Knowledge grows

Input from Yara to the public consultation on Ireland's first national mitigation plan

Joachim Lammel & Frank Brentrup

May 31st 2017

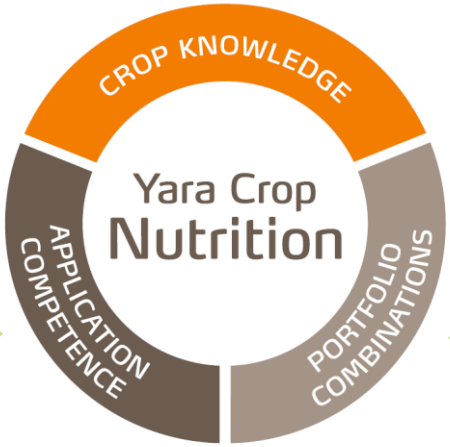
About Yara:

“Our aspiration is to be the leading provider of sustainable crop nutrition solutions, supporting farmer profitability through knowledge, quality and productivity”.

Yara Crop Nutrition - our approach

Consolidated and deep knowledge on crops

Tools and services, application competence



Large portfolio of fertilizer product for better efficiency

Yara has one of the largest product portfolios of any fertilizer company

- Yara produces several hundred different crop nutrition products
- Yara is able to offer tailored crop nutrition solutions to farmers
- Yara is the largest producer of Nitrates, NPK’s and Urea (including Urea with nBPT) in the EU

The public consultation

Roinn Cumarsáide, Gníomhaithe ar son na hAeráide & Comhshaoil
Department of Communications, Climate Action & Environment

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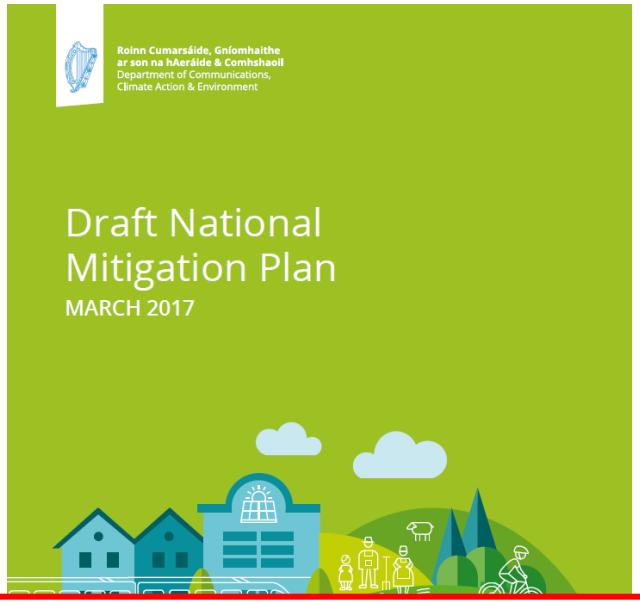
Public Consultation on Ireland's first National Mitigation Plan

News & Media

15 March 2017

The Minister for Communications, Climate Action and Environment, Denis Naughten T.D., today launched a statutory public

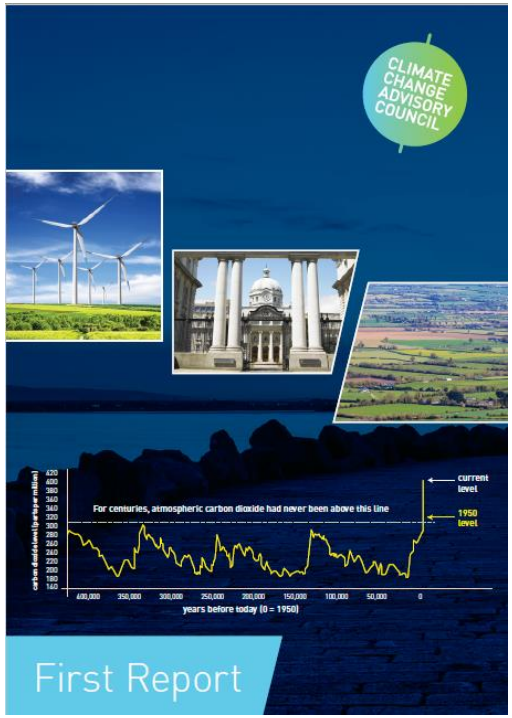


Responses to the consultation paper will be reviewed and considered by the Department of Communications, Climate Action and Environment and other responsible Government Departments and will inform the finalisation of the National Mitigation Plan. The closing date for receipt of submissions is **26 April 2017**.

CLIMATE CHANGE ADVISORY COUNCIL

FIRST REPORT

November 2016



Ongoing deployment of technological breakthroughs that reduce the emissions intensity of agricultural production must be encouraged. For example, recent research has identified fertilisers which have lower emissions of nitrous oxide, which is a potent greenhouse gas. A shift from calcium ammonium nitrate (CAN) fertiliser to such a fertiliser could reduce annual emissions by 1.5 million tonnes, and reduce costs for farmers.[36] Uptake of this option is required in a manner that is captured by the national inventory development process.

Reference 36: publication from Harty et al. (2016)

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Reducing nitrous oxide emissions by changing N fertiliser use from calcium ammonium nitrate (CAN) to urea based formulations

M.A. Harty [a,c], P.J. Forrestal [a], C.J. Watson [b,c], K.L. McGeough [b], R. Carolan [b], C. Elliot [c], D. Krol [a], R.J. Laughlin [b], K.G. Richards [a,*], G.J. Lanigan [a]

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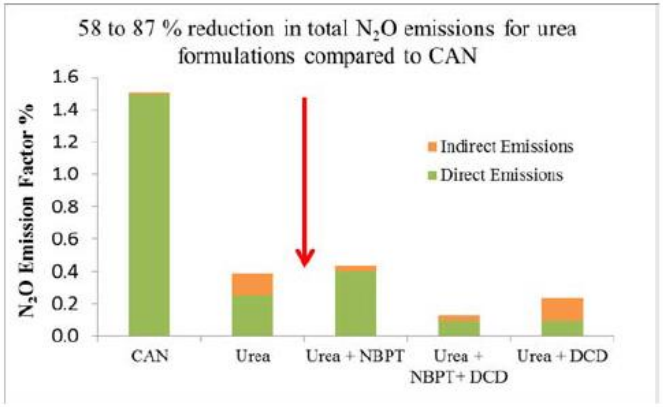
[c] School of Biological Sciences, Queen's University, University Road Belfast, BT7 1NN, Northern Ireland, United Kingdom

