TEAGASC RESEARCH INSIGHTS

LEADING RESEARCH FOR TOMORROW'S AGRI-FOOD SYSTEMS

Overview of new MACC – methodology, key findings and potential impact

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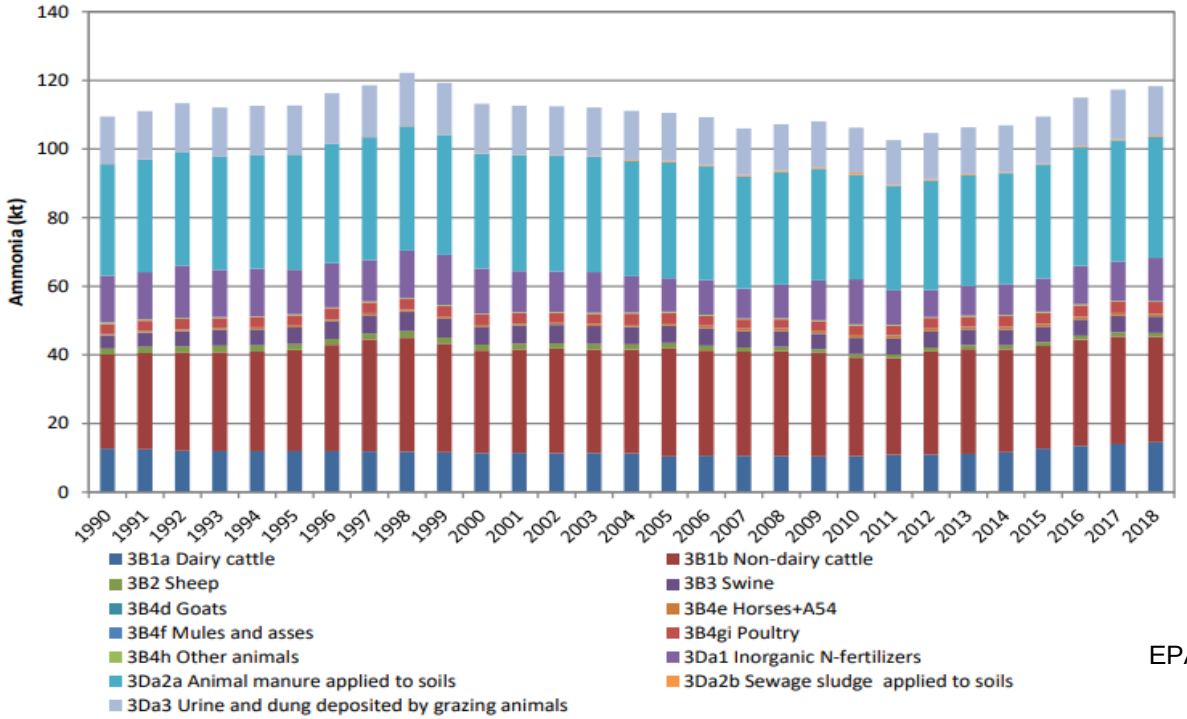
Overview of the presentation

- Ammonia – Introduction and Challenges
- MACC Methodology
  - Emission factors
  - Activity data
- Example of implementation of abatement pathway
- Results of mitigation
- Impact on national emissions profile

Importance of ammonia

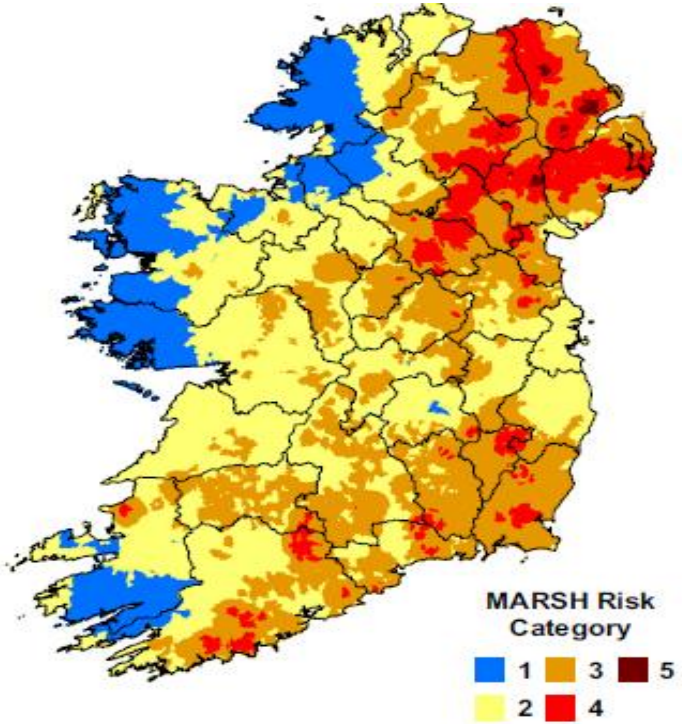
- 99% ammonia produced by agriculture
- Negative impacts on health and ecosystems
- Regulated by the National Emissions Ceiling Directive (NECD) and Habitats Directive

