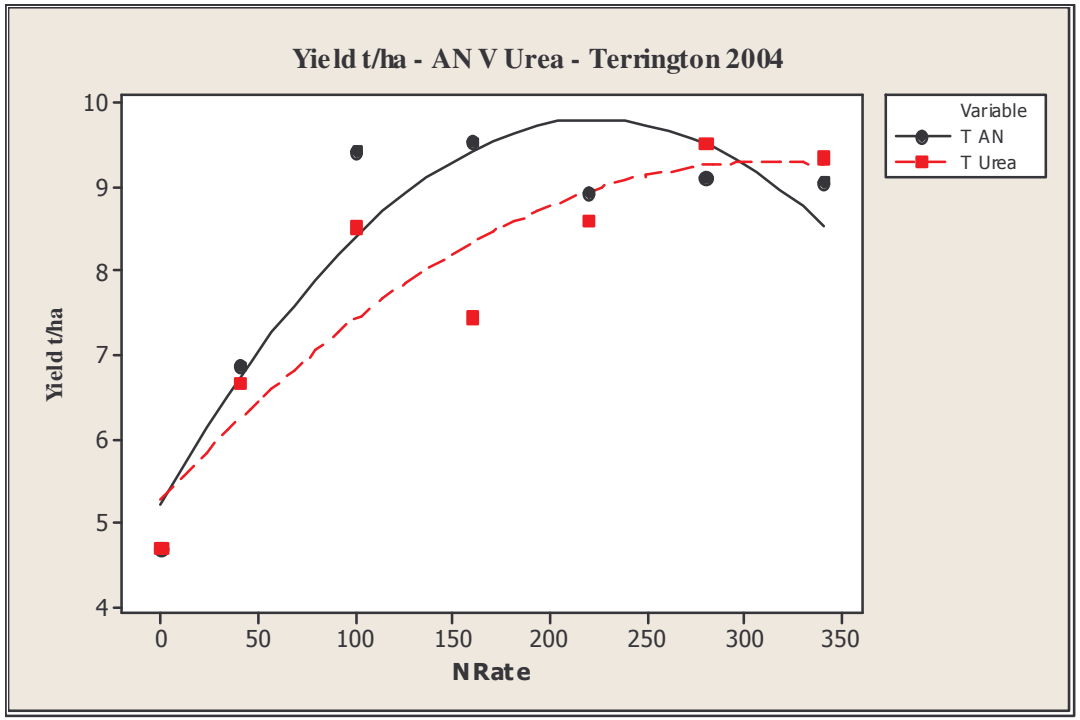
High Mowthorpe 2004



NH4 Losses %	AN Margin/N Cost £/ha	UREA-N Margin/N Cost £/ha	Difference £/ha
0	249.82	279.84	-30.02
10	249.82	274.32	-24.50
20	249.82	260.30	-10.49
30	249.82	246.24	3.58
40	249.82	218.06	31.75
50	249.82	181.39	68.42

Optimum AN-N – 270kg/ha
Optimum UREA-N – 280kg/ha
Value of – 0N = £227/ha
Cost of – Urea-N = £101/ha
Cost of – AN - £124/ha

