Ammonia emissions, impacts & solutions.

Dr. Dominika Krol – Teagasc

Dr. David “Dáithí” Kelleghan – University College Dublin

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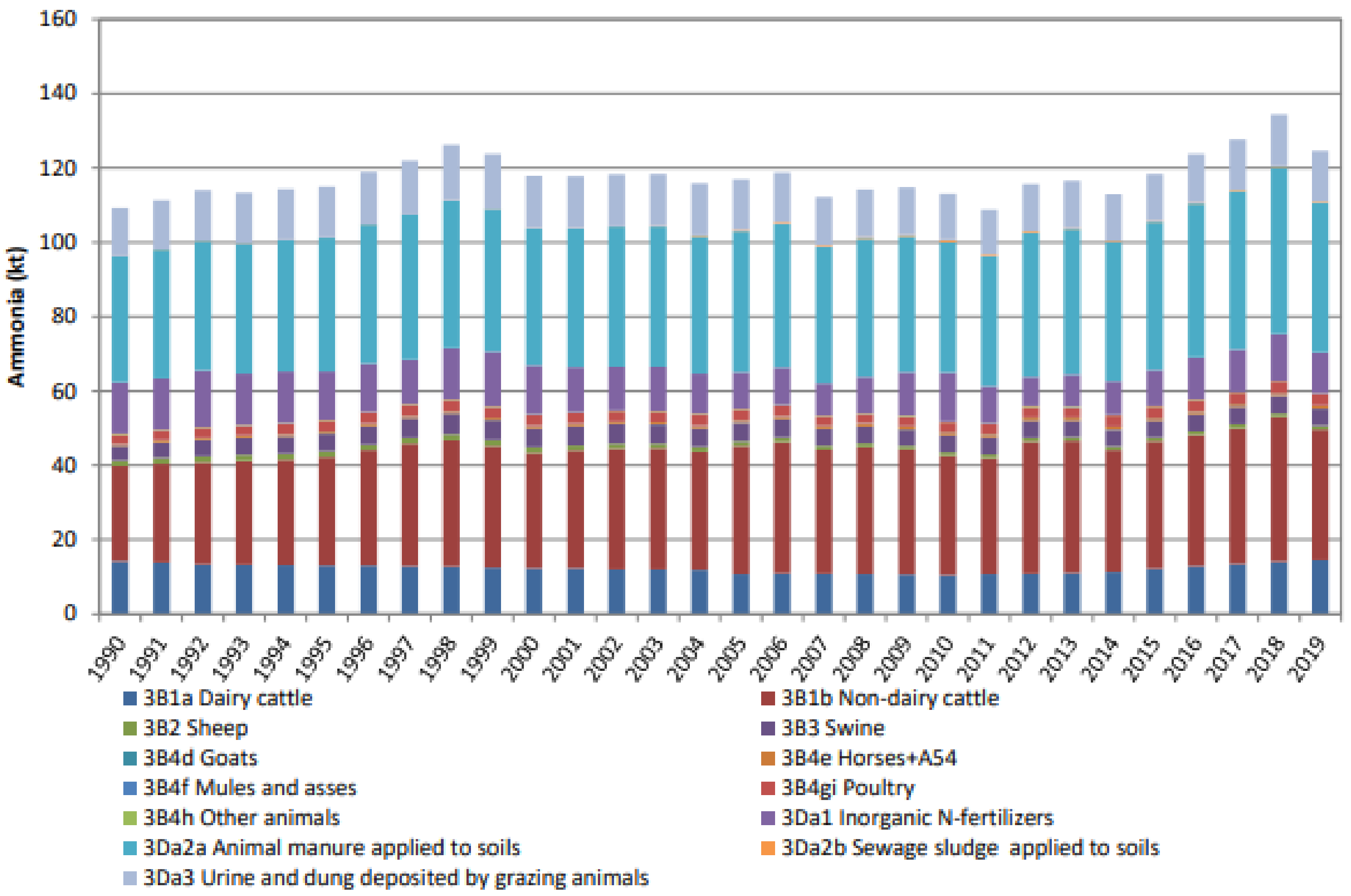
Agriculture ammonia emissions profile



EPA, 2021

Agriculture ammonia emissions profile

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
National Total NH3	114.810	110.432	117.077	117.918	114.238	119.525	124.819	128.635	135.214	125.404
NEC ceiling 2010-2019	116.000	116.000	116.000	116.000	116.000	116.000	116.000	116.000	116.000	116.000

EPA, 2021

Agriculture ammonia future compliance

	Emissions (kilotonnes)			2020-2029 and 2030 Reduction commitments (% reduction compared with 2005)	
	2020	2025	2030	2020-2029	2030
Total NH3 With Existing Measures	126.74	130.42	129.92	118.37	113.59
Total NH3 With Additional Measures	124.65	114.45	112.74	-1%	-5%

