Institution: University of Aberdeen

Unit of Assessment: 6 - Agriculture, Veterinary and Food Science

Title of case study: Climate-friendly agriculture for policy makers and farmers

1. Summary of the impact

Climate change, and the need to feed 9-10 billion people by 2050, are two of the greatest challenges facing humanity this century. Agriculture needs to provide more food from less input, and with agriculture contributing around a quarter of human greenhouse gas emissions, it needs to do so while reducing its impact on the climate. Research in UoA6, led by Pete Smith underpins (a) international climate policy choices to reduce greenhouse gas emissions from agriculture and (b) development of a greenhouse gas accounting software tool, The Cool Farm Tool. This is being used in 18 countries around the world (including some of the largest emitting countries) by a consortium of the world's leading agri-food companies including e.g. Unilever, PepsiCo, Tesco, Heineken, Heinz, McCain, Sysco, Ben & Jerry's, Costco, Yara and Marks & Spencer, to reduce the climate impact of farming. These major companies control large parts of the global food supply chain and have ambitious emission reduction targets. Through both policy and industry channels, this work is having a global impact on greenhouse gas emission reductions in agriculture, by raising consciousness of emissions from agriculture, and engaging farmers and producers in practices to reduce greenhouse gas emissions, thereby promoting climate friendly farming.

*The specific **impacts on the environment** are: (a) increased awareness of greenhouse gas emissions by producers, reduced climate impact of farming for growers and suppliers, (b) influence of policy debate on climate change and farming; **impacts on production** are that costs of production have been reduced, and **impacts on commerce** are: (a) the adoption of new technology and (b) improvement in the environmental performance of leading agri-food companies.*

2. Underpinning research

The team, led by **Professor Pete Smith** at the University of Aberdeen, has developed modelling and measurement-based methods to: (a) assess greenhouse gas (GHG) emissions from agriculture and forestry, and (b) quantify the climate mitigation potential in agriculture globally. The work, beginning in the 1990s and leading to a number of seminal publications, culminated in the first all-GHG global assessment of agricultural mitigation potential [1]. This paper formed the basis of the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) chapter on agricultural GHG mitigation [3], for which Smith was Convening Lead Author. The findings have been used by the IPCC, the United Nations Framework Convention on Climate Change (UNFCC) and by companies (e.g. McKinsey & Co.) advising a number of international governments on GHG reduction opportunities in agriculture. The science summarised in this work is at the core of the software "Cool Farm Tool" used by leading agri-food companies to make ambitious GHG reductions in their food supply chains. This project is implemented by the Cool Farm Institute, (http://www.coolfarmtool.org/) under the scientific guidance of **Dr Jon Hillier** and Smith.

The underpinning research on agricultural GHG emissions is described in >200 journal papers (from 1996 to present) dealing with aspects of GHG emissions and mitigation in agriculture. Professor Smith's team has world leading expertise in modelling agricultural GHG emissions, attracting >£7.8M of research funding to Aberdeen since 2003, which is part of the reason Smith was chosen to lead these chapters for the IPCC 4th (2007) and 5th (due 2014) Assessment Reports.

The work on soil carbon sequestration began in 1995, but only 21 of the >220 journal papers on the topic were published before the author joined the University of Aberdeen in 2001. The vast bulk of the development occurred at the University of Aberdeen (>200 journal papers), where the Cool Farm Tool was developed.

The team developing the science leading to the development of the Cool Farm Tool are P. Smith (Professor of Soils & Global Change; 2001-present); **Professor Jo U. Smith** (Professor; 2013-

present); Hillier (Independent Research Fellow and main developer of the Cool Farm Tool; 2005-present); plus 30+ PDRAs over the 10-year period.

3. References to the research

[1] Smith, P, Martino, D, Cai, Z, Gwary, D, Janzen, HH, Kumar, P, McCarl, B, Ogle, S, O'Mara, F, Rice, C, Scholes, RJ, Sirotenko, O, Howden, M, McAllister, T, Pan, G, Romanenkov, V, Schneider, U, Towprayoon, S, Wattenbach, M & Smith, JU. (2008). Greenhouse gas mitigation in agriculture. *Phil. Trans. R. Soc. B.* 363, 789-813. (Cited 293 times on WoK). *First all-GHG global assessment of agricultural mitigation potential. Formed basis of chapter on agricultural mitigation in IPCC 4th Assessment Report*.

[2] Smith, P, Martino, D, Cai, Z, Gwary, D, Janzen, HH, Kumar, P, McCarl, B, Ogle, S, O'Mara, F, Rice, C, Scholes, RJ, Sirotenko, O, Howden, M, McAllister, T, Pan, G, Romanenkov, V, Schneider, U & Towprayoon, S (2007). Policy and technological constraints to implementation of greenhouse gas mitigation options in agriculture. *Agriculture, Ecosystems & Environment* 118, 6-28. (Cited 119 times on WoK). *Seminal assessment of the policies driving agricultural mitigation actions globally and the barriers to implementation. With [1], formed basis of chapter on agricultural mitigation in the IPCC 4th Assessment Report [3]*.