Importance of ammonia



EPA, 2020

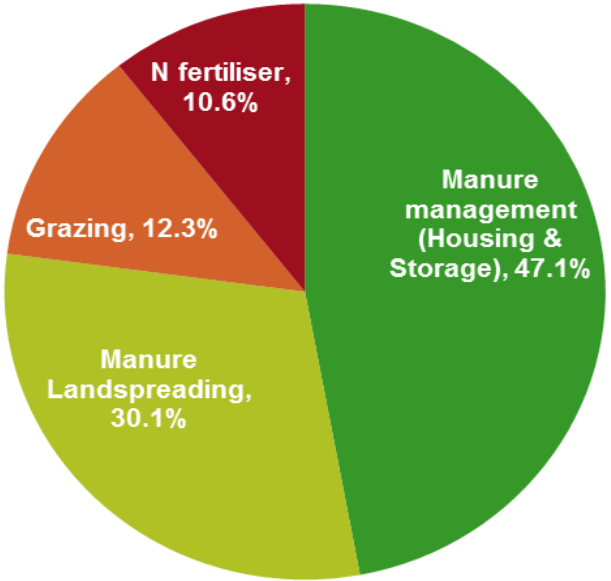
Importance of ammonia



Kelleghan et al., 2019

Ammonia challenge

- In breach of NECD since 2016
- 1% reduction relative to 2005, currently estimated at 112.13 kT NH_3 to be achieved in the 2020 commitment period
- 5% reduction relative to 2005, currently estimated at 107.5 kT NH_3 to be achieved in the 2030 commitment period



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Ammonia challenge

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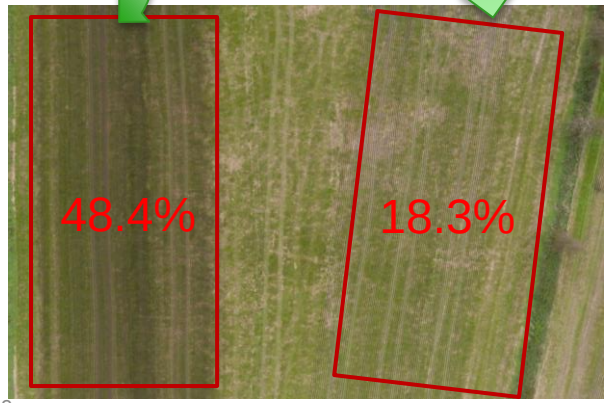
MACC Methodology

- MACC – Marginal Abatement Cost Curve
- Emissions = activity data x emission factors (EFs)
- Activity level scenarios 2021-2030 (FAPRI model)
- Emission factors from the EPA national inventory model (Duffy et al., 2020)

