Extended Abstract
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Paper/Poster Title	**Integrated Assessment of Farm-Level Mitigation Measures for Gaseous Emissions**

Abstract prepared for presentation at the 98th Annual Conference of The Agricultural Economics Society will be held at The University of Edinburgh, UK, 18th - 20th March 2024.

Abstract	***200 words max***
Gaseous emissions continue to pose a serious threats to human health and the environment locally, regionally and globally. This has resulted in several studies advocating for the implementation of mitigation measures to reduce the emissions of harmful gases. While the vast majority of studies focus on a single type of gas, much less attention has been paid to the complementary or conflicting effects of mitigation measures across multiple gaseous emissions dimensions. To address this research gap, this study uses Irish farm level data to assess the holistic costs and benefits of a suite of mitigation measures that have the potential to abate greenhouse gases, ammonia or both. A cost-benefit analysis framework is employed to access the impact of the mitigation measures across five different farm system types. Results indicate that the relative effectiveness of the mitigation measure varies depending on the gaseous emission dimension being examined. Analyses that fail to account for such synergistic and antagonistic impacts may lead to erroneous policy decisions.	

Keywords	**ammonia, multi-pollution, GHG, mitigation, trade-off.**
JEL Code	Sustainability Q56 see: www.aeaweb.org/jel/guide/jel.php?class=Q)

Introduction

The environmental impacts of greenhouse gas (GHG) and ammonia (NH_3) emissions continue to pose serious concerns for Irish, European and global agriculture (Emmerling et al., 2020; EPA, 2022b; Hyde et al., 2021; OECD, 2019). On one hand, GHG emissions have far-reaching climatic impacts, both regionally and globally, leading to shifts in temperature, precipitation, relative humidity, and sunlight hours, as well as climatic shocks like floods, droughts, and hailstorms. This in turn, affect crop and livestock production (UN, 2023). NH_3 emissions on the other hand can impact the local ecosystem causing eutrophication and acidification of soils, as well as affecting human health directly through reduced air quality. NH_3 emissions can cause soreness of the eyes and throat, and impaired respiratory function due to the formation and inhalation of fine particulate matter ($PM_{2.5}$). This can be a contributory factor in premature death due to respiratory illness (Wyer et al., 2022).
Despite conscious national efforts to reduce gaseous emissions from agriculture, Ireland has been non-compliant in reaching its emission targets. The agricultural sector is responsible for 99.4% of the country's NH_3 emissions (Hyde et al., 2021) and 38.4% of GHG emissions (EPA, 2023). Previous emissions reduction targets across both these dimensions have not been achieved. Building on the previous work by (Buckley et al., 2020; Lanigan et al., 2018; Ogunpaimo et al., 2022, 2023), this study seeks to 1) Assess the synergistic or antagonistic effect of a suite of abatement measures across GHG and NH_3 dimensions simultaneously and

2) Explore the cost-benefit analysis of implementing these individual measures to reduce gaseous emissions.

Methodology

100 – 250 words

This study integrates the IPCC approach for accounting for GHG emissions (Duffy et al., 2022) and the framework for estimating NH_3 emissions under the EU NEC Directive at farm scale (Hyde et al., 2022) to assess the cost-effectiveness and cost-benefit analysis of a suite of mitigation measures. Emissions are estimated based on activity data related to an emission factor. This study uses farm level activity data from the Teagasc National Farm Survey (NFS) 2020, which is part of the European Union Farm Accountancy Data Network (FADN). A total of 812 farms were included in the analysis, this sample represents 90,000 farms in the national population based on weighting factors provided by the CSO. Data on NH_3 and GHG emission factors were obtained from the relative Irish National Inventory GHG and NH_3 reporting frameworks (Duffy et al., 2022; Duffy et al., 2020; Hyde et al., 2021; Hyde et al., 2022).

Results

100 – 250 words

When analysing the abatement potential of measures across different farm systems it was found that certain measures are better at reducing certain types of emissions than others. For instance the use of LESS measure was more efficient in reducing NH_3 emissions than GHG emissions, also the study revealed the presence of ancillary effects amongst abatement measures in reducing gaseous emissions. It's important to consider the heterogeneity of impact across different farm systems when looking at sustainable practices because different measures can have different effects in reducing gaseous emissions across farms which could lead to suboptimal decision-making if not considered. Also it is indicative that the overall impact of implementing these abatement options is beneficial (benefits outweigh the costs) for all the abatement measures across the different farm systems on average as against their use in reducing a single-pollutant.

Discussion and Conclusion

100 – 250 words

This research addresses a gap in knowledge by investigating the significance of variations in farming systems when analysing the cost and benefits of reducing gaseous emissions. Prior studies failed to consider the overall advantages of abatement measures for different types of farms. Results here indicate that assuming all abatement measures are beneficial for every farm is inaccurate. This paper investigated the synergistic and antagonistic effects of abatement measures across two different gaseous emissions dimensions. This comprehensive approach was employed to avoid potentially suboptimal assessments of the overall impact of abatement measures on policy decisions, which may arise from evaluating benefits based on a single emission type.

More importantly, the net benefit accruing from an integrated assessment produces different results then when examining abatement measure across a single gaseous emission dimension (GHG or NH_3). This study thus concludes that the environmental and economic impact of reducing gaseous emissions is higher than the individual environmental pollution thus to foster the adoption of these, farmers' efforts should be geared towards promoting the measures that have co-benefits.

To reduce gaseous emissions in agriculture effectively, it is important to have clear policies that encourages farmers and other stakeholders to take specific steps. These practical measures should be implemented, and farmers must be motivated to take them. Finally, to fully assess the impact of abatement measures on gaseous emissions and make sustainable policy recommendations, it's important to take into account the heterogeneity of farms.