Institution: University of Edinburgh and SRUC, Scotland's Rural College

Unit of Assessment: 6

Title of case study: Quantifying the capacity for reducing greenhouse gas emissions from agriculture

1. Summary of the impact (indicative maximum 100 words)

Impact: Policy. First ever Scottish and UK Government estimates for reducing greenhouse gas emissions from Agriculture, Land Use change and Forestry (ALUF) in Scotland and the UK to 2020.

Significance: The global policy agenda on greenhouse gas (GHG) reductions requires governments to seek ways to reduce emissions cost-effectively. Scotland and the UK have statutory targets on emissions reduction. The research showed which measures can be implemented at a cost that is less than the government's benchmark. It has saved the equivalent of £250 million worth of avoided climate damages.

Beneficiaries: Government departments and policy makers, farmers, general population.

Attribution: Intra-disciplinary work by Prof. Moran, Dr. Wall (SRUC).

Reach: Immediate impact at Scottish and UK national level has led, by repute, to a broadening of impact (through extension of the underlying methods) for applications internationally (i.e. France).

2. Underpinning research (indicative maximum 500 words)

Our research (2008-) identified the most practical mitigation methods for greenhouse gas emission from agriculture land use change and forestry (ALUF). ALUF is responsible for around 7% of UK GHG emissions. These are coming under increasing scrutiny as the UK seeks to meet its commitments on GHG reductions [3.1]. Previous work on mitigation potential in the agricultural sector had not sought to consider relative costs of mitigation measures, and so policymakers had no basis for including the sector in GHG reduction targets.

The UK government empowered the Committee on Climate Change (CCC) to explore how emission reductions could be shared across UK industry and research at SRUC was commissioned as part of this effort to explore the science and economics of mitigation methods in ALUF. SRUC research [3.2, 3.3, 3.4] has improved the government's understanding of how Marginal Abatement Cost Curves (MACCs) can be applied to evaluate alternative approaches to mitigating climate change from the ALUF sector. Drawing on economic theory of efficient pollution control, a MACC is a policy support tool that helps identify the most cost-effective ways of reducing pollution. They show how much different measures can reduce emissions by, and how much the reduction will cost society in terms of environmental, financial, and political implications. With this information, government can then determine how much mitigation effort should be sought in a specific sector, and where in that particular sector efforts should be concentrated. A MACC also assesses the potential offered by new technologies, and is therefore useful in guiding research priorities.

Beginning in 2008, our researchers (inter-disciplinary work by Prof. Moran (Team Leader, employed 1999-onwards), and Dr. Wall (Researcher, employed 2001-onwards) (drawing on fundamental research in animal [3.4] and crop and soil science) first identified the range of possible mitigation measures (over 100), and studied their technical potential (i.e. how much mitigation each measure could deliver if used in the UK). They then estimated the costs of implementing such measures across a range of farm types and land uses. This process involved a review of experimental evidence and evaluation of papers, addressing uncertainties surrounding nitrous oxide and methane generation and management and behavioural processes [3.5]. After analysing the original measures, a short list of the 31 most effective and practical mitigation measures was subsequently combined in a MACC to demonstrate the cost-effectiveness of each measure. Some were shown to increase profitability whilst decreasing emissions (e.g. improved nitrogen application efficiency); whilst others have little environmental impact, and cost the sector

money (e.g. improved land drainage).

Collaborator: Prof. Smith (Univ. of Aberdeen) worked on land use change aspects of the work.

3. References to the research (indicative maximum of six references)

3.1) SAC (2008). UK marginal cost curves for the agriculture, forestry, land-use and land-use change sector out to 2022 and to provide scenario analysis for possible abatement options out to 2050 – RMP4950. Report to The Committee on Climate Change & Defra http://tinyurl.com/p6sag96

3.2) Moran, D., MacLeod, M., Wall, E., Eory, V., McVittie, A., Barnes, A., Rees, R., Topp, C. F. E. and Moxey. A. (2011). Marginal abatement cost curves for UK agricultural greenhouse gas emissions. Journal of Agricultural Economics. 62 (1): 93-118. http://dx.doi.org/10.1111/j.1477-9552.2010.00268.x

3.3) Moran, D., MacLeod, M., Wall, E., Eory, V., McVittie, A., Barnes, A., Rees, R., Topp, C. F. E., Pajot, G., Matthews, R., Smith, P. and Moxey, A. (2011). Developing carbon budgets for UK agriculture, land-use, land-use change and forestry out to 2022. Climatic Change. 105 (3): 529-553. http://dx.doi.org/10.1007/s10584-010-9898-2

3.4) MacLeod, M., Moran, D., Eory, V., Rees, R. M., Barnes, A., Topp, C. F. E., Ball, B., Hoad, S., Wall, E., McVittie, A., Pajot, G., Matthews, R., Moxey, A., Williams, A. and Smith, P. (2009). Developing greenhouse gas marginal abatement costs curves for agricultural emissions from crops and soils in the UK. Agriculture Systems. 103 (4): 198-209. http://dx.doi.org/10.1016/j.agsy.2010.01.002