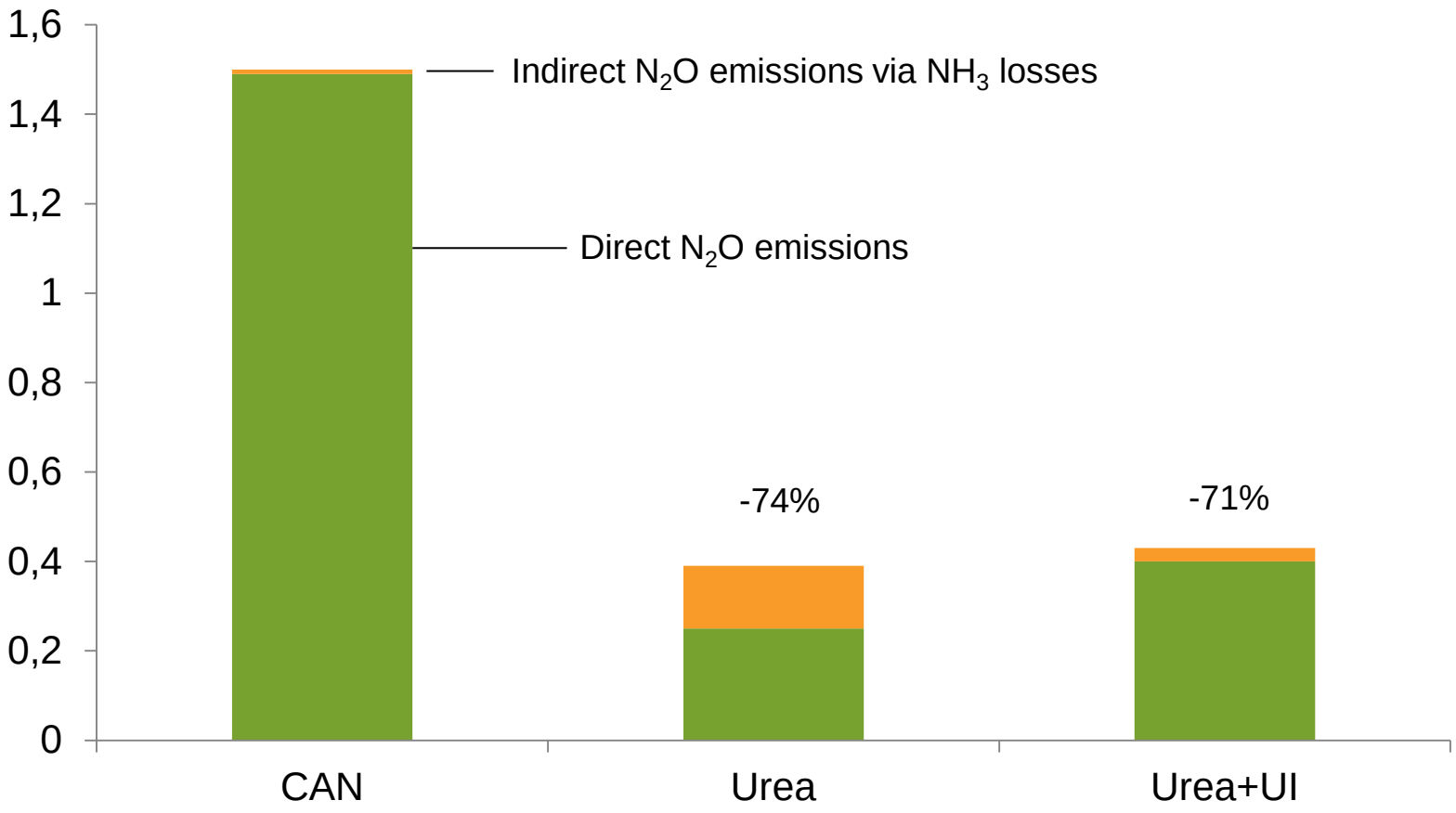
HIGHLIGHTS

- N_2O emission factor for CAN was higher than the IPCC default and variable between sites and years.
- Urea products decreased direct N_2O emissions from CAN on average by 80%
- Switching from CAN to urea products reduces both N_2O emissions and fertiliser costs.

GRAPHICAL ABSTRACT



Emission factors including indirect N_2O emissions for Irish grassland (data from Harty et al., 2016)



Countries have to report CO_2 emission from urea use: IPCC methodology

Volume 4: Agriculture, Forestry and Other Land Use

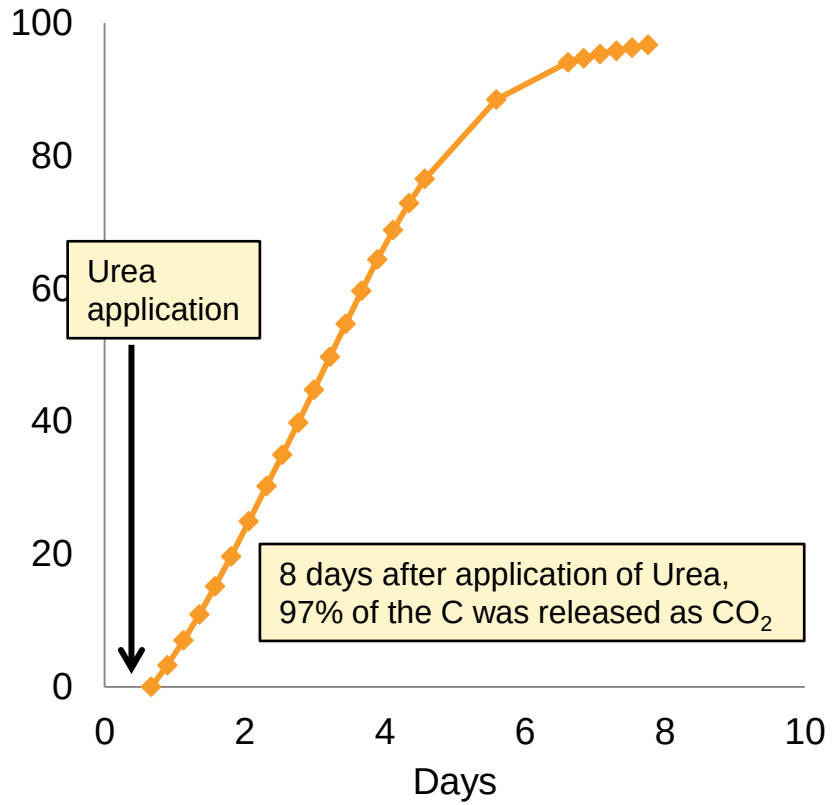
11.4 CO_2 EMISSIONS FROM UREA FERTILIZATION

Adding urea to soils during fertilization leads to a loss of CO_2 that was fixed in the industrial production process. Urea ($CO(NH_2)_2$) is converted into ammonium (NH_4^+), hydroxyl ion (OH^-), and bicarbonate (HCO_3^-), in the presence of water and urease enzymes. Similar to the soil reaction following addition of lime, bicarbonate that is formed evolves into CO_2 and water. This source category is included because the CO_2 removal from the atmosphere during urea manufacturing is estimated in the Industrial Processes and Product Use Sector (IPPU Sector).

0.73 kg CO_2 per kg urea = **1.59 kg CO_2 per kg N**

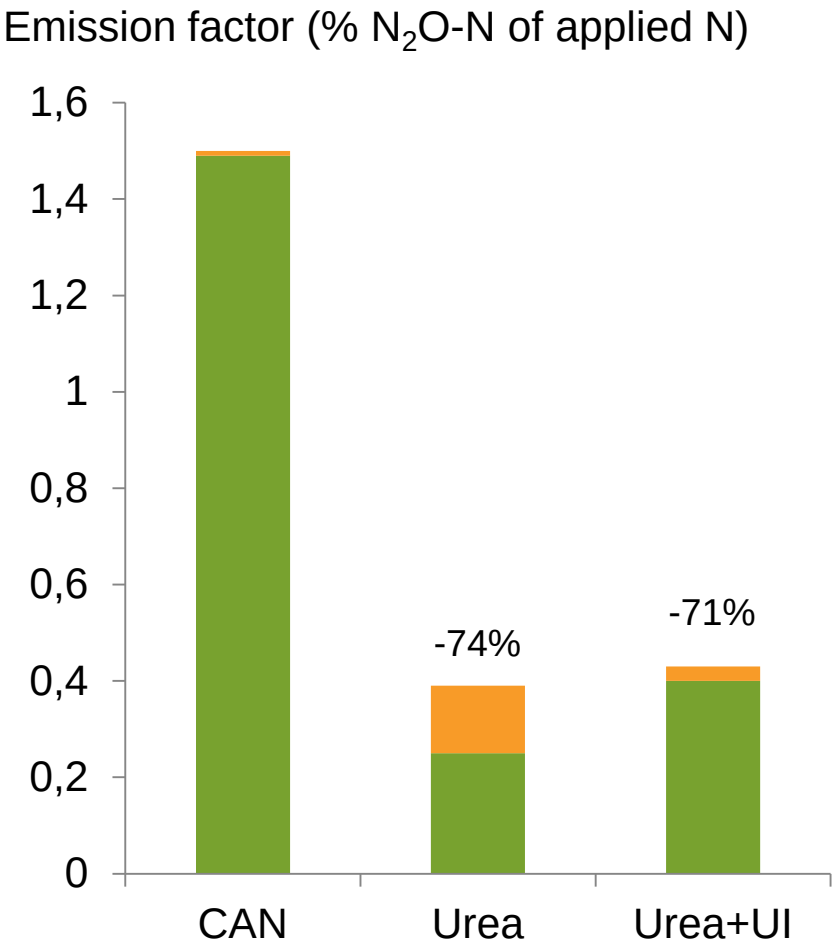
Source: 2006 IPCC Guidelines, Chapter 11: N_2O Emissions from Managed Soils, and CO_2 Emissions from Lime and Urea Application