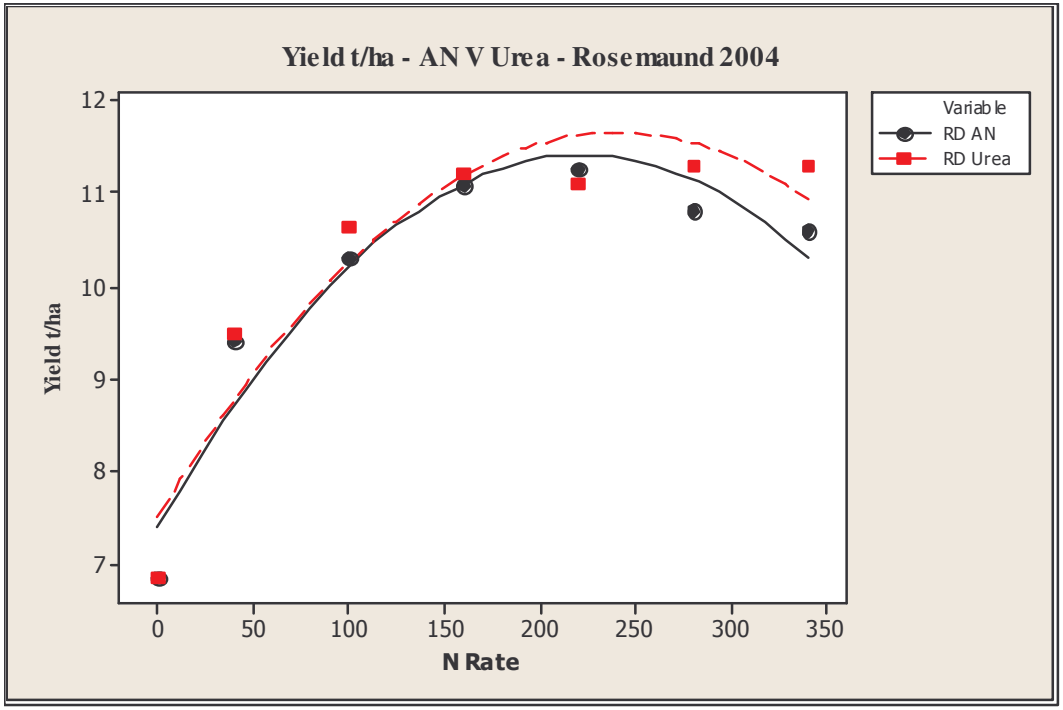
Terrington 2004



NH4 Losses %	AN Margin/N Cost £/ha	UREA-N Margin/N Cost £/ha	Difference £/ha
0	310.19	408.13	-97.94
10	310.19	256.90	53.30
20	310.19	246.96	63.23
30	310.19	231.12	79.07
40	310.19	134.98	175.22
50	310.19	107.33	202.86

Optimum AN-N – 220kg/ha
Optimum UREA-N – 320kg/ha
Value of – 0N = £374/ha
Cost of – Urea-N = £115/ha
Cost of – AN - £101/ha

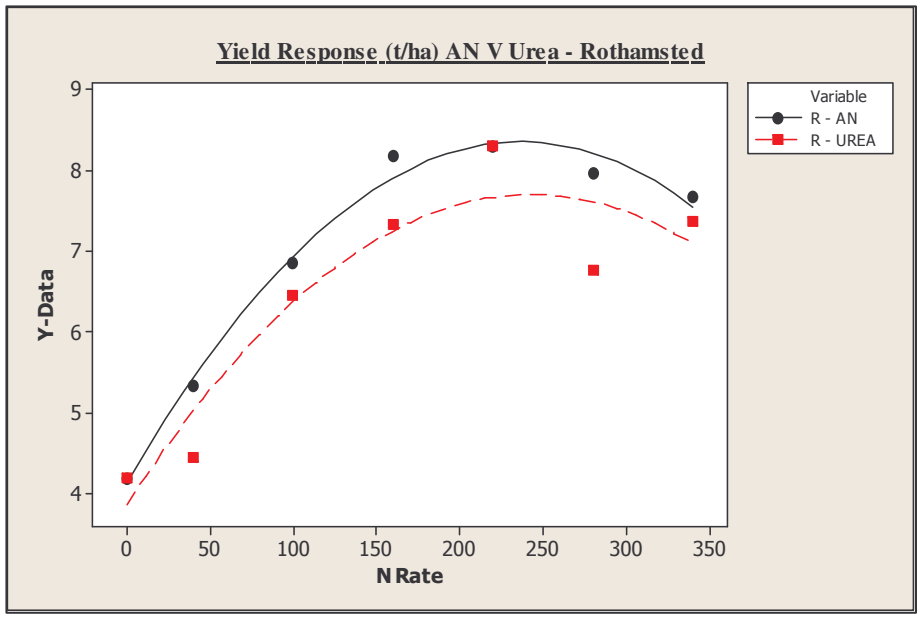
Rosemaund 2004



NH4 Losses %	AN Margin/N Cost £/ha	UREA-N Margin/N Cost £/ha	Difference £/ha
0	285.30	298.67	-13.38
10	285.30	296.05	-10.75
20	285.30	283.59	1.70
30	285.30	269.61	15.69
40	285.30	240.11	45.18
50	285.30	214.77	70.53

Optimum AN-N – 220kg/ha
Optimum UREA-N – 240kg/ha
Value of – 0N = £549/ha
Cost of – Urea-N = £86/ha
Cost of – AN - £101/ha

