# Balancing Emissions and Sustainability in Irish Agriculture

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## 1. Introduction

Agricultural production is a major source of both greenhouse gas (GHG) and ammonia emissions. Reducing GHG emissions is crucial to mitigating climate change and keeping global warming below 2 degrees and as close to 1.5 degrees as possible. In addition, reducing ammonia emissions protects air quality, ecosystems, and human health by preventing pollution and acidification of soils and water bodies. Both are vital for ensuring environmental sustainability and long-term public well-being.

There are different ways of expressing the amount of emissions that result from the production of food. The first is the carbon intensity or kg $CO_2e$ $kg^{-1}$ food produced, which is an efficiency metric and is important metric for consumers. The carbon intensity of food, varies considerably for the same food products between countries and is an important metric for the international reputation of Irish food (Shalloo and Herron, 2024). Another option is expressing the total amount of emissions on a hectare or farm basis. While a low carbon intensity is good, it can still result in high levels of emissions per hectare in intensive farming systems producing more food output per hectare. These different ways of expressing emissions can lead to confusion, particularly when seeking to achieve national reduction targets, which focus exclusively on the total emissions generated, as reported in the national inventory, rather than emissions intensity per unit of output.

In Ireland, GHG abatement is guided by the Climate Action and Low Carbon Development (Amendment) Act 2021. It commits to a 51% reduction in GHG emissions by 2030 and achieving climate neutrality by 2050. At the EU level, the European Climate Law enshrines the goal of climate neutrality by 2050 and a 55% reduction in GHG emissions by 2030, both part of the broader European Green Deal. In Ireland, the agricultural sector target for 2030 is a 25% reduction in emissions compared to 2018. The EU have also set a Land-Use, Land-Use Change and Forestry (LULUCF) target for Ireland to reduce emissions by 0.626 $MtCO_2e$ compared to a 2016-2018 reference level.

The objective of this paper is to summarise the current agriculture and LULUCF emission trends, sources of emissions and mitigation potential to meet the Irish and international emissions commitments.

## 2. Emission trends and sources

Irish agriculture accounts for 38% of national GHG emissions in 2022 (EPA, 2024). The main agricultural GHG emissions sources are methane from enteric fermentation, nitrous oxide from agricultural soils and methane from manure management. Ireland agricultural emissions associated with the production of food are high due to the large amount of dairy and animal protein products that are exported globally. The emissions are dominated by methane produced during digestion and is a difficult gas to reduce without decreasing food production. The main sources and projections of GHG emissions relative to 2018 inclusive of mitigation are shown for Agriculture in Figure 1 and LULUCF in Figure 2.

Agricultural GHG emissions are projected by the EPA to decrease to 18.15 $MtCO_2e$ by 2030 under the *with additional measures* scenario from the Teagasc MACC (Figure 3). However, in its analysis the EPA were unable to model 1.5 $MtCO_2e$ of mitigation in the Teagasc MACC primarily associated with diversification resulting in the reduction of animal numbers.

The LULUCF inventory has been significantly revised since 2018 resulting in major changes in historical emissions and future projections. While emissions from drained grasslands have been revised downward due to changes in the area (Tuohy et al. 2023) and the emission factor there have been increases in Wetland emissions (EPA, 2024). The GHG emissions associated with LULUCF are projected to increase, relative to the 2016-18 baseline of 4.18 $MtCO_2e$ to 4.91 $MtCO_2e$ in 2030 under the additional scenarios projection (Figure 2).

Agriculture accounts for 99.4% of national ammonia emissions, primarily from livestock production (90.4%) and urea fertiliser use (8.9%). Since 2018, emissions have steadily declined to 128.7 kt in 2022, but Ireland failed to meet the 2020 target and has been served with an EU infringement notice. The latest EPA projections, under *with additional measures* (Buckley *et al.* 2020), indicate that Irish $NH_3$ emissions will decline to 112.6 kt in 2030 and meet the emission reduction target (EPA, 2024).