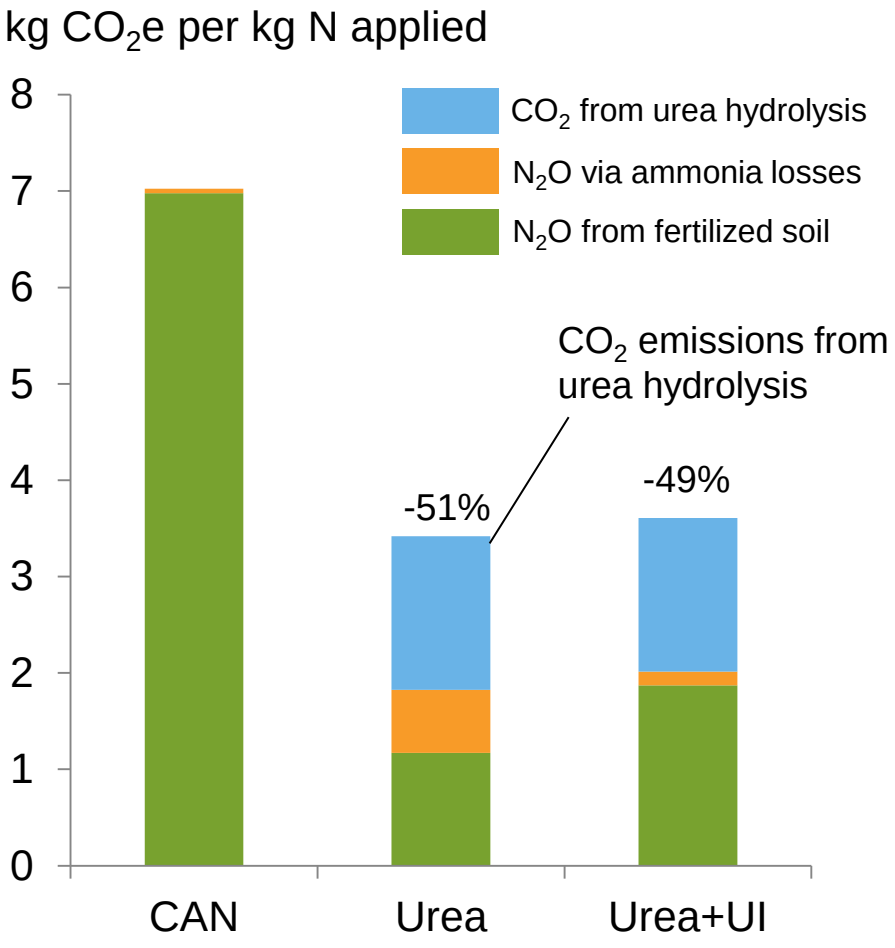
CO_2 emission (as % of CO_2 added with Urea)



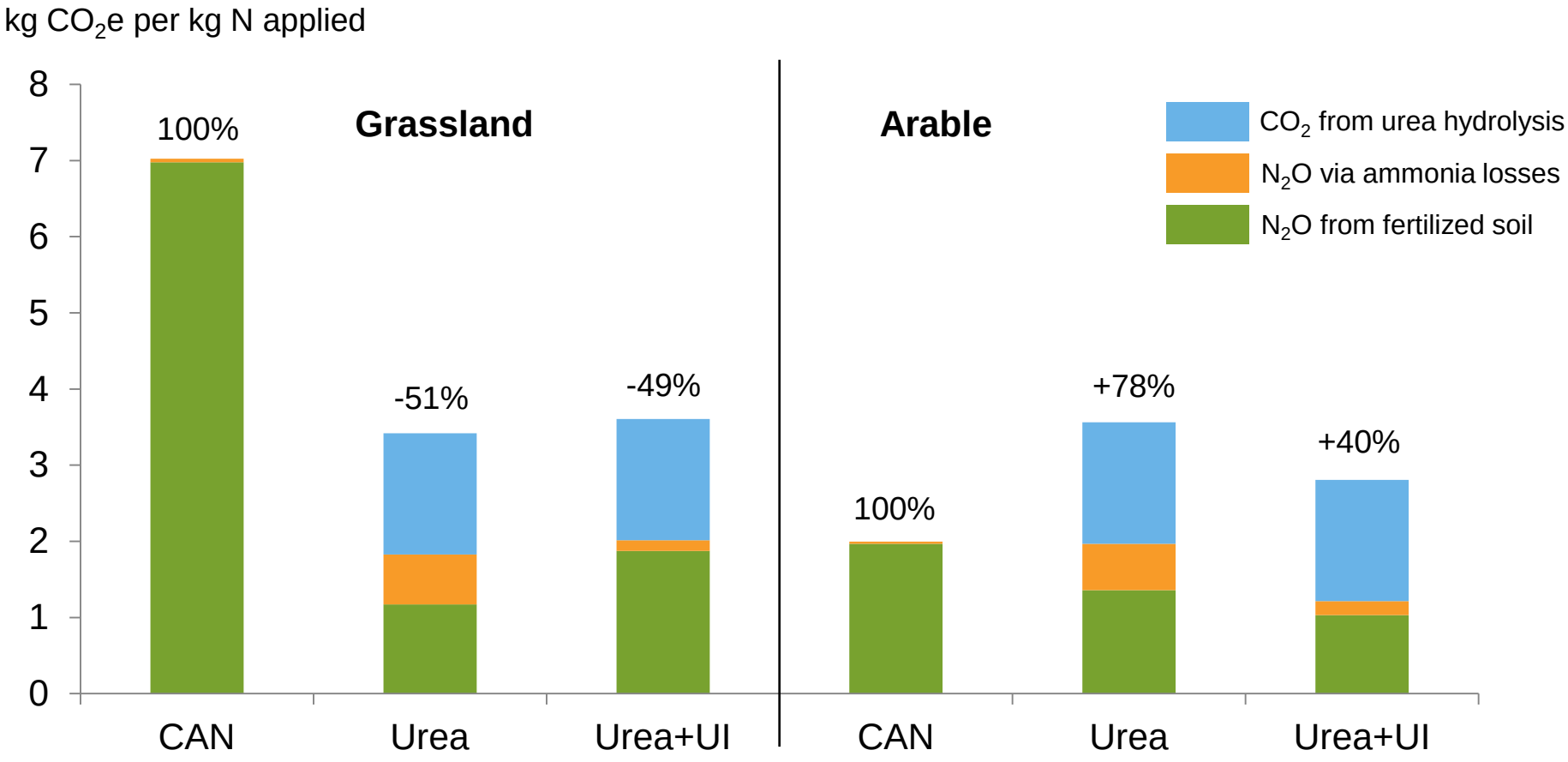
Source: Yara International ASA

GHG emissions from fertilizer use on grass expressed in kg CO_2-equivalents including CO_2 from urea hydrolysis





