

Greenhouse gas emissions from grasslands



The Challenge

The Scottish government has declared climate emergency response to concerns about the accumulation of greenhouse gases in our atmosphere and the role they play in contributing to global climate change. Challenging targets have been set to reduce greenhouse gas emissions, and given that agriculture is a significant emission source, there is a need to understand the magnitude of emissions and approaches that can be taken to reduce them.

The Research

The Crichton Dairy Research Centre has provided a crucial platform for measuring emissions of greenhouse gases associated with dairy production. The work has focussed on measurements of the greenhouse gas nitrous oxide which is released from soils following the application of nitrogen-based fertilisers and manures. A series of experiments have been undertaken in which differing amounts and forms of nitrogen fertilisers animal excreta and manures were applied to grasslands and measurements made over a period of at least a year of the amounts of nitrous oxide released. Other studies explored mitigation approaches that could be used to reduce emissions including varying the rate and timing of nitrogen applications and the use of inhibitors.

The Results

The Crichton work has improved our understanding of the factors responsible for nitrous oxide emissions from grassland soils. Crichton is associated with high nitrous oxide emissions when compared to many sites elsewhere in the country (Fig. 1). Our measurement have shown that emissions are strongly linked to the amounts of nitrogen applied, but also the soil conditions at the time of application. Emissions of nitrous oxide associated with the deposition of slurry and animal excreta were significantly lower than had previously been assumed. This work has allowed us to develop improved models of carbon and nitrogen turnover in soils and therefore extrapolate the findings to other sites.



The Impact

Our measurements and models have been used at a national scale to improve our reporting of greenhouse gas emissions from agriculture. The UK has a legal obligation to produce annual reports of emissions both as a consequence of international agreements and in order to assess progress towards national policy targets. This work has helped inform these reports. The research is also used for consultancy and teaching purposes to help the farming community to move towards lower carbon farming practices.

The Future

Crichton remains a core site for measurements of greenhouse gas emissions that are being used to test novel approaches to mitigation. We are currently working with European partners to investigate the opportunities for mixed grass swards and precision management to be used to reduce nitrous oxide emissions and increase carbon sequestration. Historical data from over 20 years of research at Crichton are also invaluable in developing new models and understanding of the complex interactions involved in controlling greenhouse gas emissions from grazed grasslands.

Additional Information:

Publications:

Bell,M.J., Cloy,J.M., Topp,C.F.E., Ball,B.C., Bagnall,A., Rees,R.M. & Chadwick,D.R. 2016. Quantifying N₂O emissions from intensive grassland production: the role of synthetic fertilizer type, application rate, timing and nitrification inhibitors. *The Journal of Agricultural Science*, 154, 812–827.

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Chadwick,D.R., Cardenas,L.M., Dhanoa,M.S., Donovan,N., Misselbrook,T., Williams,J.R., Thorman,R.E., McGeough,K.L., Watson,C.J., Bell,M., Anthony,S.G. & Rees,R.M. 2018. The contribution of cattle urine and dung to nitrous oxide emissions: Quantification of country specific emission factors and implications for national inventories. *Science of The.Total Environment*, 635, 607–617.

Fuchs,K., Merbold,L., Buchmann,N., Bretscher,D., Brilli,L., Fitton,N., Topp,C.F.E., Klumpp,K., Lieffering,M., Martin,R.I., Newton,P.C.D., Rees,R.M., Rolinski,S., Smith,P. & Snow,V. 2020. Multimodel Evaluation of Nitrous Oxide Emissions From an Intensively Managed Grassland. *Journal of Geophysical Research: Biogeosciences*, 125, e2019JG005261.

Lee,M.A., Todd,A., Sutton,M.A., Chagunda,M.G., Roberts,D.J. & Rees,R.M. 2017. A time-series of methane and carbon dioxide production from dairy cows during a period of dietary transition. *Cogent Environmental Science*, 3, 1385693.

Hargreaves, PR, Rees, RM, Horgan, GW and Ball, BC. 2015. Size and persistence of nitrous oxide hot-spots in grazed and ungrazed grassland. *Environment and Natural Resources Research*, 5, 1-15.

Links to website: <https://www.farmingforabetterclimate.org/>

Other: <https://pure.sruc.ac.uk/en/persons/bob-rees>

Figure 1. Annual emissions of nitrous oxide at Crichton receiving increasing rates of N fertiliser, compared with other UK grassland sites (from Cardenas et al 2019).

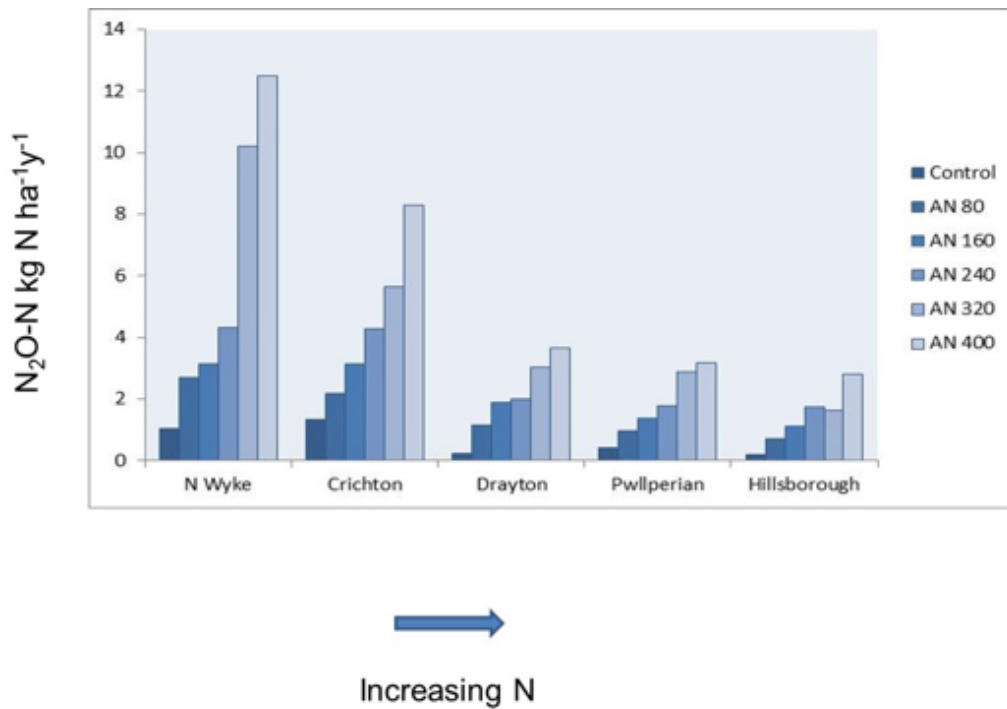


Figure 2. Chambers used to measure nitrous oxide emissions at Crichton.