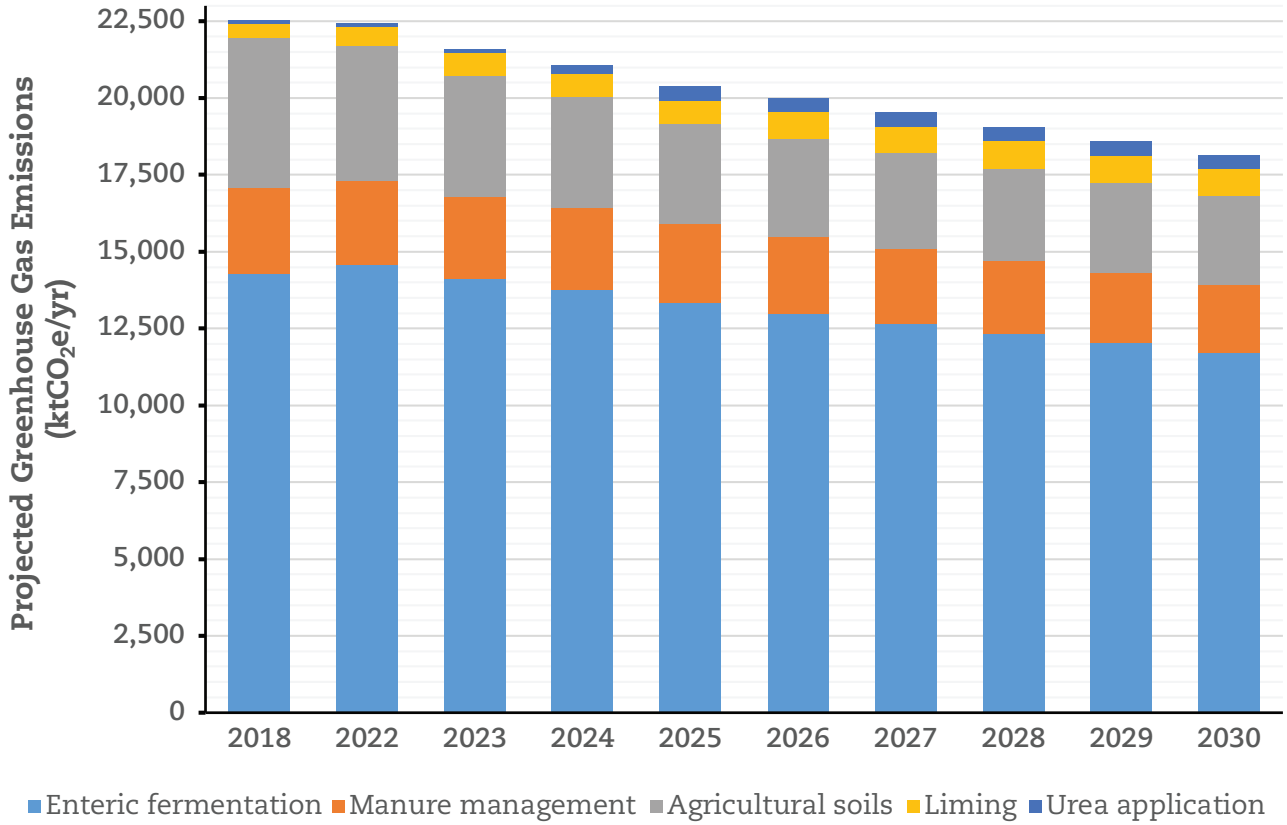


**Figure 1** Agricultural GHG emissions in 2018 and 2022 and projected emissions trends (with additional mitigation) from 2023 to 2030 including the source of emissions (Adapted from EPA, 2024).