[3] Smith, P, Martino, D, Cai, Z, Gwary, D, Janzen, HH, Kumar, P, McCarl, B, Ogle, S, O'Mara, F, Rice, C, Scholes, RJ, Sirotenko, O, Howden, M, McAllister, T, Pan, G, Romanenkov, V, Rose, S, Schneider, U & Towprayoon, S. (2007). Agriculture. Chapter 8 of *Climate change 2007: Mitigation*. Contribution of Working group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O. R. Davidson, P. R. Bosch, R. Dave, L. A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. (Citations unknown). *Chapter used by governments globally to identify mitigation actions in agriculture, and to formulate policy to reduce GHG emissions from farming*.

[4] Smith, JU, Smith, P, Wattenbach, M, Zaehle, S, Hiederer, R, Jones, RJA, Montanarella, L, Rounsevell, MDA, Reginster, I, Ewert, F. (2005). Projected changes in mineral soil carbon of European croplands and grasslands, 1990-2080. *Global Change Biology* 11, 2141–2152. (Cited 118 times on WoK). *Paper examining the carbon sequestration potential of agricultural soils in Europe, and the likely stability of the soil carbon sink under future climate.*

[5] Hiller, J.G., Walter, C., Malin, D., Garcia-Suarez, T., Mila-i-Canals, L. & Smith, P. 2011. A farm-focused calculator for emissions from crop and livestock production. *Environmental Modelling and Software,* 26, 1070-1078. (Cited 14 times on WoK). *First description of the Cool Farm Tool in a peer-reviewed journal*.

[6] Hillier, J, Brentrup, F, Wattenbach, M, Walter, C, Garcia-Suarez, T, Mila-i-Canals, L, & Smith, P (2012). Which cropland greenhouse gas mitigation options give the greatest benefits in different world regions? Climate and soil specific predictions from integrated empirical models. *Global Change Biology*, 18(6) 1880-1894. (Cited 2 times on WoK). *Application of a version of the Cool Farm Tool globally to assess the most beneficial mitigation options for each region*.

Relevant grant funding:

>£7.8M grant funding awarded to P. Smith since 2003 for work on GHG emissions and emission reduction in agriculture, underpinning the development of the Cool Farm Tool. Main funding sources are EU, NERC, BBSRC, ESRC, UKERC, ETI, Scottish Government, Defra, DECC, Welsh Government, plus charities (e.g. Greenpeace), international bodies (e.g. FAO), overseas bodies (e.g. Irish EPA), private sector (e.g. Shell, Unilever, International Fertilizer Manufacturers Association) and other bodies (e.g. UK Met Office, Natural England).

4. Details of the impact

Process through which the research led to the impact: The papers that formed the basis of the IPCC chapter on agricultural GHG mitigation came to public prominence in 2007 with publication of the IPCC 4th Assessment Report. As this was the first systematic, global, multi-gas assessment of GHG mitigation potential in agriculture, it was quickly seized upon by other global bodies (e.g. United Nations Framework Convention on Climate Change: [a]) prompting significant **impact on**

public policy, whereby **guidelines were informed by the research** to set international and national GHG reduction targets, and identify cost effective measures to meet these targets. **Impacts on commerce** have also occurred through adoption of the research by companies providing consultancy to a number of international governments (e.g. McKinsey & Co. [b]), and agri-food businesses who are able to **improve their performance** by reducing expensive inputs.

Impacts on the environment have been even more significant, leading to reduced climate impact of farming for growers & suppliers through **changed management of the environmental risk** presented by GHG emissions. Smith was approached by Unilever, acting on behalf of a number of global agri-food companies in 2009, to develop the science described above into a practical software tool that could be used across the world in a variety of food supply chains to help the companies meet their ambitions to significantly reduce GHG emissions from agriculture [c]. The first version of the tool was delivered in 2010, and has since been used in 16 farming systems, in 18 countries sponsored by 18 agri-food companies and NGOs (e.g. [c, d, e, g, h, I, j]). Some of the largest agri-food companies (e.g. Unilever, PepsiCo, Tesco, Heinz, Sysco, and Costco) sponsor this work, representing a significant proportion of global agricultural food chains. A number of these companies have ambitious emission reduction targets (e.g. PepsiCo aims to reduce emissions by 50% in 5 years); these companies are now reducing GHG emissions by engaging their producers in measures to reduce emissions, facilitated by the Cool Farm Tool as described by the companies themselves in a number of case studies (http://www.coolfarmtool.org/CaseStudies).

Contribution by the University of Aberdeen: The work described above, culminating in the IPCC chapter, was underpinned by a sustained body of research in Smith's team. The IPCC chapter is necessarily co-authored from experts around the world, but Smith led the team that conducted the assessment, and was lead author of the chapter and underpinning papers (see section 2). The development of the software tool was in collaboration with Unilever and the industry-funded Sustainable Food Lab; Hillier and Smith led the scientific and technical aspects of the development.

