SUDEN & AGRI-I projects
What was done & key findings
focus on grassland

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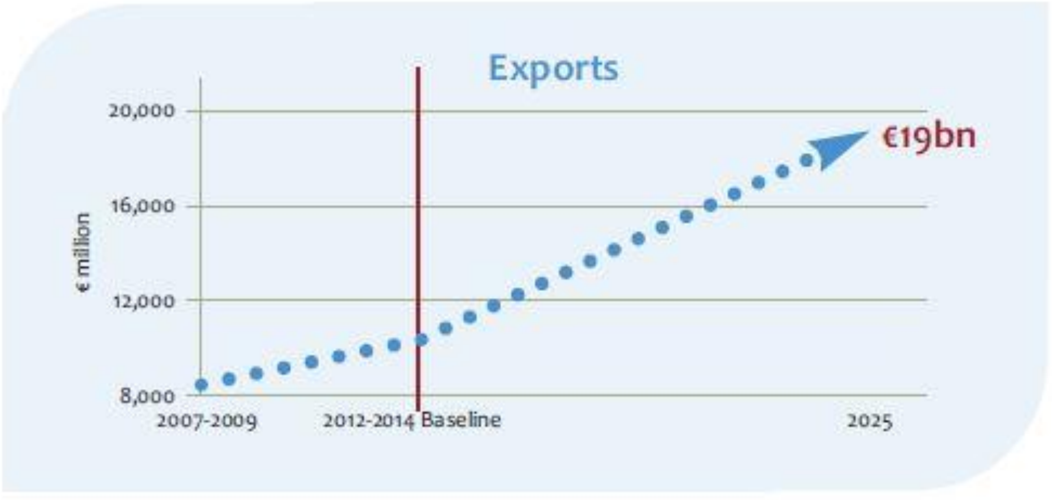
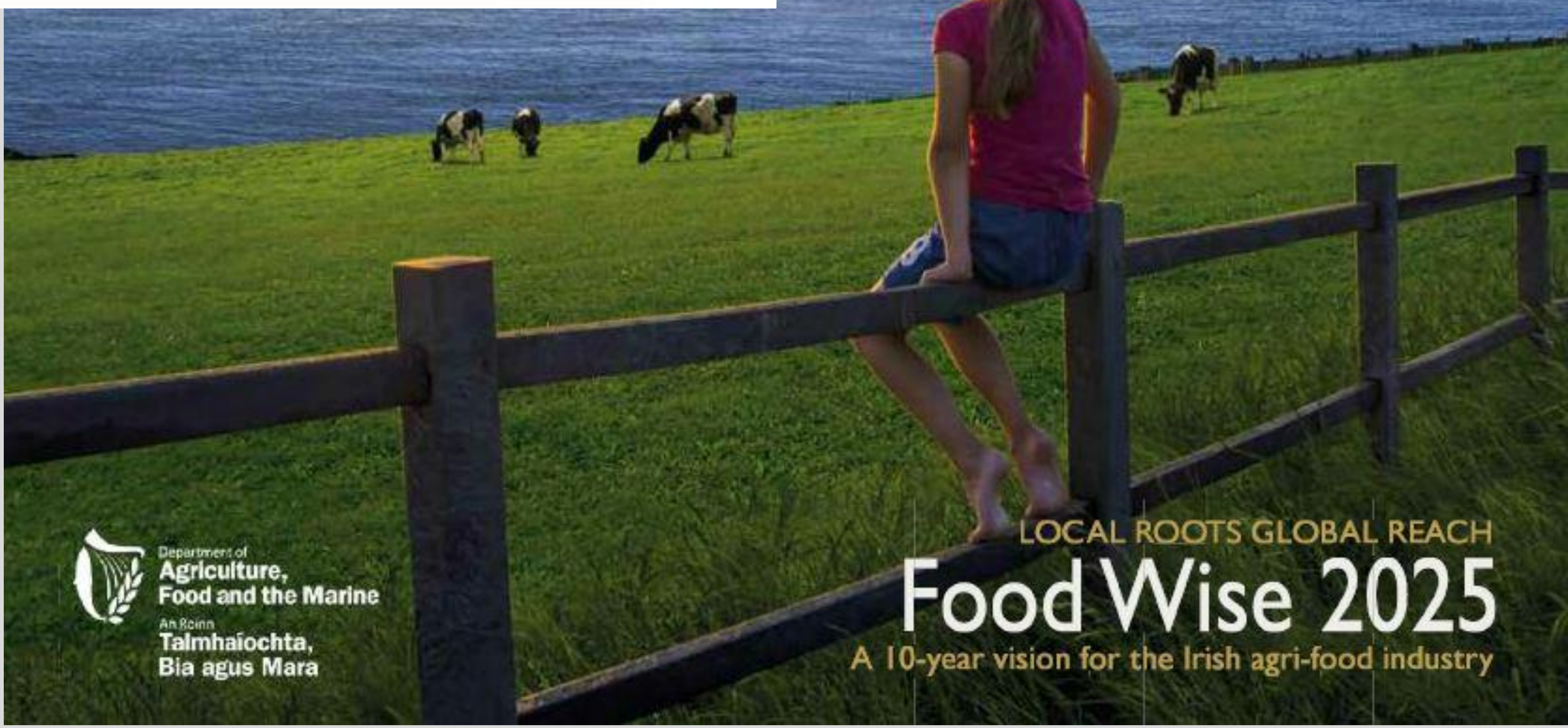
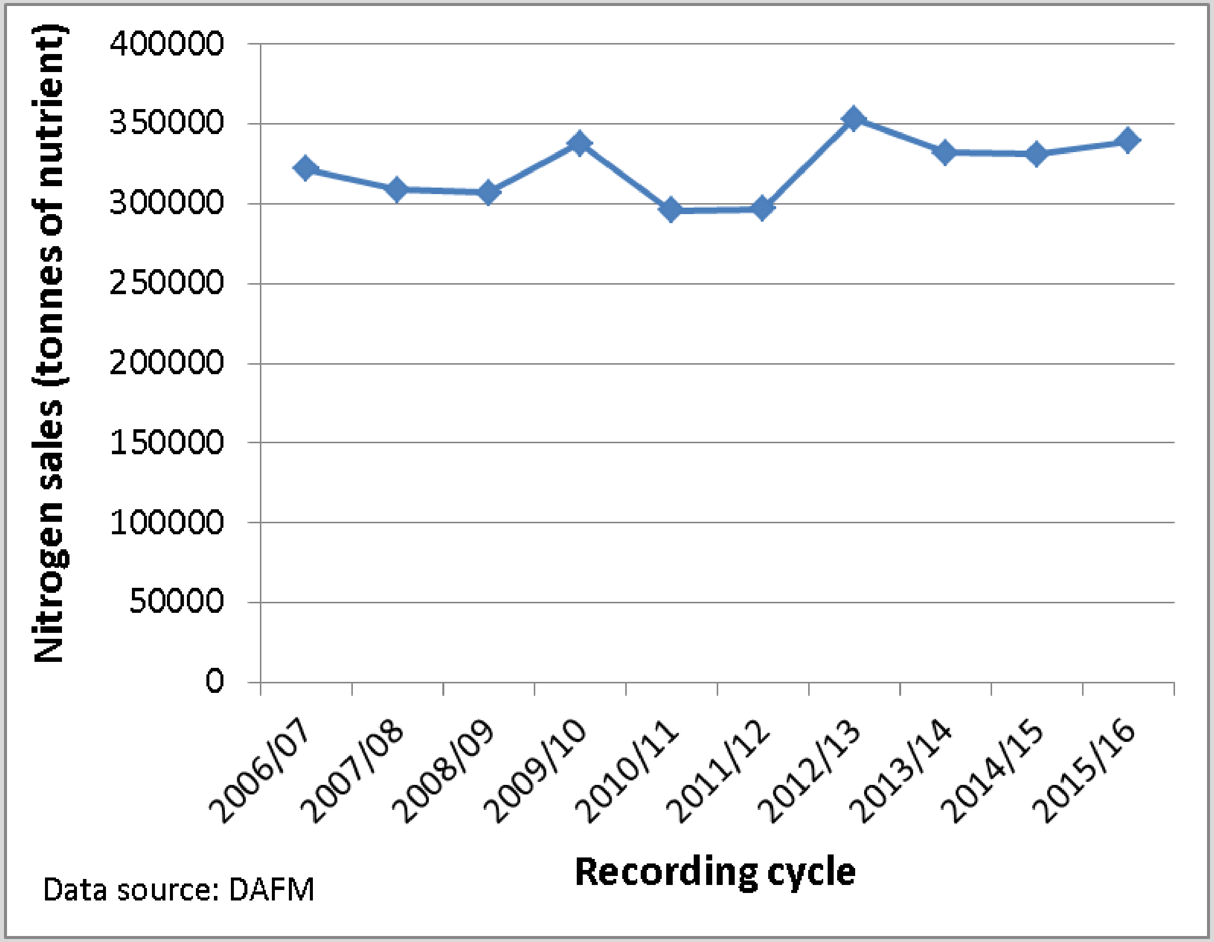
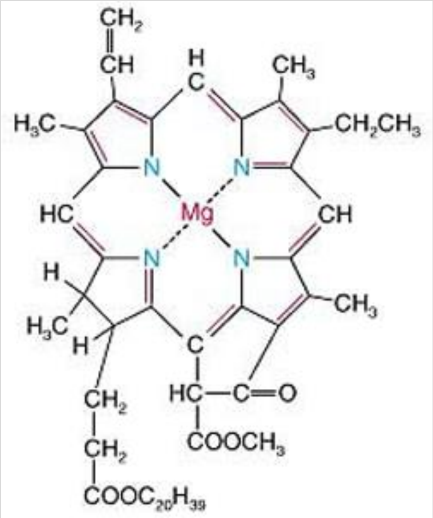