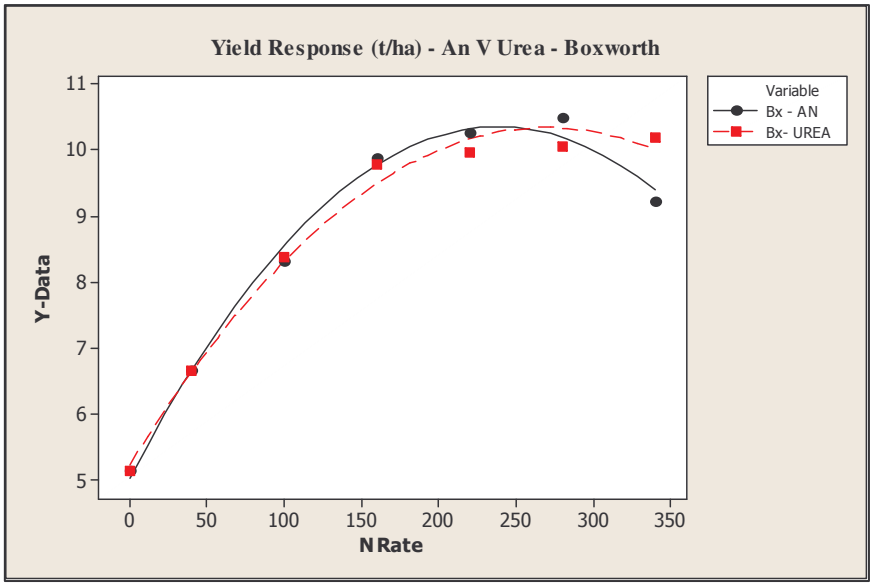
Rothamsted 2005



NH4 Losses %	AN Margin/N Cost £/ha	UREA-N Margin/N Cost £/ha	Difference £/ha
0	225.00	197.00	28.00
10	225.00	194.00	31.00
20	225.00	182.00	43.00
30	225.00	169.00	56.00
40	225.00	141.00	84.00
50	225.00	117.00	108.00

Optimum AN-N – 240kg/ha
Optimum UREA-N – 240kg/ha
Value of – 0N = £335/ha
Cost of – Urea-N = £86/ha
Cost of – AN - £110/ha

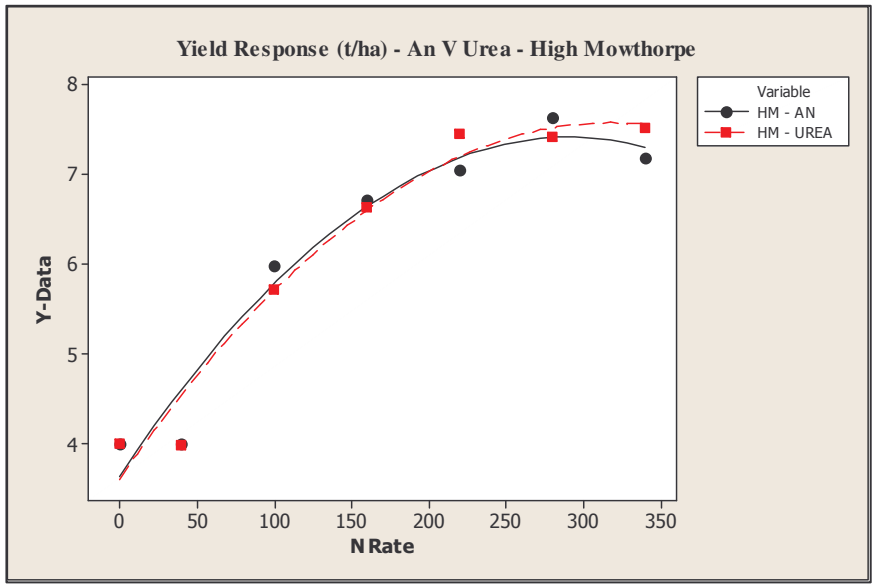
Boxworth 2005



NH4 Losses %	AN Margin/N Cost £/ha	UREA-N Margin/N Cost £/ha	Difference £/ha
0	311.00	316.00	-5.00
10	311.00	316.00	-5.00
20	311.00	308.00	3.00
30	311.00	300.00	11.00
40	311.00	252.00	59.00
50	311.00	212.00	99.00

Optimum AN-N – 240kg/ha
Optimum UREA-N –270kg/ha
Value of – 0N = £411/ha
Cost of – Urea-N = £97/ha
Cost of – AN - £110/ha