There are three levels of beneficiary: (1) policy makers who have benefited from the science arising from the research to allow them to design policy based on quantifiable outcomes and costs, (2) agri-food businesses and farmers who, through the Cool Farm Tool, have access to tools to help them reduce the environmental impact of their farming operations, (3) society, which benefits from reduced climate change due to reduced GHG emissions (which account for ~25% of human GHG emissions).

Claimed impact as defined by REF guidance:

Evidence of the extent of the impact described: 18 companies are sponsoring the Cool Farm Institute which was set up to maximise global access and use of the Cool Farm Tool to assess GHG emissions and devise roadmaps for GHG emission reduction. The work is having real impact e.g. the PepsiCo "50 in 5" target was introduced in 2010 and the Cool Farm Tool is one of two tools supporting this programme. Emissions have been reduced as a result. Progress toward its "50 in 5" targets is published in PepsiCo's yearly sustainability updates, which are published and independently assured by Deloitte LLP. Other examples include Unilever which has embedded the Cool Farm Tool into its farmer and supplier sustainable agriculture self-assessment platform, H.J. Heinz which chose to focus on a key crop and a major growing region – California tomatoes – where they source from approximately 270,000 acres annually, and Oxfam GB which has used the Cool Farm Tool to examine the effects of climate change on smallholder farmers in Guatemala producing frozen vegetables for export. These and other case studies are described at http://www.coolfarmtool.org/CaseStudies. **Impacts on the environment** have already been significant through quantified emission reductions on trial farms, and through engagement in GHG emission reduction of previously unaware producers and farmers supplying the global food companies listed, leading to a **reduced climate impact of farming for growers and suppliers.**

Dates when impacts occurred: Society will ultimately benefit from reduced GHG emissions from agriculture, but the benefits may not be felt for some time since emission reduction has long-term, rather than short-term, effects. In the meantime, many other beneficiaries have already benefited from the impact described here. Policy makers and shapers have already benefited from the science provided on GHG mitigation potential in agriculture (e.g. UNFCCC 2008 position paper for

climate negotiations: [a]) leading to **impact on public policy**, whereby **guidelines have been informed by this research evidence**. Similarly, agri-food companies and farmers have already benefited through use of the Cool Farm Tool to help reduce GHG emissions in their food supply chains which has driven **impacts on the environment** through **changed management of the environmental risk** presented by GHG emissions and **impacts on commerce** by allowing agri-food companies to **improve their performance** (both environmental and economic) by reducing inputs [c].

5. Sources to corroborate the impact

Examples of Policy impact:

[a] **UNFCCC document used to frame climate negotiations based on work described here**: http://unfccc.int/resource/docs/2008/tp/08.pdf.

[b] **Use of the science in formulating Marginal Abatement Costs Curves for advising governments**: http://www.mckinsey.com/client_service/sustainability/latest_thinking/pathways_to_a_low_carbon_economy

Examples of Impact of the Science on Agri-Food Businesses and Growers:

[c] **Project using the Cool Farm Tool in 18 countries**: http://sustainablefood.org/index.php?option=com_content&view=article&id=117&Itemid=53

[d] **Download site for the free software**: http://www.coolfarmtool.org/CoolFarmTool

[e] **PepsiCo's description of their use of the Cool Farm Tool of 350 UK potato farms and reports of annual progress toward its "50 in 5" targets supported by the Cool Farm Tool**: http://www.pepsico.co.uk/purpose/environmental-sustainability/agriculture; http://www.pepsico.co.uk/resources-library/2337/1

[f] **Testimonials from growers as users of the Cool Farm Tool** (e.g. "*I do have to tell you, this Cool Farm Tool is really something, I have mentioned it at numerous meetings, talking to different people about where we go next and what's out there. I always get something out of these things, many feel you don't have time to do this stuff but this keeps you right there, keeps you on the cutting edge and I appreciate all the time you guys have put into it, it's a pretty amazing tool.*") Large U.S. tomato farmer: http://www.coolfarmtool.org/ForGrowers

[g] **H.J. Heinz's description of their use of the Cool Farm Tool on California tomatoes – where they source from approximately 270,000 acres annually**: http://www.coolfarmtool.org/reports/Heinz_CFO_Report_UK_Feb_2012.pdf

[h] **Unilever and the cool farm tool - Carbon footprint data collection from agricultural suppliers using the Cool Farm Tool**: http://www.coolfarmtool.org/reports/Unilever_case_study-CFI-2012.pdf.

[i] **Use of the CFT to monitor the climate impact of the proposed practices and identify hotspots of GHG emissions in coffee production – the Sangana PPP Kenyan coffee case study**: http://www.coolfarmtool.org/reports/SanganaPPP_GuideBook_4CClimateCode.pdf

[j] **Marks & Spencer's Carmel McQuaid talks about Cool Farm Tool in The Guardian**: http://www.guardian.co.uk/sustainable-business/blog/institute-farmers-agriculture-business-emissions