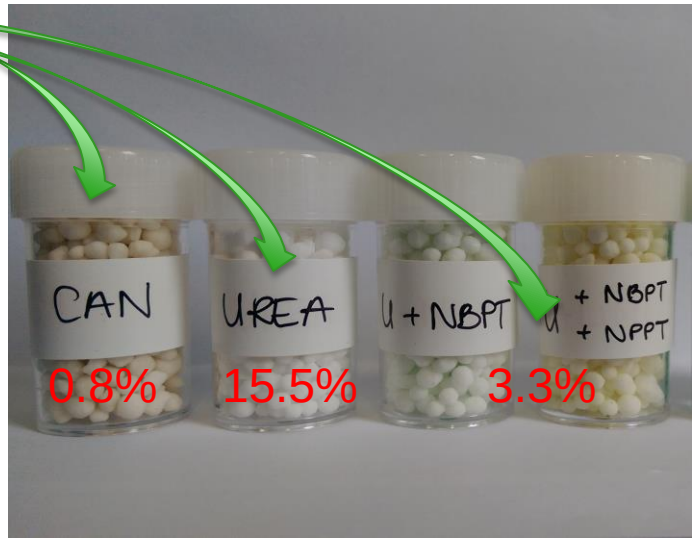
Emission factors

- Outlined for each measure in Chapter 4
- EFs in baseline vs EFs in mitigation

Emission factors



Emission factors



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Mitigation Measures – 13 in Total

- Fertiliser
  1. Protected urea (Ag. Climatise pathway – 100% urea and 50% CAN to PU by 2025)
  2. Liming (1.5% pa.)
  3. Clover (25% of Dairy farms)
- Bovine
  4. Low Emissions Slurry Spreading (Ag. Climatise pathway – 90% by 2030) – by contractors
  5. Crude Protein reduction in feeds (Dairy cow – 1%)
  6. Covering of slurry stores (67% increasing to 100% by 2030)
  7. Adding slurry amendments (30% by 2030)
- Pigs
  8. Low Emissions Slurry Spreading (Ag. Climatise pathway – 90% by 2030) – by contractors
  9. Crude Protein reduction in feeds (Finisher pigs – 1.8%)
  10. Covering of slurry stores (87% increasing to 100% by 2030)
  11. Adding slurry amendments (30% by 2030)
- Poultry
  12. Drying of Poultry Manure (100% by 2030)
  13. Adding slurry amendments (30% by 2030)

Activity level scenarios – FAPRI Ireland

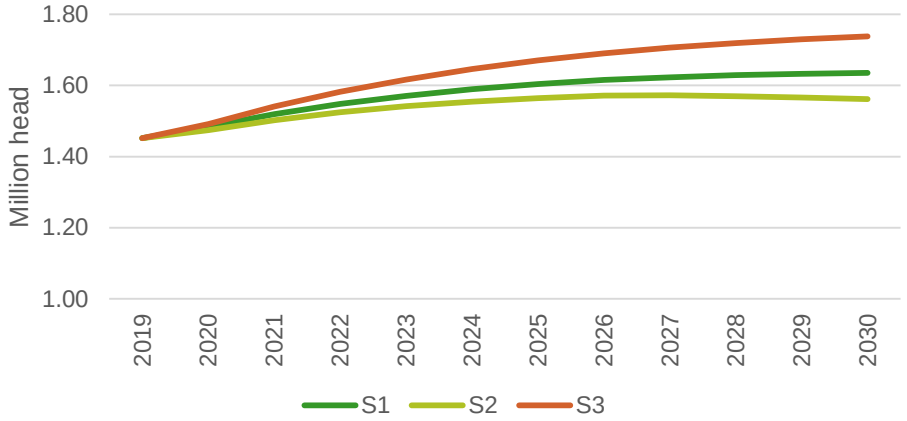
- 3 Activity level scenarios (S1 to S3)
  - FAPRI Ireland – provided to EPA in Q3 2019
  - BAU, low activity, high activity – sensitivity analysis

- S1 - Business as usual
  - No change under CAP
  - Soft Brexit

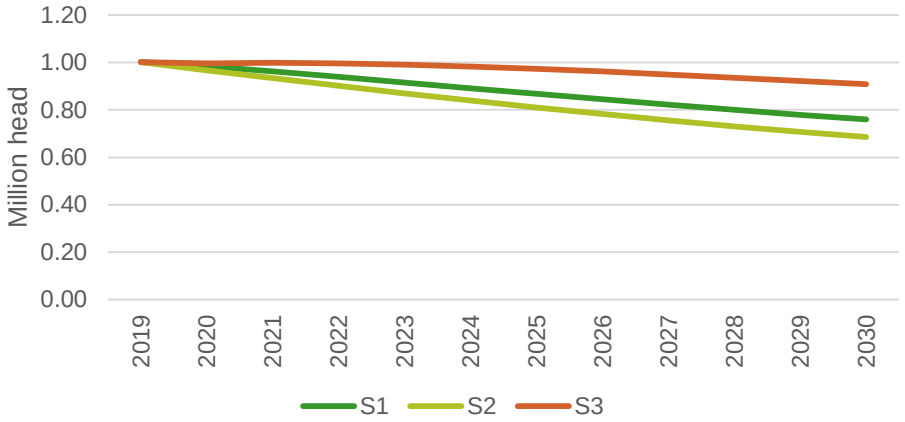
- S2 - Lower activity level
  - No change under CAP
  - Hard Brexit