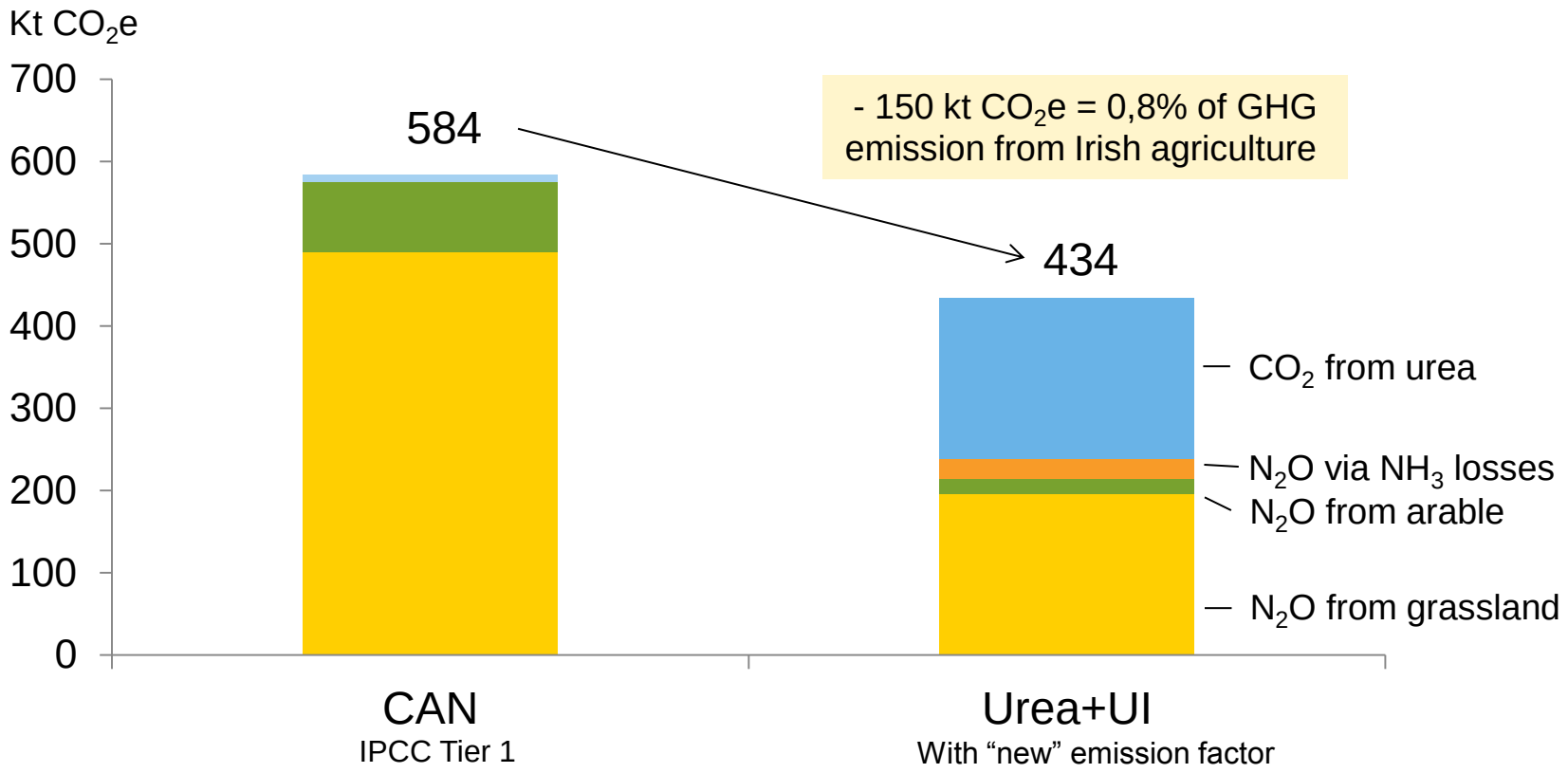
When CO_2 emission from Urea hydrolysis is included, the advantage of replacing CAN with Urea is reduced on grassland and is absent on arable land



Source: Harty et al. 2016: data for N_2O from grassland and N_2O via ammonia emission; Roche et al. 2016: data for N_2O from arable soil; 2006 IPCC Guidelines, Chapter 11: data for CO_2 from urea hydrolysis

GHG emissions reduction if straight CAN is replaced by Urea+UI and the “new” emission factors are applied to Urea+UI

Calculation for 123 kt N, of which is 85% is used in grass and 15% in arable



Conclusion

- A replacement of CAN by Urea + UI will reduce Irish GHG emissions by approximately 150 kt CO2e.
- There may be significant trade-offs such as increased ammonia emissions, yield loss and potential health risks.

Increased ammonia emissions in Ireland if CAN (123 kt N) is replaced by Urea with urease inhibitor

N form	Urea	Urea+UI**
Emission factor*	13%	-70% = 3.9%
Increase in Irish NH_3 emission (%)	+14.6%	+3.8%
Increase in Irish NH_3 emission (t)	+15,300	+4,000

Total ammonia emission in Ireland in 2014: 105,000 t

* EEA/EMEP Emission Inventory Guidebook 2016
** 70% emission reduction from: Guidance from the UNECE Task Force on Reactive Nitrogen, 2014

New EU rules on fertiliser emissions could cost Irish farmers millions

Farming Independent team
November 30 2016 12:13 PM

Ireland must reduce its ammonia (NH3) discharges from farming by 5pc in the period to 2030. Pic Roger Jones.

Ireland must reduce its ammonia (NH3) discharges from farming by 5pc in the period to 2030. Major changes to management practices on farms will be required to meet the new limits, including moving away from traditional fetilisers such as urea, and greater use of the trailing shoe and trailing hose when spreading slurry.

The full cost of these mitigation measures is put at €35.6m a year by Teagasc.

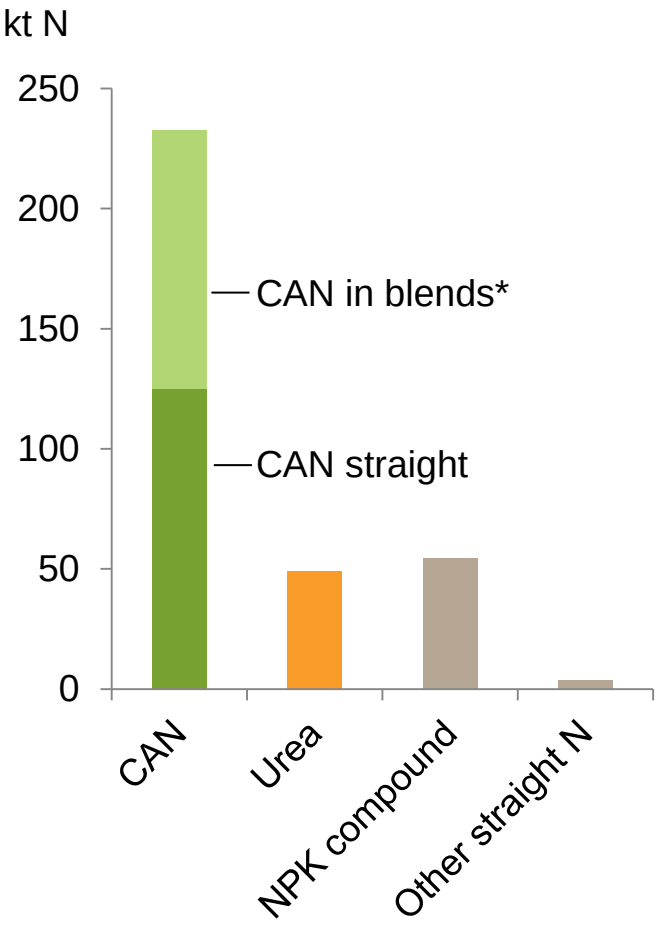
Plant uptake of urease inhibitor and its influence on crop physiology is reported in literature

- Crops can take NBPT up via the root or leaves
- Some authors report a transient yellowing of the leaf tips at day 7 after application of NBPT or an impact on the amino acid profile
- It indicates an influence on crop physiology and N metabolism.
- Yara's research shows crop uptake but then a rapid decomposition in the crop thereafter.
- If urea with NBPT is used appropriately we do not expect any problem. Poor fertilizer management such as immediate grazing after fertilizer application may be a potential risk.