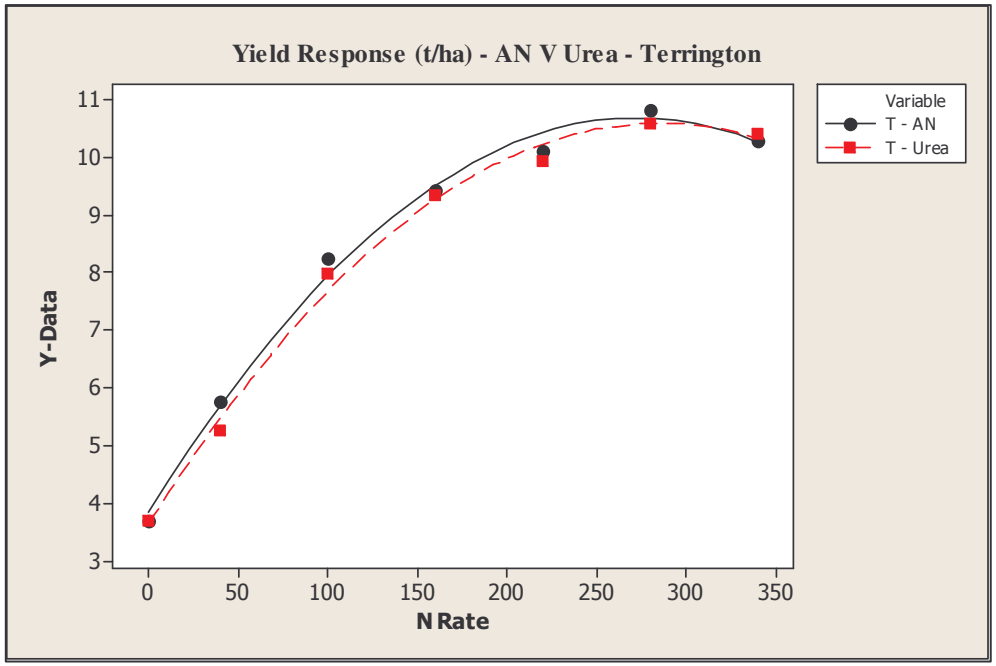
High Mowthorpe 2005



NH4 Losses %	AN Margin/N Cost £/ha	UREA-N Margin/N Cost £/ha	Difference £/ha
0	235.00	264.00	-29.00
10	235.00	262.00	-27.00
20	235.00	250.00	-15.00
30	235.00	234.00	1.00
40	235.00	212.00	23.00
50	235.00	185.00	50.00

Optimum AN-N – 294kg/ha
Optimum UREA-N – 319kg/ha
Value of – 0N = £227/ha
Cost of – Urea-N = £115/ha
Cost of – AN - £135/ha

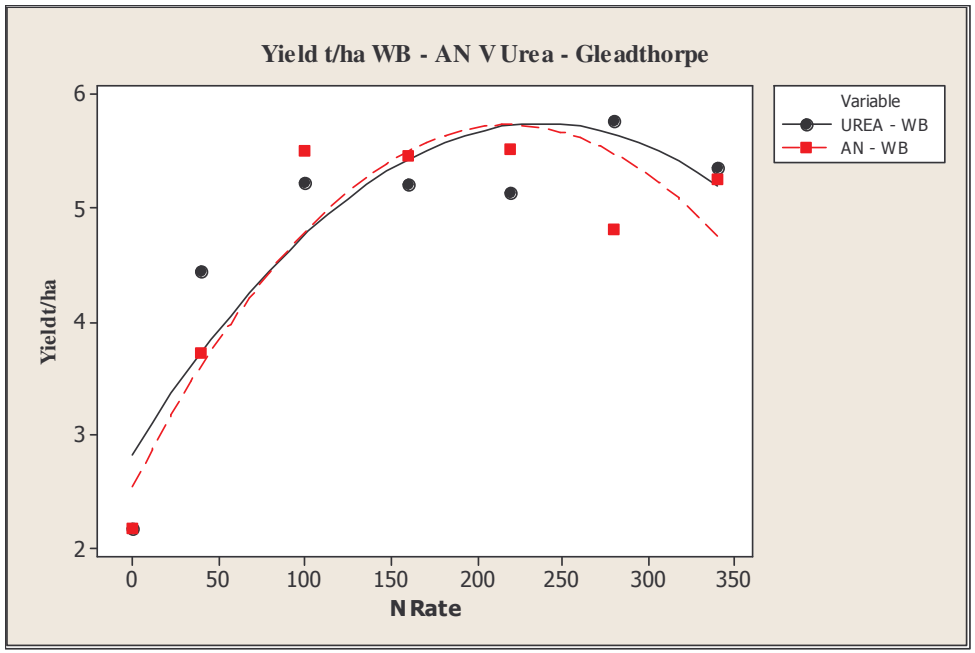
Terrington 2005



NH4 Losses %	AN Margin/N Cost £/ha	UREA-N Margin/N Cost £/ha	Difference £/ha
0	431.00	453.00	-22.00
10	431.00	445.00	-14.00
20	431.00	424.00	7.00
30	431.00	403.00	28.00
40	431.00	361.00	70.00
50	431.00	309.00	122.00