Exports
20,000
16,000
12,000
8,000
€ million
€19bn
2007-2009
2012-2014 Baseline
2025


Department of
Agriculture,
Food and the Marine
An Roinn
Talmhaíochta,
Bia agus Mara
LOCAL ROOTS GLOBAL REACH
Food Wise 2025
A 10-year vision for the Irish agri-food industry

Nitrogen is a cornerstone input in agriculture

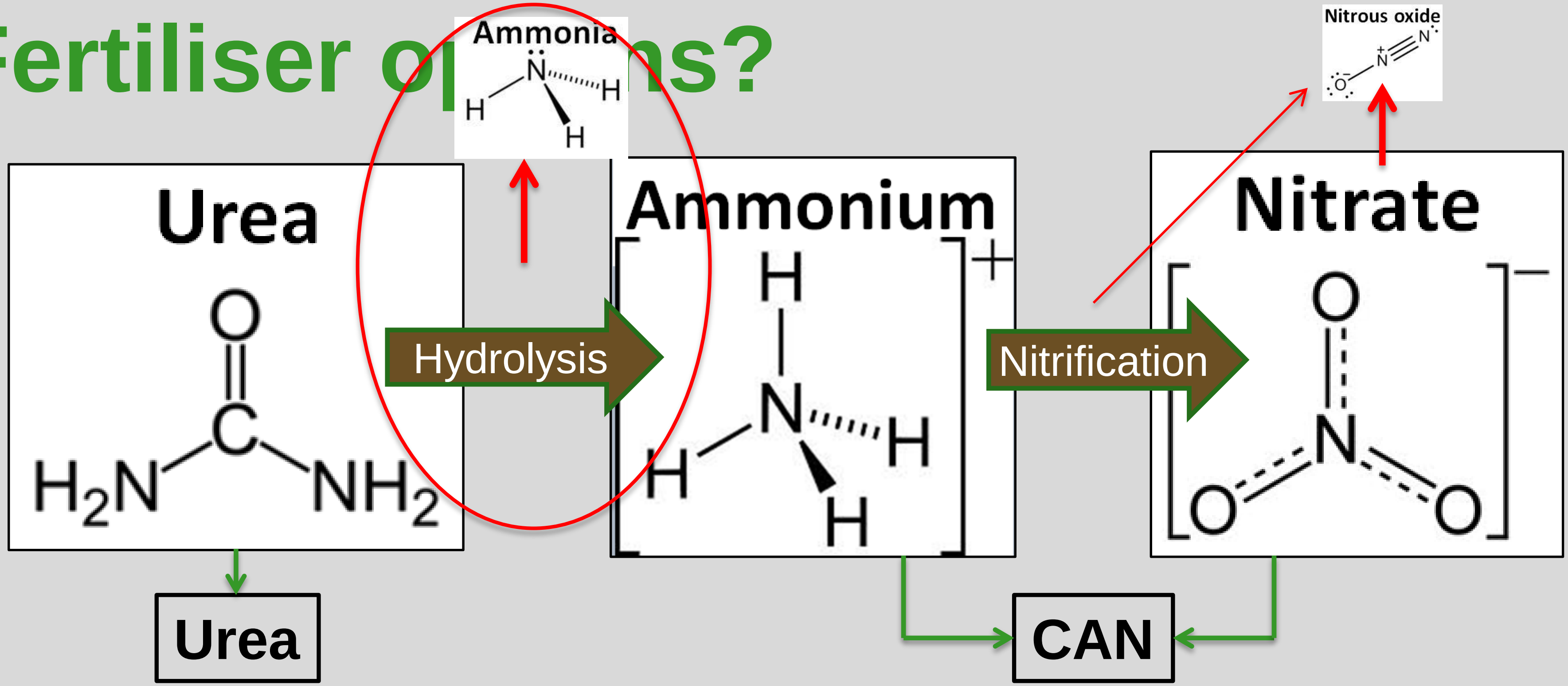




How can we apply N in Ireland while balancing the challenges of:

- Yield
- Efficiency
- Ammonia
- Greenhouse gas
- Leaching
- Cost

Fertiliser options?



- <u>Protected urea?</u>

Protected from ammonia loss by an active ingredient such as *N*-(n-butyl) thiophosphoric triamide (NBPT)

Fertiliser treatments tested

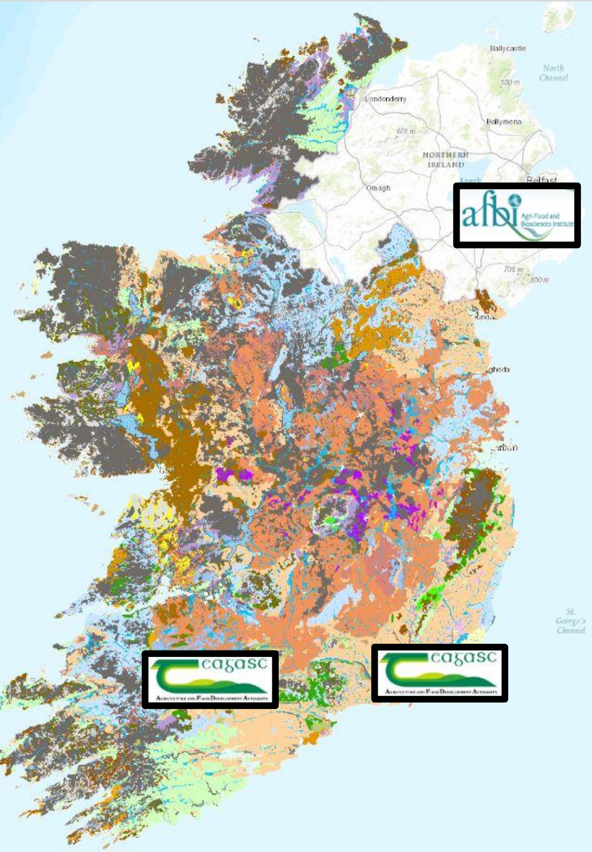
@ 100, 200, 300, 400, 500 kg N/ha/year

- Calcium Ammonium Nitrate (CAN)
- Urea
- Urea + NBPT

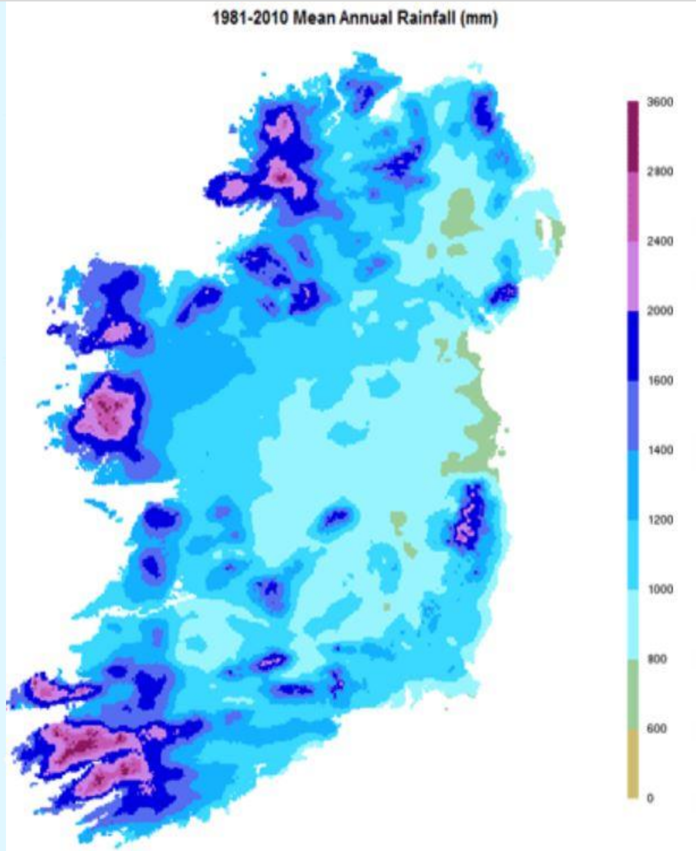
@ 200 kg N/ha/year

- Urea + DCD
- Urea + DCD +NBPT

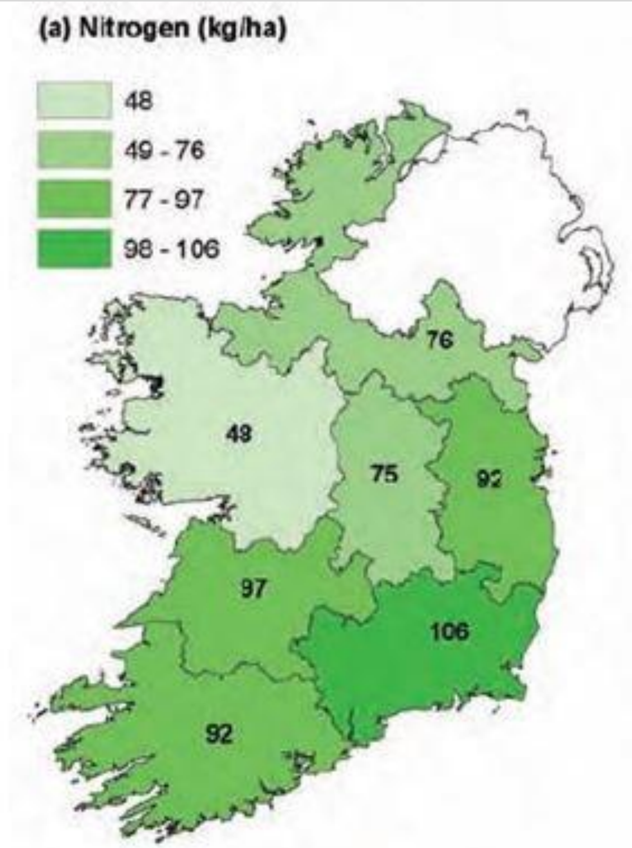
Fertiliser applied in 5 equal split applications during the year