- S3 - Higher activity level
  - CAP - Coupled payment on suckler cows
  - Soft Brexit

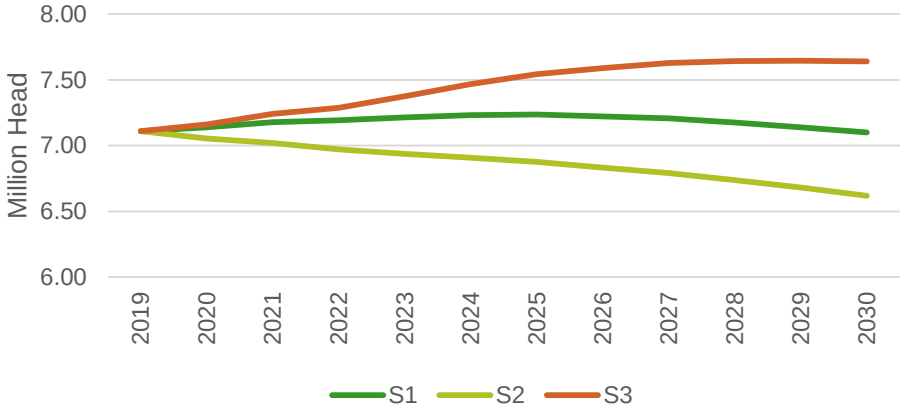
Dairy Cow Numbers



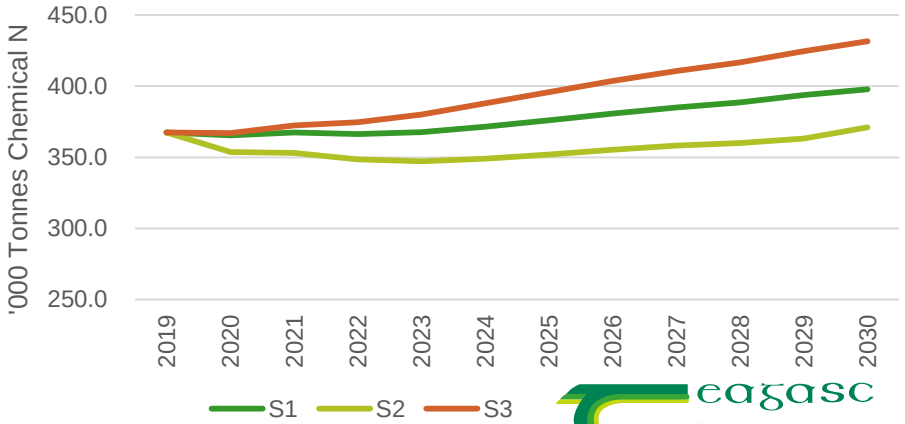
Suckler Cow Numbers



Total Bovine Numbers



Chemical Fertiliser Projections



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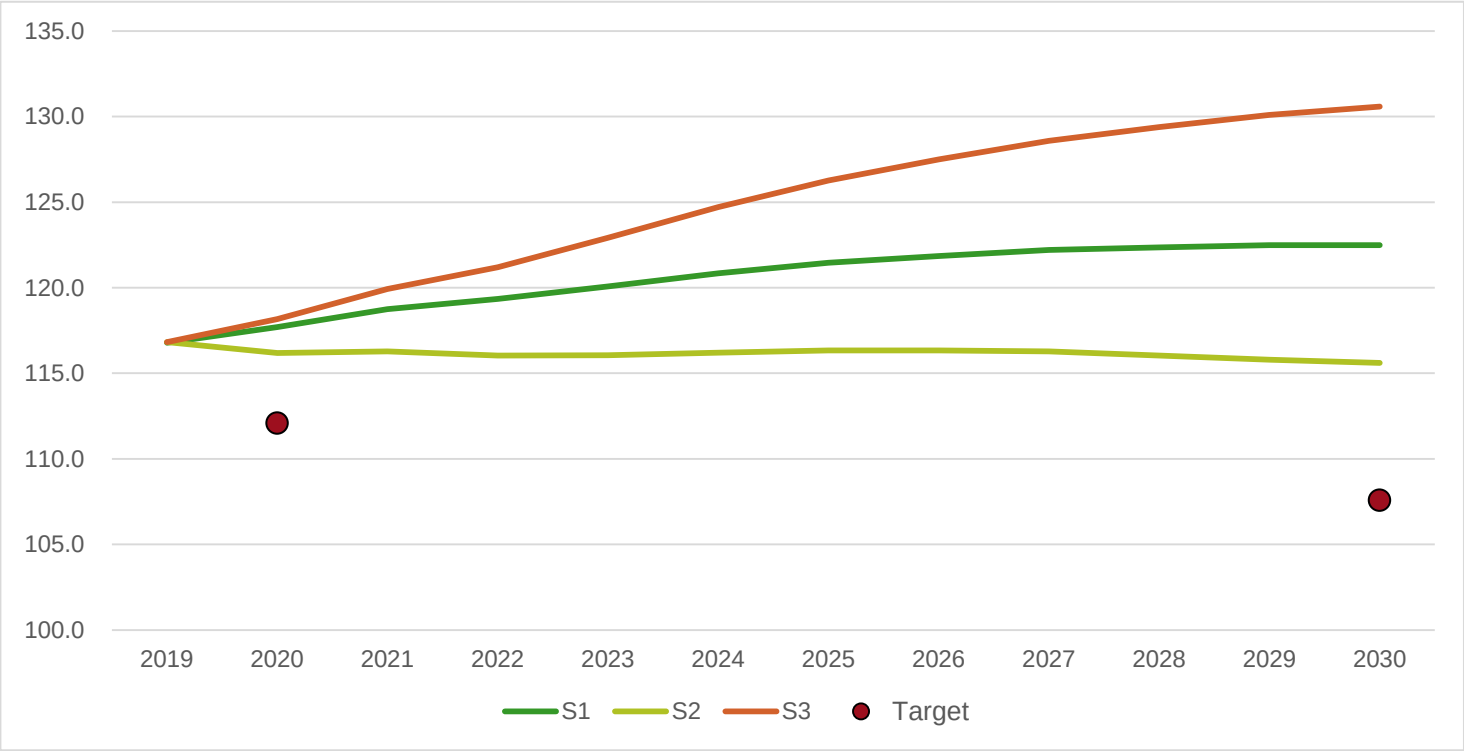
Ammonia emissions – no mitigation



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Example measure – Protected Urea

4.1 Fertiliser Measures

4.1.1 Protected Urea

Description

Adoption of the Ag-Climatise proposal….

Table 4.1: Results Protected Urea Fertiliser Mitigation Pathway

Abatement in 2030 (kilotonnes NH_3)	Cost in 2030 (€'million)	Average per annum abatement 2021-2030 (kilotonnes NH3)	Average per annum cost 2021-2030 (€'million)	Average cost efficacy (€ per kg abated)
3.27	-€9.25	3.11	-€7.15	-€2.30

Rationale

Outline of scientific evidence behind pathway……..

Assumptions

Mitigation

Adoption of the Ag-Climatise proposal….

Cost

Cost is based on the quantities and price of different fertilisers ……

National emission inventory capture mechanism

Recorded through sales of fertilisers …….

Barriers to uptake

Any constraints? ….