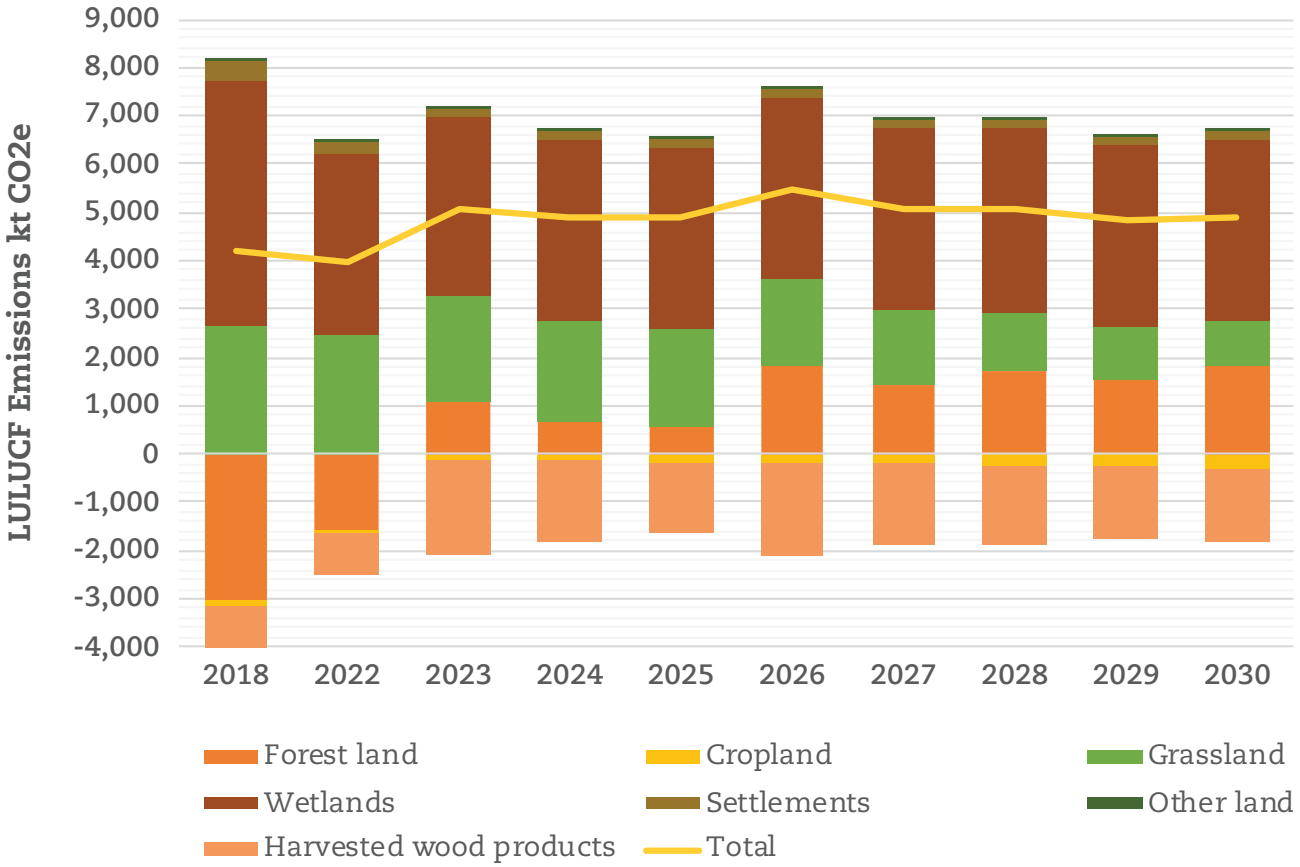


**Figure 2** Projected LULUCF emissions in 2018 and 2022 and projected emissions (with additional mitigation) from 2018 to 2030 including the source of emissions (Adapted from EPA, 2024).

## 3. Emission mitigation

Mitigation is required to reduce gaseous emissions from agriculture and LULUCF. The Teagasc MACC (Buckley *et al.*, 2020; Lanigan *et al.*, 2023) summarises the science on the current technical measures that are available to farmers and other landowners to reduce emissions and increase carbon sinks. The GHG mitigation potential in 2030 is summarised for agriculture (Figure 3) and LULUCF (Figure 4). Both of these MACCs show that there are a large number of technical measures to reduce emissions and the cumulative reductions in 2030 for agriculture was 4.9 $MtCO_2e$ and and 4.1 $MtCO_2e$ for LULUCF. Some of the measures, such as feed additives/supplements/slurry amendments, are at the advanced research stage, but are costly to implement, requiring incentives for farmer adoption. The MACC analysis highlighted that, under a stable to declining national herd, very ambitious and rapid adoption of measures would be required to meet the 2030 targets.

Currently good progress has been made on the implementation of some of the MACC measures such as reducing chemical fertiliser use, replacing urea and calcium ammonium fertiliser with protected urea and adoption of organic farming. The introduction of the national biomethane strategy and the new Forestry Programme 2023-2027 provide the policy support for these MACC measures and give farmers and land owners with viable diversification options. Reducing enteric methane emissions is progressing through feed additive research and was demonstrated on 18 Signpost farms in winter 2023. Progress on reducing the age of finishing has slowed and requires a whole industry support to achieve the 3 month reduction in finishing age of beef cattle. Further industry and government support is required by farmers to increase the adoption of measures and in particular measures such as methane reducing feed and manure additives that do not have production efficiency benefits and are a cost to farmers.