EPA, 2021

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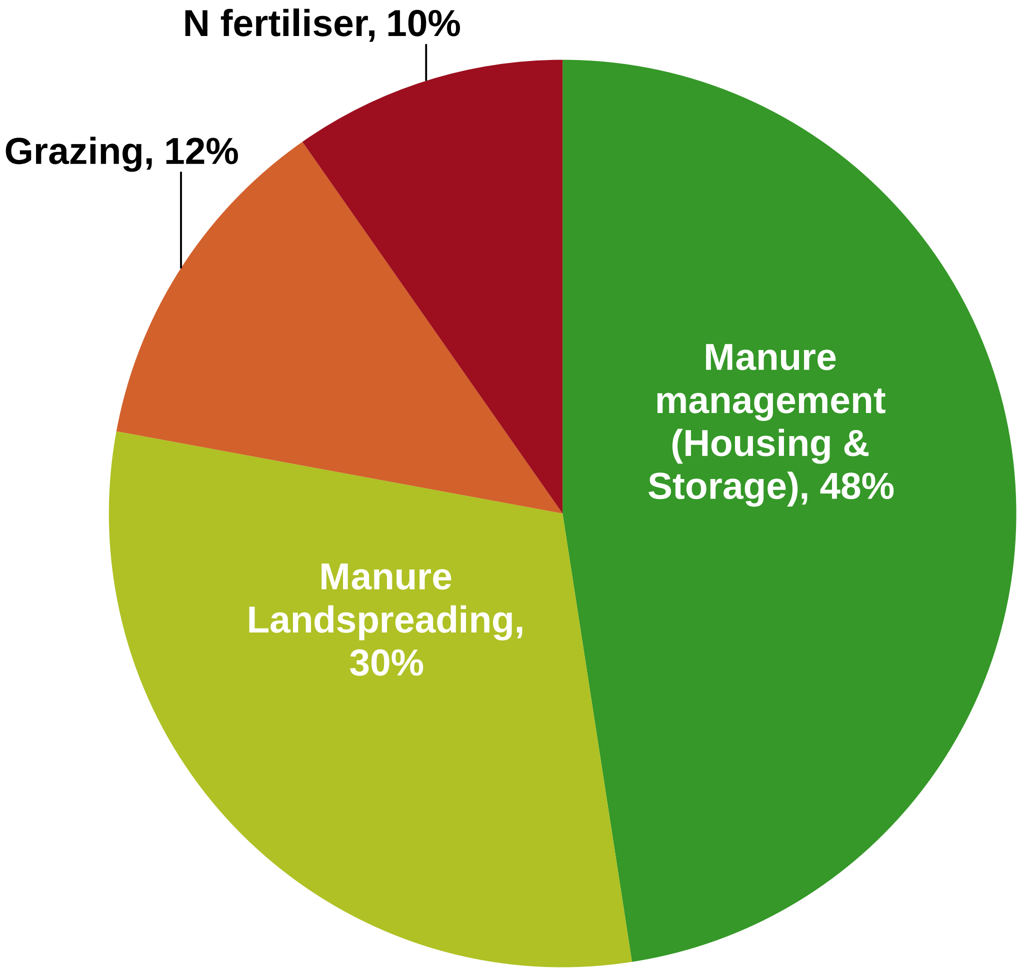
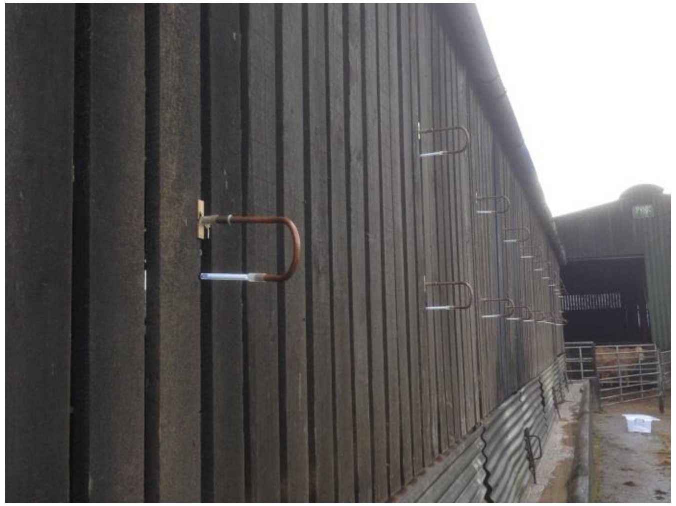
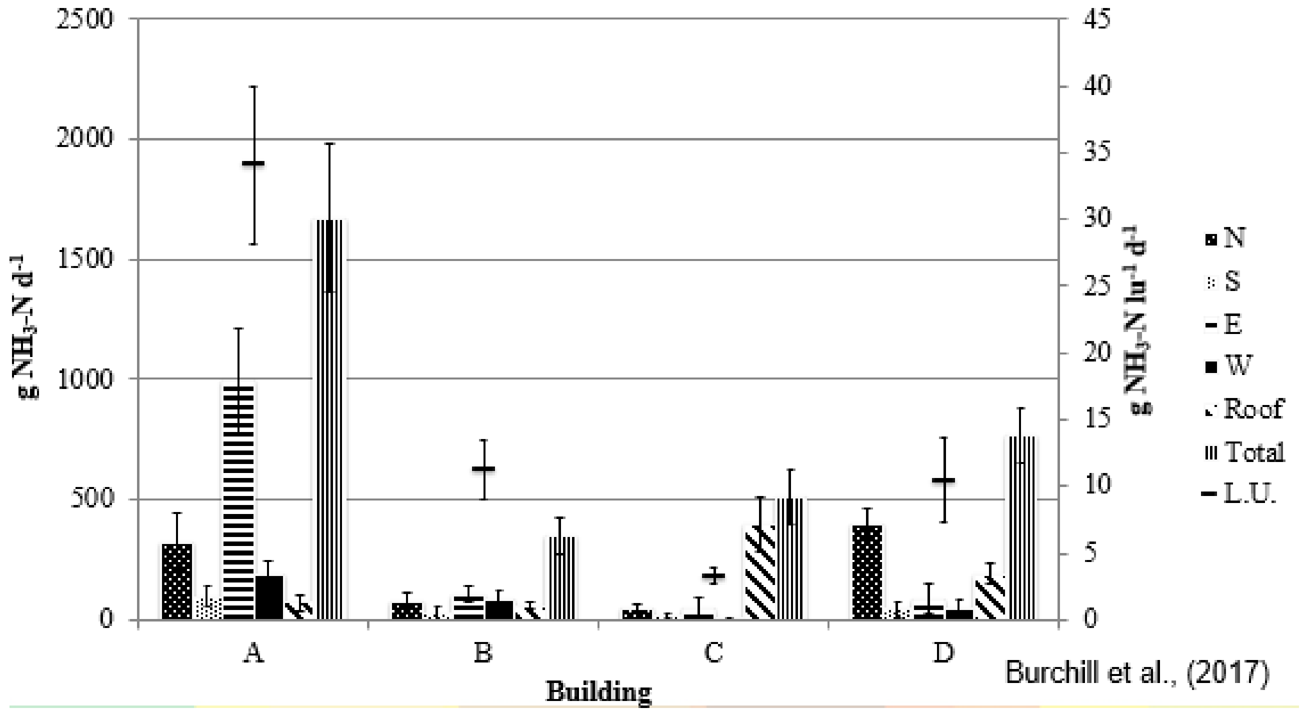
Sources of ammonia in Irish Agriculture



EPA, 2019

Ammonia from housing





- High variability in emission levels between buildings and orientation (wind)
- Variable building designs
- Emissions factors higher from slatted (28%) vs straw-based solid floors (17%)
- Large N loss pathway