Optimum AN-N – 280kg/ha
Optimum UREA-N – 280kg/ha
Value of – 0N = £294/ha
Cost of – Urea-N = £101/ha
Cost of – AN - £129/ha

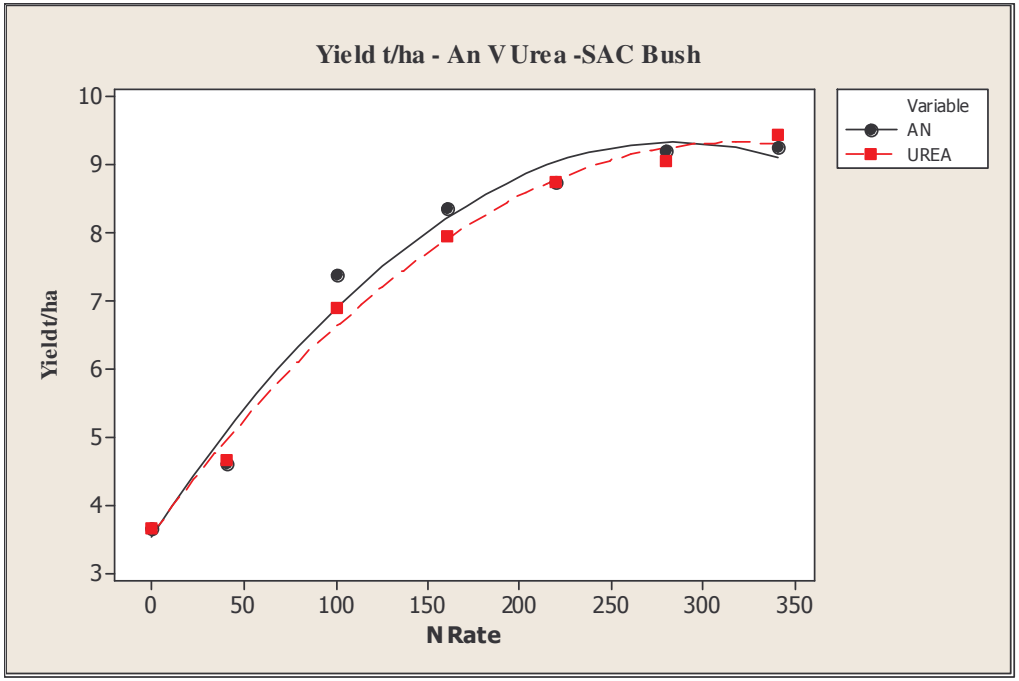
Gleadthorpe (WB) 2005



NH4 Losses %	AN Margin/N Cost £/ha	UREA-N Margin/N Cost £/ha	Difference £/ha
0	185.49	197.52	-12.03
10	185.49	196.54	-11.06
20	185.49	188.84	-3.35
30	185.49	179.54	5.94
40	185.49	159.36	26.13
50	185.49	141.74	43.74

Optimum AN-N – 220kg/ha
Optimum UREA-N – 240kg/ha
Value of – 0N = £174/ha
Cost of – Urea-N = £86/ha
Cost of – AN - £101/ha

SAC Bush 2005



NH4 Losses %	AN Margin/N Cost £/ha	UREA-N Margin/N Cost £/ha	Difference £/ha
0	327.66	341.39	-13.73
10	327.66	337.70	-10.03
20	327.66	325.79	1.87
30	327.66	297.15	30.51
40	327.66	266.10	61.57
50	327.66	226.83	100.83

Optimum AN-N – 280kg/ha
Optimum UREA-N – 320kg/ha
Value of – 0N = £292/ha
Cost of – Urea-N = £115/ha
Cost of – AN - £129/ha

Main practical conclusions on Grain Protein

- At a fixed rate of 220kg/ha applied N, grain N% values were generally lower from use of granular urea (98% of AN)

- Lower still from use of liquid UAN (96% of AN).

