Stakeholder Meeting, Dublin, 10 June 2016

AGRI-I
Agricultural Greenhouse Gas Research Initiative - Ireland

Sustainable Nitrogen Fertiliser Use & Disaggregated Emissions of Nitrogen

Fertiliser formulation for the reduction of gaseous emissions

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Department of Agriculture, Environment and Rural Affairs
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Department of Agriculture, Food and the Marine
An Roinn Talmhaíochta, Bia agus Mara

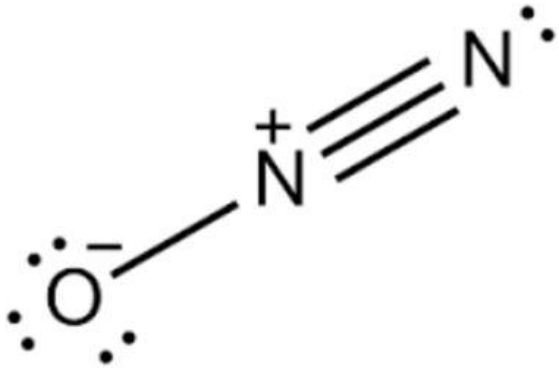
teagasc
Agriculture and Food Development Authority

Fertiliser nitrogen (N) affects gaseous N emissions

Greenhouse gas (GHG)

Nitrous oxide (N_2O)

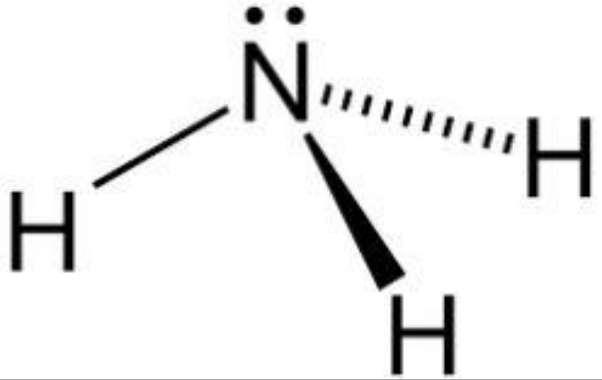
1. How much are we losing?
2. What can we do about it?



Gaseous N air pollutant

Ammonia (NH_3)

1. How much are we losing?
2. What can we do about it?



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1. How much are we losing?
2. What can we do about it?
3. What is the impact on yield and efficiency?

Sustainable Nitrogen Fertiliser Use & Disaggregated Emissions of Nitrogen

Grassland
6 site-years
Annual N rates 0 – 500 kg/ha
Suite of fertiliser N formulations

Spring barley
8 site-years
Annual N rates 0 – 200 kg/ha
Suite of fertiliser N formulations

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Forrestal P.J.


Haldrup
Forrestal P.J. '13


Forrestal P.J.


