Extended Abstract
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Paper/Poster Title	Analysis of the effect of regional anaerobic digestion on farm level emissions in Ireland

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***

The development of regional Anaerobic Digestion (AD) in Ireland will provide renewable biomethane for energy users to decarbonise however there is an absence of data on the effect on farm level emissions. This paper uses farm level data from Ireland to provide economic returns and greenhouse Gas (GHG) emissions per hectare for production of silage, supply of slurry and return of digestate from a regional anaerobic digester.

In the case of production of silage a simulated bio-economic model is used for a multi-cut grass-clover silage replacing the existing farm enterprise which is traditionally a perennial rye grass system with the excepting of arable farmland. The yield is presumed to be consistent between systems. The results show a 60-80% reduction in GHG emissions is possible in this scenario with majority of GHG savings coming from substitution of ruminants and associated reduction in enteric fermentation. The relative economic returns vary based on substituted enterprise.

In the case of slurry supply the existing enterprises are maintained as are the economic returns however the slurry is exported fresh to a regional AD facility. The results show a reduction in farm level emissions of between 8-11% depending on farm system.

Anaerobic Digestion has the potential to reduce farm levels emissions while providing secure supply of renewable energy. The supply may also provide a diversification option which could increase the viability levels of original enterprises.

Keywords	Anaerobic digestion, Bioenergy, Biomethane, GHG Emissions
JEL Code	e.g. Energy: Demand and Supply Q41 see: www.aeaweb.org/jel/guide/jel.php?class=Q)

Introduction	***100 – 250 words***

The Irish governments Climate Action Plan 2023 sets a target for anaerobic digestion of 5.7TWh of Biomethane by 2030 and a reduction in agricultural related GHG emissions by 25% by 2030. This biomethane will provide renewable energy equivalent to approximately 10% of current gas demand while it has the potential to also reduce GHG at a farm level.

The renewable Energy Directive (REDII) sets criteria and minimum limits on the GHG emissions savings of the biomethane for it to be classified as renewable. The use of grass silage for AD is considered a second generation biofuel however when codigested with animal manures, the major GHG emissions savings come from the animal manures. In REDII animal manures receive a manure credit due to capturing the methane which would have been emitted from standard manure management.

The costs of producing grass clover silage is modelled based on simulated data for a multi cut grass-clover sward while farm level data is used for yield. Farm level data is used for slurry production on farm. The issue of scale is abstracted by dealing on a 'per hectare' basis for economics and emissions.

Methodology	***100 – 250 words***

This paper used a simulated bio-economic model to facilitate the calculation of agricultural feedstock costs on a per hectare for use in a regional AD plant. The model was used to quantify the cost of producing and utilising a grass-clover sward, for which historic data from our Teagasc, National Farm Survey Data was not available. Constructed data, from various sources were used to populate the bio-economic model.

The model is a spreadsheet-based, bio-economic simulation model, which includes input of physical and financial variables. It is based on a single year deterministic input framework, but is re-simulated under different annual conditions. Agronomic defaults in terms of field operations are based on various literature sources and output from the Grange Feed Cost Model (GFCM, Finneran et al., 2010).

The GHG emissions are based on National Farm Survey Data (Buckley and Donnellan, 2023) with agronomic defaults used for the farm practices effected by adoption of AD.

Results	***100 – 250 words***

The transition of the existing farm enterprise to production of multi cut, grass-clover silage to supply and AD plant can reduce GHG emissions on average by 60-80% depending on the existing farm enterprise. The majority of GHG savings coming from substitution of ruminants and associated reduction in enteric fermentation. The relative economic returns vary based on substituted enterprise. Dairy farming remains more profitable however beef enterprises could see equal or increased financial returns depending on sale price of silage.

In the case of slurry supply the existing enterprises are maintained along with those economic returns however the slurry is exported fresh to a regional AD facility. The results show a reduction in farm level emissions of between 8-11% depending on farm system. The emissions reductions is from reduction in slurry storage on farm and its associated methane emissions. This is consistent with results from O'Brien et al 2021 who carried out analysis for a typical dairy farm in Ireland.

Discussion and Conclusion	***100 – 250 words***

The integration of regional AD plants into agricultural practices has the potential to reduce the farm level emissions. The largest GHG emissions savings per hectare are associated with the silage production due to the modelled reduction in stocking of ruminants. It is envisaged that 120,000ha would be required to supply silage to these regional AD, or 2.7% of the utilized agricultural area in Ireland.

The reduction of GHG emissions from manure management has a more modest saving per farm, 8-11% however requires less practice changes for the farmer. Equally a farm larger number of farms will be required to supply slurry to fulfil the 5.7TWh goal, it is estimated that 20% of the winter slurry is required thus the overall effect is as important as the silage.

While the supply of slurry to regional AD reduces the emissions at a farm level the manure credit may actually be associated to the biomethane and thus credited the energy sector as opposed to the 25% target for agriculture. This could potentially be detrimental to the adoption of this sustainable technology.

It has been shown that AD has the potential to reduce GHG emissions at a farm level while it may also increase the viability levels of original enterprises. There are further socio-cultural elements which will also need to be evaluated.