- **Aside from real or perceived concerns, any NBPT detected in food could become an instant trade issue.**
- **There are no internationally agreed maximum residue levels of NBPT in food.**

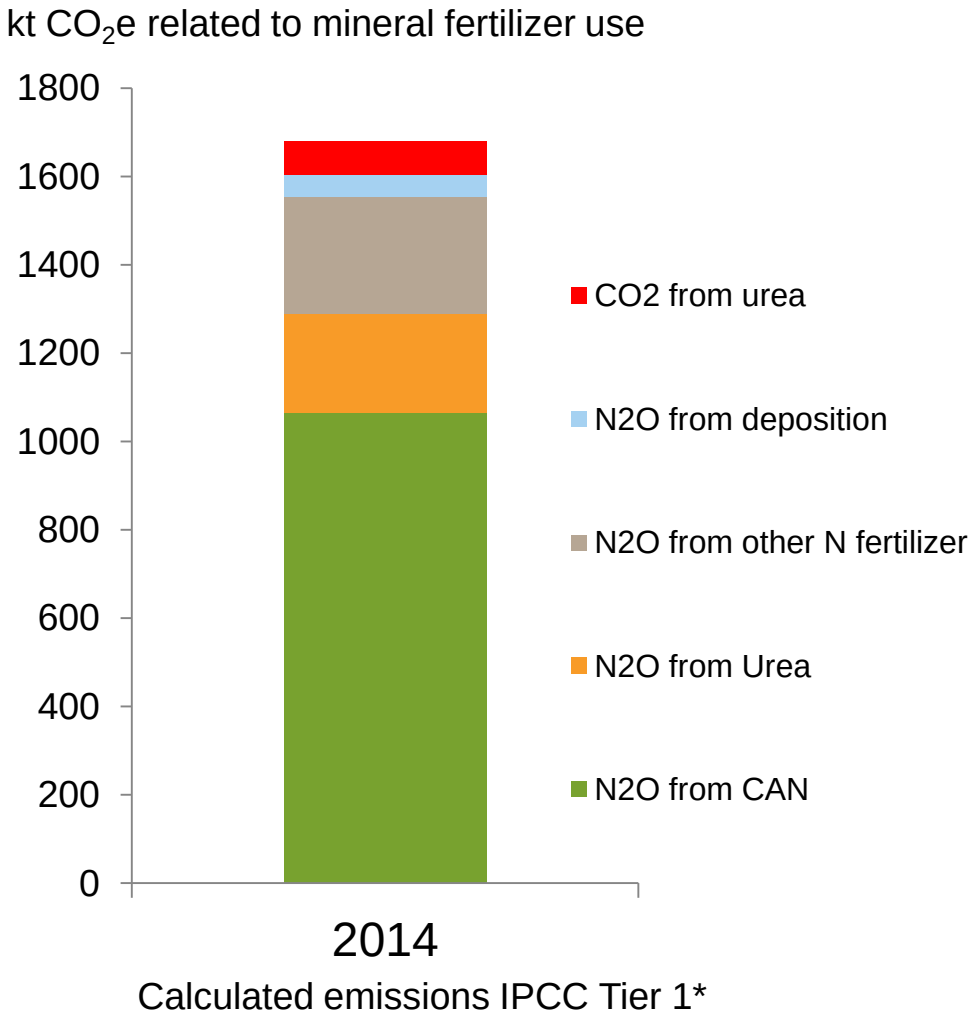
Progress since then

N fertilizer use and related GHG emissions in ROI in 2014



* NPK blends not included in the research

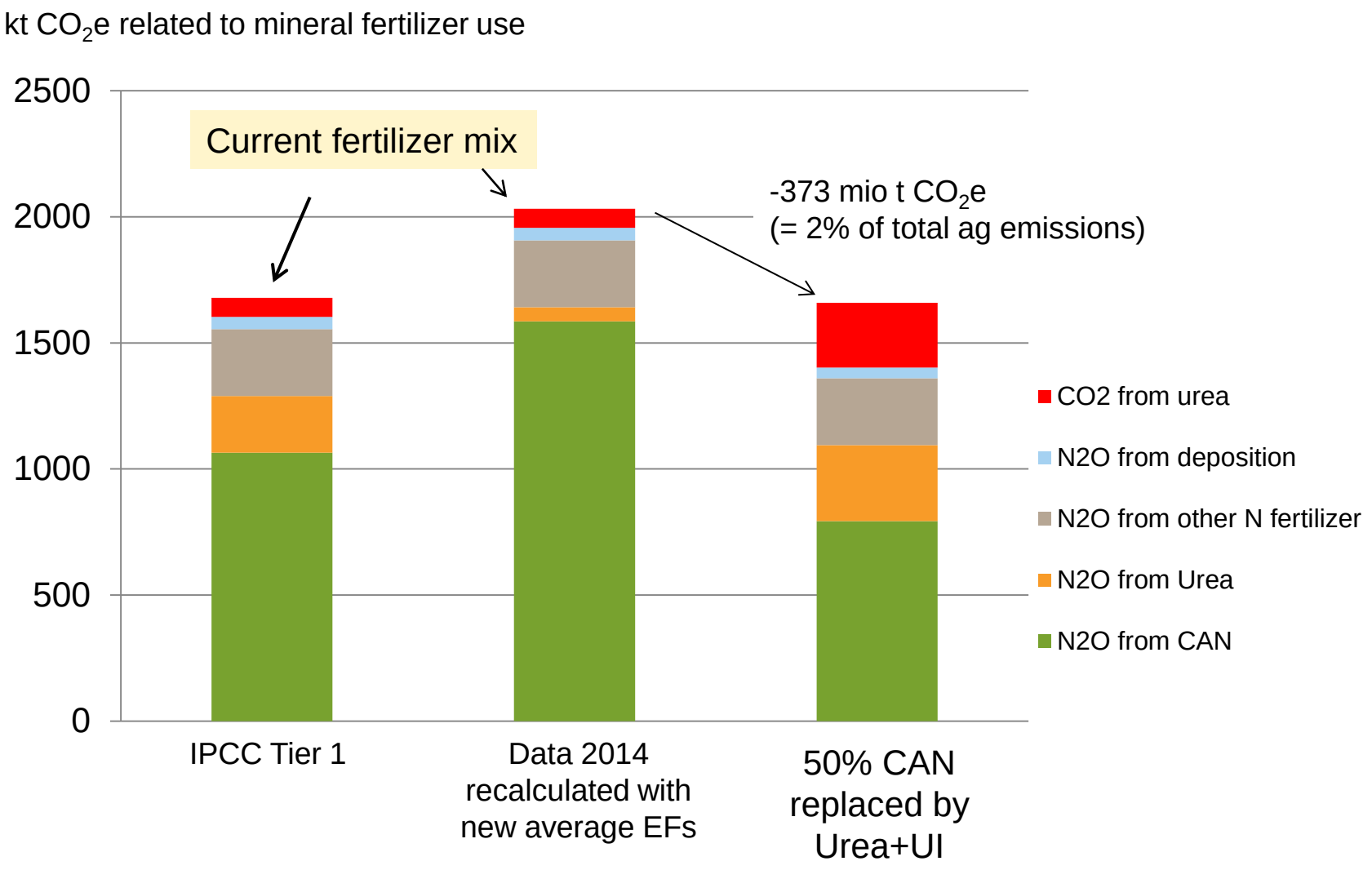
Source: Department of Agriculture, Food and the Marine, 2017