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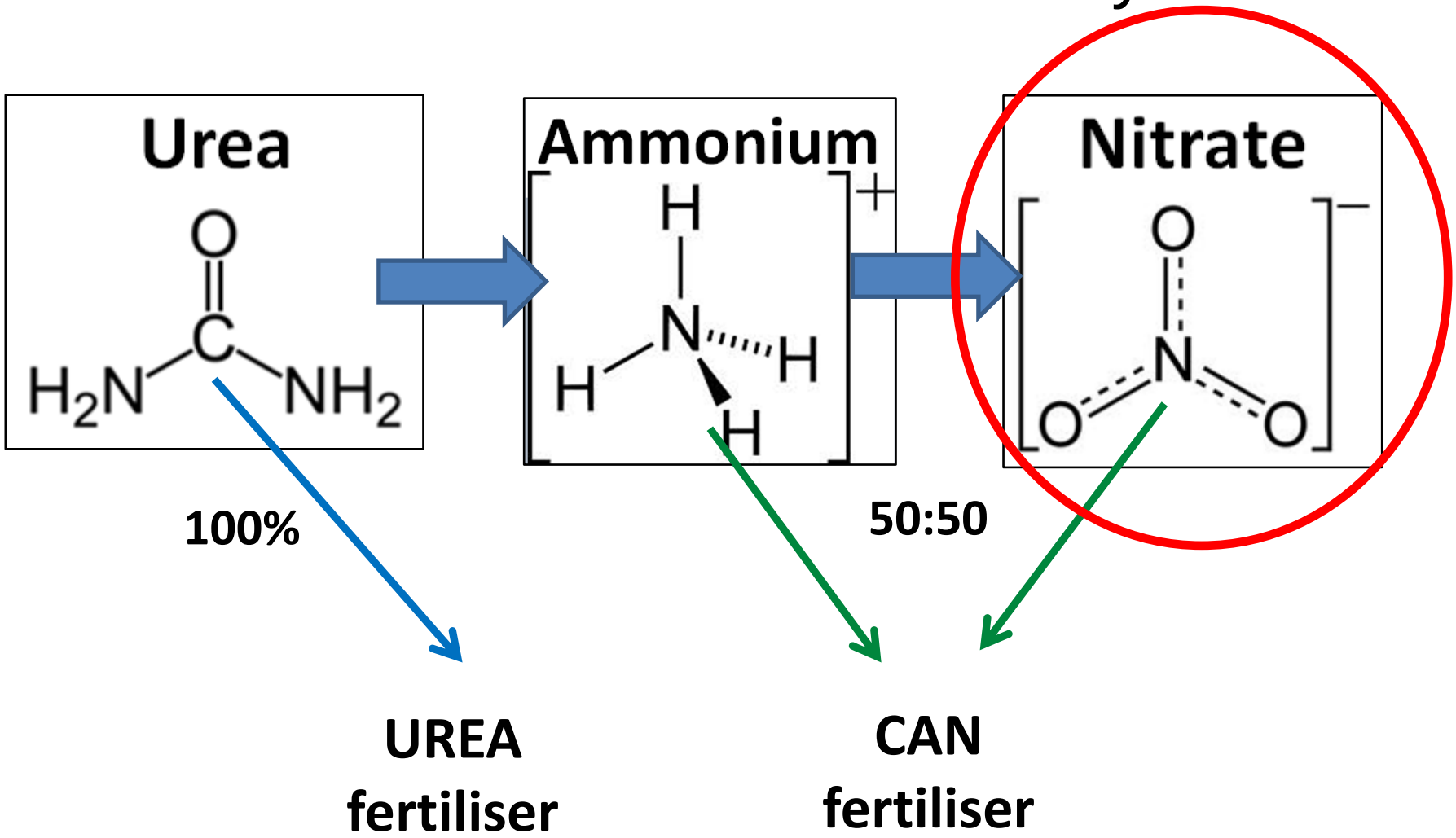
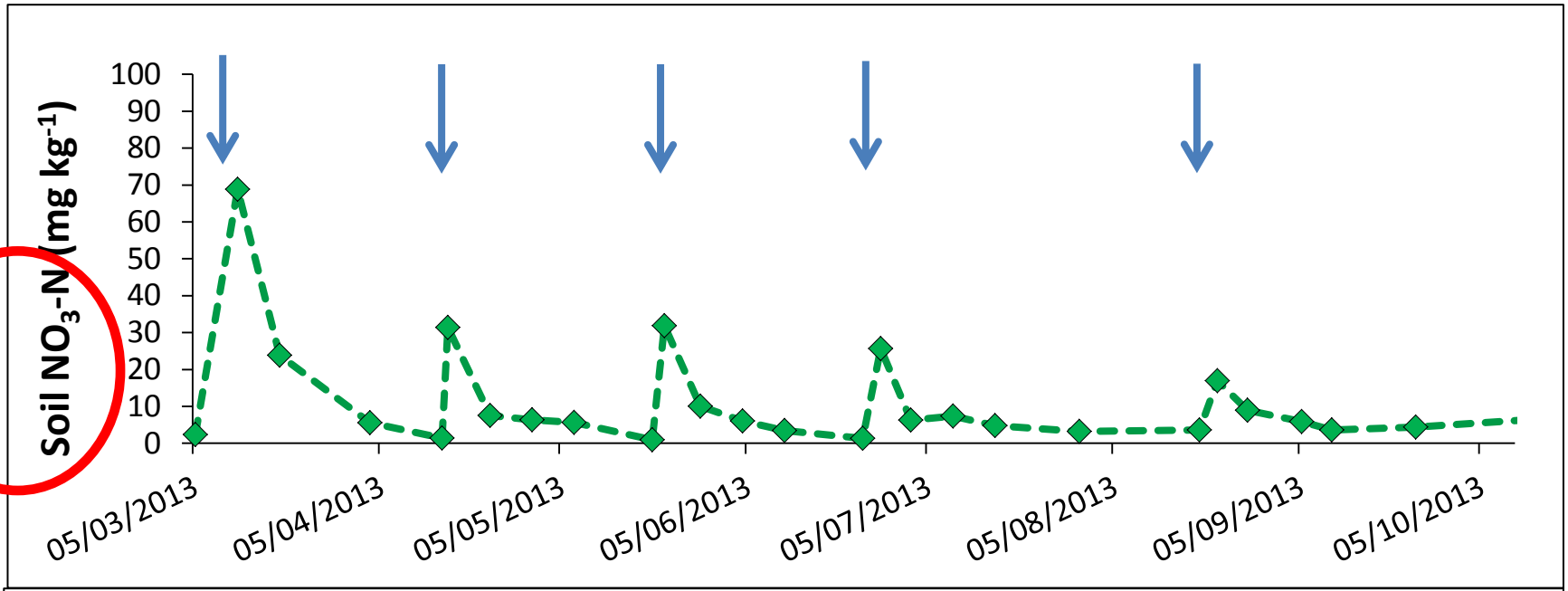
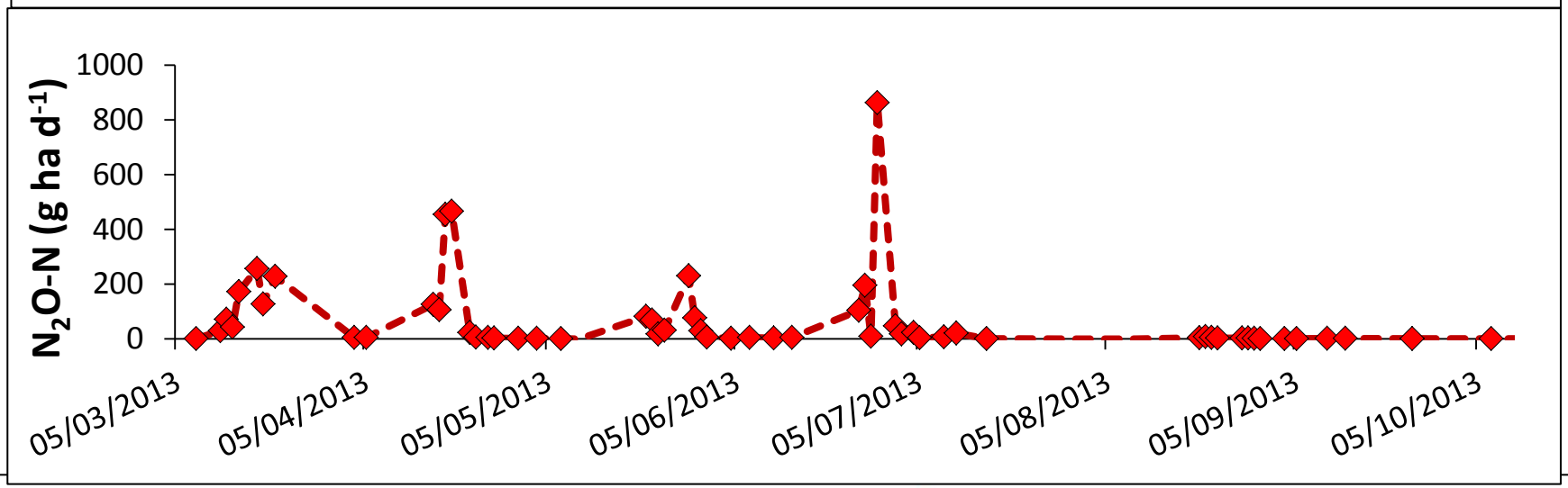
1. How much are we losing?

