Teagasc Statement to the Dail Joint Committee on Agriculture on "Carbon sequestration and storage in agriculture"

Introduction

The Climate Action Plan has set a 22%-30% emission reduction target for agriculture by 2030 and a 37-58% reduction in LULUCF (Land Use, Land Use Change and Forestry) emissions. There are large scientific uncertainties associated with the measurement of agriculture and LULUCF emissions and removals due to the biological nature of the emissions that vary substantially in space and time, making it difficult to both mitigate emissions, enhance removals and to verify the extent of the mitigation achieved. Indeed, the Plan makes particular reference to the technical difficulties associated with reducing methane emissions from enteric fermentation and LULUCF uncertainties.

The Profile of LULUCF emissions and removals and Projections to 2030

Unlike the majority of EU countries, land-use in Ireland is a net emitter of greenhouse gases. This is due to the fact that a) Ireland has a relatively low land area under forestry and b) has a large area of peat soils that have been exploited either for energy production or agriculture. The proportion of forest area across the EU is 38%, while it is 11% in Ireland. Denmark and Netherlands are also net LULUCF emitters and both countries have low forest cover and a large proportion of exploited peat soils. In 2018 forests and associated harvested wood products sequestered 4.79 Mt CO_2e. Wetlands (peatlands and fens) were a net GHG emitter, driven by the 75,600 hectares used for peat extraction which emitted 2.46 Mt CO_2e. However, the largest emitter was grasslands which emitted 7.02 Mt CO2e. This runs counter to the expectation of most people, who assume grassland sequesters carbon. Indeed, the 3.9 million hectares of grassland on mineral soils was calculated in the national inventory to sequester 1.98 Mt CO_2e. However, there was also 337,000 hectares of managed pasture on drained peat soils which were calculated to emit 9.05 Mt CO_2e. The reason these soils emit so much CO_2 is that peatlands form under waterlogged, low oxygen conditions that promote low levels of decomposition which leads to build-up in organic matter. Most peat soils are also acidic which further preserves organic matter, so that while grasslands on mineral soils typically have 100-500 tC ha^{-1}, peat soils can have 1,000- 5,000 tC ha^{-1}. Once these soils are drained, oxygen levels increase and decomposition of the peat commences.

The emissions from LULUCF are projected to rise from 4.8 Mt CO2e in 2018 to 7.1 Mt CO2e in 2030. This is driven by sustained emissions from grassland on peat soils and a reduction in the forest sink.

This reduction is driven by low rates of afforestation and the age-class profile of forests, with a large proportion ready for clear-felling.

As stated earlier, there is a high uncertainty relating to emissions and removals surrounding LULUCF and new emission factors may have a large impact on inventories. Recently, new national-specific emission factors have been quantified for forest peat soils. These new emission factors, when adopted by the EPA, will increase CO_2 losses from afforested peat soils from 0.45 tCO_2e per annum to 1.68 tCO_2e. This is projected to substantially reduce the size of the forest sink, with forestry projected to be a *net GHG source* by 2030.

Currently, the emission and removal national inventory calculations for grassland use generic Tier 1 emissions factors and there is an urgent need to generate national-specific factors for grassland on mineral and organic soils. In order to a) reduce these uncertainties and b) quantify the national values for mineral grassland sequestration and peat soil emissions, Department of Agriculture, Food and the Marine (DAFM) have provided funding to Teagasc in order to establish a National Agricultural Soil Carbon Observatory (NASCO). This observatory is currently being deployed across the country and will consist of circa 30 sites where field-scale CO_2, CH_4 and water fluxes will be directly measured using eddy covariance flux towers. In addition, the soil organic carbon baseline levels are currently being measured across more than 100 Signpost Farms, with these soils being resampled regularly. Teagasc research, using projects such as NASCO and Signpost Farms, aims to improve the measurement of C sequestration and focuses on:-

- *Producing Irish-specific CO_2 emission factors for drained and rewetted peat soils.* Flux monitoring towers (see Figure 1) are being deployed on grassland and cropland based on peat and fen soils. The CO_2 and methane emissions associated with drainage and raising of the water table will be quantified.
- *Producing Irish-specific land management C sequestration factors across the main mineral and organo-mineral soils* that are verifiable and can be inputted into national inventories. The sequestration rate of mineral grassland will be quantified as will the impact of management (optimal soil fertility (N,P,K, pH), stocking rate, grazing vs cut pastures).
- *Improving estimation of carbon sequestration in hedgerows and on farm trees and woodland*. The FarmCarbon Project is currently quantifying the sequestration rate of hedgerows and the impact of management on C sequestration.
- *Developing a Land-Use decision support tool* that aids in the development of a national Land-Use Strategy. Complex process models for quantifying soil-based GHG emissions and C sequestration are currently being adapted to Irish conditions. These will be used to develop a

stakeholder Land-Use Decision-Support Tool. Developing a carbon farming decision support tool. Teagasc are currently revising the Carbon Navigator and developing a new Farm GHG calculator to estimate the impact of mitigation options on the farm GHG emissions and economic performance.