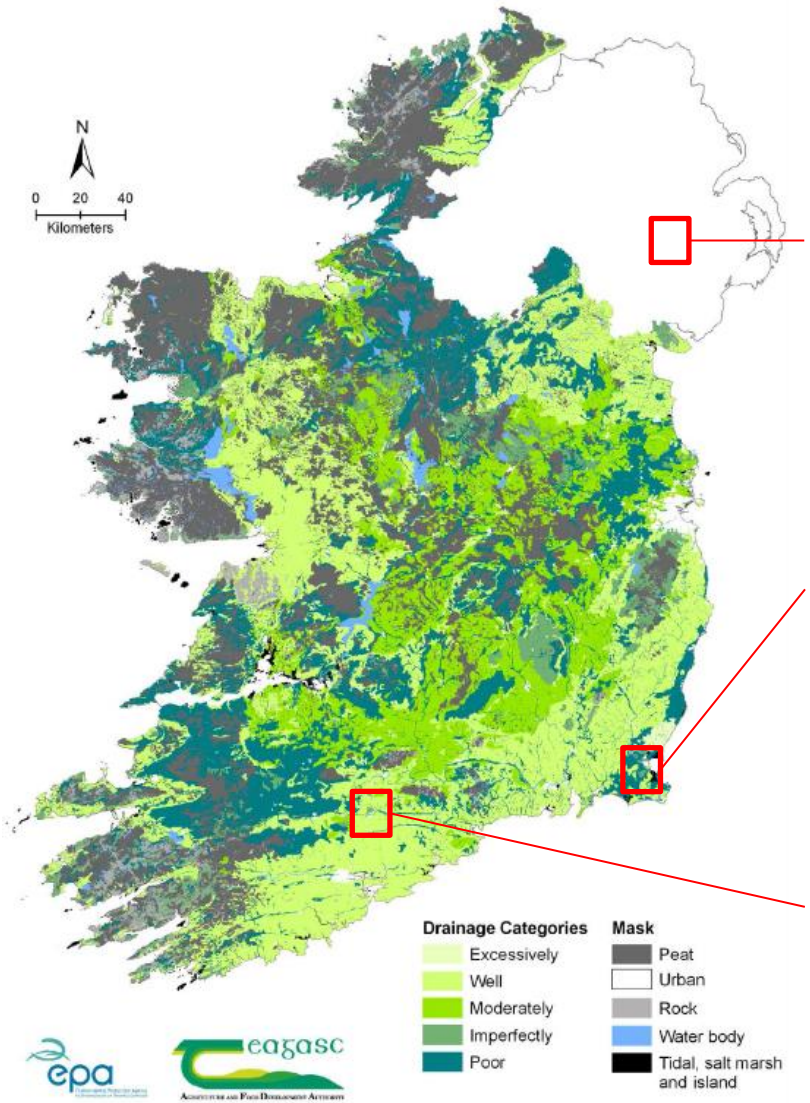
Calculated emissions IPCC Tier 1*

* Calculated for 2014 based on fertilizer mix 2015/16

Mineral N fertilizer related GHG emissions in 2014 and impact if 50% of all CAN is replaced by urea + inhibitor



Drainage map of Ireland and location of trial sites



Site Hillsborough

- Imperfectly drained
- pH: 5.74 and 5.60
- Clay loam
- Total C: 5.99 and 5.16%

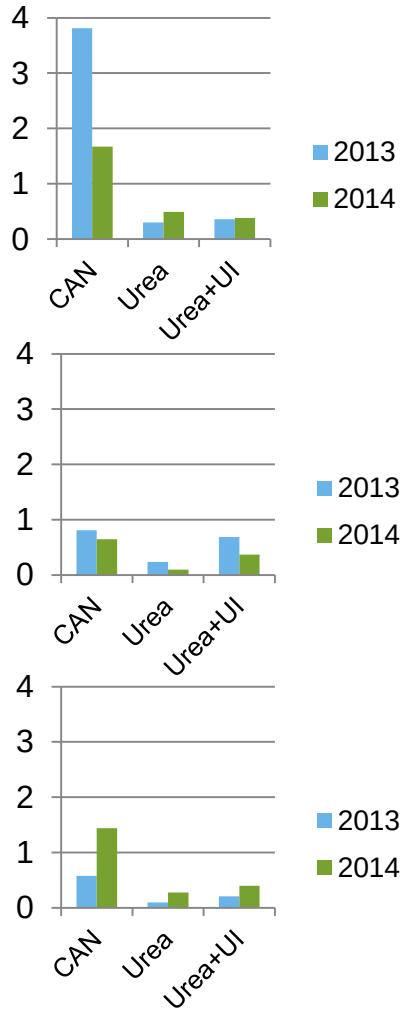
Site Johnstown Castle

- Well and moderately drained
- pH: 5.53 and 5.69
- Sandy loam
- Total C: 3.16 and 2.83%

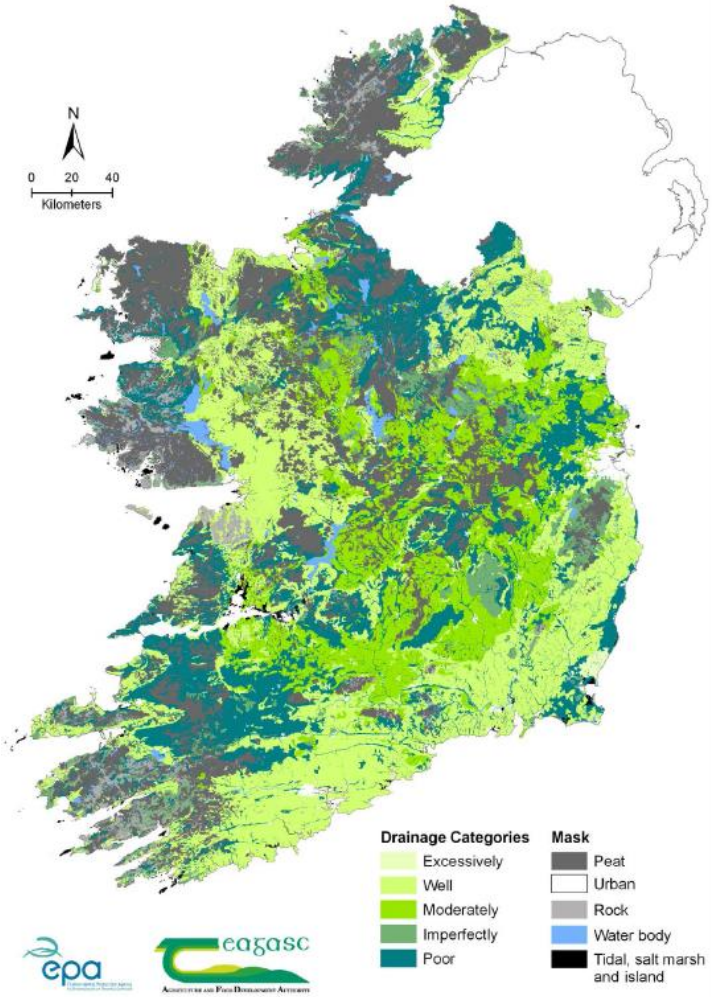
Site Moorepark

- Well drained
- pH: 5.55 and 5.37
- Sandy loam
- Total C: 3.00 and 3.02%

N_2O emission factor (%)



Harty et al. suggest to adjust emission factor according to drainage categories of grassland in the Republic of Ireland



Emission factors from Harty et al. (2016)