Modelling Approach - Protected Urea Example

- S1 Activity Level Baseline – No intervention / business as usual

Ag. Climatise - Protected Urea Pathway	Year									
Baseline Projections - S1	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Total Chemical N ('000 tonnes)	367.5	----------→								397.7
Straight CAN ('000 Tonnes - Chemical N)	135.5	----------→								146.6
High CAN - Low PK Compounds ('000 Tonnes - Chemical N)	123.3	----------→								133.4
High PK Compounds ('000 Tonnes - Chemical N)	55.4	----------→								59.9
Straight Urea ('000 Tonnes - Chemical N)	47.6	----------→								51.5
Protected Urea ('000 Tonnes - Chemical N)	1.8	----------→								1.9

Protected urea mitigation pathway - Assumptions

Assumptions - Mitigation Potential	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
% Quantity Substitution - Protected Urea for Straight Urea	33%	66%	100%	---------->						100%
% Quantity Substitution - Protected Urea for Straight CAN	10%	20%	30%	40%	50%	---------->				50%
% Quantity Substitution - Protected Urea for high CAN - Low PK Compounds	10%	20%	30%	40%	50%	---------->				50%

Fertiliser projections	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total Chemical N ('000 tonnes)	366.4	---------->								395.1
CAN - Straight ('000 Tonnes - Chemical N)	121.9	---------->								73.3
CAN - Low PK Compounds ('000 Tonnes - Chemical N)	111.0	---------->								66.7
High PK Compounds ('000 Tonnes - Chemical N)	55.4	---------->								59.9
Straight Urea ('000 Tonnes - Chemical N)	31.4	---------->								0.0
Protected Urea ('000 Tonnes - Chemical N)	42.3	---------->								190.8

Protected urea pathway - mitigation

- Change to S1 fertiliser activity level baseline with protected urea pathway adopted – Effect on NH3 (benefit side)

Emission Factors (NH3 - g per kg)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CAN - Straight	8	----------→								8
CAN Compounds	15	----------→								15
Straight Urea	155	----------→								155
Protected Urea	33	----------→								33

Abatement Reduction / Increase (kilotonnes NH3)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Substitution Protected Urea for Straight Urea - NH3 Reduction	-2.0	----------→								-6.4
Substitution Protected Urea for Straight CAN - Increase in NH3	0.4	----------→								1.9
Substitution Protected Urea for Low PK Can Compounds – Increase in NH_3	0.2	----------→								1.3
Total Net Reductions incl. NUE (kilotonnes NH3)	**-1.38**	----------→								**-3.27**

Protected urea pathway - cost

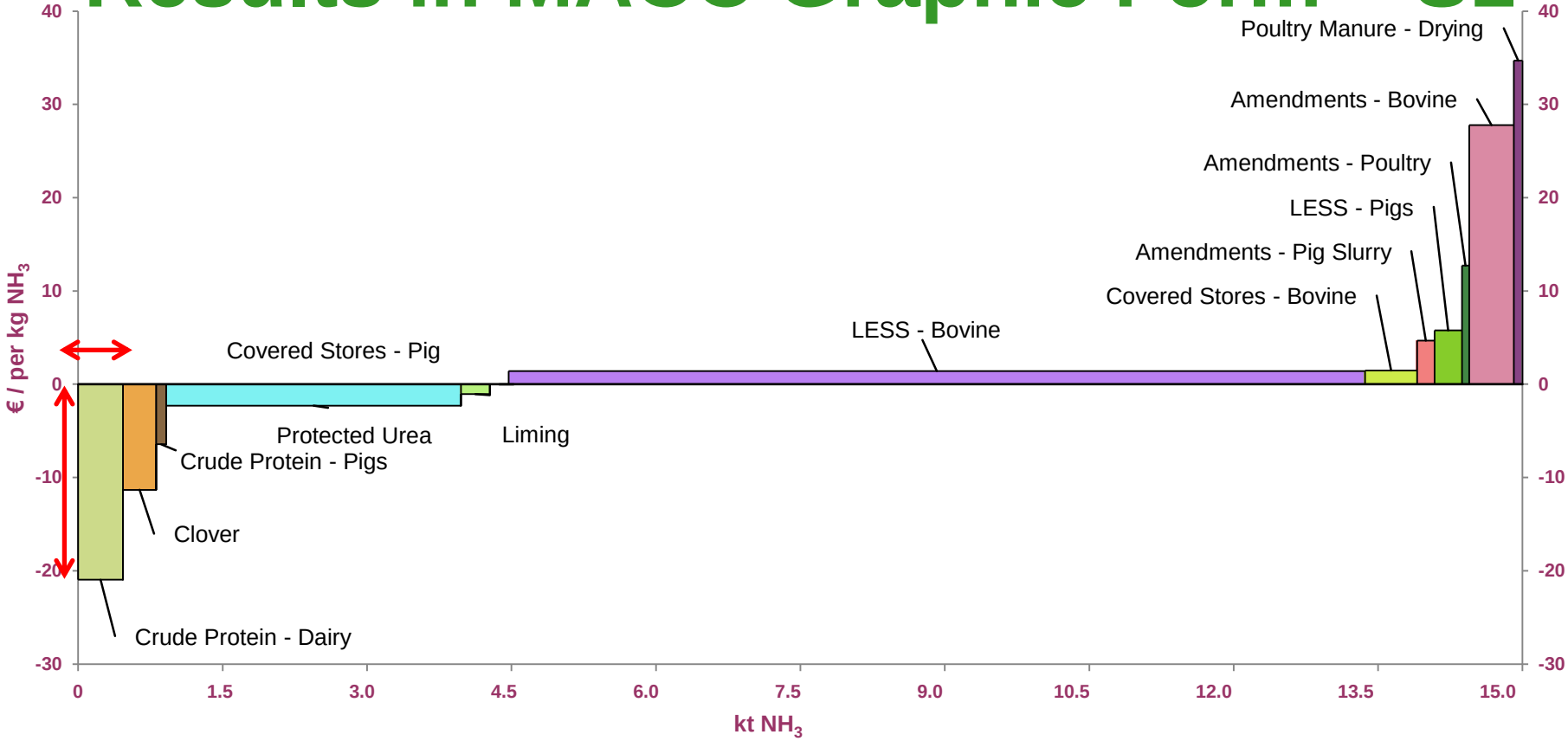
- Change to S1 fertiliser activity level baseline with protected urea pathway adopted – Effect on cost side