The main N formulations currently used

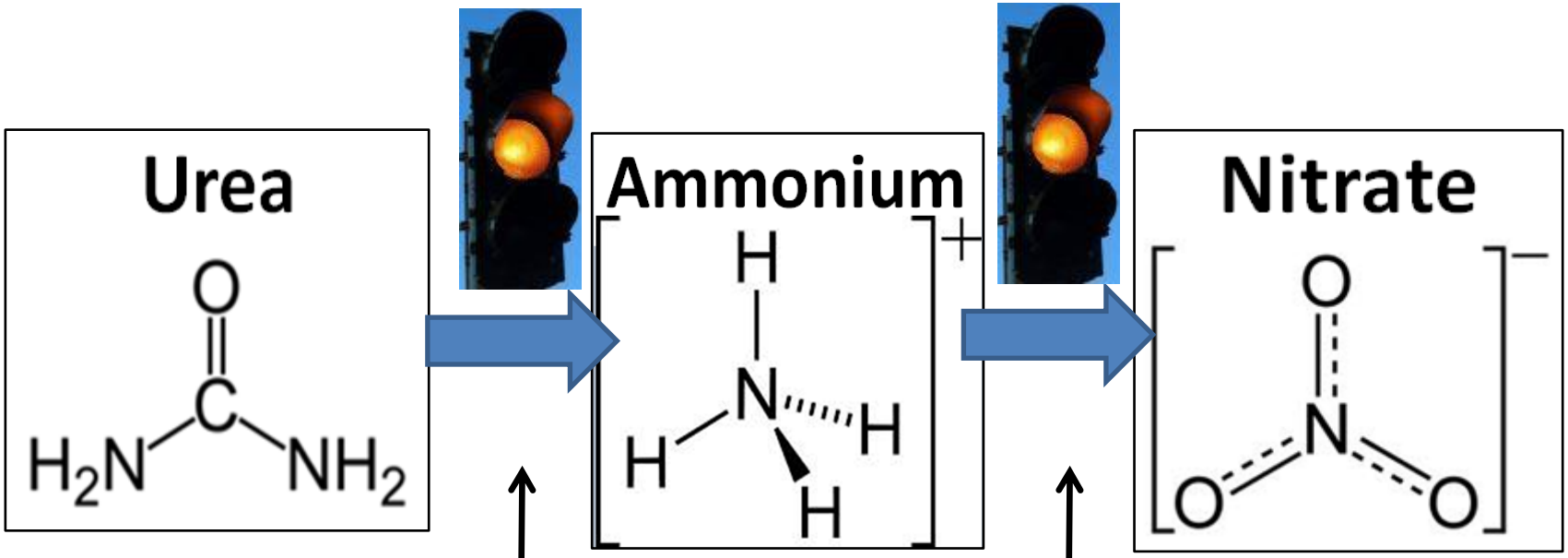


Nitrate links to loss of the GHG N_2O





Stabilising fertiliser N

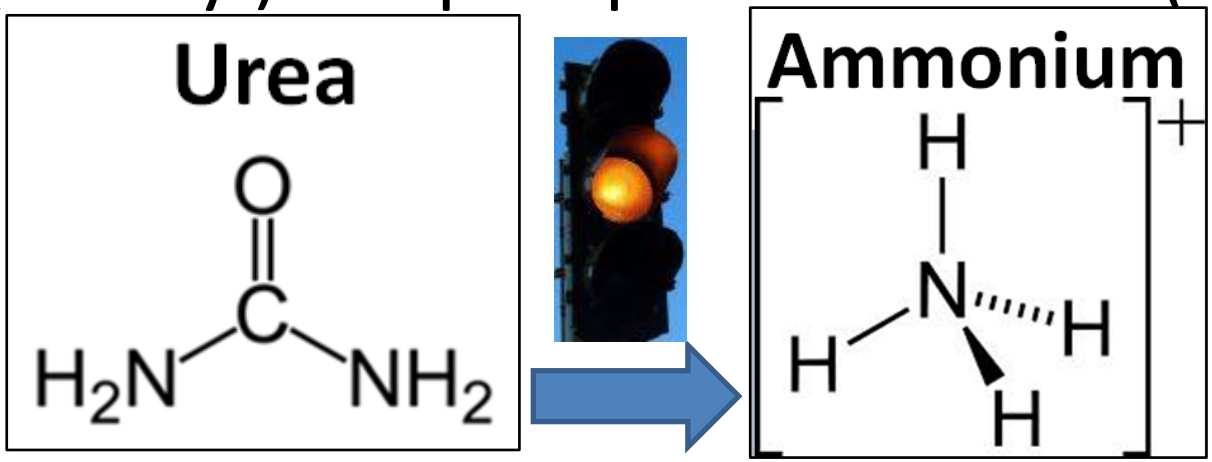


Urease inhibition:
Moderates the rate of urea hydrolysis reducing loss of the gaseous air pollutant NH_3

Nitrification inhibition:
Moderates the rate of NH_4^+ nitrification reducing NO_3^- related losses such as the greenhouse gas N_2O

Urease inhibition

N-(n-butyl) thiophosphoric triamide (NBPT)



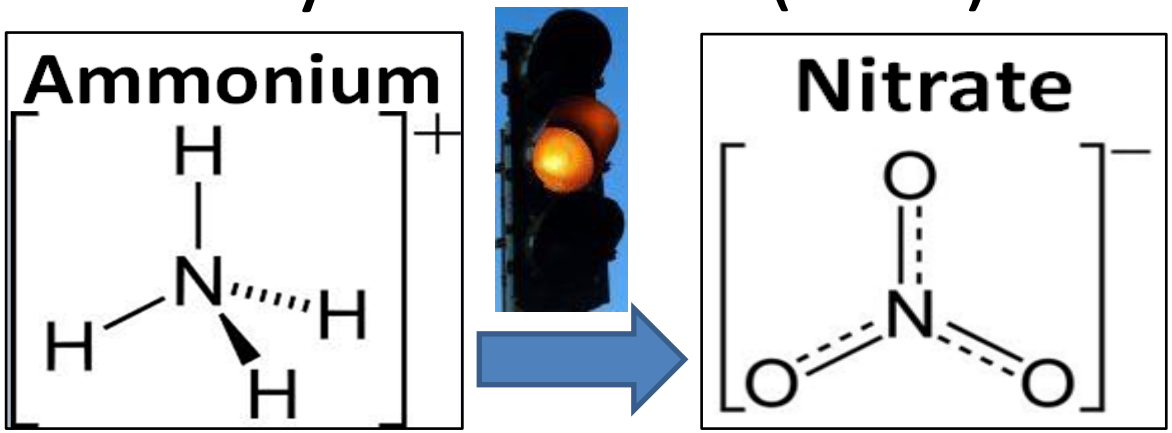
- Most widely used globally (Chien *et al.*, 2009)
- Active ingredient is off patent
- Koch hold patents on AGROTAIN® formulation
- Urea + AGROTAIN® is marketed in Ireland as Koch advanced Nitrogen (KaN) 660 ppm NBPT
- It is this formulation of NBPT which was tested in the current work

AFBI and Teagasc's use of a commercial product in this research does not imply any endorsement or warranty of any quality for any specific purpose, of such a product.