- Granular urea resulted in an average reduction of 0.05% grain N (0.3% protein on 100% DM basis)

- Liquid UAN resulted in an average reduction of 0.08% grain N (0.5% protein)

- Significant differences ($p<0.05$) were found at High Mowthorpe (2004) confirming this general effect::-

- Lower grain N% U vs AN
- Lower grain N% UAN vs AN
- Lower grain N% UAN vs U

Main practical conclusions on spreading

- Spread tests at 12 and 24m through two spinning disc and one oscillating spout machines, as well as SP5 test rig and wind tunnels.
- All AN products spread well at 24m when machines set-up properly.
- Some granular urea products spread well at 24m when machines set-up properly.
- No prilled urea was was of sufficient quality to fully spread test
- AN products alone achieved good spreads at 12m target with oscillating spout

Main environmental conclusion

The UK Government emission factors for loss of ammonia from urea and AN are too low.

The biggest issue here is with urea on cereals

Increased urea use and a change in the EFs gives the UK a problem with meeting the Kyoto agreement and Gothenburg protocol targets for reduction in ammonia emissions.

”Hah! Urea may lose more N through volatilisation, but it’s compensated by increased leaching losses from AN!”

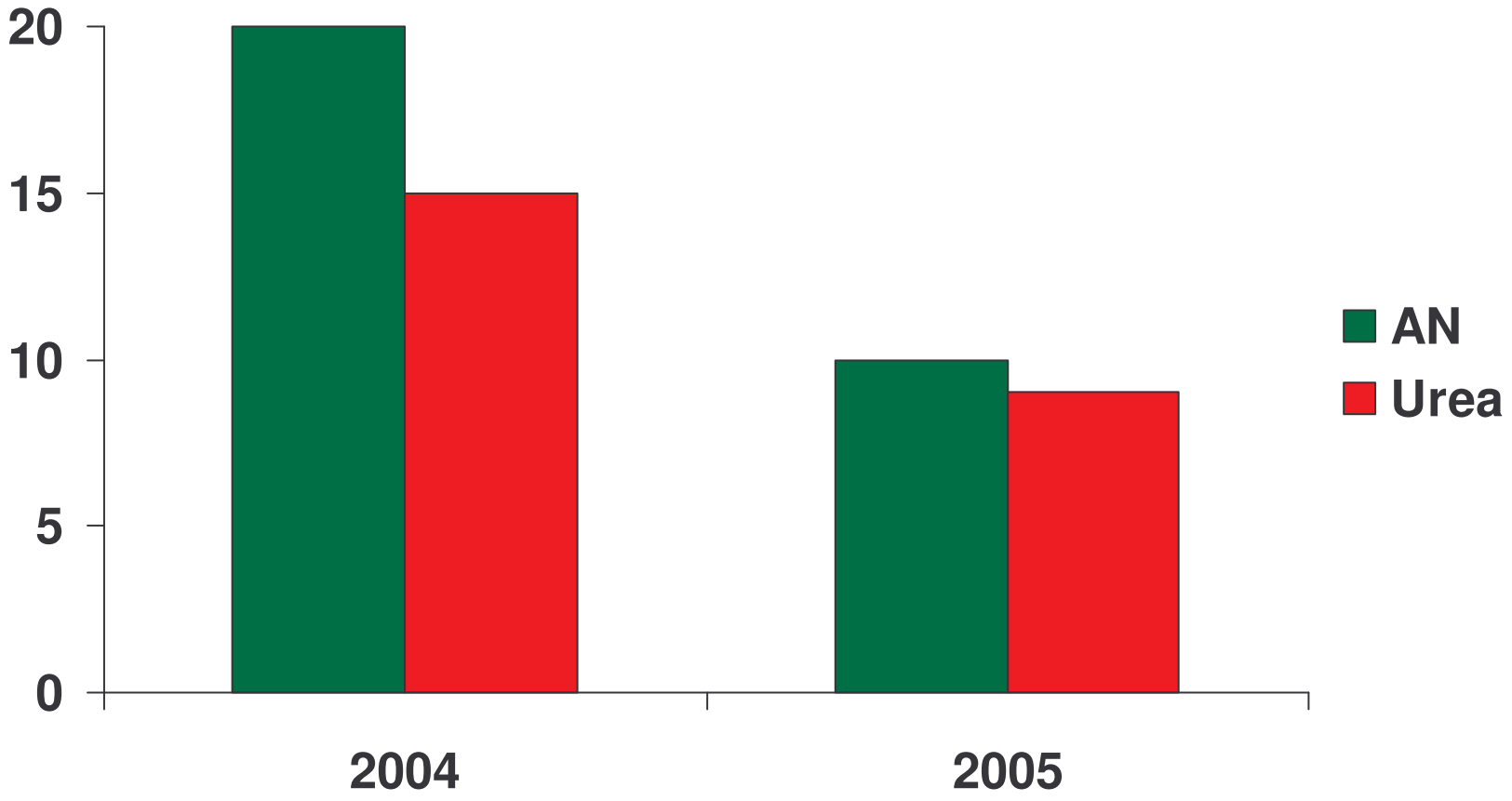
No! The experiments concluded that leaching and surface run-off losses of N were the same for AN and Urea, on both grass and cereal sites …

Quoting the report:

‘There were no consistent differences in total N losses [to water] between AN and urea at all eight study sites. Hence, a switch from AN to urea is *not* likely to change total N losses to surface and ground water systems.’