3.5) Moran, D., Lucas, A. and Barnes, A. (2013). Mitigation win-win. Nature Climate Change. 3 (7): 611-613. http://dx.doi.org/10.1038/nclimate1922

4. Details of the impact (indicative maximum 750 words)

Impact on Policy

Our research has identified approximately 10 million tonnes of carbon dioxide equivalent that, under ideal conditions, could be mitigated from the ALUF sector by 2022. This information has provided a basis to develop a voluntary target of around 3 million tonnes of CO_2 equivalent agreed between Defra and the agricultural sector. As such, the research has had immediate consequences for thousands of farm enterprises and the industries that supply their inputs and provide them with advice.

Our work has informed policy design by showing which measures can be implemented at a cost that is less than the government's benchmark cost for reducing carbon emissions. UK and devolved governments continue to request input from our framework to evaluate policy options for the development of further voluntary action by the agricultural industry (i.e. 200,000 UK holdings). The potential value of the saving is significant and using the government's benchmark cost of carbon, we have estimated is the equivalent of £250 million worth of avoided climate damages. The findings have been adopted by the CCC in the setting of sectoral carbon budgets within the UK government and devolved administrations. In Scotland for example, the work has provided the basis for government targets and the current voluntary government policy known as Farming for a Better Climate. It has also been used as an evidence base for the development of low carbon action plans to reduce carbon within the industries involved within the sector.

Impact on Public Engagement

We have maximised the impact of the work through a concerted knowledge exchange programme, deliberately going beyond the academic audience and targeting those responsible for developing policy in this area, as well as those responsible for land management. This has been achieved through a wide range of activities including presentations to the UK and Scottish Governments, the CCC, press briefings with ministers, policy briefings and presentations to organisations representing land managers. The work has highlighted to industry that many of the measures to reduce carbon can also potentially improve the profitability of the farming enterprise. By focusing on these win-win situations, policy targets are more likely to be achieved.

Impact beyond the UK

Within and beyond the UK, our research has demonstrated the validity of the MACC approach to understanding agricultural emissions, and the initial SRUC research team has since been busy responding to requests for follow-on research from Defra and the Scottish Government. The work has also attracted widespread international interest from other countries facing similar challenges and was presented as part of an international workshop in Dublin in 2009 and Copenhagen in 2010. The researchers involved have been invited to present the work to international organisations such as the Food and Agriculture Organisation of the United Nations and the Organisation for Economic Development amongst others. Further requests for advice have since been received from the Irish Agricultural and Food Development Authority (TEAGASC), China, and Vietnam. Our staff co-authored a report with INRA on the French national GHG budget [5.10].

5. Sources to corroborate the impact (indicative maximum of 10 references)

5.1) Building a low-carbon economy – the UK's contribution to tackling climate change. Committee on Climate Change (2008). http://tinyurl.com/qje6x6t (Chapter 9).

5.2) Reducing emissions from agriculture and land use, land-use change and forestry (see chapter 7 of the 4th Carbon Budget Report from the Committee on Climate Change). http://tinyurl.com/p3o2xwe

5.3) Scottish Government. Farming for a Better Climate. http://tinyurl.com/pxkgbuu

5.4) Economic analysis of AFOLU Low Carbon options: Use of Marginal Abatement Cost Curves to appraise climate smart agriculture policy options (FAO MACC guidance) http://tinyurl.com/nfmllka

5.5) CAP reform bulletin. The challenge of reducing agriculture's greenhouse gas emissions. http://tinyurl.com/ndecmnp

5.6) The significance of this work in the UK was widely recognised in government and by academic peers. The latter resulted in a Green Gown award in 2010. See url below for commendation: http://tinyurl.com/olvss8o

5.7) We have also responded to three requests from the Scottish Government to use the MACC to provide figures for their separate mitigation proposals contained in Low Carbon Scotland: The Report on Proposals and Policies (RPP). http://tinyurl.com/o4uhhpf

5.8) Kavita Srinivasan or Michael Thomson; Senior Analysts | Secretariat for the Committee on Climate Change 7 Holbein Place, London, SW1W, 8NR Kavita.Srinivasan@theccc.gsi.gov.uk; michael.thomson@theccc.gsi.gov.uk

5.9) Dr Sylvain Pellerin, Directeur de recherches INRA Chargé de mission "Bouclage des cycles N et P, stockage de carbone dans les sols", équipe d'animation du département "Environnement et Agronomie" INRA, Centre de Bordeaux-Aquitaine, pellerin@bordeaux.inra.fr http://tinyurl.com/k35h54e

5.10) What contribution of French agriculture emissions reduction in greenhouse gas emissions? Summary report of the study by INRA on behalf of ADEME, the MAAF and MEDDE - July 2013. http://tinyurl.com/ow66asq