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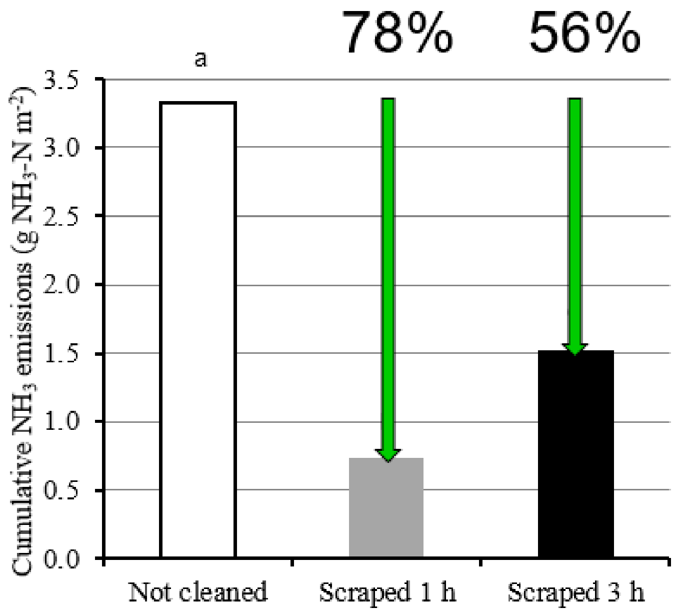
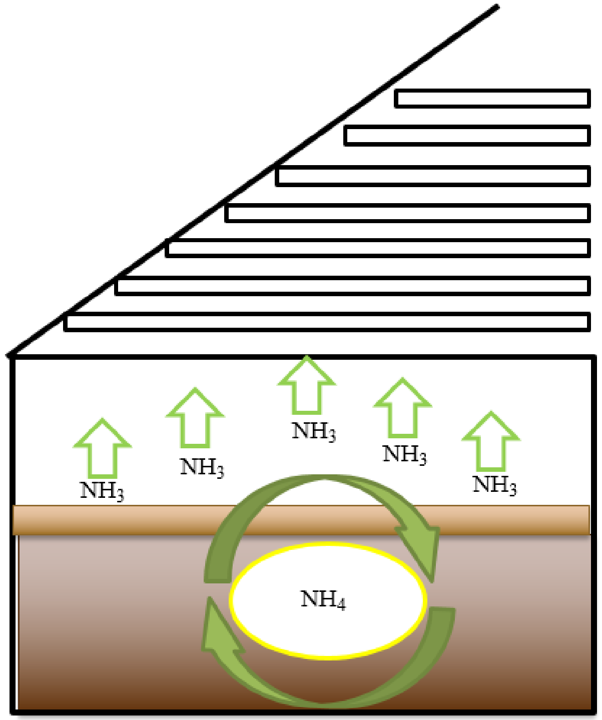
Ammonia from housing - mitigation

- Scrapers
- Washing scraped surfaces
- Floor design:
  - Slope
  - Urine channels
  - Grooved floors / slats
  - Slat mats +/- non-return valves
- Additives on floor surface
- Reducing crude protein in diets
- Reducing housing length (extended grazing)



Ammonia from slurry storage



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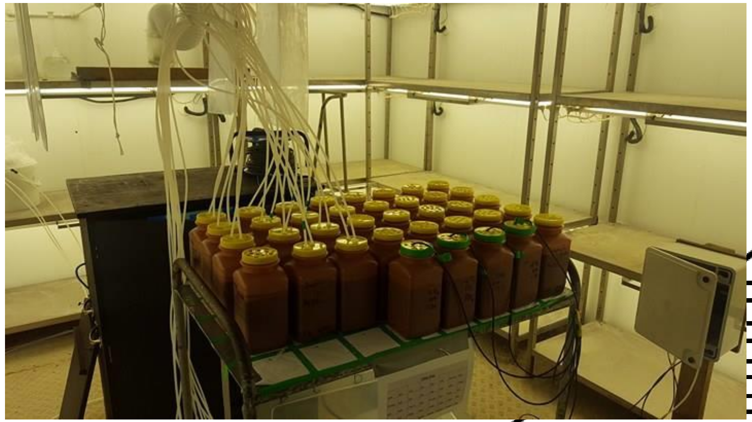
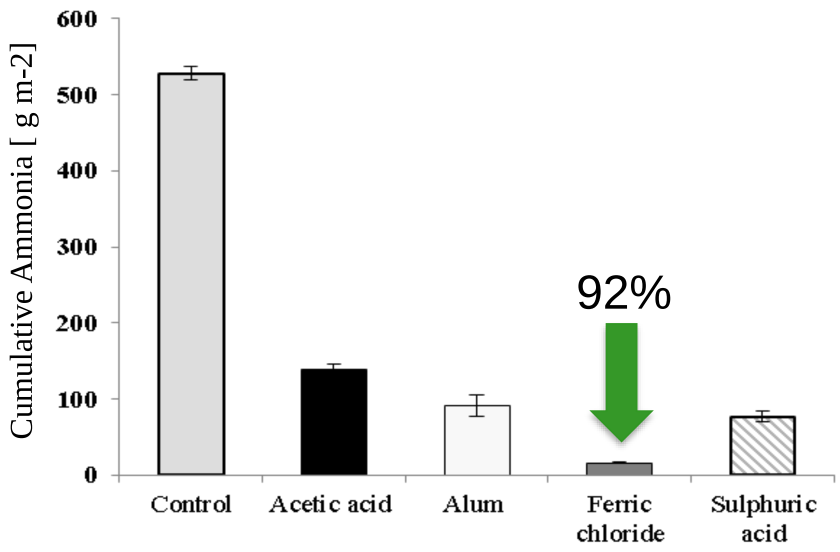
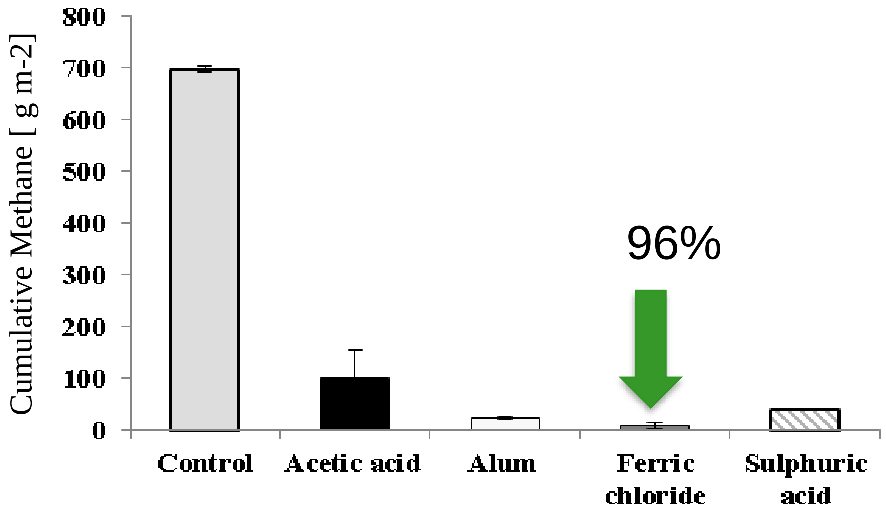