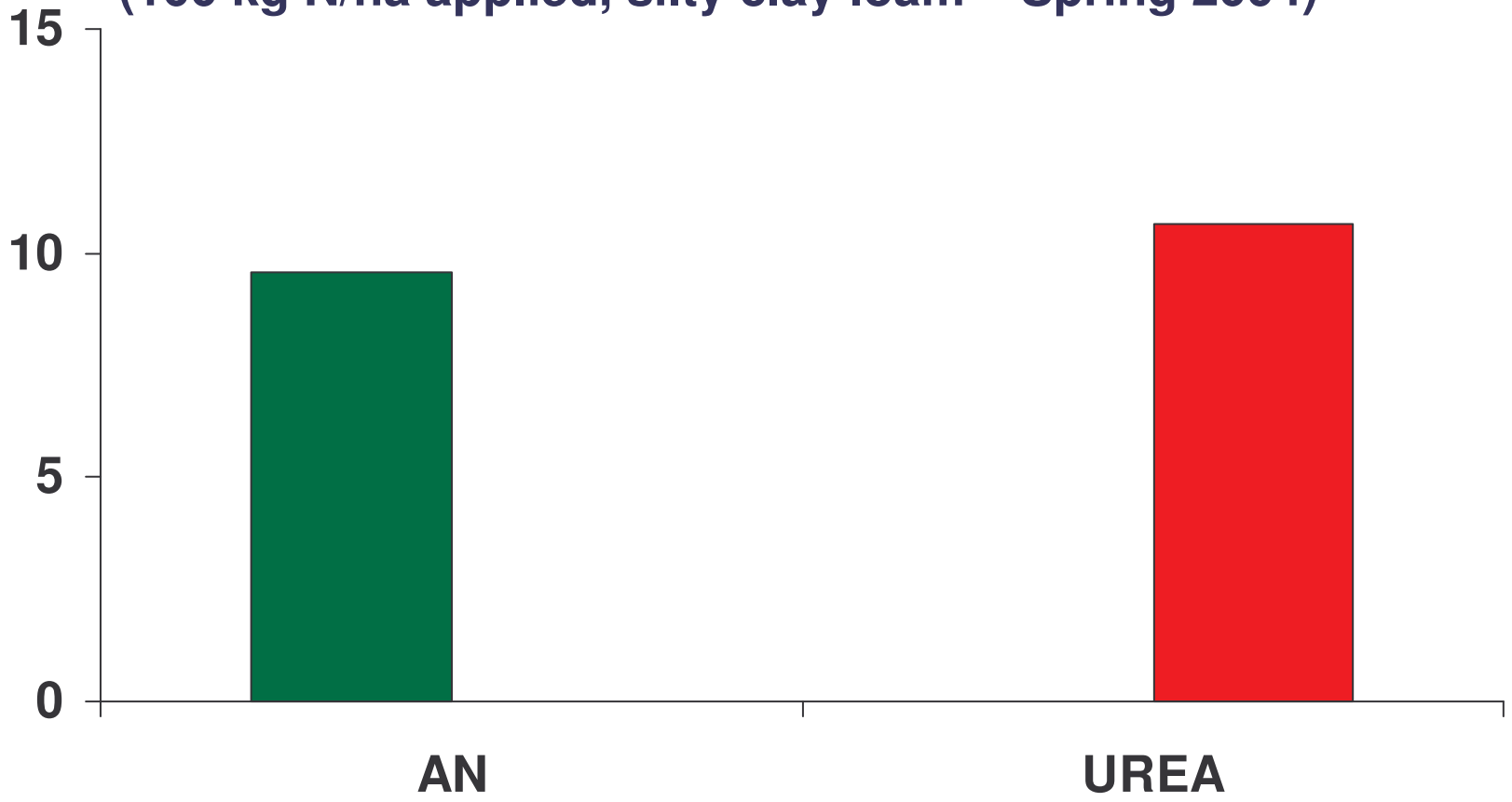
% N lost to leaching, on cereals – Woburn

