

Defra's agriculture and climate change policy and research programme

V. TURNER

*Agriculture & Climate Change, Farming for the Future Programme, Defra
5C, 9 Millbank c/o Nobel House, Smith Square, London, SW1P 3JR*

Summary

Agriculture has a central role to play in helping to tackle climate change and adapt to its impacts, and in managing the natural environment more broadly. Defra's "vision" for 2020 is of a farming sector which is competitive and profitable without subsidy; making a net positive environmental contribution; and managing sustainably the landscape and the natural assets that underlie it. Specifically on climate change, Defra aims to enable the agricultural sector to fulfil its potential in contributing to climate change mitigation, and to provide farmers with the information they need in order to adapt to the impacts and make the most of the opportunities presented by climate change. This paper provides an overview of the role of agriculture in climate change and sets out the policy framework to help ensure that government and the agriculture sector can work together in tackling climate change, and provides some information about Defra's current policies and research programme in this area.

Greenhouse gas emissions from agriculture

Globally the agriculture, forestry and land management sector is a major contributor to climate change – collectively it is the second largest source of emissions after the energy sector. The Stern Review on the economics of climate change (published in October 2006) highlighted that agriculture accounts for around 14% of global greenhouse gas (GHG) emissions, and a further 18% of emissions are due to deforestation, largely driven by the conversion of forest to agricultural land. With an increasing global population and increasing demand for agricultural products, these figures could rise.

Within the UK, agriculture is responsible for around 7% of our total GHG emissions. It is the single largest emitter of nitrous oxide, a greenhouse gas which is 296 times more potent than carbon dioxide – it accounts for 67% of the UK's total nitrous oxide emissions, mainly from manure and the use of nitrogen fertilisers. It also accounts for a large proportion of methane emissions (37% of the UK's total), which come mostly from manure and the digestive systems of livestock. As with nitrous oxide, methane also has much greater global warming potential than CO₂ (it is 21 times more powerful). Action to reduce emissions of these two gases can therefore have a significant impact on climate change. Figure 1 (Annex A) shows the main sources of agricultural greenhouse gas emissions. Livestock are clearly the biggest contributor, but it is important to keep in mind that the feed for livestock (including its nutritional quality) also contributes to emissions.

GHG emissions from agriculture are currently declining, mainly due to reductions in livestock numbers and reduced use of nitrogen fertilisers – agricultural methane emissions

have fallen from 1.023 million tonnes in 1990 to 0.873 million tonnes in 2005 (a decrease of about 15%), and nitrous oxide emissions fell from 0.103 million tonnes in 1990 to 0.085 million tonnes in 2005 (about 17%). However, agricultural emissions are set to rise again from 2010 onwards. It is also important to note that emissions from agriculture have not decreased as much as emissions from other sectors, so agriculture's share of both methane and nitrous oxide emissions is in fact increasing as shown in figures 2 and 3 (Annex A).

Farmers and land managers can support mitigation efforts by reducing direct emissions of methane and nitrous oxide – for example by using fertiliser more efficiently, by providing animals with diets that specifically match their nutrient requirements, and by improving manure management (including by using anaerobic digestion) to reduce methane emissions.

Agriculture also makes a contribution to carbon dioxide emissions (for example from the consumption of fuel for vehicles, and electricity and heat for buildings), and has an important role in protecting stores of carbon in woodlands and soils, and in providing biocrops and biomass as alternatives to fossil fuels.

Adapting to the impacts of climate change

Climate change is likely to mean warmer, wetter winters and hotter, drier summers. Crop yields may be affected by changes to temperatures, rainfall, CO₂ concentrations in the atmosphere, and more extreme and variable weather. There may also be an increased risk of new crop diseases and some pests may become more serious and may move into previously “safe” areas. Some changes may bring benefits and business opportunities, such as longer growing seasons, possible increases in growth rates and yields, the opportunity to grow new or novel crops, and reduced on-farm energy costs – for example for grain drying.