NBPT

- Ammonia loss is a relatively fast process => activity needed for a relatively short period
- Short half-life: 0.59 day at pH 6.1 (Engel et al., 2015)
- Low loading to environment @ 200 kg N/ha/yr = **287** g NBPT/ha/yr
- Targeted delivery on fertiliser granule
- Research on NBPT in Ireland going back to the 1980's (e.g. Watson et al., 1990)

Nitrification inhibition Dicyandiamide (DCD)



- Nitrification is occurring continually => longer action needed
- DCD average half-life of 37 days at 15 ^{o}C (McGeough et al., 2016)
- @ 200 kg N/ha/yr = 7 kg DCD/ha/yr
- Targeted delivery incorporated into the fertiliser granule
- Not commercially available in Ireland
- Been around for many years:
  - Fox and Bandel (1989) evaluated yield response throughout 1980's in Maryland and Pennsylvania

Fertiliser formulations tested and presented today

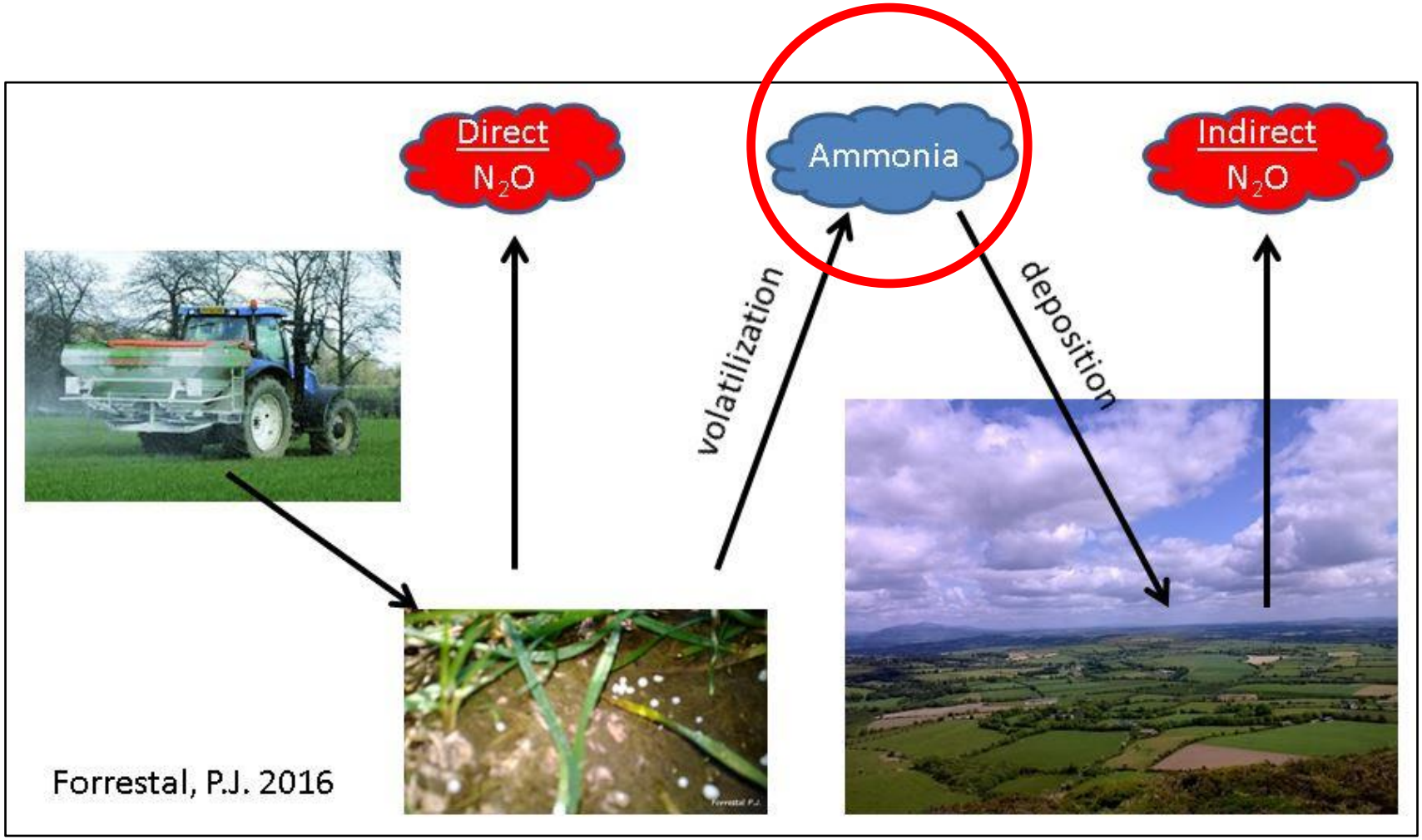
CAN

Urea

Urea
+ NBPT

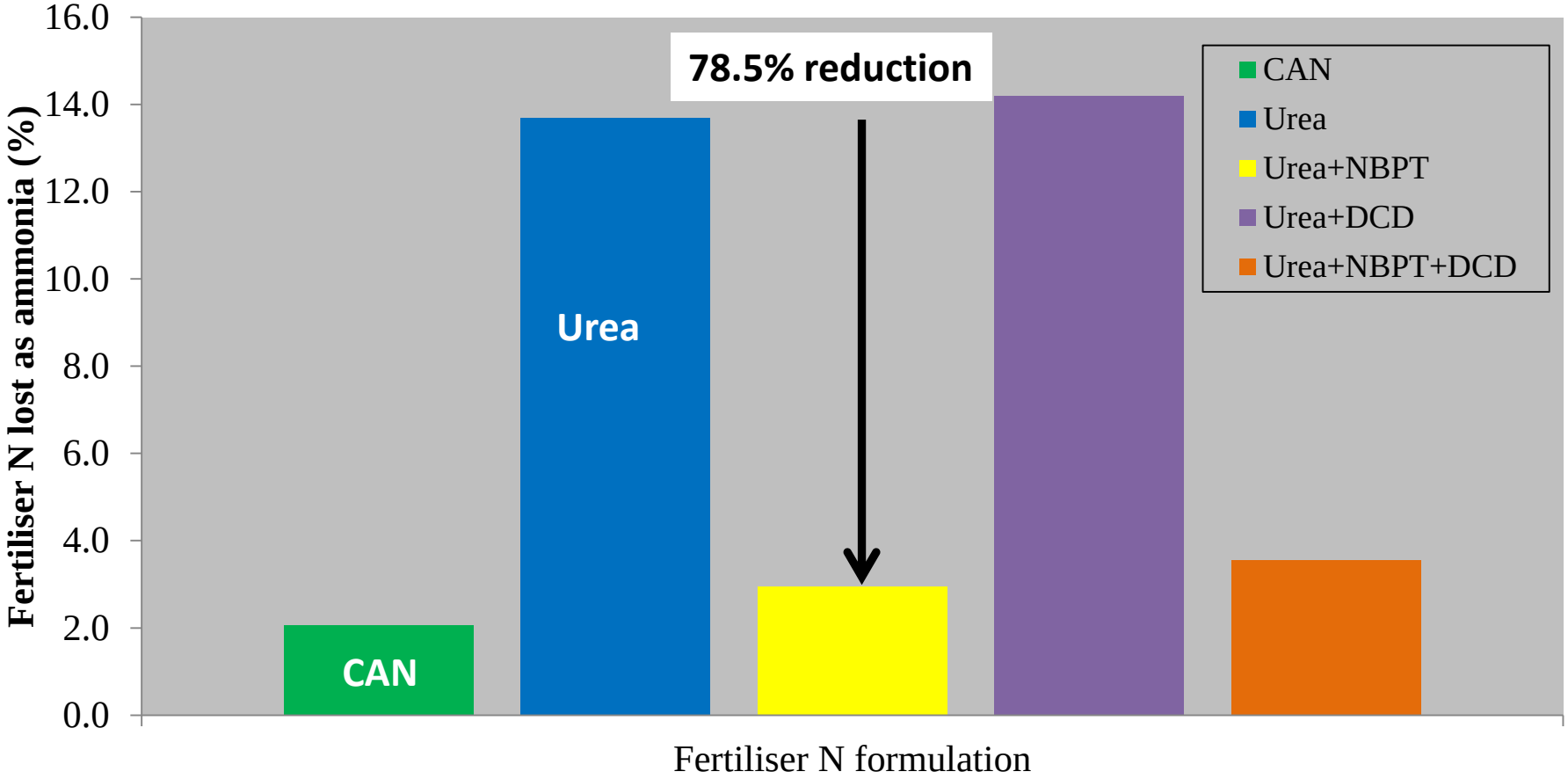
Urea
+ NBPT
+DCD

Urea
+ DCD

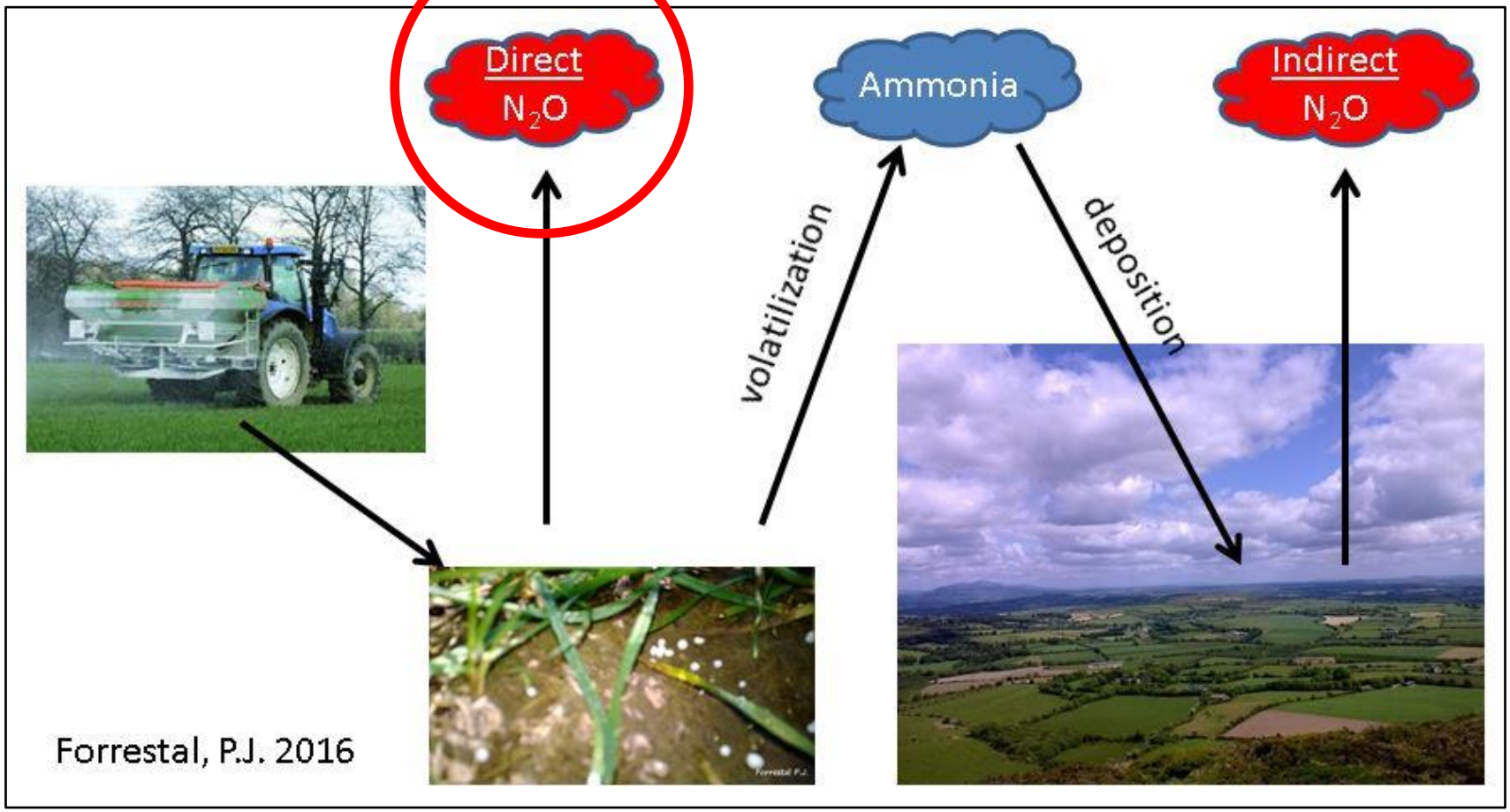

Direct
N_2O
Ammonia
Indirect
N_2O
volatilization
deposition
Forrestal, P.J. 2016

Are there Ammonia gas loss differences between fertilisers?