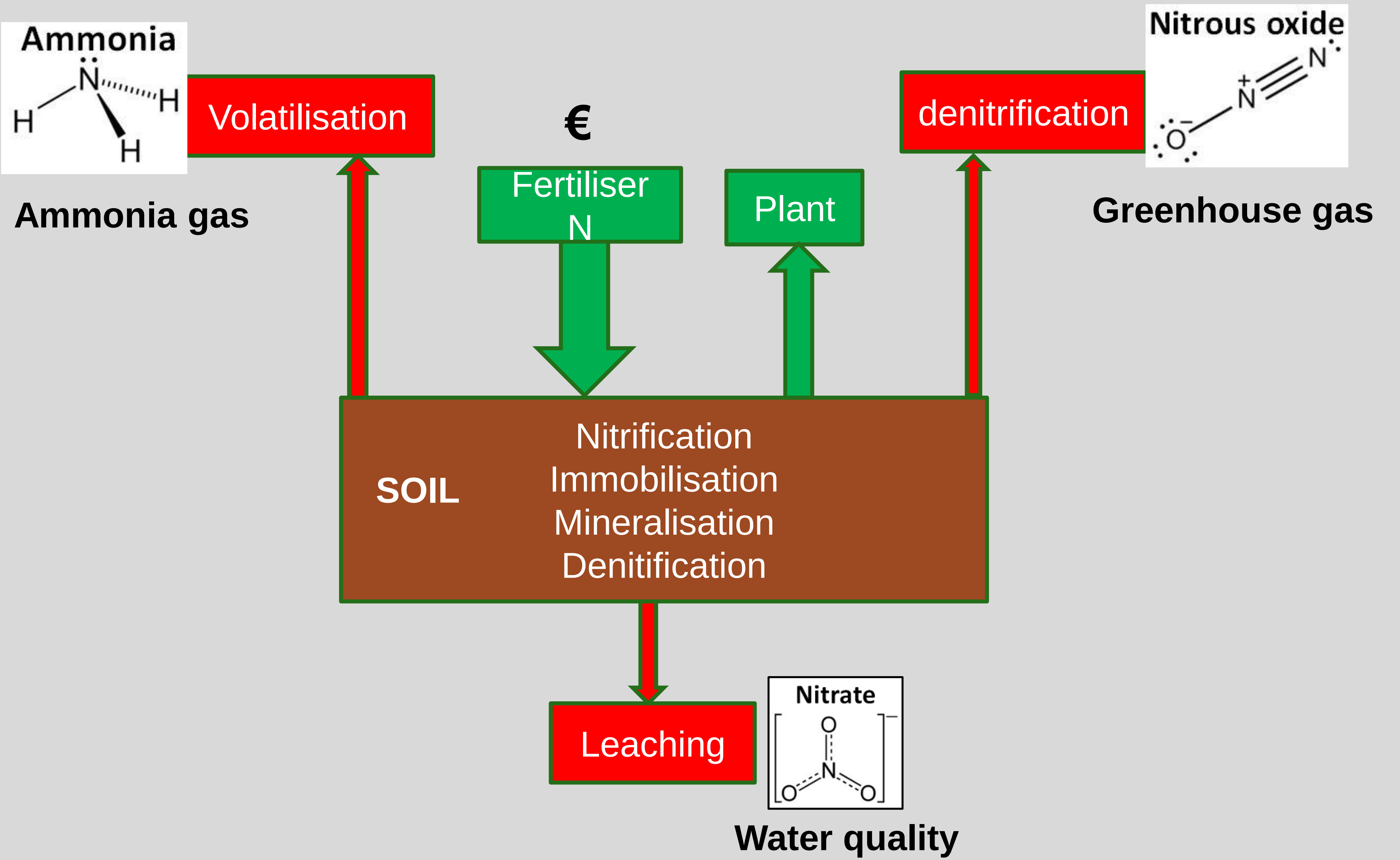
Soils



Precipitation



N use (2008 Fertiliser Use Survey)



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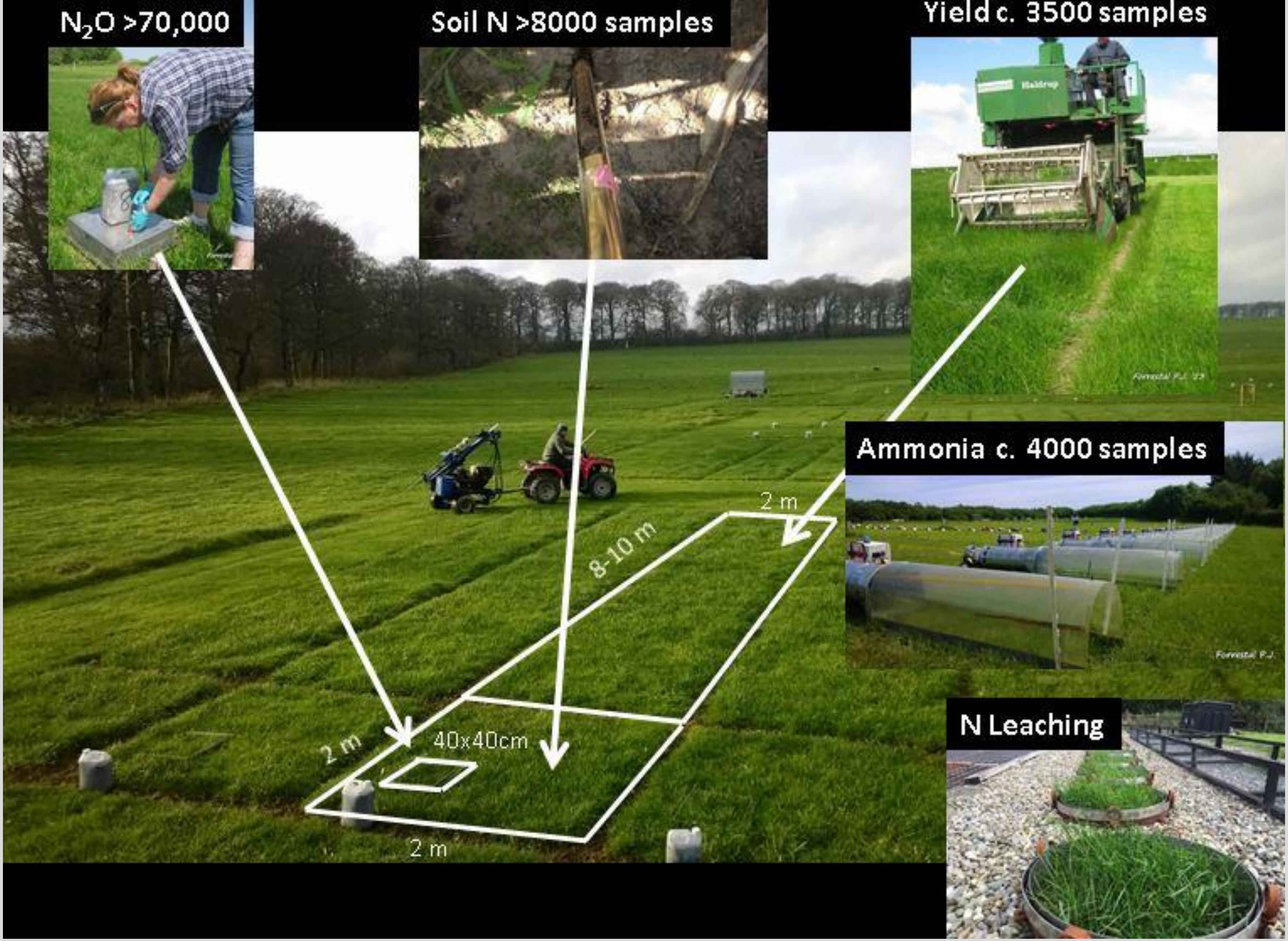
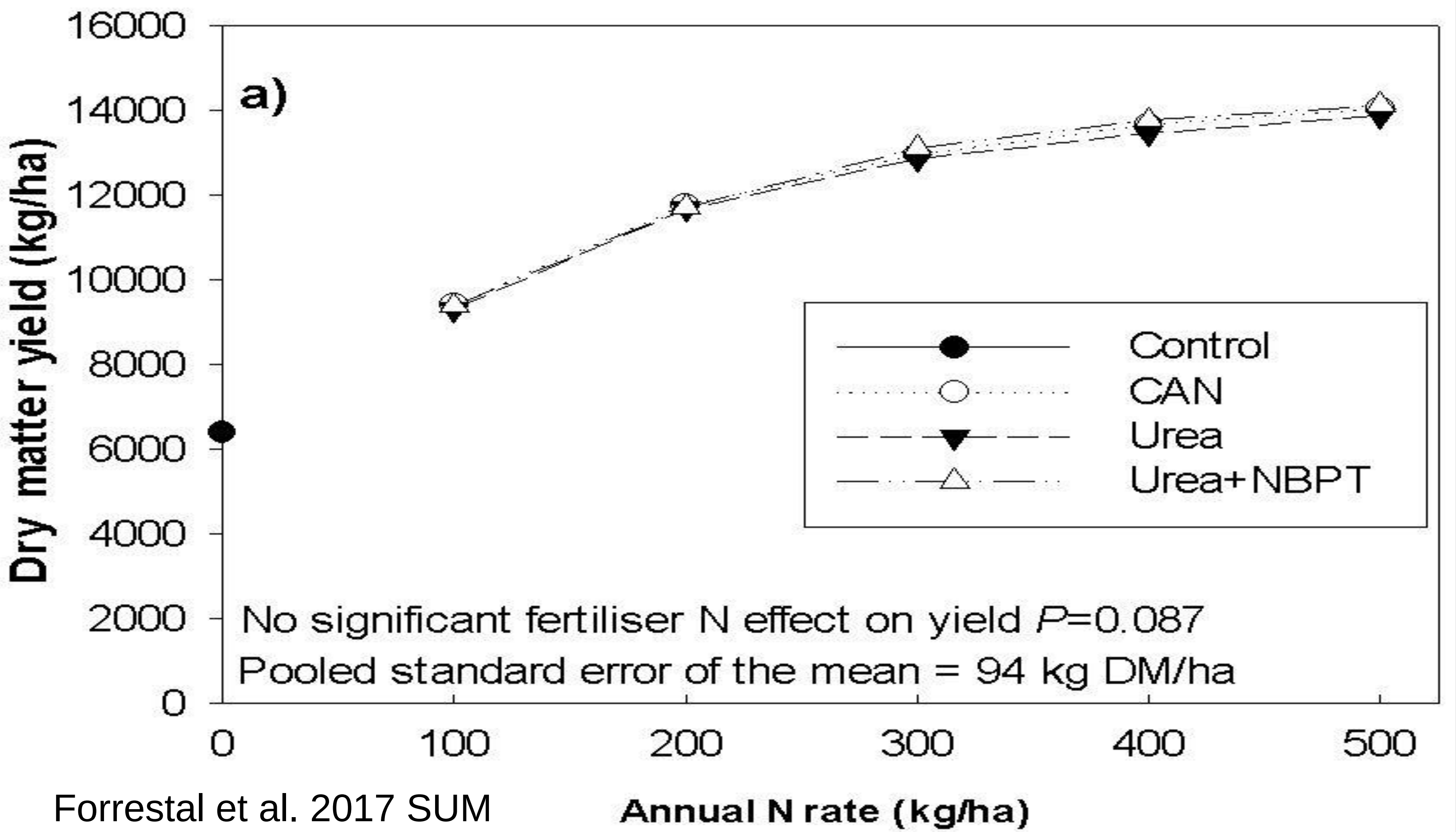


