Whole Farm Modelling for Quantification of Greenhouse Gases and Mitigation-related Land Use Planning Decisions

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Introduction

Agriculture contributes about 12% of greenhouse gas (GHG) emissions globally, although the magnitude of this at the regional or farm scale varies widely and will depend on soils, climate and management practices, where GHG accounting and land use planning decisions for mitigation and/or offsetting could play a pivotal role.

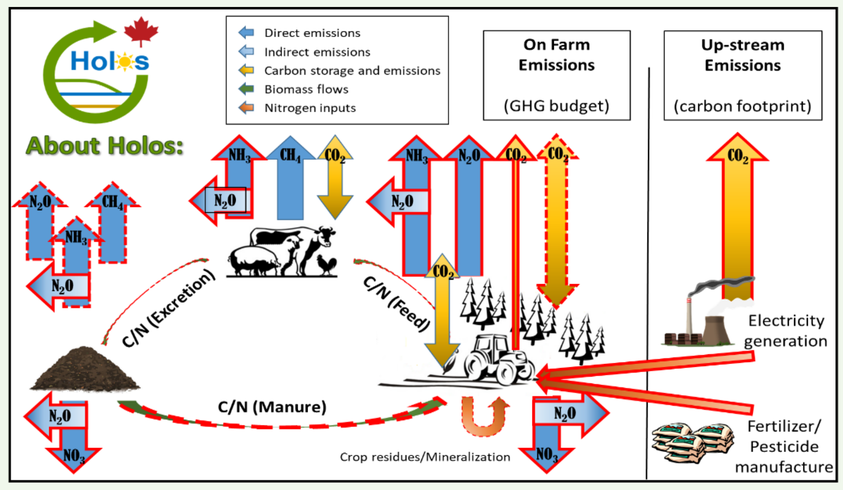
Methodologies

We evaluated a Canadian Whole Farm Model 'HOLOS' V3.0.

This model can provide reasonable estimates of the overall GHG balance/budget at a land parcel to farm scale.

It uses predefined emission factors (EFs) for N_2O (direct and indirect), CH_4 (enteric and manure) and CO_2 (biomass and soil C) including energy usage.

We used Irish data based on a 45-ha farm consisting of 2/3rd pasture and 1/3rd silage with 176 livestock units.