- Yes: urea > CAN
- Urea + NBPT ≈ CAN

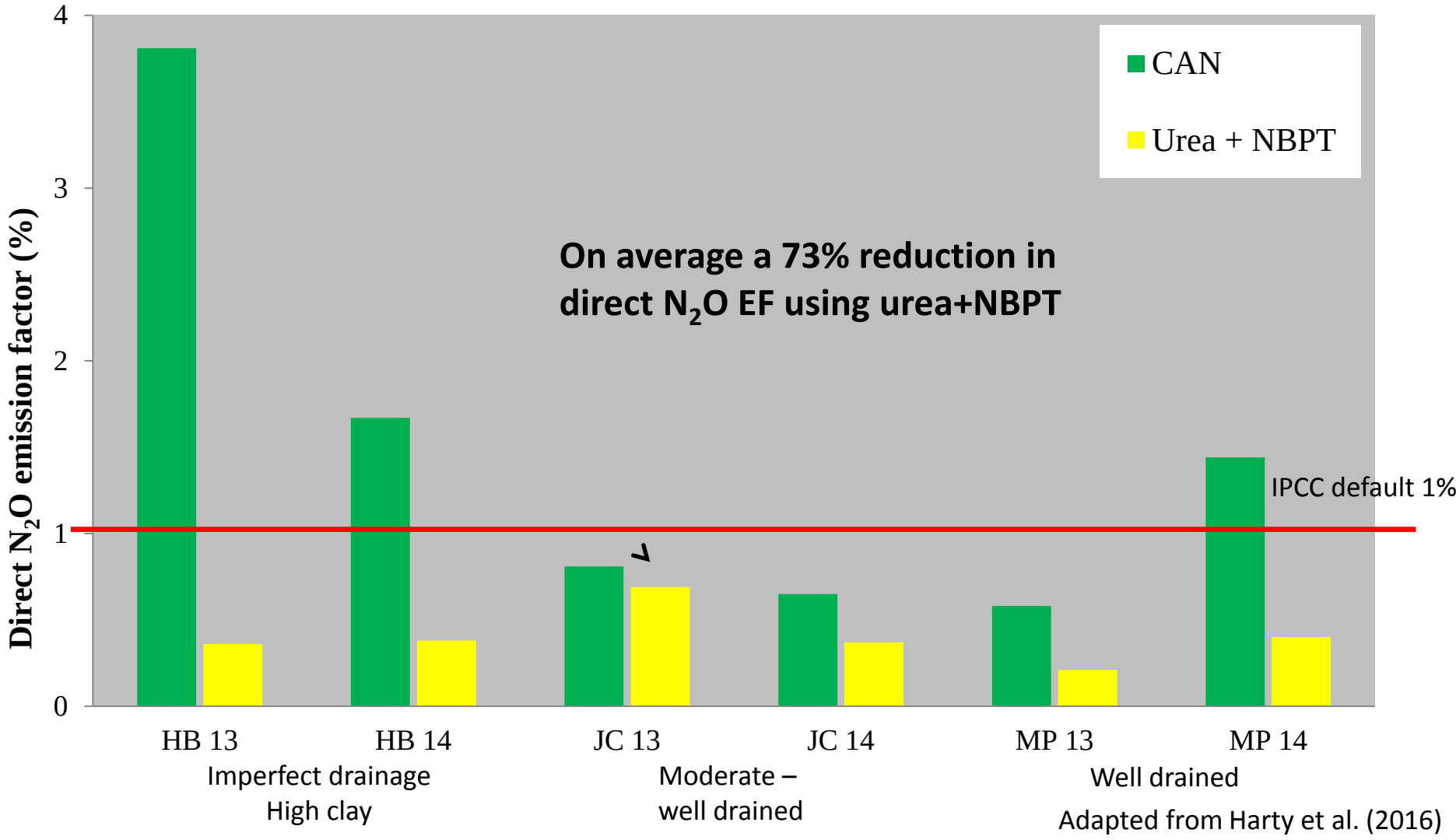


Based in Misselbrook et al., 2004; Forrestal et al., 2016; Kim et al., 2012



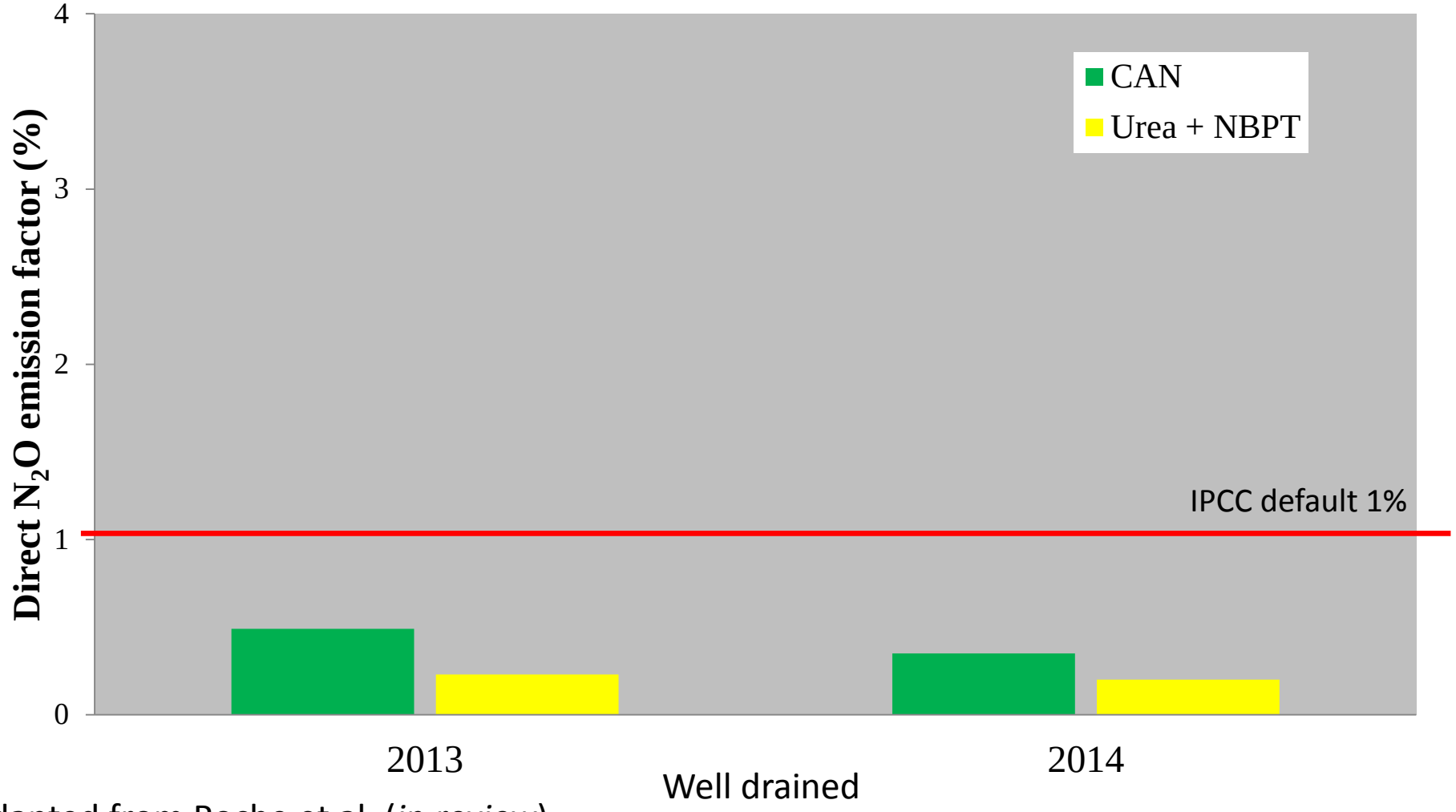
The percentage of N fertiliser lost as N_2O is known as the emission factor (EF)