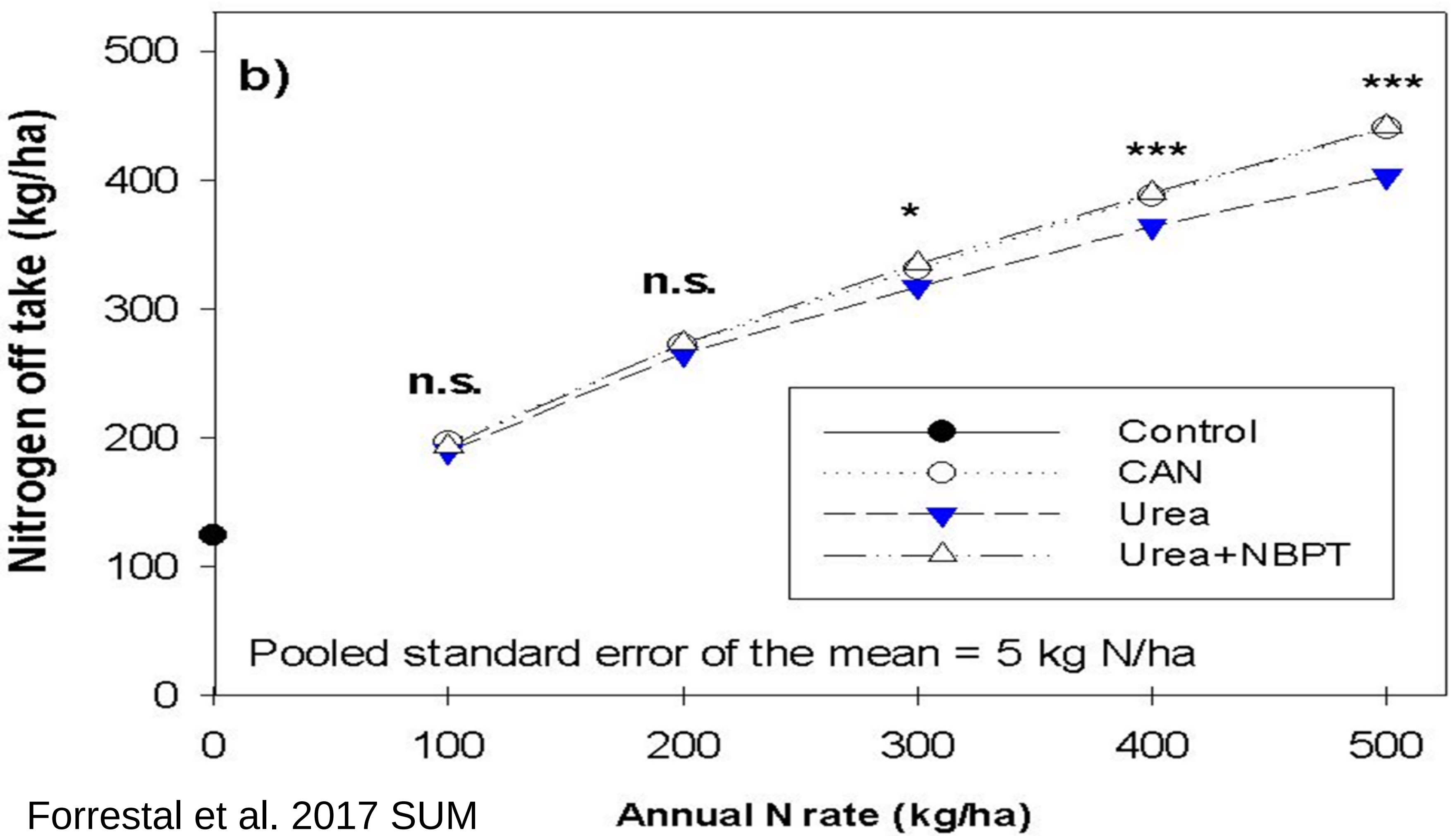
N2O >70,000
Soil N >8000 samples
Yield c. 3500 samples
Ammonia c. 4000 samples
N Leaching
2 m
8-10 m
2 m
40x40cm
2 m