Ammonia from slurry storage - mitigation





Ammonia from slurry storage - mitigation

Amendment	Impact on gaseous losses / Efficacy			Reference
	Ammonia	Methane	Nitrous oxide	
In storage				
Alum	82% ↓	96% ↓	N/A	Kavanagh et al. 2019
Ferric chloride	96% ↓	98% ↓	N/A	Kavanagh et al. 2019
Acetic acid	73% ↓	94% ↓	N/A	Kavanagh et al. 2019
Sulphuric acid	85% ↓	95% ↓	N/A	Kavanagh et al. 2019
Sugar beet molasses	~65% ↓	~80% ↑	N/A	Kavanagh et al. 2021
Apple pulp	~50% ↓	~30% ↑	N/A	Kavanagh et al. 2021
Grass silage effluent	~40% ↓	~60% ↓	N/A	Kavanagh et al. 2021
Spent brewer's grain	~25% ↓	~150% ↑	N/A	Kavanagh et al. 2021
Commercial A	-	-	N/A	Kavanagh et al. 2021
Commercial B	-	-	N/A	Kavanagh et al. 2021
Commercial C	-	-	N/A	Kavanagh et al. 2021
Commercial D	-	10% ↓	N/A	Kavanagh et al. 2021
At landspreading				
Alum	92% ↓	-	202% ↑	Brennan et al. 2015
Ferric chloride	54% ↓	99% ↓	154% ↑	Brennan et al. 2015
Polyaluminium chloride	65% ↓	121 ↓	29% ↓	Brennan et al. 2015
Biochar	77% ↓	-	62% ↓	Brennan et al. 2015

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Ammonia from slurry storage - mitigation

Nitrogen flow

Housing

Storage

Spreading

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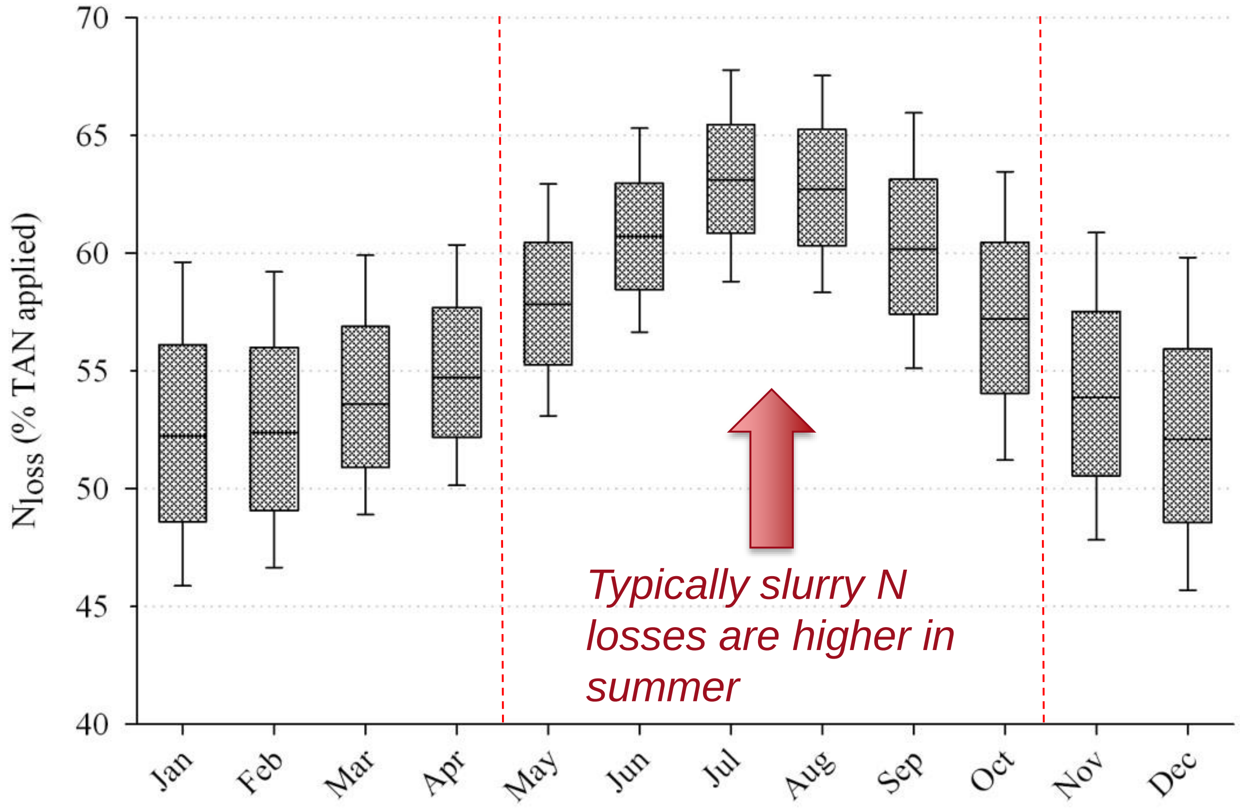
Ammonia from slurry spreading

- Ammonia emissions increase in dry, sunny & windy weather
- Majority of N loss occurs within 24 hours after application

Effect of season on potential NH3 volatilisation



Lalor & Lanigan (2010)
Søgaard et al. (2002)