Assumptions - Costs	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Chemical N savings ('000 tonnes) versus baseline	-1.11	→								-2.62
€ per kg Straight CAN	€0.89	→								€0.89
€ per kg in high CAN Compounds	€0.87	→								€0.87
€ per kg straight urea	€0.72	→								€0.72
€ per kg protected urea	€0.80	→								€0.80
Cost (CAN, Urea, P. Urea) - Baseline Fertiliser (€'million)	€263.5	→								€285.2
Cost (CAN, Urea, P. Urea) - Ag. Climatise Fertiliser Scenario (€'million)	€261.5	→								€276.0
Total cost / benefit €'million (negative sign is a saving)	**-€2.05**	→								**-€9.25**

Protected urea pathway - cost effectiveness

Ag. Climatise - Protected Urea Pathway	Year										
Assumptions - Mitigation Potential	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**Total**
Total Net Reductions incl. NUE (kilotonnes NH3)	-1.38	-2.81	-4.19	-3.65	-3.09	-3.13	-3.17	-3.20	-3.24	-3.27	-31.13
Assumptions - Costs											
Total cost / benefit €'million (negative sign is a saving)	-€2.05	-€3.41	-€5.13	-€6.91	-€8.74	-€8.85	-€8.95	-€9.04	-€9.15	-€9.25	-€71.49
Cost effectiveness											
€ per kg NH3 abated (negative sign is a saving)	**-€1.49**	**-€1.21**	**-€1.22**	**-€1.89**	**-€2.83**	**-€2.83**	**-€2.83**	**-€2.83**	**-€2.83**	**-€2.83**	**-€2.30**