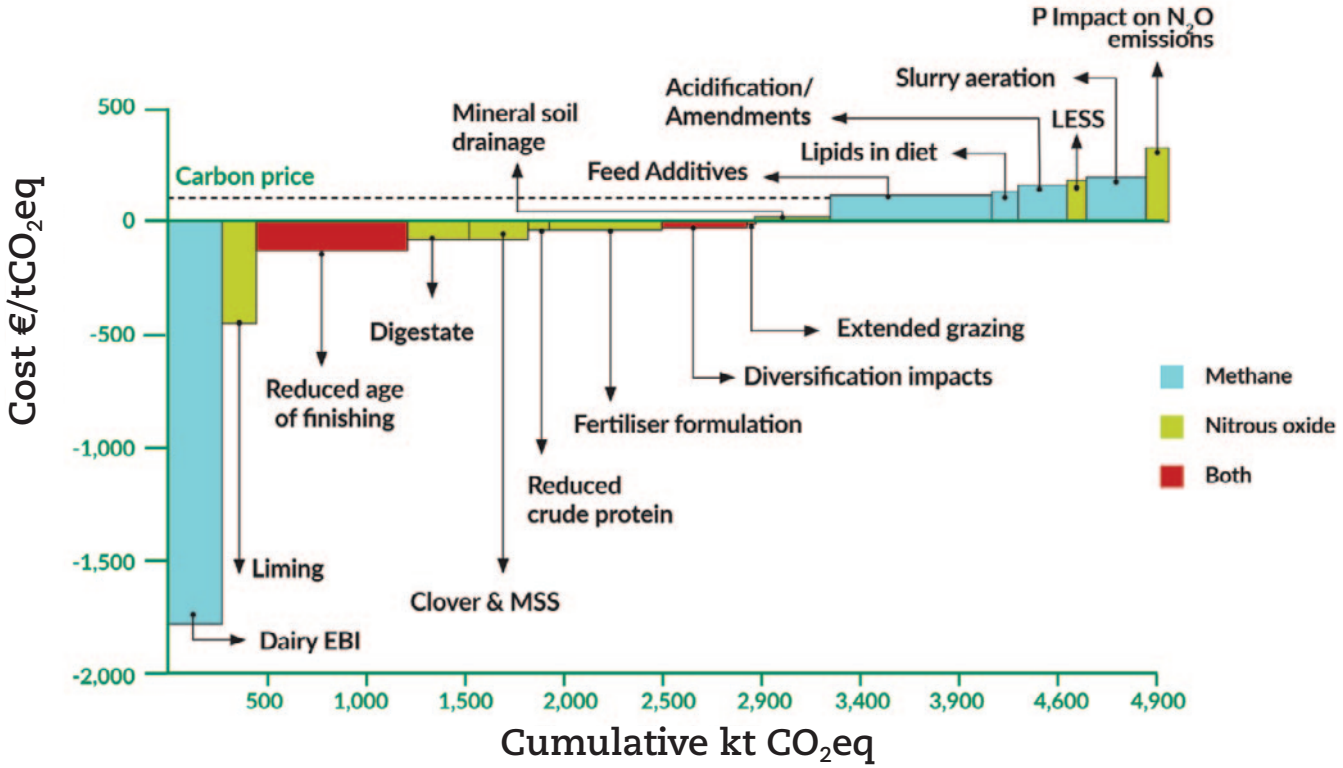


**Figure 3** The Agricultural MACC under very ambitious measure adoption (Lanigan *et al.* 2023). The horizontal axis is cumulative carbon reduction and the vertical axis is the measure cost.

