Extended Abstract

Please do not add your name or affiliation

Paper/Poster Title	**Moving from economic to biophysical allocation in life cycle assessments: A typology of winners and losers**

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***
Based on farm data, this study models dairy GHG emissions with a life cycle assessment method. Different allocation rules between dairy and beef production are applied, including economic and biophysical, to explore whether the methodological choice influences the result. Farmers are categorised into cohorts based on differences in dairy GHG emissions allocated with the economic and the biophysical rules. The future step in this research is to test for differences in farm and farmer characteristics across the farmer cohorts. In this way, we will examine whether farms are affected differently by the methodological choice. Overall, understanding how the move from economic to biophysical allocation affects emissions is important to target and improve communication about carbon footprinting with farmers.	

Keywords	Life cycle assessment; economic allocation; biophysical allocation; dairy GHG emissions; farmer typologies.
JEL Code	Q1; Q5. see: www.aeaweb.org/jel/guide/jel.php?class=Q)

Introduction	***100 – 250 words***
Current recommendations in life cycle assessment (LCA) methodologies suggest to allocate emissions between dairy and beef production of dairy cattle based on the amount of energy used to produce milk vs. meat. This allocation rule, referred to as biophysical allocation, differs from more traditional approaches, whereby emissions were allocated based on differentiations in economic output. While considered as ‘fairer’ to divide emissions between milk and meat in carbon footprinting exercise, this methodological change may have important implications on modelled greenhouse gas (GHG) emissions for individual farms. In fact, practitioners and agricultural advisors may face challenges to communicate changes in results to farmers due to revisions in methodological guidance. In the case of Ireland, for instance, the yearly Teagasc sustainability assessment is subject to this change. Hence, it is important to 1) understand how dairy GHG estimates may vary across allocation rules, and 2) examine whether farms are affected differently depending on their characteristics. In turn, this will help to target and improve communication strategies with pools of farmers who may be affected the most.	

In this context, the objective of this study is to model dairy GHG emissions with different allocation rules, compare results, and investigate if farms achieve different results depending on their farmer characteristics.

Methodology	***100 – 250 words***

This study uses unbalanced panel data from the Teagasc National Farm Survey (NFS). The Teagasc NFS is collected on a representative sample of approximately 1,000 Irish farms as part of the EU Farm Accountancy Data Network. In this research, we restrict the sample to specialised dairy farms from 2014 to 2021, constituting a sample of about 2,400 observations.

Dairy GHG emissions are modelled using a cradle-to-dairy enterprise gate LCA model. Emissions are allocated between dairy and beef production of dairy cattle using three allocation rules: 1) economic allocation, whereby emissions are allocated to the dairy herd according to the percentage of dairy gross output coming from milk sales; 2) 5-years economic allocation, whereby emissions are allocated using the economic rule averaged over 5 years to control for milk price volatility; and 3) biophysical allocation, whereby emissions are allocated according to the percentage of dairy cow energy used to produce milk. Emissions are reported per kilogram (kg) of fat-protein-corrected-milk (FPCM).

GHG emissions are compared across the 3 allocation rules using *t*-tests. Then, farmers are categorised into 3 cohorts depending on the differences between their GHG emissions modelled with the economic allocation rule vs. the biophysical allocation rule. For simplicity, farmers for whom GHG emissions are lower using the biophysical allocation than the economic one are labelled the ‘winners’. Farmers for whom emissions are higher are considered the ‘losers’. Farmers for whom emissions remain unchanged are the baseline. Differences in farm and farmer characteristics among the three cohorts are tested for to build a farmer typology.

Results	***100 – 250 words***

On average, GHG emissions allocated with the economic rule are equal to 1.090 kg of CO_2e per kg of FPCM produced (SD = 0.204). On average, GHG emissions allocated with the 5-years economic rule are equal to 1.091 kg of CO_2e per kg of FPCM produced (SD = 0.203), and those allocated with the biophysical rule are 1.151 kg of CO_2e per kg of FPCM produced (SD = 0.224).

When conducting the t-test diagnosis, the results reveal statistically significant differences across the 3 allocation rules.

On average, GHG emissions allocated with the biophysical rule are 5.7% higher than the ones allocated with the economic rule (SD = 7.8). For 78.8% of the sample, emissions are at least 1% higher when allocated with the biophysical rule; these farmers are labelled the ‘losers’. 12.5% of farmers are in the winning group, with emissions being at most 1% lower when allocated with the biophysical rule. Finally, 8.7% of farmers that remain unchanged (between -1 and +1% change).

The next step of this research is to build farmer typologies by testing for differences in farm and farmer characteristics across the 3 cohorts. Variables of interest include, among others, milk yield per cow, stocking rate, dairy specialisation, and herd size. We expect to observe significant differences across the 3 cohorts.

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

The results of this preliminary study point out that the chosen LCA allocation rule can significantly affect dairy GHG emissions, in line with previous LCA literature. For the vast majority of the sample, GHG emissions are underestimated when allocated with the economic rule.

This study has important implications for communicating carbon footprinting results to farmers, as methodological decisions can influence the results. In instances where dairy GHG emissions were traditionally allocated with the economic rule (such as in the yearly Teagasc sustainability assessment), it will be important to communicate to farmers how and why dairy GHG emissions have changed when moving to the biophysical rule. Through this study, understanding which cohorts of farmers are the most affected by the change will be important to develop a suitable and targeted communication strategy.