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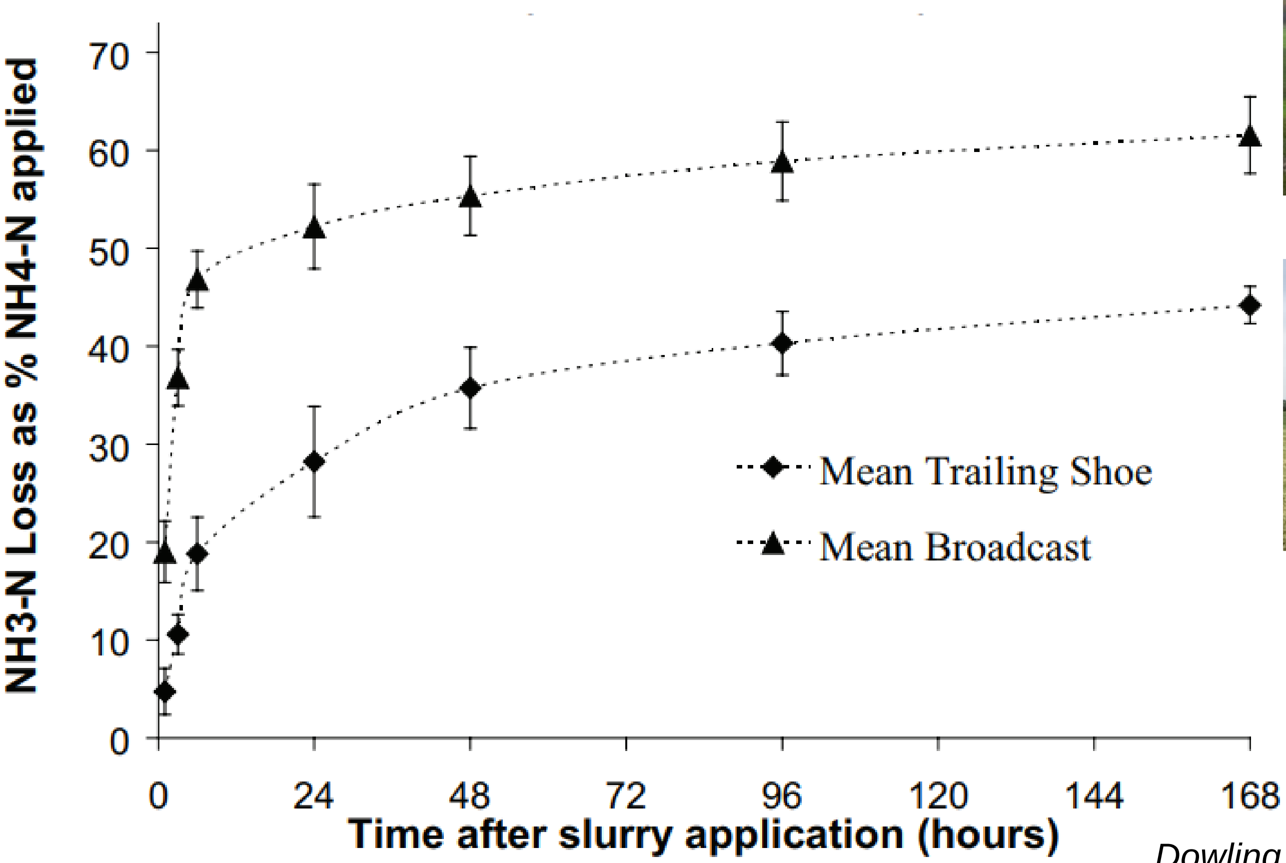
Ammonia from slurry spreading - mitigation



Dowling et al. (2010)

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Ammonia from slurry spreading - mitigation

Slurry landspreading emission factors on grassland (as proportion of TAN)	Splashplate	Trailing hose (30% reduction)	Trailing shoe (60% reduction)	Injection (70% reduction)
Spring & Autumn	26 %	18.2 %	10.4 %	7.8 %
Summer	48 %	33.6 %	19.2 %	14.4 %