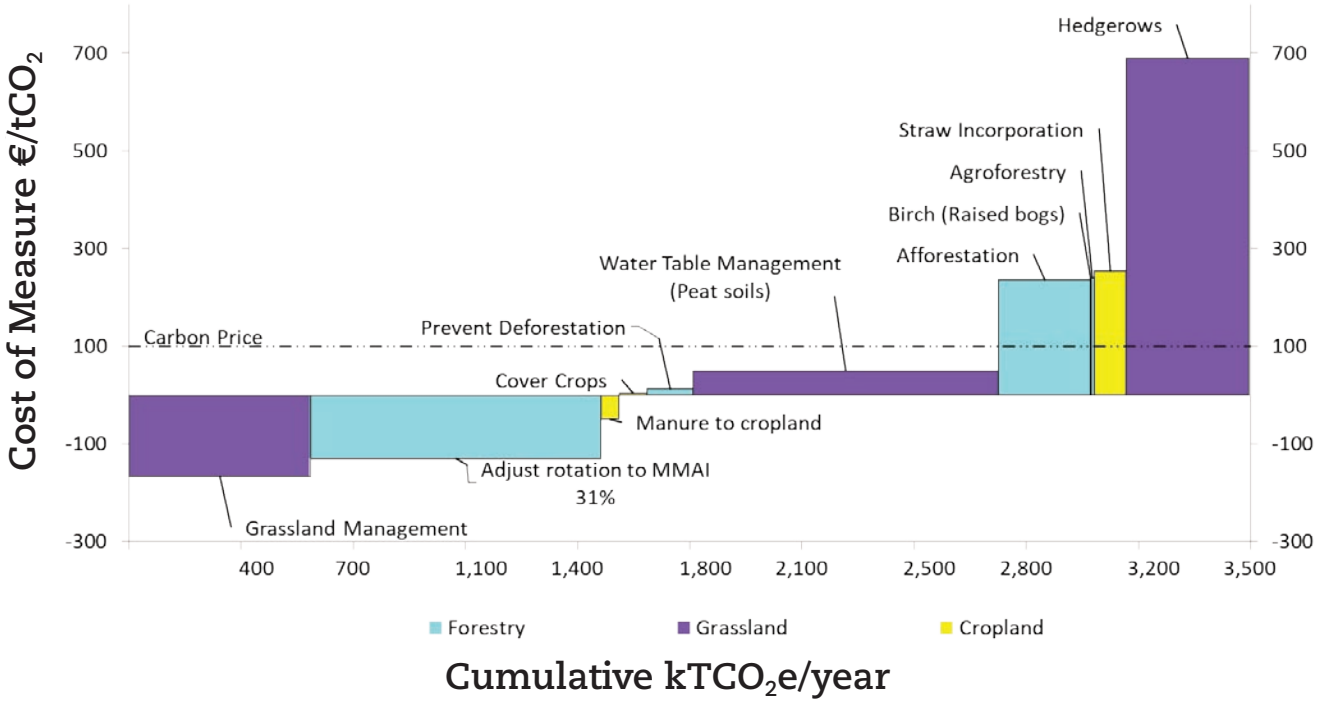


**Figure 4** The LULUCF MACC under very ambitious measure adoption (Lanigan *et al.* 2023). The horizontal axis is cumulative carbon reduction and the vertical axis is the measure cost.

The adoption of the MACC mitigation measures results in absolute emissions reductions and it will also reduce the carbon foot print of Irish dairy and meat products. The footprint of Irish food products is low in comparison to other EU countries. There is great potential to reduce the foot print further and contribute to absolute emissions reduction (Herron & Shalloo 2024).

### 4. Adoption of Mitigation Measures

There is a major industry and Teagasc initiative to promote the adoption of mitigation measures that are highlighted in the Teagasc MACC. The new Signpost advisory and farm demonstration programmes demonstrate best practice and enable farmers to develop their farm sustainability plan using the new sustainability tool AgNAV. These initiatives are a global first and demonstrate the prioritisation that the sector gives to mitigation of gaseous emissions.

The Teagasc MACC 2018 and 2023 have both highlighted that knowledge transfer is important, but will not be able to deliver the changes required on its own. Further policy and financial incentives are required to support farmers and landowners to reduce emissions and transition to meeting the target of climate neutrality 2050. Policy mechanisms led by government, such as regulation or supports, are needed to make adoption more attractive, particularly for measures that cost farmers money and lack production benefits. Private mechanisms/incentives led by the broader agri-food industry such as carbon farming, voluntary production standards or market based incentives are also needed to increase mitigation measure adoption at farm level.

### 5. Future research needs

Improving current mitigation measures, developing new measures and ensuring their adoption are steps that are urgently needed to reduce GHG emissions from agriculture and LULUCF. Increased focus is required on a. methane-reducing feed and slurry additives for grazed grasslands, b. breeding of low-emission ruminants, c. development of low nitrogen systems, and d. integrating trees into agricultural systems to enhance carbon capture, biodiversity, and water quality. Further research is needed to understand what influences adoption across different farm types, as a one-size-fits-all policy may not suffice. This will help identify barriers and enable policymakers to tailor a mix of incentives, regulations, education, and outreach to boost the adoption of mitigation measures.

## Acknowledgements

Dr. B. Hyde (Environmental Protection Agency) for helpful comments on the paper. This research was conducted as part of the Teagasc Climate Centre.

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