Yield? CAN, Urea, Urea+NBPT
Six site-years 30 N applications



Forrestal et al. 2017 SUM

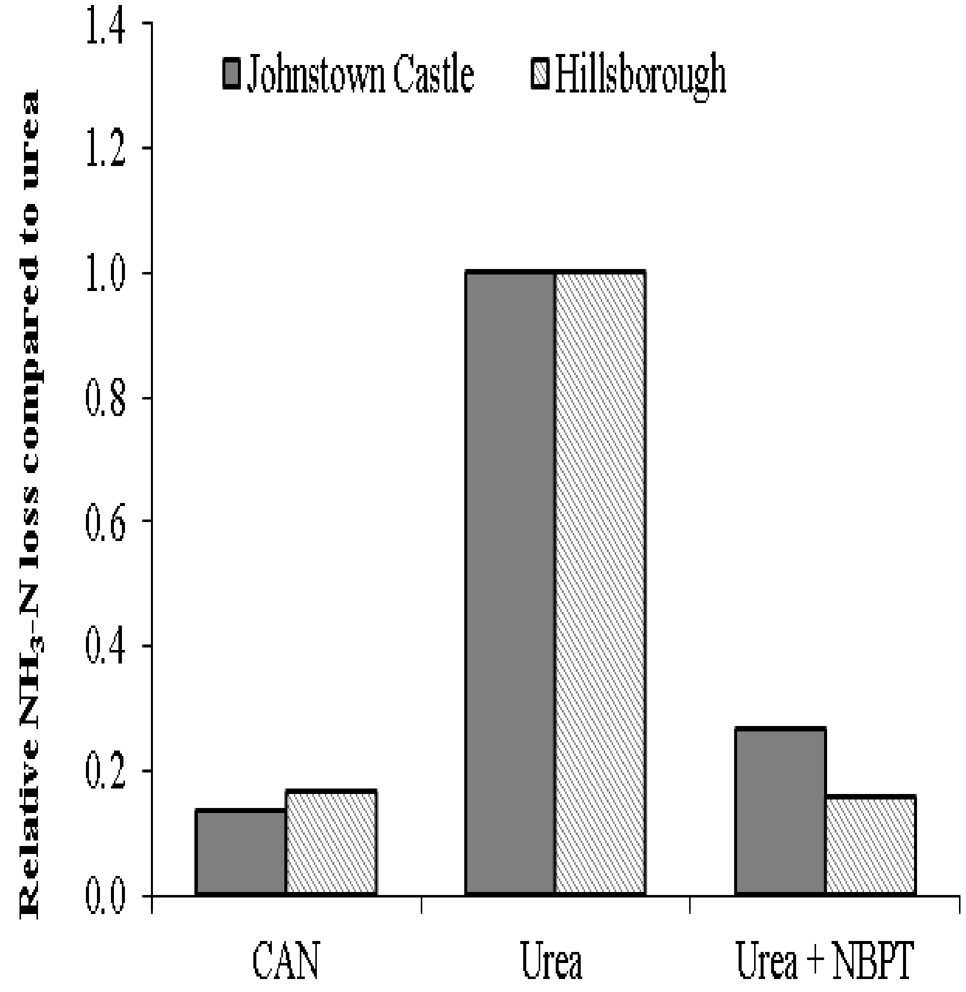
N recovery efficiency?
CAN vs Urea vs Urea+NBPT



Forrestal et al. 2017 SUM

Ammonia (NH_3): a nitrogen gas loss example sources

Ammonia (NH_3)



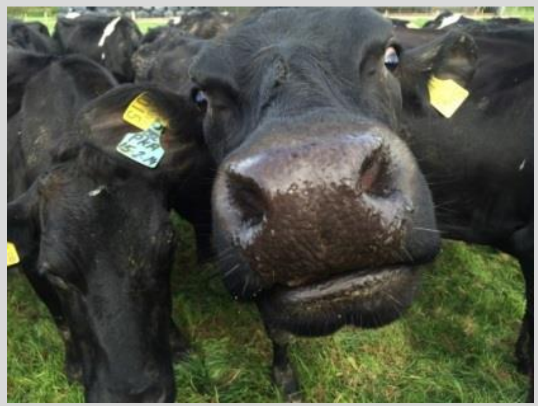
Adapted from Forrestal et al. (2016)

- Urea highest ammonia loss
- NBPT reduced loss by 78.5% on average (n=10)
- CAN and urea+NBPT not significantly different

Greenhouse gas nitrous oxide

Carbon dioxide
e.g. engines burning diesel

Methane
e.g. cows



x 25 CO_2

Nitrous oxide
e.g. fertiliser

x 298 CO_2

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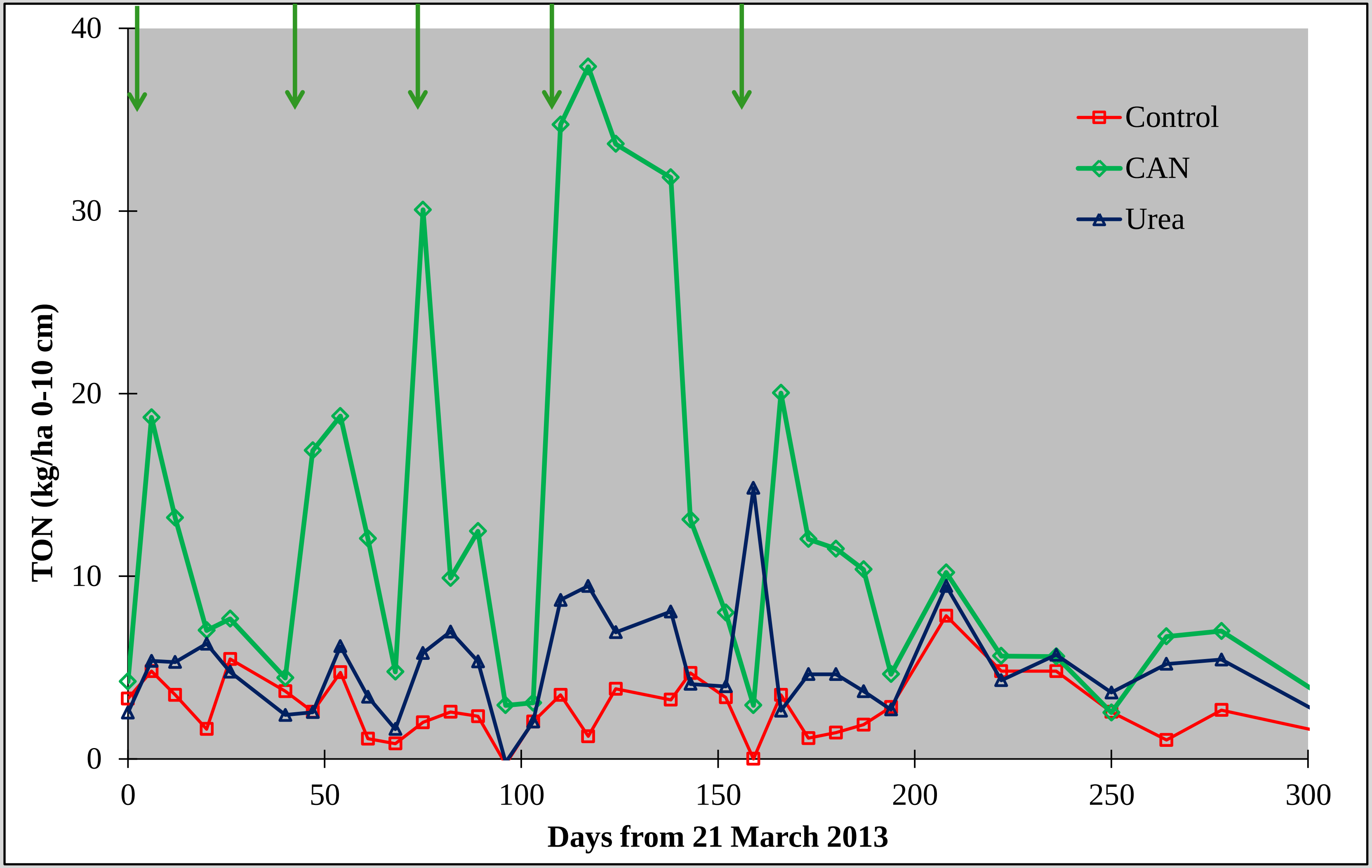
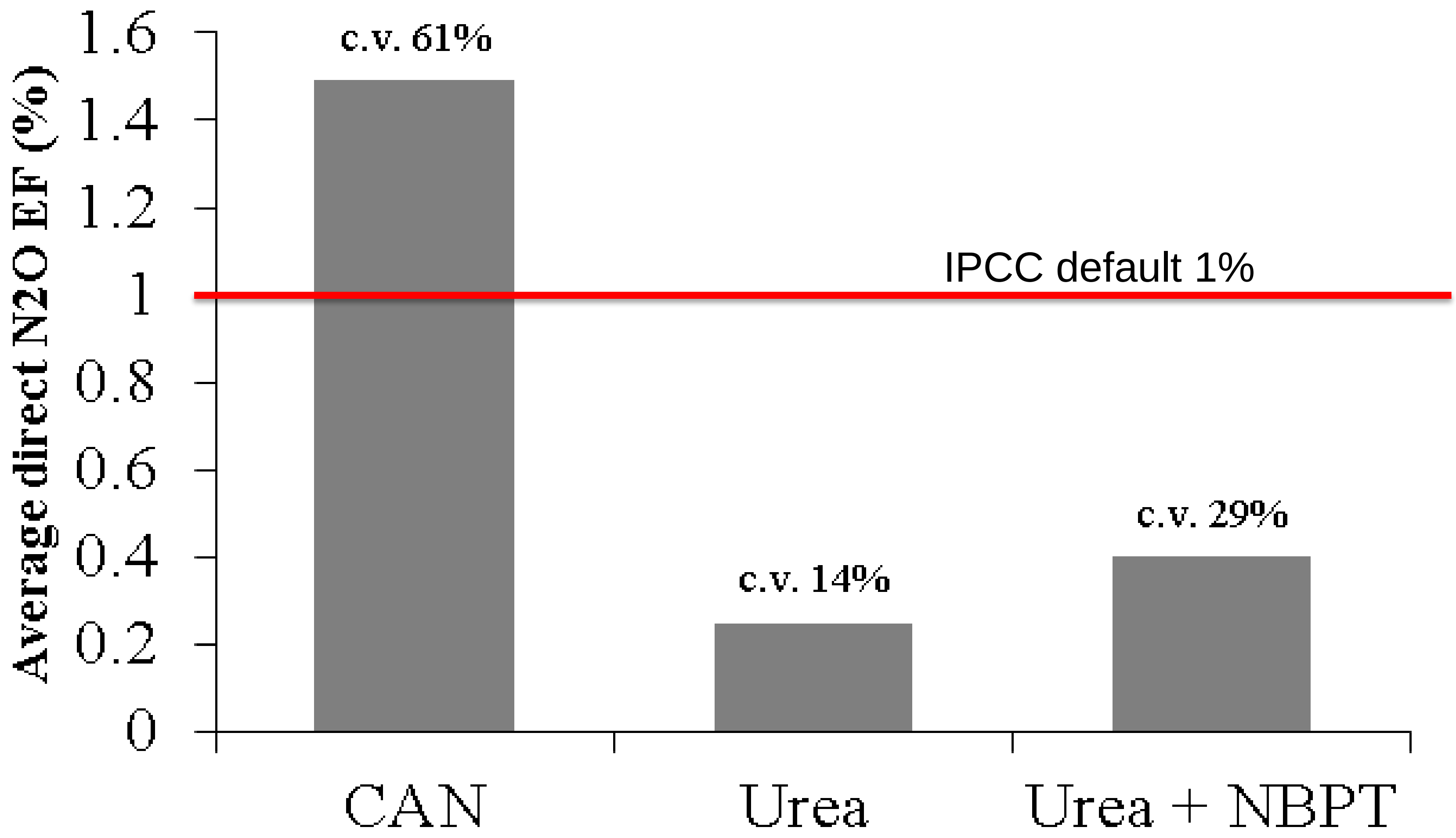
Priming the soil for denitrification when nitrate is added