Grassland: Urea + NBPT reduces **direct** N_2O compared to CAN

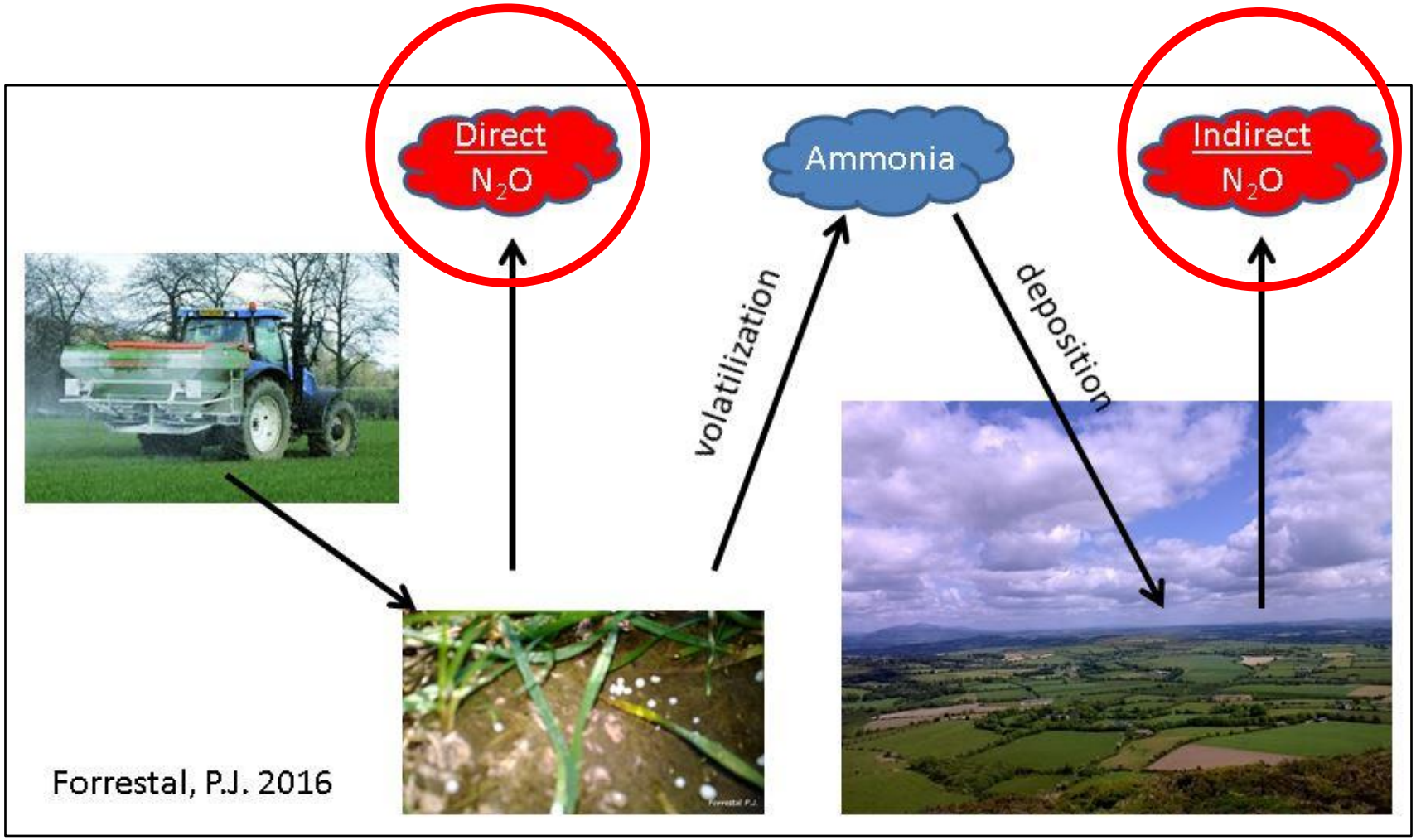


Adapted from Harty et al. (2016)

Spring barley: direct N_2O losses lower than the default



Adapted from Roche et al. (*in review*)