- Developing strategies that could be used to incentivise C sequestration and monetarise the long term curation soil C stocks, so that policy makers can have options to allow farmers to gain added value for good soil husbandry.

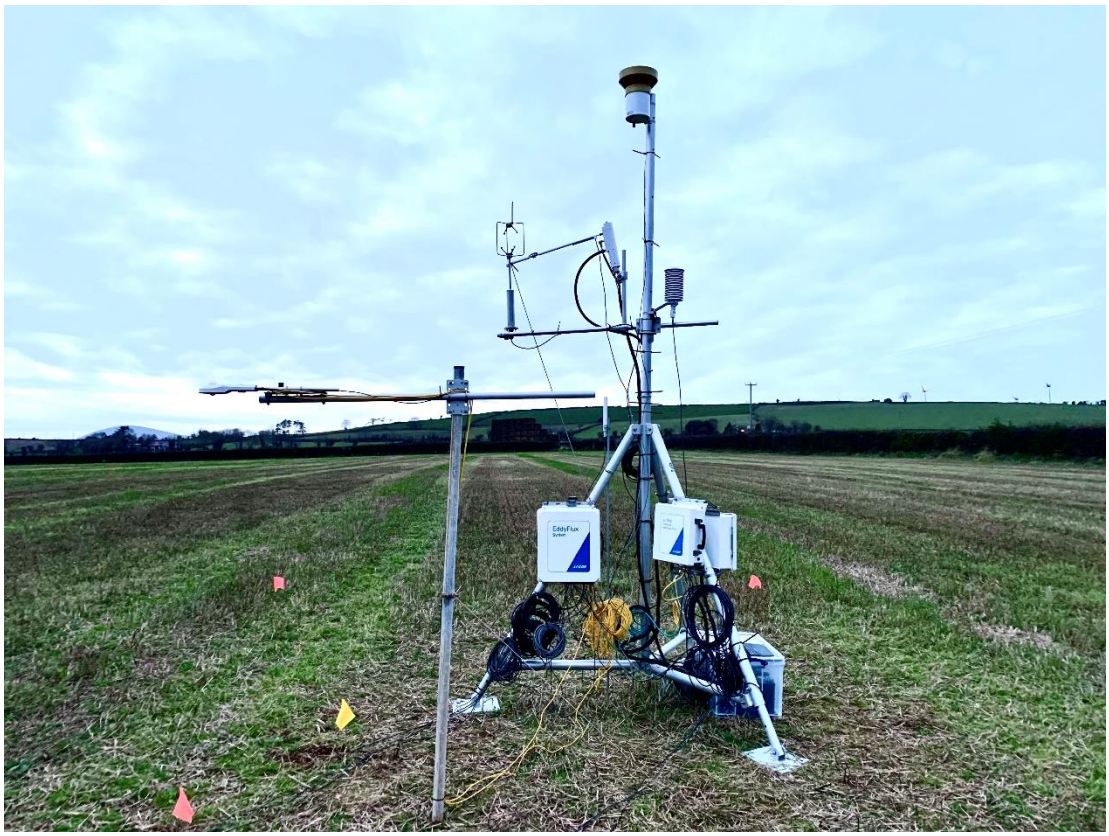

Figure 1: A CO_2 flux monitoring tower at Castledockrell Co. Wexford.

Mitigation measures to 2030

There is considerable scope to both reduce LULUCF emissions and also to enhance carbon sinks. In order to achieve long term net Climate Neutrality, the rate of afforestation will have to increase significantly. For instance, if afforestation rates were to continue at current rates (or up to 3,500 ha per annum), the forest sink sequestration rate would be less than 1 $MtCO_2e\ yr^{-1}$ by 2050. However, increasing rates to 8,000 ha per annum by 2030 would result in a 2.1 $MtCO_2e\ yr^{-1}$ by 2050, while doubling this to 16,000 ha would generate a sink of 4.5 $MtCO_2e\ yr^{-1}$. However, in the short term, afforestation will only generate a small contribution (circa. 0.2 $MtCO_2e\ yr^{-1}$) towards the 2030 target. This is due to the fact that a) there are net GHG emissions associated with land preparation for forest establishment and b) young forests do not sequester much carbon.

Alternative management of the current forest estate provides an opportunity to maintain the forest C sink. Reduction in thinning rate would increase sequestration by on average 0.24 Mt CO_2e yr^{-1} over the 2021-2030 period, while increasing the rotation age to the mean maximum annual increment (MMAI) could improve the forest GHG balance by up to 2 million tonnes. Whilst this should ultimately result in higher yields, an alteration in rotation length would have to be carefully considered as it would have economic impacts for the forestry sector and could lead to a short-term deficit in timber supply of between 20%- 50% out to 2030.