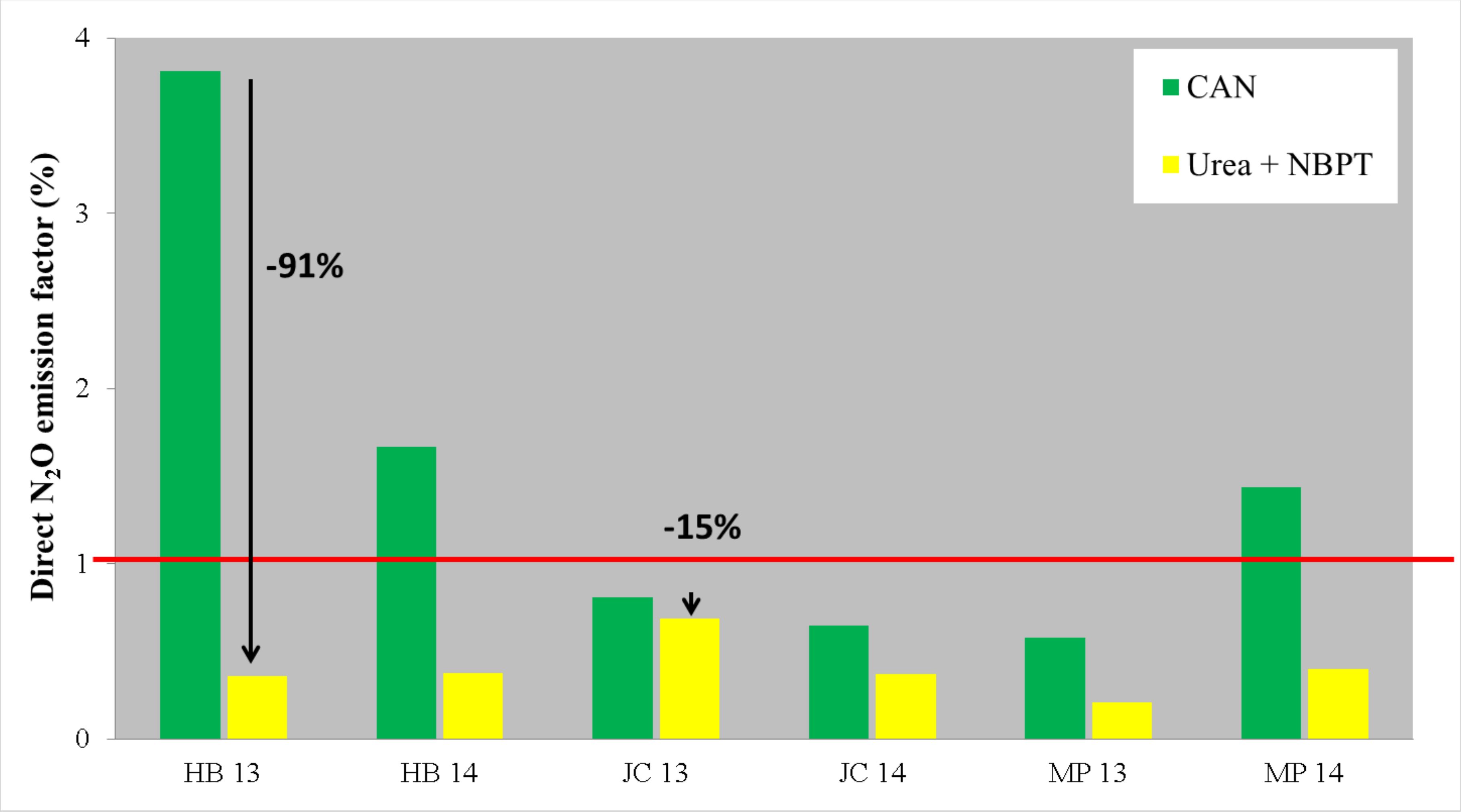


Average direct nitrous oxide (N_2O) emission



Adapted from Harty et al., 2016)