(100 kg N/ha applied, sandy loam – Spring 2004 and 2005)



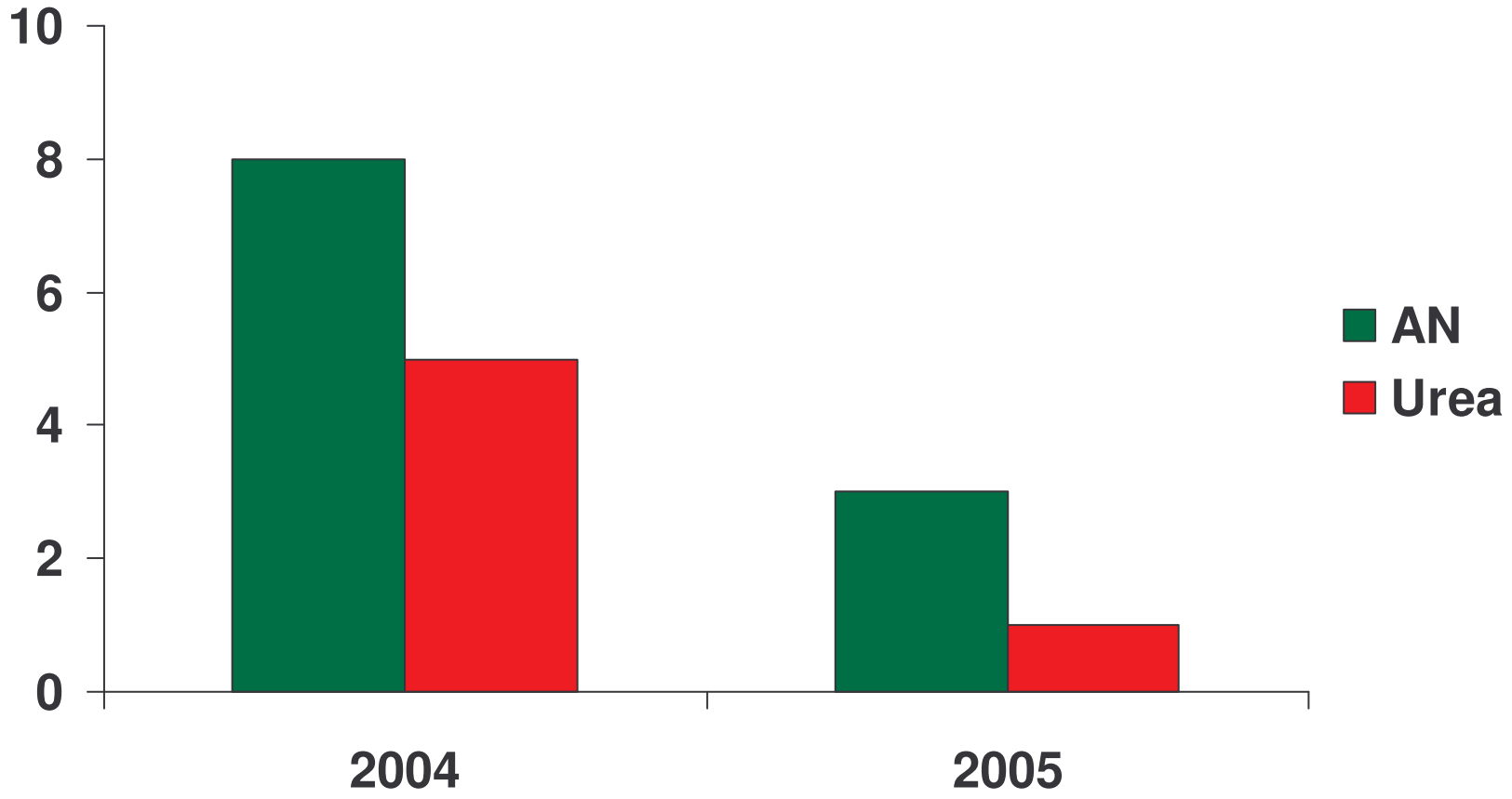
% N applied lost to surface run-off and drain flow, on grassland following a heavy rain event – Rosemaund

(100 kg N/ha applied, silty clay loam – Spring 2004)



% N lost to leaching, on grass – Rowden

(150 kg N/ha applied, silty clay loam – Spring 2004 and 2005)



Summary

- Government funded project
- Independent Scientists
- “Best Option for the environment and farming remains AN”
- 20% more Urea-N was needed to achieve same yield and protein
- Volatilisation punch hole in Governments “Environmental Targets”
- AN reduces the **RISK** in your business