Results in MACC Graphic Form – S1



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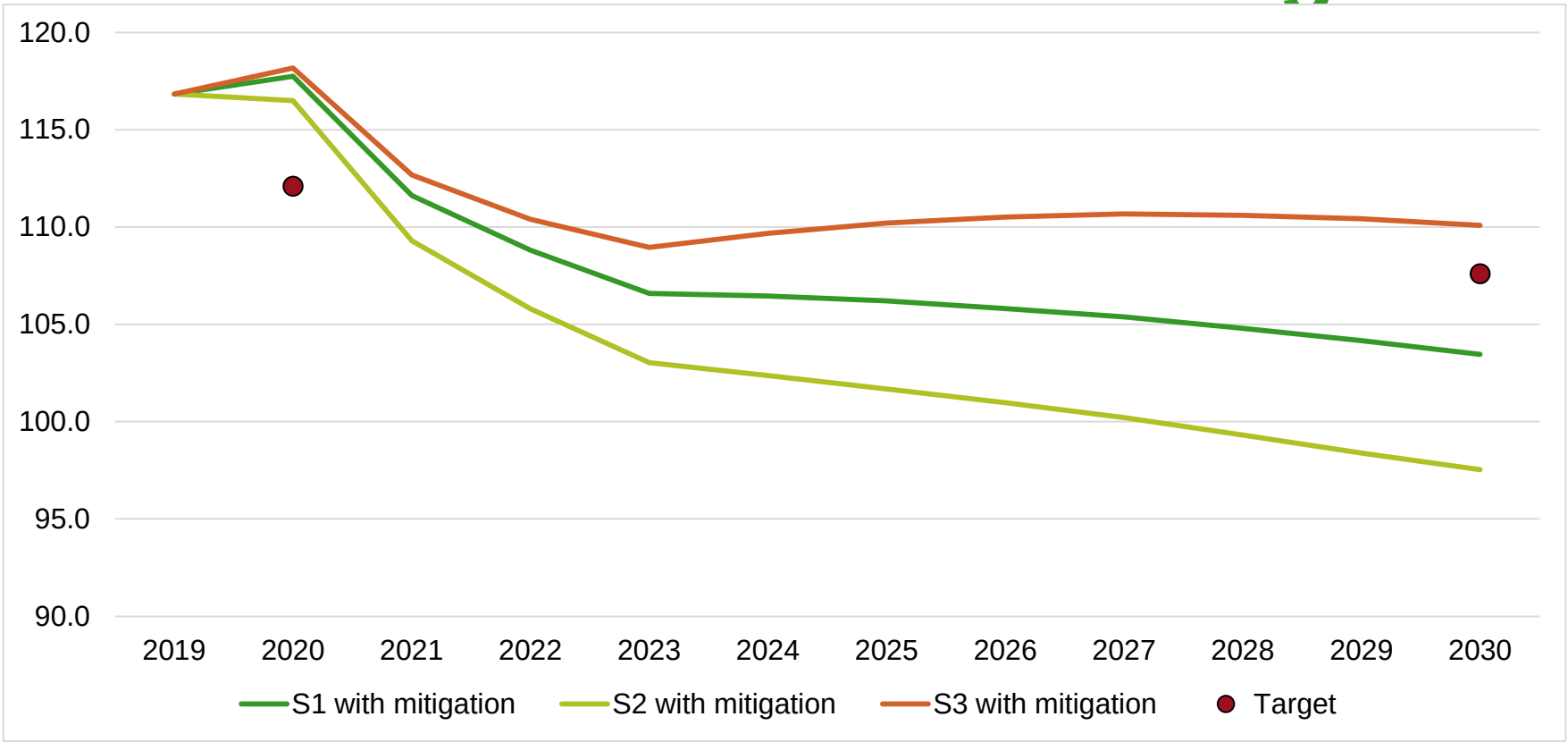
Ammonia emissions with mitigation



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Achieving impact - Caveats

- Uncertainty around activity levels (Brexit, Covid-19)
- Adoption rates
- Efficiency gains – will lead to an associated reduce in chemical N fertiliser at farm level
- Synergistic and antagonistic effect of measures on other environmental dimensions (GHG, water quality, biodiversity)

Take home messages

- 13 Measures explored
  - Significant overall abatement potential
  - All predicated on improving NUE and reducing N use
  - Diverse range of abatement potential (0.08 to 9.04 kt)
  - 6 measures cost negative (-€22.21 million) & 7 cost positive (€33.07 million)

- 80% of abatement can be achieved by 2 of the pathways
  - LESS for bovines (€1.40 per kg NH_3 abated)
  - Switch to protected urea fertiliser (-€2.30 per kg NH_3 abated)

https://www.teagasc.ie/media/website/publications/2020/NH3-Ammonia-MACC.pdf

THANK YOU FOR YOUR ATTENTION





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