Nitrous oxide: CAN highly variable



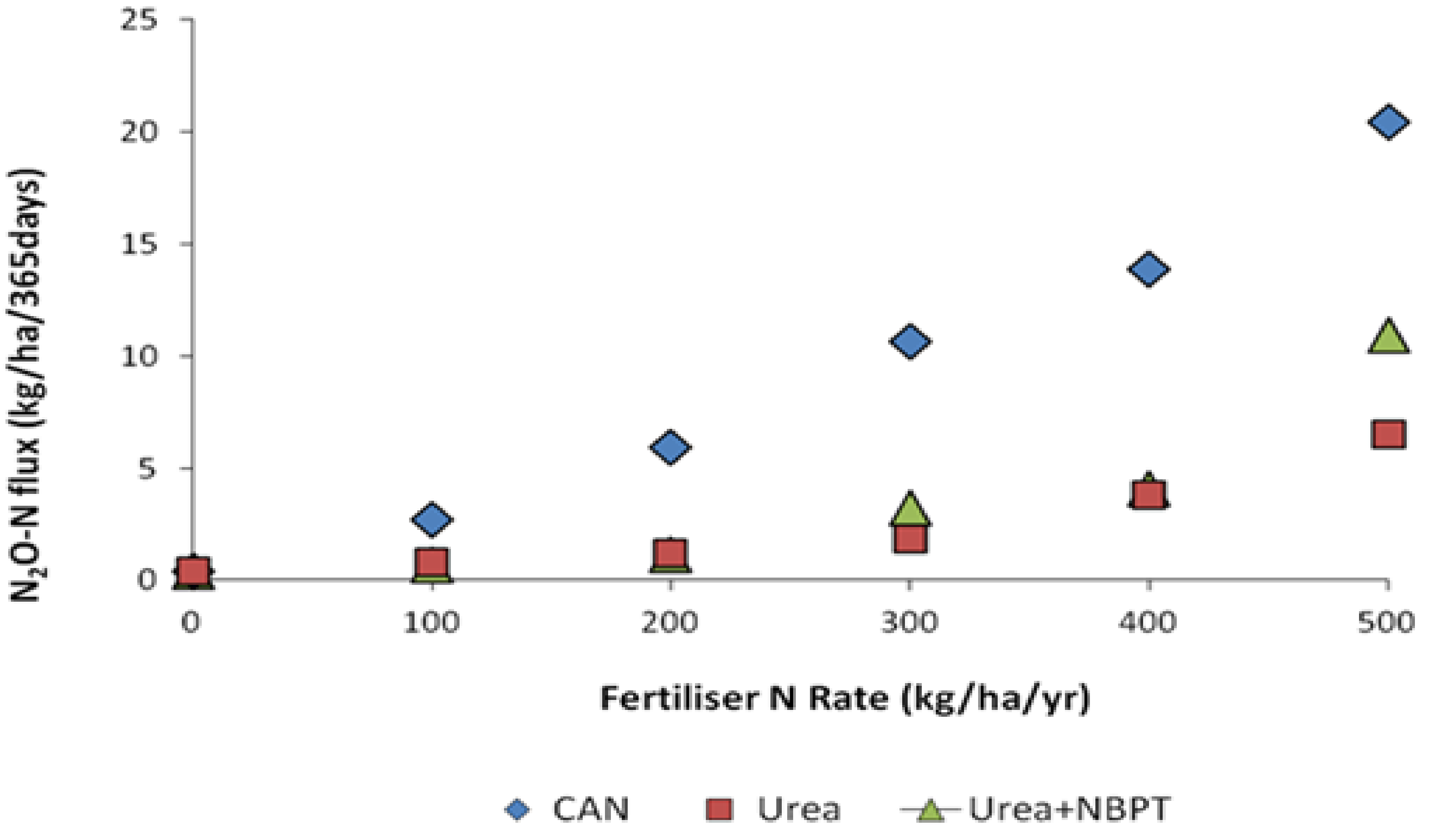
Imperfect drainage
High clay

Moderate – well drained

Well drained

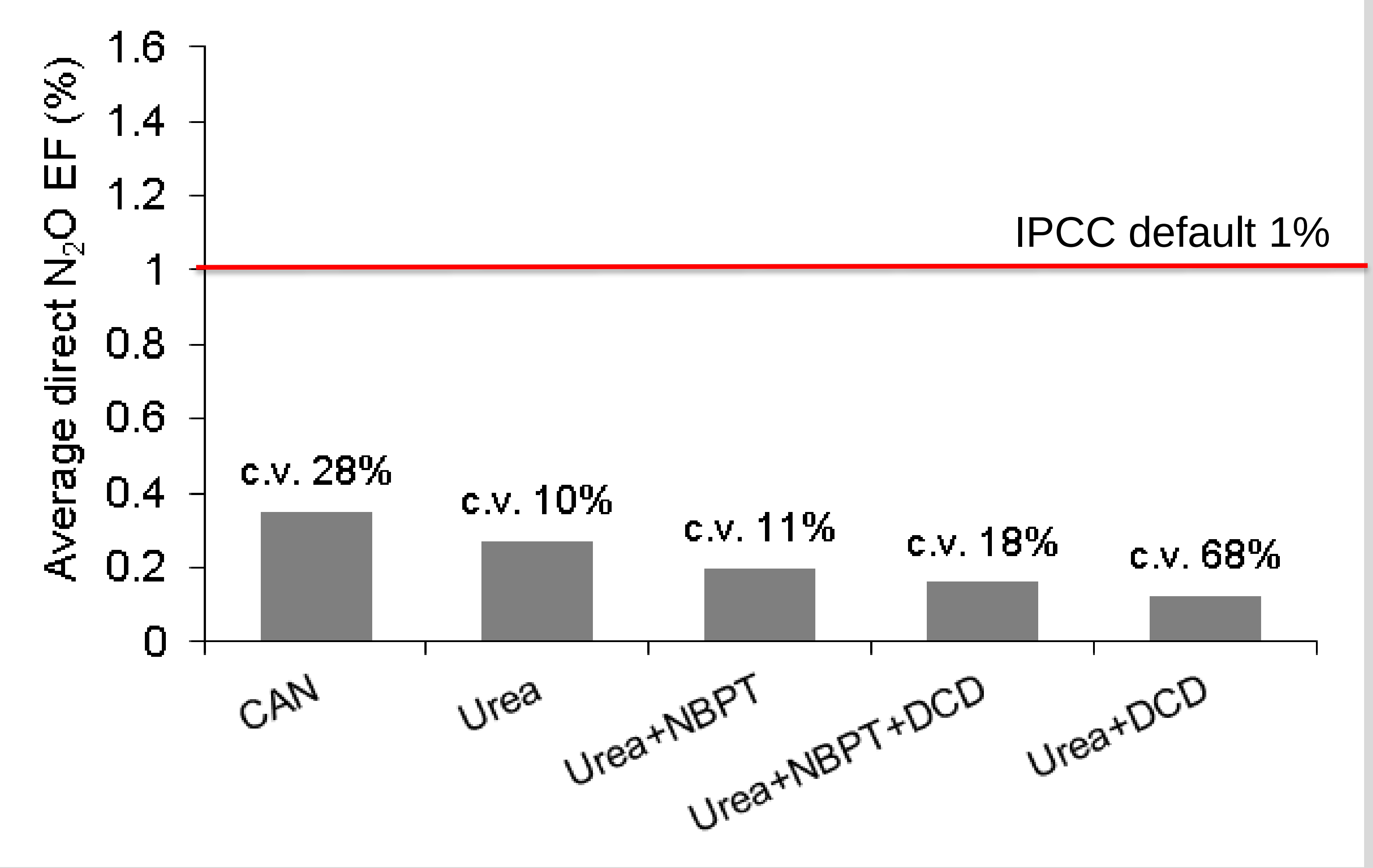
Adapted from Harty et al., 2016)

Importance of N rate in emissions



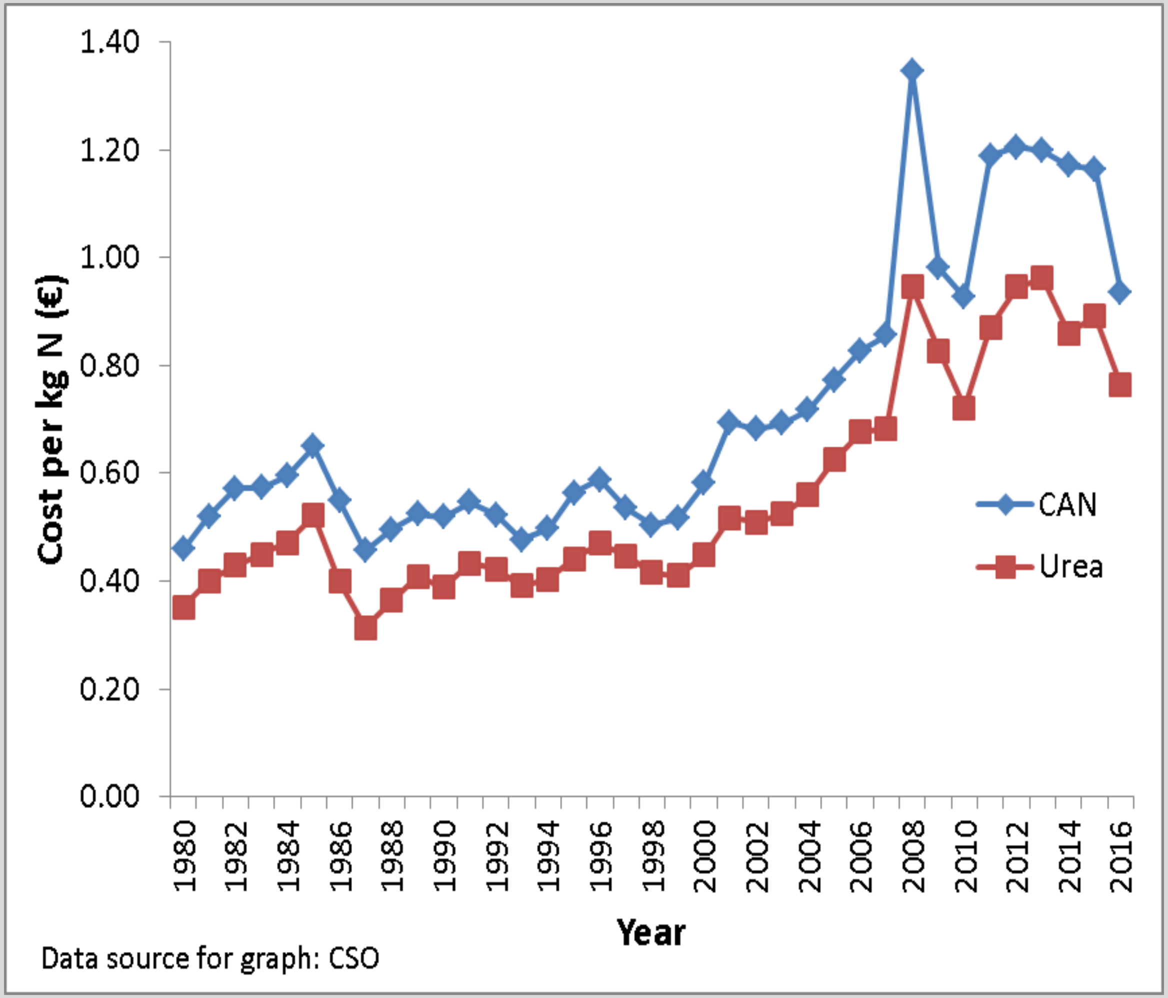
Adapted from Carolan et al. (in prep)

Contrasts with spring barley where direct N_2O emissions were similar for all fertilisers



Adapted from Roche et al. (2016)

Cost?



1980-2016

Urea 22% less expensive than CAN on average

Protected urea cost? Recent entrant, 5% less than CAN often quoted – varies but scope to be competitive with CAN