Direct
N_2O
Ammonia
Indirect
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volatilization
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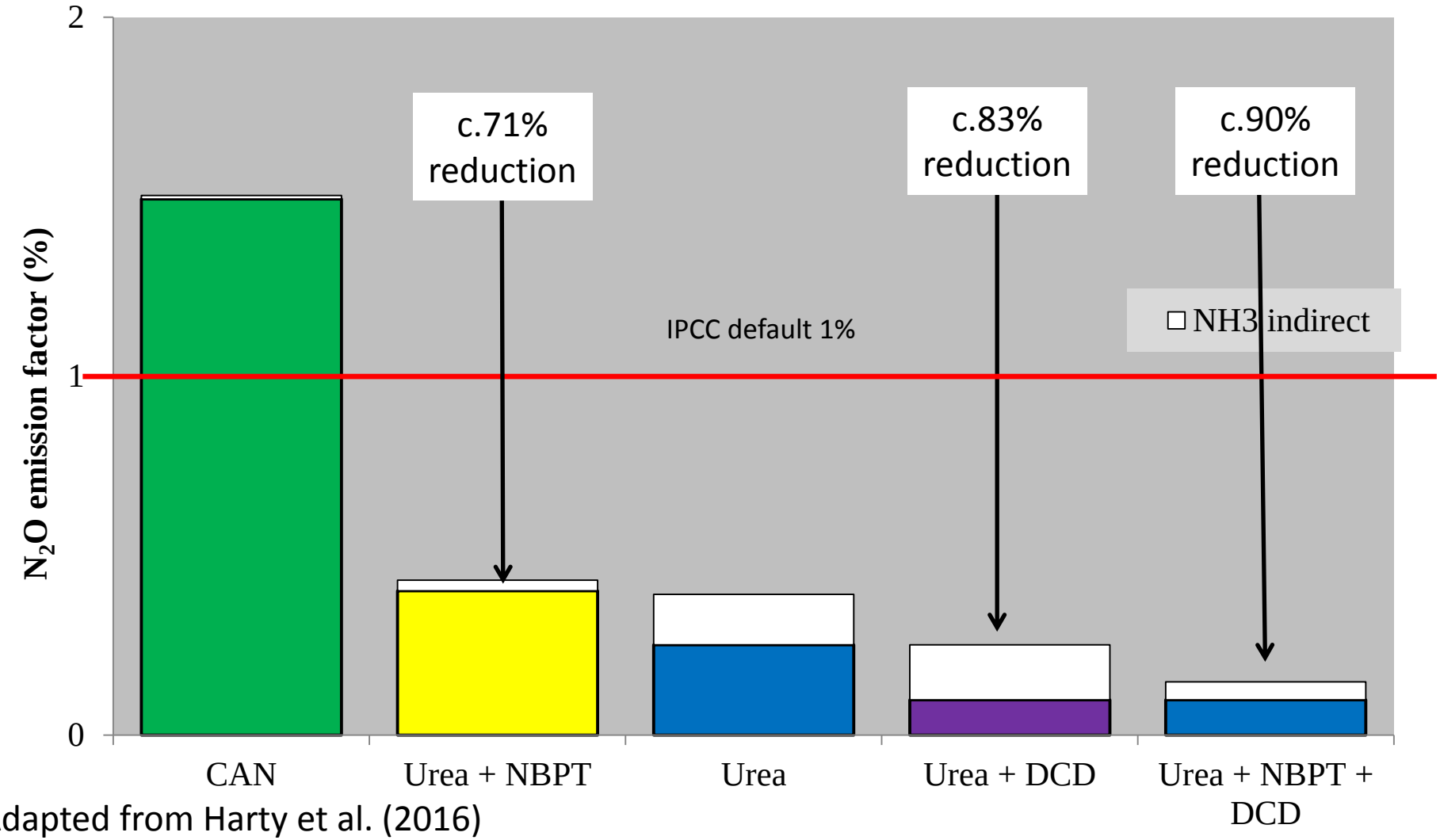
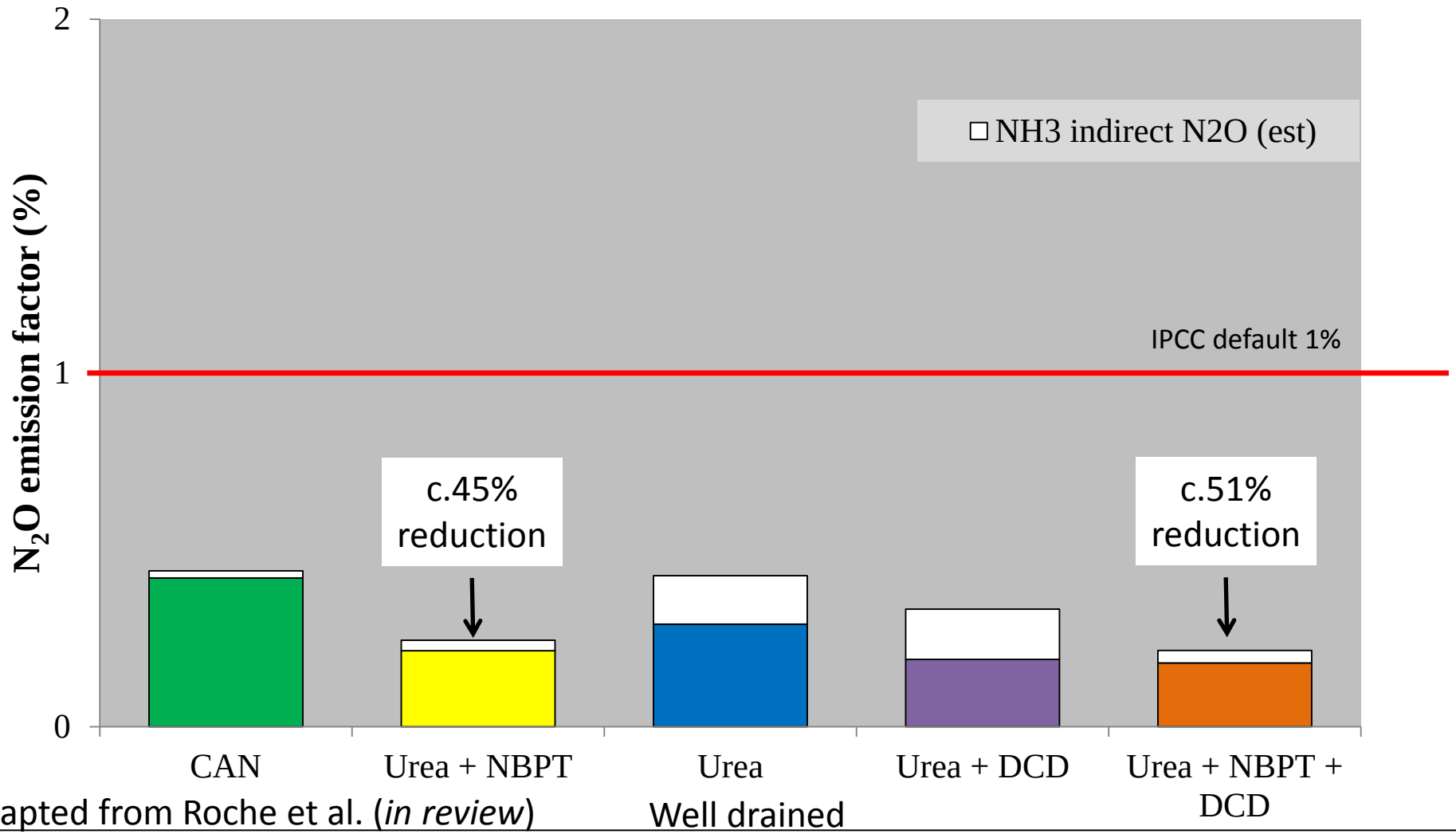
Forrestal, P.J. 2016

Grassland: CAN N_2O loss is more than previously thought urea + NBPT reduces fertiliser N_2O loss



Adapted from Harty et al. (2016)

Spring barley: CAN N_2O loss is less than previously thought further reductions possible with urea + NBPT



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Key messages

Sustainable Nitrogen Fertiliser Use & Disaggregated Emissions of Nitrogen

Ammonia (NH_3)

- NBPT is highly effective in reducing ammonia loss from urea:

  Urea + NBPT ≈ CAN with v. low ammonia loss

The GHG Nitrous oxide (N_2O)

- **Grassland:** the CAN N_2O EF is c. 50% higher than the default
- Urea + NBPT reduces the N_2O EF by c. 71% compared to CAN
- Up to c. 90% EF reduction possible with urea+NBPT+DCD
- **Spring barley:** the CAN EF is lower than the default
- Urea + NBPT gives further reductions

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Thank you for your attention

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&

Department of Agriculture, Environment and Rural Affairs

(DAERA E&I, Project 13/4/06)

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