Climatic changes, combined with global population increases, may put additional pressure on food production and, in turn, on increased production from available arable land. The effects of climate change may also impact on trade and commodity prices. For example, drought in certain parts of world and severe flooding and excess rain in others, combined with other factors such as increasing consumption, have contributed to a recent rise in grain prices.

In addition to being directly affected by climate change, farmers – as custodians of the land – will increasingly have a role in managing the broader impacts, such as the likelihood of increased water shortages, the risks of flooding, and the risks to certain vulnerable species.

The policy framework

Climate change:

The UK is committed under the Kyoto Protocol to reduce emissions of the “basket” of six greenhouse gases (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) by 12.5% below the base year (1990) level, during the first commitment period (2008-2012). Final estimates for 2005 emissions

(published in 2007) showed that the UK was ahead of its Kyoto Protocol target, with emissions of the basket of six GHGs at 15.6% below the base year. Our latest UK greenhouse gas emissions projections indicate that, taking into account the net impact of allowances and credits surrendered through the EU emissions trading scheme, emissions of the basket of six gases might be around 23% below Kyoto base-year levels in 2010. Projected CO₂ emissions for the UK are expected to be 16% below 1990 in 2010. Although the projections show that we expect significant reductions in carbon dioxide emissions by 2010, the projected fall would not be enough to achieve the domestic goal to reduce carbon dioxide emissions to 20% below 1990 levels by 2010. This target was always designed to be challenging but now looks increasingly difficult to achieve.

The UK Climate Change Programme, published in March 2006, aims to put the UK back on track to meet this domestic target. The Programme highlights the importance of the agriculture, forestry and land management sector in achieving our climate change goals.

In March 2007 the Government published its draft Climate Change Bill. The draft Bill is the first of its kind in the world, and will make the UK the first country to set a long-term legal framework for reducing emissions over the next 45 years and beyond, through international and domestic action. The Bill includes targets to reduce the UK's CO₂ emissions by 60% by 2050 and 26-32% by 2020. Five-year carbon budgets will set binding limits of CO₂ emissions, beginning with the period 2008-2012. A Committee on Climate Change will be established to advise on the optimal pathway towards achieving these medium and long term targets. The Bill also includes enabling powers to introduce new GHG emissions trading schemes.

Sustainable agriculture and climate change:

Defra's "vision" for English farming in 2020 is of a sector which:

- is profitable in the marketplace, continuing to produce the majority of the food we consume;
- makes a positive net environmental contribution, notably in respect of climate change, but also more widely; and
- manages the landscape and the natural assets that underlie it.

The Strategy for Sustainable Farming and Food and the associated Forward Look document set out the action needed to achieve this. Defra has established its Farming for the Future Programme to concentrate on the following issues that are central to this vision:

- Agriculture and climate change
- Integrated farming
- Enhanced skills for farming
- Smarter regulation
- Nutrient management
- Farm health planning.

The aim of the workstream on Agriculture and Climate Change is to enable the agricultural sector to fulfil its potential in contributing to climate change mitigation, and to provide farmers with the information they need in order to adapt to the impacts and make the most of the opportunities presented by climate change. It is helping to achieve the agriculture-

related commitments in the Climate Change Programme, and includes five main areas of work:

(i) Raising awareness among farmers of their role in tackling climate change and the need to adapt, and achieving behaviour change to reduce GHG emissions:

- We are working with the Rural Climate Change Forum (our main advisory body) to identify the priority good practices – both to reduce agricultural GHG emissions and to adapt to climate change – that we should be communicating to farmers, and the key channels to communicate those messages.
- This project also includes looking at other levers and incentives, such as agri-environment schemes, that could be used to bring about changes in farmers' behaviour.
- The sorts of behaviour changes the project will encourage may include: more efficient management and use of fertilisers and manure; measures to increase livestock nutrient efficiency; the use of new technologies such as improved genetic resources; the increased use of anaerobic digestion to methane from manure and other organic wastes (which is a key strand of the project); the establishment of permanent grassland or woodland; and the sustainable production of biomass to replace fossil fuels.