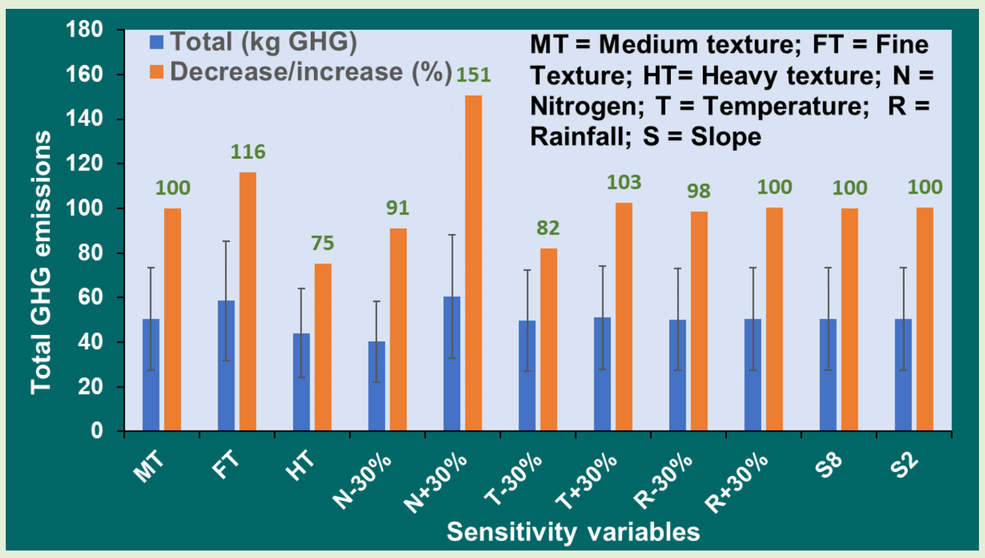


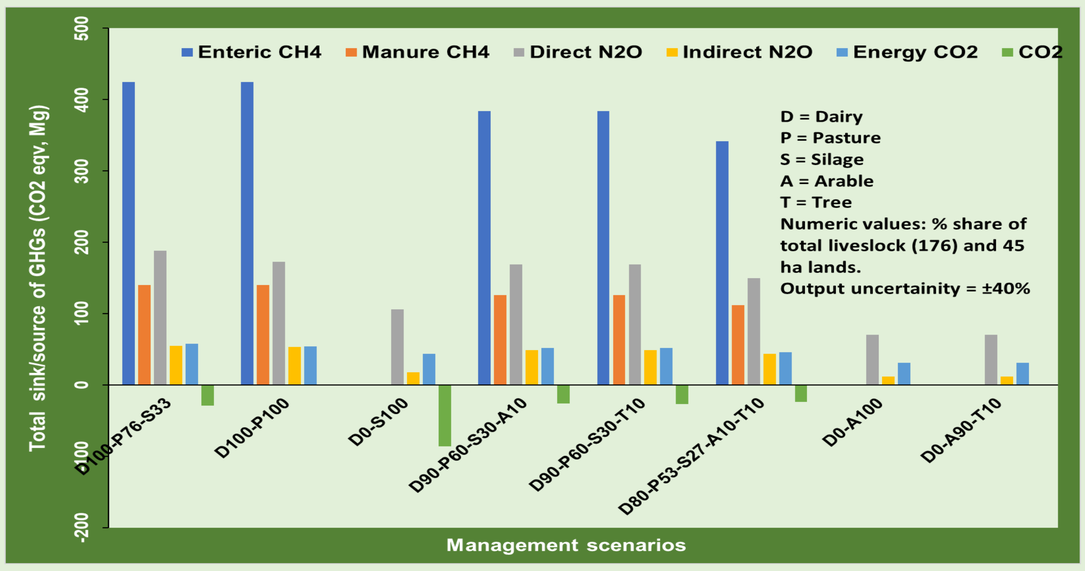
Schematic diagram of the Holos Model.

Results

The response of GHG emissions to soil variables depended on the ratio functions. The major drivers were N fertilizer and temperature, which when reduced by 30% decreased the total on-farm GHG emissions by 9% and 18%, respectively.

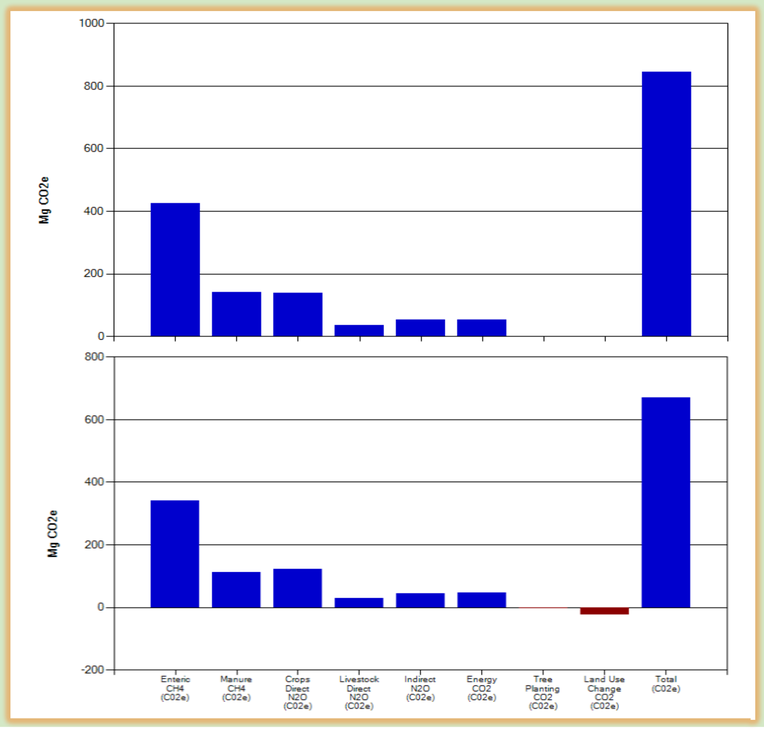
The major contribution to the total 865 Mg CO_2-equivalent emissions was from enteric-CH_4 (51%), direct-N_2O emissions (22%) and manure-CH_4 (17%).





Among the combination of land uses assessed, a reduction in dairy cattle by 10-20% decreased the emissions by 10-20% and by 86-90% when combined with silage.

These also had the highest C sink, and arable (±forestry) showed lower emissions over pasture or pasture and silage with 100% dairy cattle (837-845 Mg CO_2-equivalent).



Conclusions

The results imply that shifting from a single land use to a mixed farming system could have considerable potential for mitigating and offsetting on-farm GHG emissions.

For achieving carbon-neutrality, a reduction in livestock units and the use of inorganic fertilizers, combined with more afforestation would be required.

The HOLOS model, with improvement possibilities through the replacement of country-specific algorithms and EFs, can be useful for national GHG reporting and land use planning.

Keywords: Whole Farm Modelling, Greenhous gases, Mitigation, Land use planning decisions

This paper presented at the 2nd International Symposium on Climate Resilient Agri-Environmental Systems (ISCRAES) held from 28-31 August in Dublin, Ireland.

Acknowledgements