Reducing the emissions from grassland on peat soils will be imperative for LULUCF mitigation as this is the largest sectoral GHG source which will generally involve raising the water table. In addition, the input of nutrients from animals, manures and mineral fertilisers further accelerates decomposition and CO_2 emissions. Research projects on reducing inputs and raising the water table are currently commencing in Teagasc, as well as alternative uses for areas that are re-wetted. In addition, Teagasc's Spatial Analysis unit are engaged in surveying the current state of drainage in these grasslands, as drainage may no longer be effective on a proportion of this area, while the EPA is also involved in a large LULUCF mapping project across all land-uses.

The impact of grassland management on mineral soils is also being explored as part of the VistaMilk SFI Centre, using a combination of flux towers, soil carbon measurement and soil carbon modelling to quantify management impacts, such as soil fertility, multi-species swards and grazing intensity on soil carbon sequestration. Modelling conducted as part of the Teagasc MACC suggests that improved pasture management on 450,000 ha can sequester up to 0.48 $MtCO_2e$ yr^{-1} by 2030[1]. This data will be used in conjunction with Earth Observation data from satellites and drones to model CO_2 balance for forest, cropland and grassland ecosystems across the country as part of a Microsoft/SFI co-funded data platform Terrain AI, led by Maynooth University and involving Teagasc, TCD, UCD, DCU and UL.

The C sequestration potential of hedgerows has been investigated in Teagasc for many years with Teagasc and FERS completing the first analysis of national hedgerow carbon removal for Ireland[2] using LIDAR, investigating new technologies for mapping hedgerow carbon and mapping of carbon storage on the Devenish Dowth farm. Currently Teagasc research is being carried out to improve the national estimation of hedgerow carbon sequestration in an EPA-funded FarmCarbon project (also with FERS ltd). Recent work in Ireland and UK demonstrates that increasing hedge width and height can

[1] Lanigan & Donnellan 2018. An Analysis of Abatement Potential of Greenhouse Gas Emissions in Irish Agriculture 2021-2030. Teagasc, Oak Park.

[2] Green et al. 2019 Biomass Retrieval in Ireland using Active Remote sensing project https://www.epa.ie/publications/research/climate-change/Research_Report_305.pdf

substantially increase both above- and below-ground C sequestration, whilst also providing increased biodiversity[3]. Improved cropland management, via straw incorporation, use of cover crops and targeted incorporation of manures and/or digestate can also contribute significantly to improved farm carbon balance, whilst also improving soil health and nutrient availability. Research has also recently started in developing agro-forestry for cattle to increase carbon capture by trees and mitigating emissions from cattle.

Carbon Farming

The development of An Enabling Carbon Farming Framework is proposed under Actions 317 and 361 of the Climate Action Plan with the potential for trading, and which rewards farmers for emissions reductions and removals, including through potential private sector investment. This is in line with the EU's policy direction.

Such an approach will require the establishment of baseline data, auditing, the development of voluntary carbon codes, leveraging of private financing through public/private partnerships, and the putting in place of governance structures. Measurement, reporting and verification (MRV) of these actions will be imperative for farmers to be able to 'gain credit' for their actions. This will take a concerted effort on behalf of the entire research, inventory and knowledge transfer community. The Climate Action Plan proposes under Action 323 to establish a Centre of Excellence to co-ordinate and focus the research needs of the sector. In addition, Teagasc have several initiatives and projects to develop a new generation of GHG accounting and decision-support tools that will aid the farmer in making robust and sustainable management decisions and are also starting a new project to explore carbon farming options.

Farm Zero C is a collaboration between BiOrbic, Carbery, Teagasc and others to create an economically viable, climate neutral dairy farm on Shinagh farm in West Cork. The project presents a holistic approach to reduce greenhouse gas emissions and increase the health and resilience of the farm. The project aims to achieve net zero carbon emissions by 2027 and is also looking to improve biodiversity and water & air quality. Farm Zero C will be a beacon for sustainable agriculture and provide a bright future for farmers and rural communities.

The project is investigating strategies such as methane reducing feed additives, slurry amendments, renewable energy, multi species swards, alternative biobased fertilisers, grass biorefining and soil

[3] Black, K. Green, S., Mulooly, G., Poveda, A. 2014. Carbon Sequestration by Hedgerows in the Irish Landscape. CCRP Report. EPA, Johnstown Castle, Wexford.

carbon sequestration. The farm is also adopting technologies from the MACC curve such as low emission slurry spreading (LESS), clover, protected urea and EBI to reduce the carbon footprint.

Soil carbon sequestration could potentially aid in displacing some of the GHG emissions associated with the farm. We have established a baseline, and we will now mitigate, sample and sense so that we can work towards certification of carbon sequestration on the farm.

We are monitoring soil health and soil carbon stock changes in relation to clover and multispecies swards, land use (grassland, hedgerow, woodland) and management practices. Soil samples and satellite data are being analysed to establish changes in soil carbon and soil emissions. To aid in monitoring soil carbon levels an we aim to place an Eddy covariance (EC) tower on the farm to quantify real-time greenhouse gas fluxes and meteorological variables.