(ii) Supporting action to adapt to the impacts of climate change on agriculture:

- This project – which also directly supports Defra's Climate Change Adaptation Programme – is currently being developed. It is likely to include work to:
 - understand the key impacts of climate change – both positive (opportunities) and negative (risks) – on agriculture
 - understand how the industry needs to adapt in order to remain sustainable and economically viable
 - understand how agriculture can contribute to managing and minimising the broader impacts of climate change on land, ecosystems, biodiversity and society as a whole
 - communicate to farmers and land managers the information they need to make informed decisions to adapt their businesses, whilst recognising the broader responsibilities they have in relation to the environment and providing ecosystem services
 - identify and implement appropriate mechanisms and policy frameworks to facilitate agriculture playing its part in broader adaptation and ensure that this is not compromised by sectoral adaptation.

(iii) Exploring options for market mechanisms for greenhouse gas emissions trading for agriculture, forestry and land management:

- This project looks at the potential of an emissions trading scheme as a means to achieve emission reductions from agriculture, forestry and land management. The characteristics of the sector make emissions trading more complicated – and potentially more expensive – than for other sectors. For example the sector is made up of a large number of small units, emissions sources are diffuse, and emissions can vary considerably depending on what boundaries are set (e.g. emissions for dairy cattle are

much higher if nitrous oxide emissions associated with feed crops and grazing land are included).

- Earlier this year we commissioned a study by NERA Economic Consulting, which looked at the feasibility of a trading scheme for agriculture and the costs and benefits. Their study concludes that a “cap-and-trade” scheme (under which an emissions cap for the sector would be set and participants would have a certain number of allowances for emissions within the cap, which could be traded) would not be economically viable at this stage, but that a project-based scheme (whereby tradable “credits” would be given to enterprises that undertake projects to reduce emissions below a certain level) could have greater potential.

(iv) Driving faster growth in the uptake of anaerobic digestion:

- Anaerobic digestion (AD) captures the methane emissions from manure, slurry and other organic materials (such as food waste) to produce biogas, which can be used to generate electricity and/or heat. It is seen as a ‘win-win’ technology, as it provides a renewable source of energy, whilst helping to reduce methane emissions and contributing to more sustainable waste management. The digestate produced can be used as an organic fertiliser, which reduces the need for artificial fertilisers (the production and use of which generate GHG emissions). AD is widely used in other countries (e.g. Germany and the Netherlands) but is currently under-deployed in the UK. We want to see greater uptake of AD, not just by farmers, but also by local authorities and businesses such as supermarkets (some of which are already looking at the potential for using AD for their food waste).
- Our AD project addresses the economic, regulatory and technical barriers to greater uptake. A recent stakeholder workshop on AD concluded that there is a need for a concerted effort to build awareness of AD among planners, regulators, businesses and consumers.
- A key part of the project is the development of a “standard” and protocol for the digestate from AD – this work is led by the Environment Agency. These will set out conditions on the production and use of digestate and clarify the point at which the waste is “fully recovered” so that it ceases to be a waste, and becomes a product which can be used without being subject to waste management controls.

(v) Influencing the policies and approaches of key countries and international organisations:

- We are seeking to influence the priorities and policy approaches of other key nations and international organisations towards addressing climate change in agriculture and land management, and to promote sustainable agriculture more broadly.
- We are developing a UK-China Sustainable Agriculture Work Programme, as part of the UK’s Sustainable Development Dialogue with China.
- We are also engaging with the OECD Joint Working Party on Agriculture and Environment, and working with the international Methane to Markets Partnership, particularly the Agriculture Sub-Committee (which the UK co-chairs with Argentina).
- With the British Embassy in Berlin we are planning to hold a joint UK-Germany high level experts seminar on agriculture and climate change in Berlin (in early 2008).