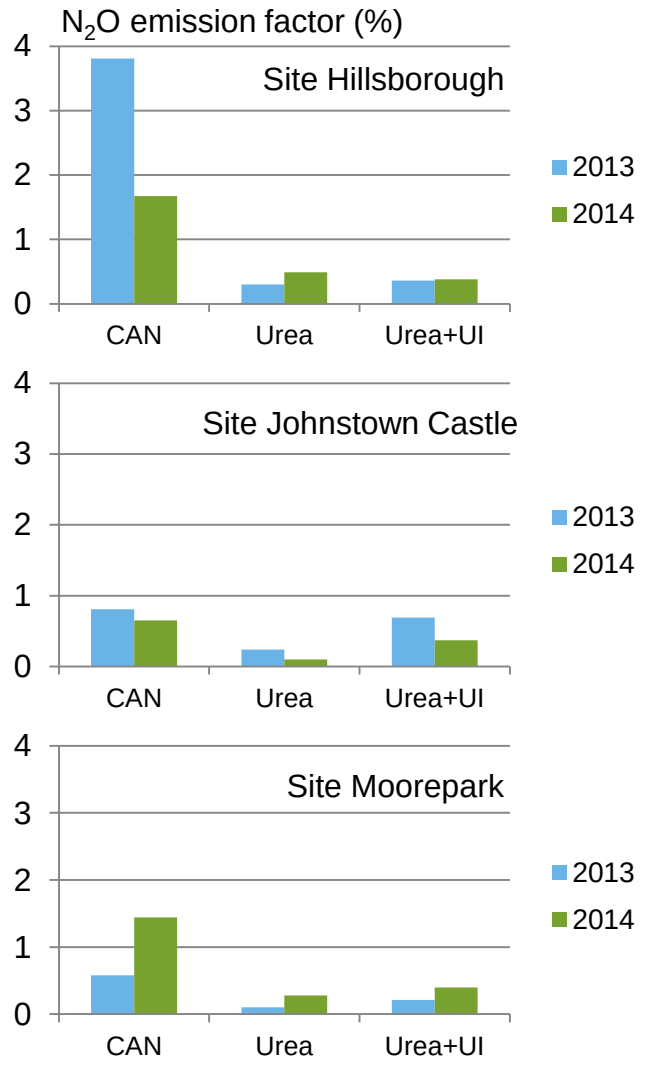
Table 6
Direct emission factor summary.

Fertiliser Form	Drainage impeded EF %	Moderately/Well drained EF %
CAN	2.74	0.87
Urea	0.40	0.18
Urea + NBPT	0.37	0.41
Urea + NBPT + DCD	0.12	0.11
Urea + DCD	0.07	0.13
CAN/Urea	n/a	0.23

Share of poor and moderately/well drained grass

	Managed grass ha		Other grass ha
Excessively	10,499	62%	803
Well	1,287,372		93,010
Moderately	661,375		42,447
Imperfectly	157,985	38%	44,611
Poor	797,567		87,663
Peat	236,938		456,646
Other[a]	26,310		60,086
Grand total	3,178,046		785,265

What if the different grassland categories are treated separately?



Emission factors per drainage class

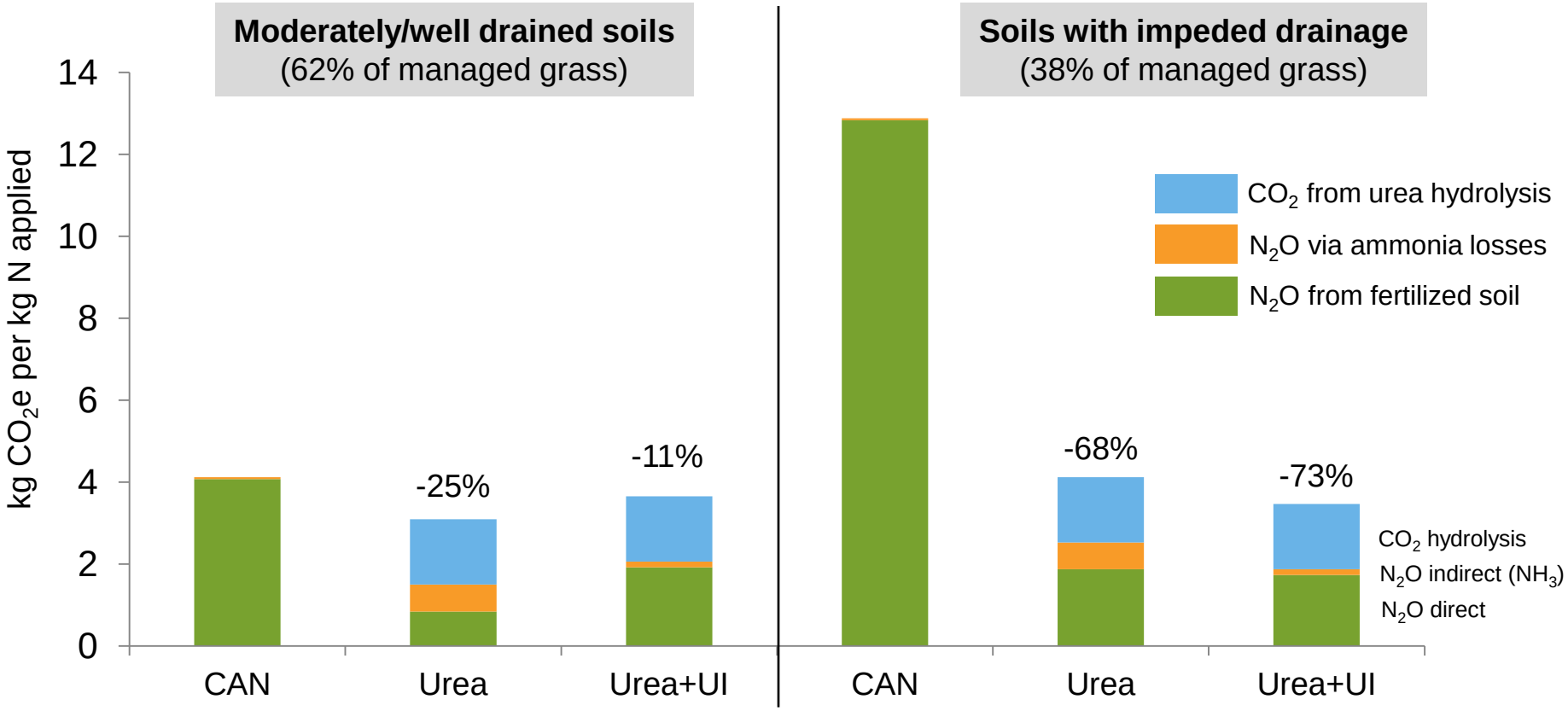
Impeded drainage:

CAN:	2.74 %
Urea:	0.40 %
Urea+UI:	0.37 %

Moderately/well drained:

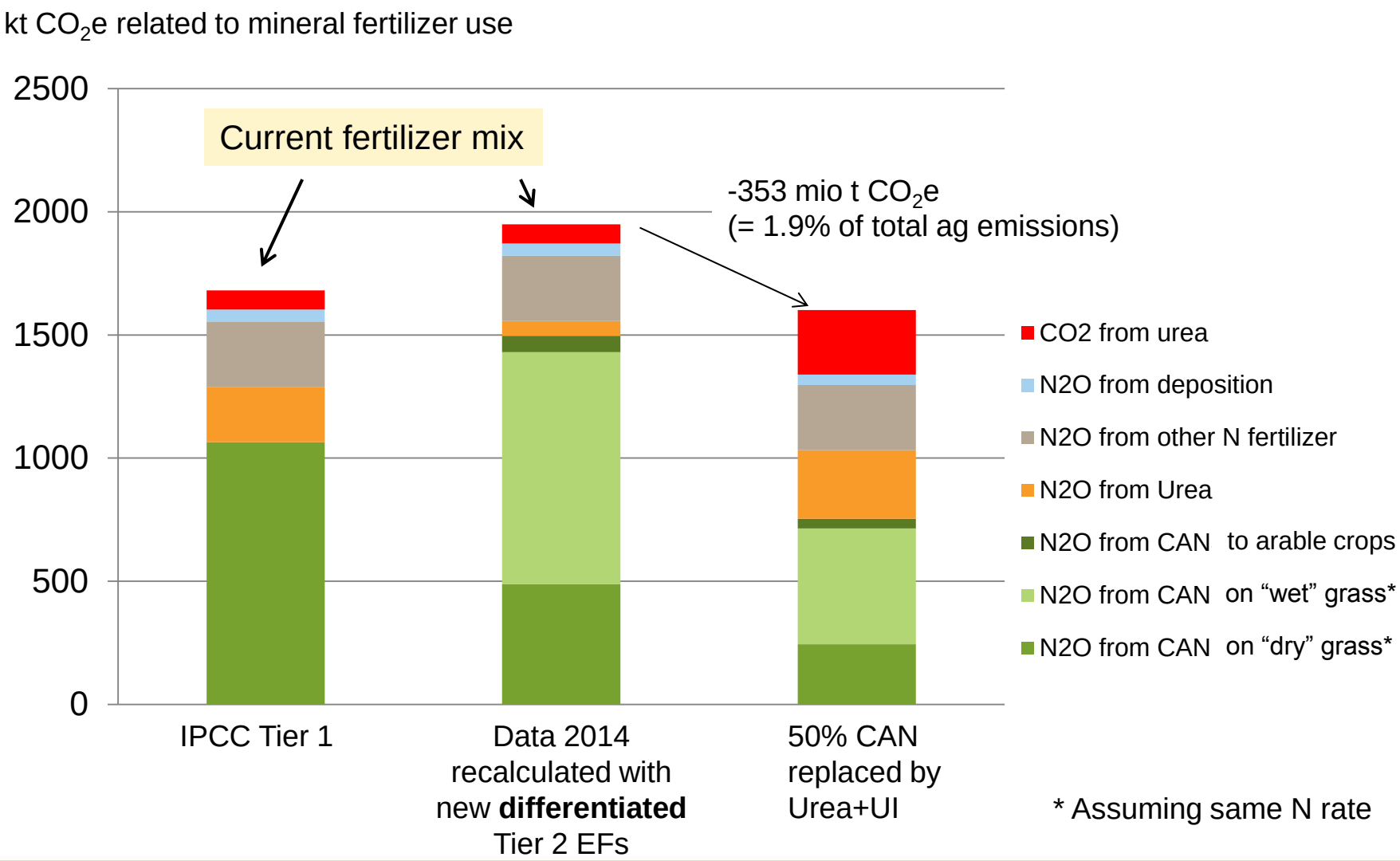
CAN:	0.87 %
Urea:	0.18 %
Urea+UI:	0.41 %