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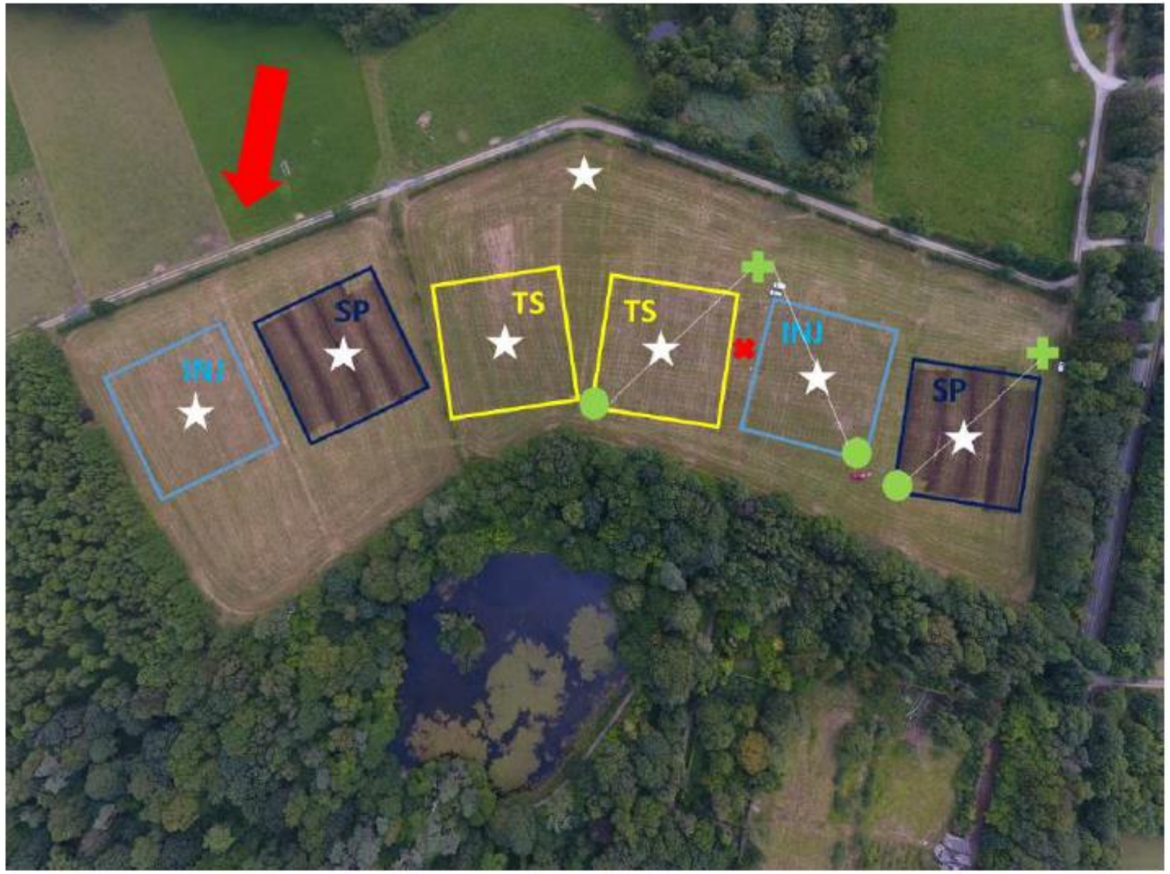
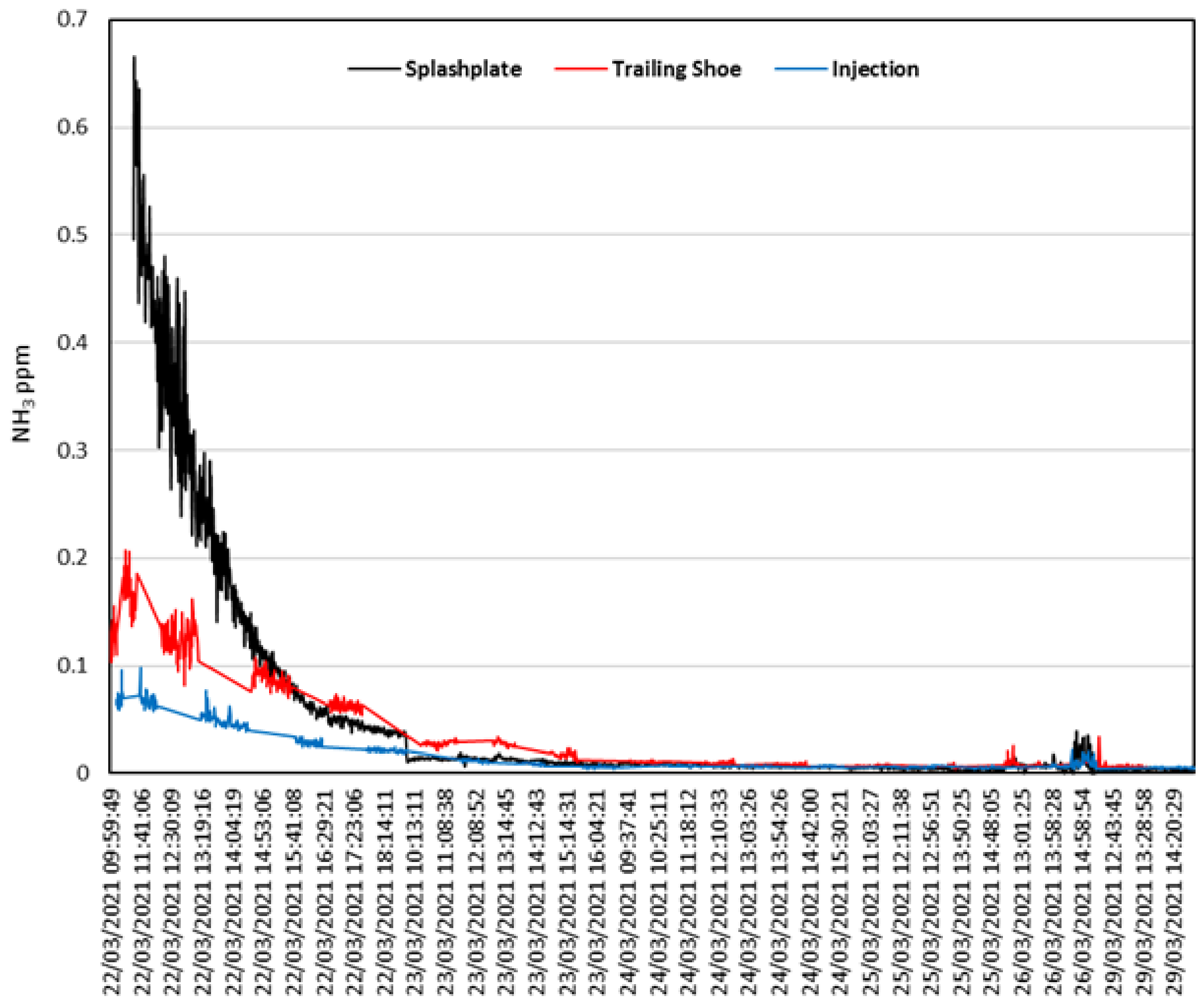
Ammonia from slurry spreading - mitigation



SP- splash plate
TS - trailing shoe
INJ – injection
IHF mast
met station
FTIR
mirror position
FTIR path
prevailing wind