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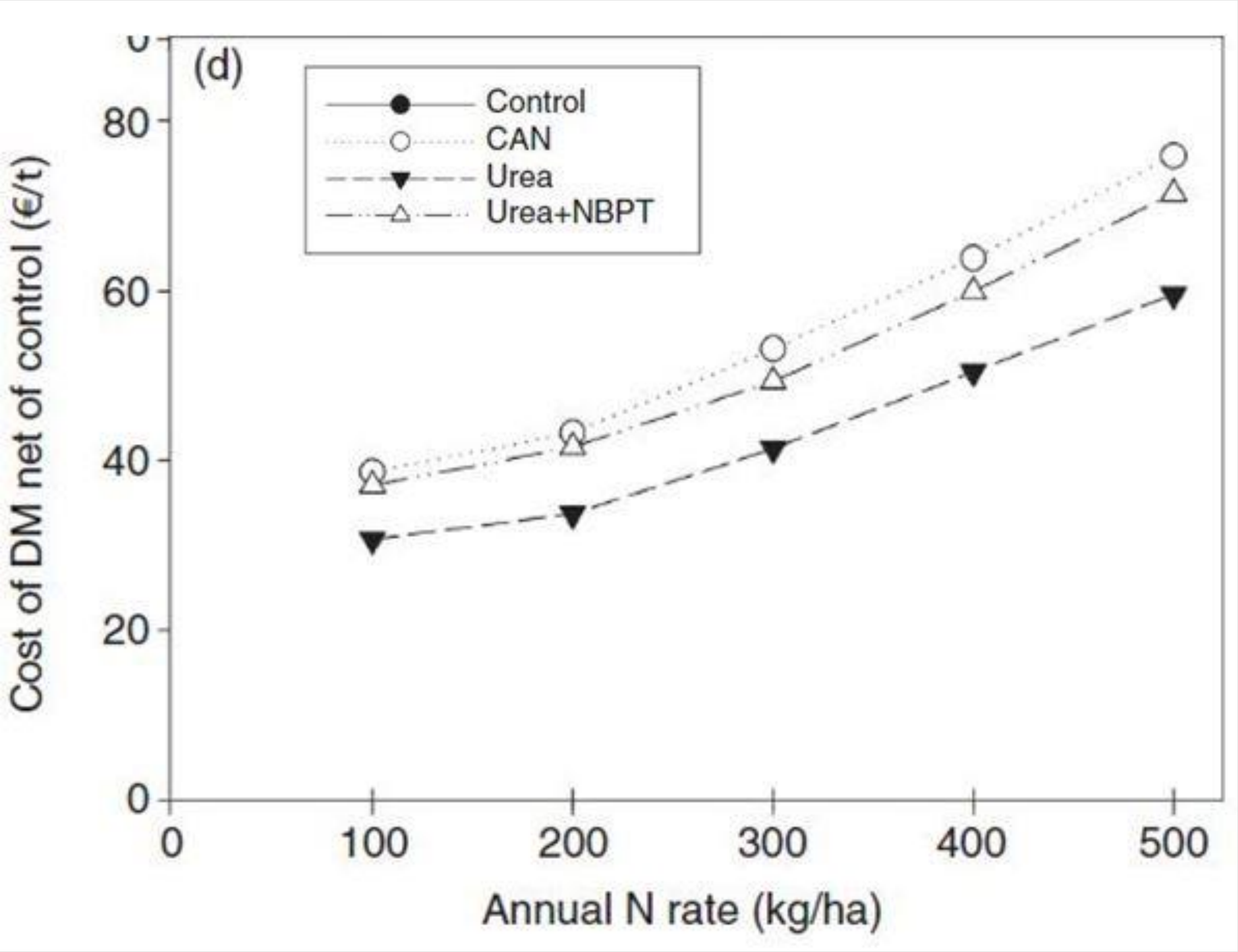
Cost



Forrestal et al. (2017)

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Long-term fertiliser N type testing

N_2O Measurements

Sustainable Nitrogen Fertiliser
Use & Disaggregated
Emissions of Nitrogen

3 sites: Hillsborough (HB), Johnstown Castle (JC), Moorepark (MP)

3 seasons: Spring, Summer, Autumn

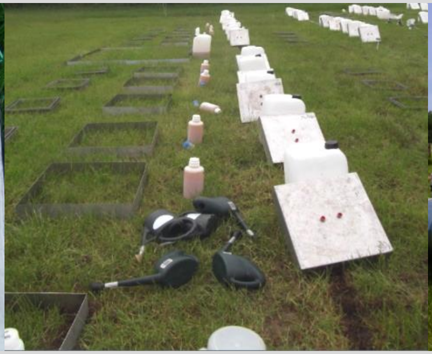
4 treatments: Control, Urine, Dung, Art. Urine

NH_3 Measurements

1 site: Johnstown Castle (JC)

3 seasons: Spring, Summer, Autumn

2 treatments: Urine & Dung



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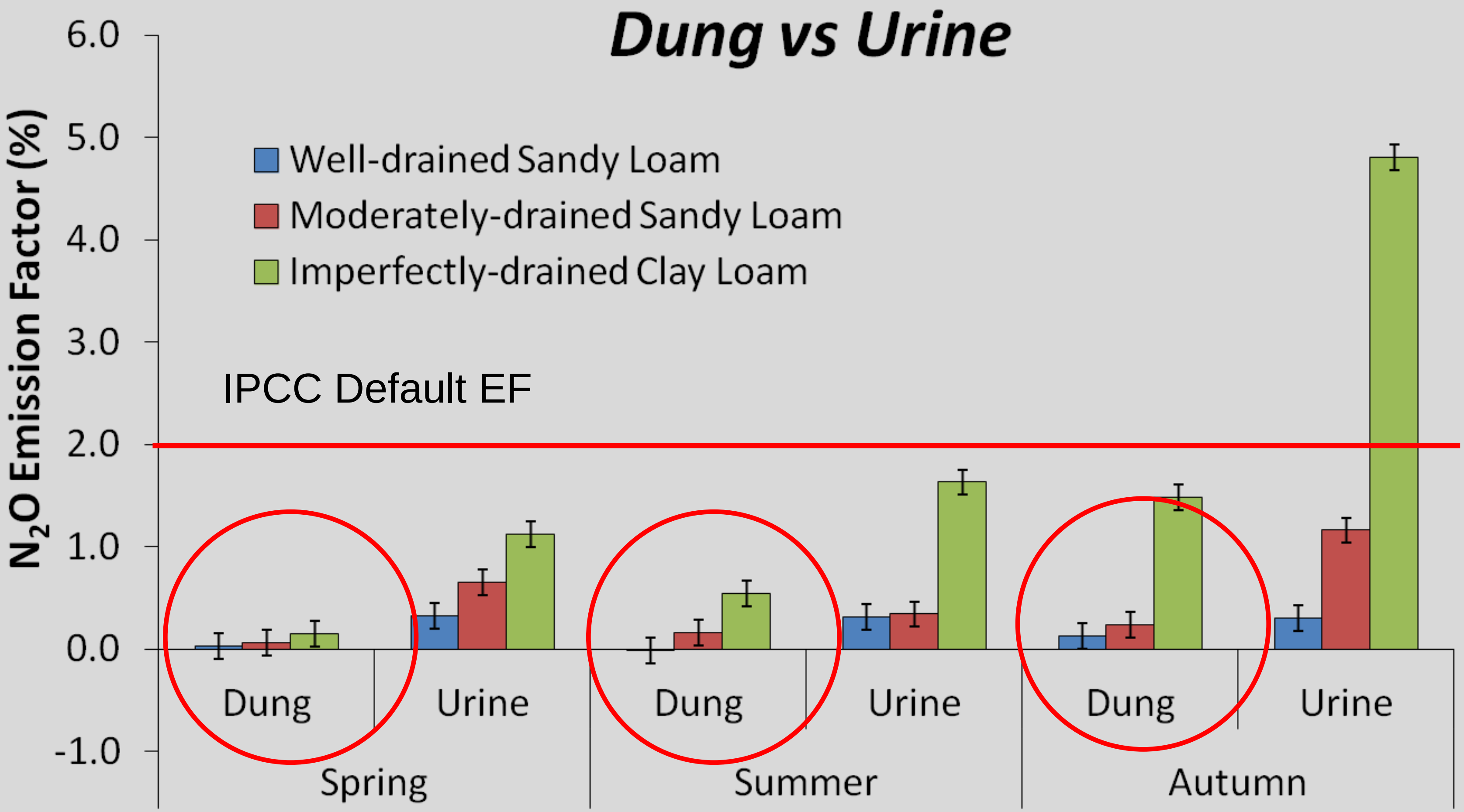

Adapted from Krol *et al*. (2016)

Papers

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8. Harty, M.A., Forrestal, P.J., Watson, C.J., McGeough, K.L., Carolan, R., Elliot, C., Krol, D.J., Laughlin, R.J., Richards, K.G., and Lanigan, G.J. Reducing nitrous oxide emissions by changing N fertiliser use from calcium ammonium nitrate (CAN) to urea based formulations. 2016. *Science of the Total Environment*. 563-564: 576-586. http://dx.doi.org/10.1016/j.scitotenv.2016.04.120
9. Hyde, B.P., Forrestal, P.J., Jahangir, M.M.R., Ryan, M., Fanning, A.F., Carton, O.T., Lanigan, G.J. and Richards, K.G. 2016. The interactive effects of fertiliser nitrogen with dung and urine on nitrous oxide emissions in grassland. *Irish Journal of Agriculture and Food Research*. 55: 1-9. doi: 10.1515/ijafr-2016-0001
10. Forrestal, P.J., Harty, M., Carolan, R., Lanigan, G.J., Watson, C.J., Laughlin, R.J., McNeill, G., Chambers, B. and Richards, K.G. 2016. Ammonia emissions from urea, stabilised urea and calcium ammonium nitrate: insights into loss abatement in temperate grassland. *Soil Use and Management*. 32: 92-100. doi: 10.1111/sum.12232
11. Fischer, K., Burchill, W., Lanigan, G.J., Kaupenjohann, M., Chambers, B., Richards, K.G. and Forrestal, P.J. 2016. Ammonia emissions from cattle dung, urine and urine with dicyandiamide. *Soil Use and Management*. 32: 83-91. doi: 10.1111/sum.12203
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Conclusion

- A relatively simple substitution of CAN with protected urea in grassland could offset the GHG emissions of thousands of dairy cows without substantially increasing farm costs

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&

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