GHG emissions from N fertilizer use on grass with different soil drainage, "new" emission factors, and CO_2 from urea



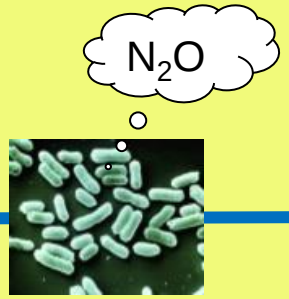
The intensity of N fertilizer use on the different grassland categories may not be the same

Mineral N fertilizer related GHG emissions in 2014 and impact if 50% of all CAN is replaced by urea + inhibitor



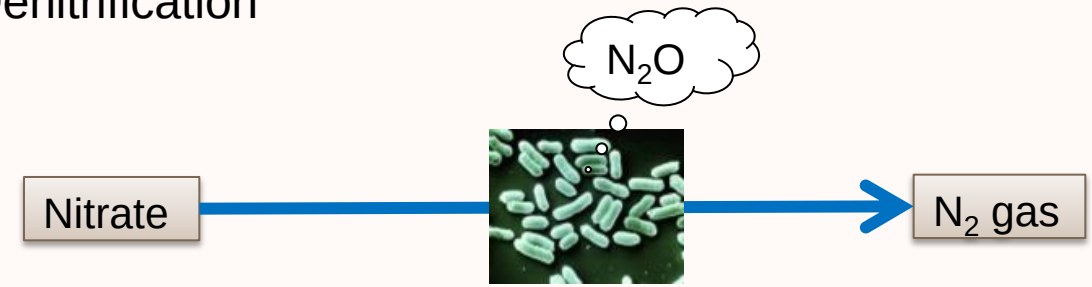
Two natural processes release N_2O from soil both are the consequence of microbial activity

Nitrification



Soil organisms use ammonium (NH_4) as energy source

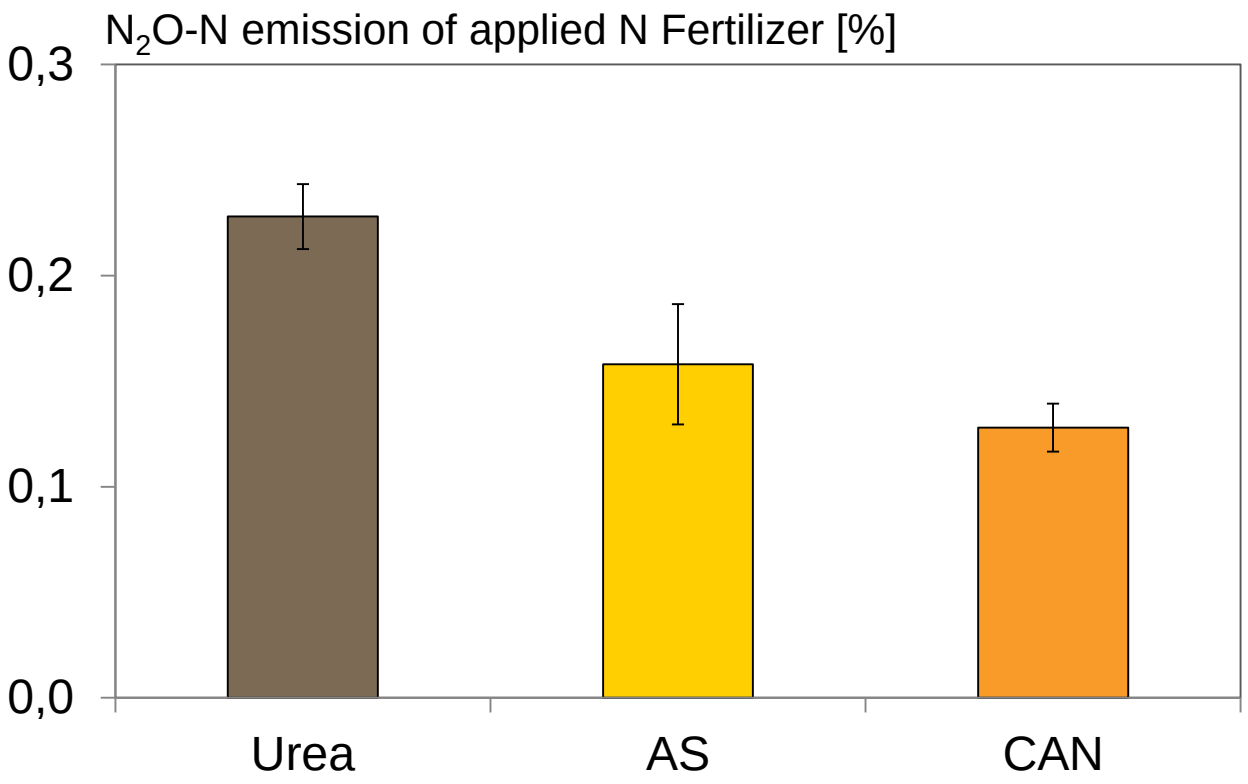
Denitrification



Conditional: if oxygen (O_2) is depleted (poor drainage), soil organisms use oxygen from nitrate (NO_3) for respiration

N_2O from both processes ≈ 1% of N (IPCC Tier 1)

N_2O emissions from fields are influenced by N fertilizer product choice



Based on 5 experiments with winter wheat during growth period;
Nitrification conditions, N rate = 220 kg N ha^{-1}

Summary

- The 1,5 million t of GHG emission reduction through a replacement of CAN by Urea as suggested by the Climate Change Advisory Council report is not confirmed.
- A switch from CAN to urea will contribute additional GHG emission because of CO_2 from urea hydrolysis
- A complete replacement of CAN by urea with inhibitor will increase ammonia emission in Ireland
- A switch from CAN to Urea will not give the expected results under all conditions
- GHG emission reduction potential of a switch from CAN to Urea on well and moderately well drained grassland is low and absent on arable land.
- The use of CAN on drainage impeded grassland is the major contributor to N_2O emission under such conditions urea with inhibitor result in GHG emission reductio
- We believe urea with inhibitor shall be used when “prescribed” for the specific local conditions