Ammonia from slurry spreading - mitigation



Publication in preparation

Triple-A

Abating Ammonia in Agriculture

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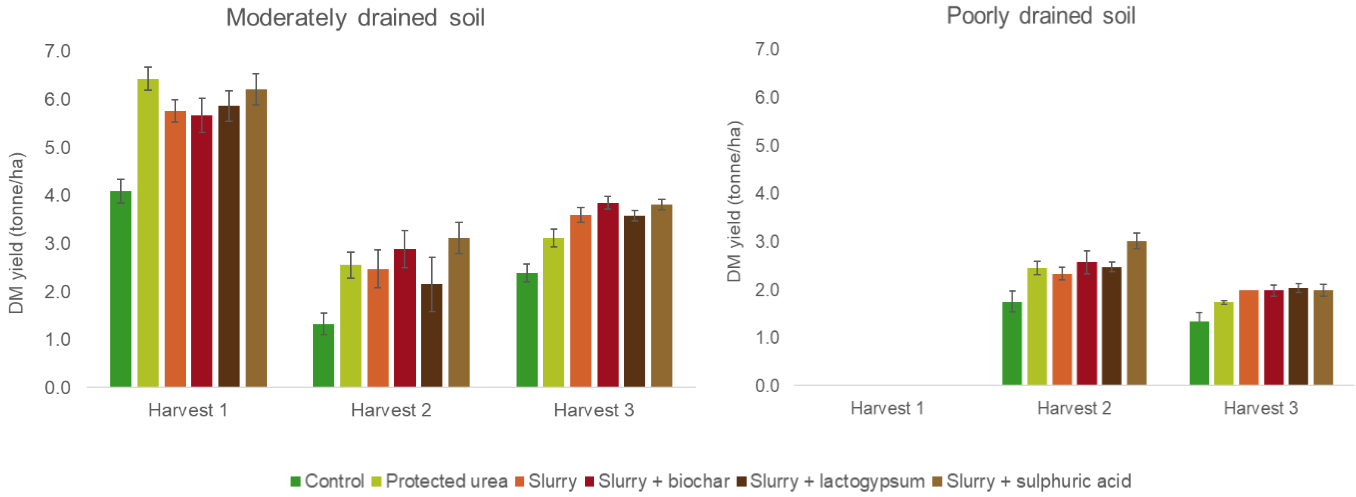
Ammonia from slurry spreading - mitigation



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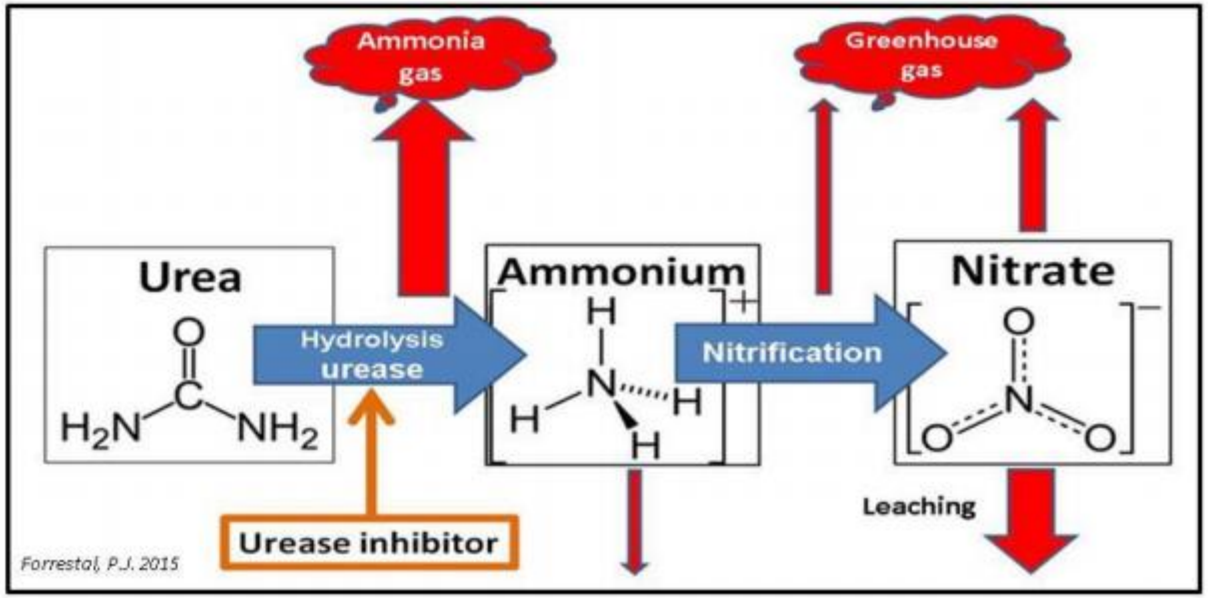
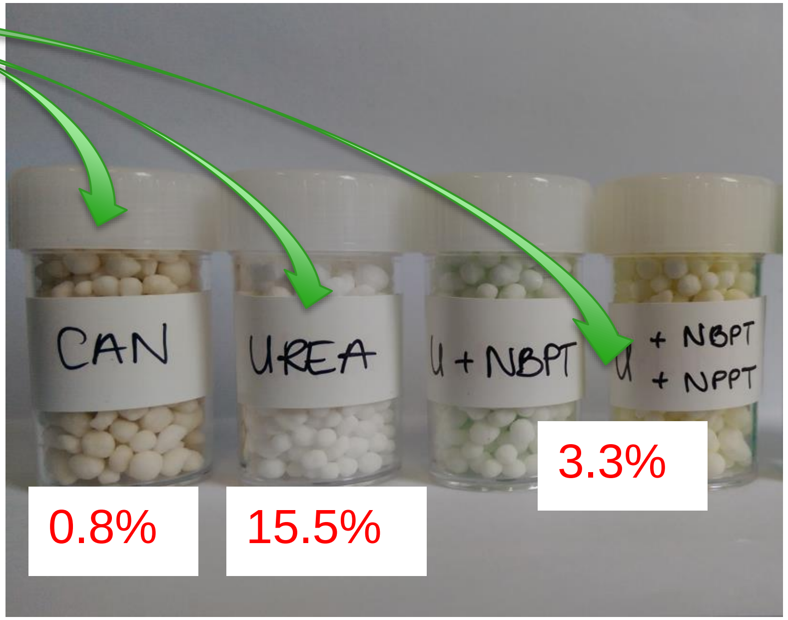
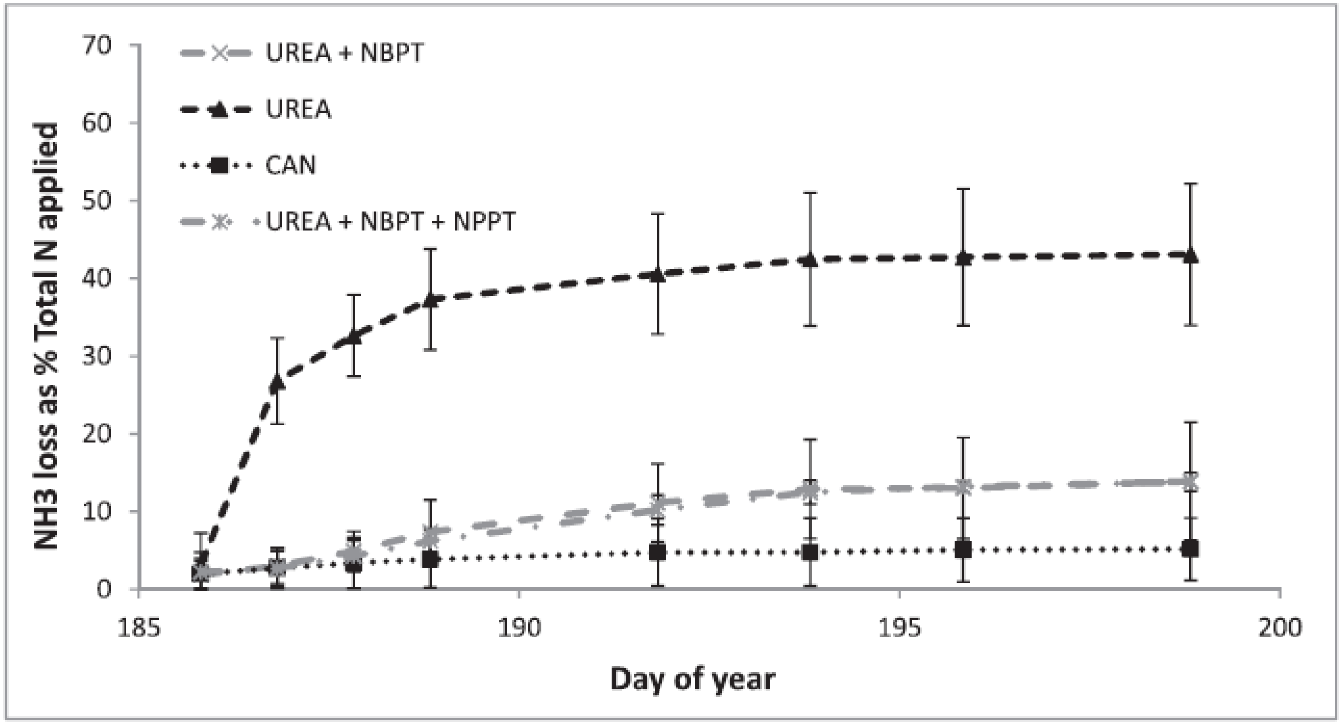
Ammonia from fertiliser - mitigation





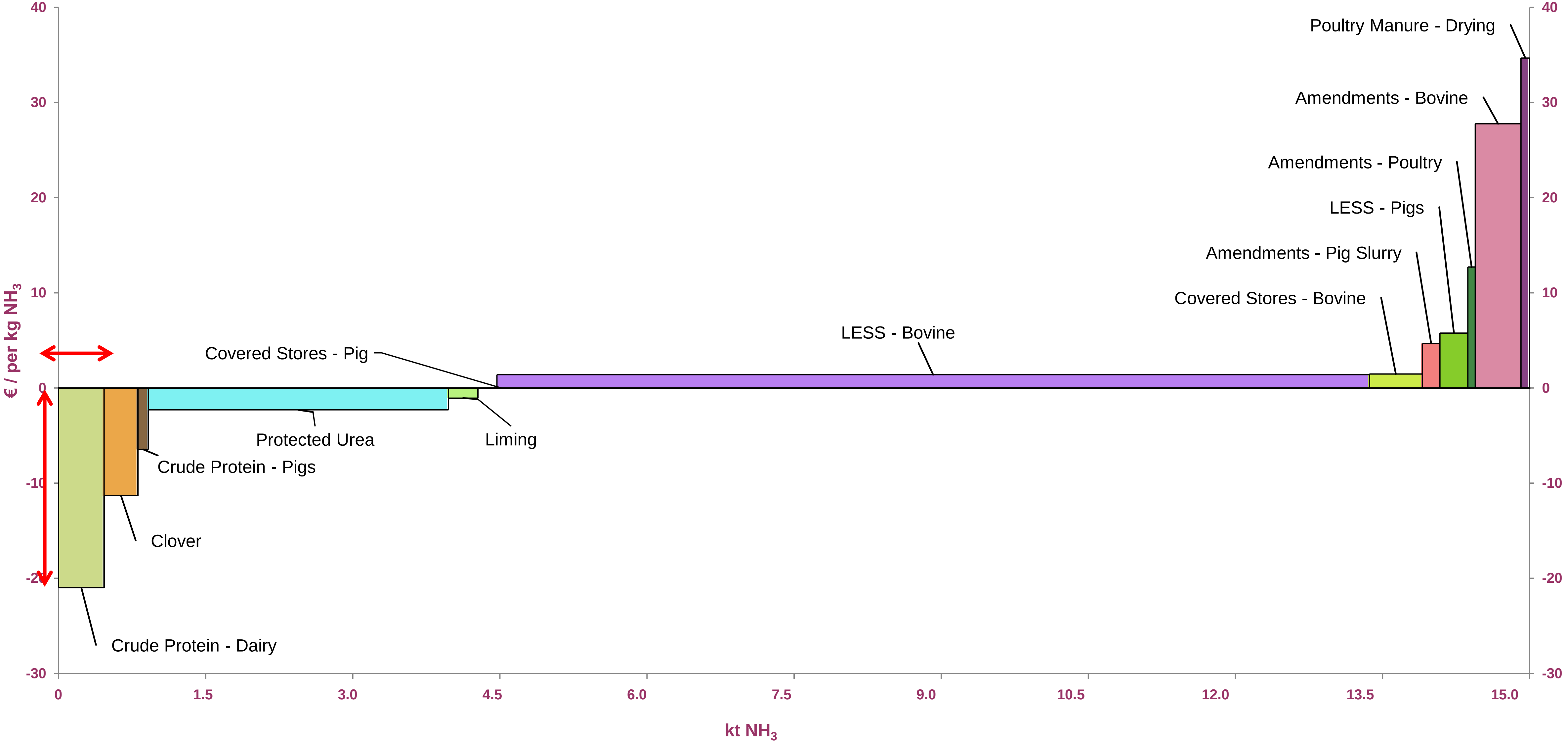
Ammonia from fertiliser - mitigation

D.J. Krol et al. / Science of the Total Environment 725 (2020) 138329



Reducing fertilisation rate by increasing NUE – LESS, liming, clover, MSS

Ammonia MACC



Buckley C. & Krol D.J. (eds.) 2020 An Analysis of the Cost of the Abatement of Ammonia Emissions in Irish Agriculture to 2030, Teagasc .

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