- We have also had a number of exchanges with New Zealand, which has a strong R&D programme on emissions from agriculture and which also is developing an emissions trading scheme to cover all sectors, including agriculture, and all GHGs.

Other issues:

There is a wide range of other policies, regulations and initiatives that could impact on agriculture and climate change. For example:

- Revisions to the RB209 guidance and the Codes of Good Agricultural Practice will reflect the importance of good nutrient management, and the need to apply fertilisers and manures according to crop need to avoid nitrate leaching.
- The current consultation on the implementation of the Nitrates Directive in England includes proposals for new measures and the extension of Nitrate Vulnerable Zones to cover about 70% of England.
- The proposed Soil Framework Directive and Defra's Soil Strategy, are both likely to include measures to maintain soil organic carbon (which is also encouraged through Cross Compliance), to improve soil structure, and to manage risks associated with climate change, such as soil erosion.
- The Renewable Transport Fuel Obligation (RTFO) means that by 2010, 5% of transport fuel sold in the UK must come from a renewable source. This may lead to an increased demand for crops such as oilseed rape or wheat as feedstocks for biofuel processing plants.
- The UK Biomass Strategy, published in May 2007, commits the Government to increasing the use of biomass as a renewable source of energy, and includes measures to achieve the target of providing 20% of electricity from renewable sources by 2020.

Research and development

Sustainable agriculture – and in particular, more sustainable cropping systems – envisages lower resource use, notably with respect to inorganic fertilisers, pesticides and energy, to reduce pollution of water, air and soil and to improve the carbon footprint of agricultural production. Defra's Sustainable Farming and Food Science Programme helps to address these issues, and explores how UK agriculture might be affected by climate change.

The basis of any cropping system is the suitability of the variety grown – as reflected by the HGCA's commitment to the Recommended Lists – and its appropriate agronomic management. New varieties, well adapted to conditions arising from climate change, will be essential for the farming systems of the future. Indeed, crop genetic improvement may be the only way to take advantage of the potential opportunities (such as greater yields) without the challenges (such as greater variability, or reduced soil moisture) becoming limiting. Commercial variety development is driven by yield and quality improvement giving a direct market return, and there is little incentive for breeders to select for other traits beneficial in relation to environmental and climate change concerns. Breeding of new varieties from initial lines with desirable traits is a long term (10 years+) process. Therefore, public funding, at the pre-breeding stage, on genetics, trait identification and marker selection, is necessary to facilitate incorporation of essentially "public goods" benefits into varieties being developed for the future.

Defra has funded this underpinning R&D through Crop Genetic Improvement Networks, for example for wheat, oilseed rape and (through the collaboratively funded OATLINK project) for oats. The HGCA is involved in these networks and, as an industry partner, in many of the associated LINK projects. These include drought tolerance; greater resource efficiency (especially of nitrogen and phosphorus) under higher temperatures; lodging in wheat; pest and disease resistance, including for example resistance to wheat blossom midge, ergot or the mycotoxin-producing *Fusarium* species that may be favoured by future conditions.

The specific agriculture and climate change research programme includes projects looking at:

- Measuring emissions from agriculture
- Mitigating agricultural nitrous oxide and methane emissions
- Climate change impacts and adaptation
- Energy in agriculture and food
- Bioenergy
- Renewable materials.

The following recent and ongoing projects may be of particular interest to the arable sector and to the HGCA

Vulnerability of UK agriculture to extreme events (AC0301; end date 31/3/2008)

Scientists are using a modelling approach to detect extreme weather events under climate change and investigate the impacts on agricultural crops. Key findings are:

- The magnitude and frequency of extreme weather events will increase in the 2080 high emissions scenario, the frequency of heat waves will increase dramatically (by an order of magnitude) and they will last up to 12 days
- more intense daily precipitation for all months except August (2080HI).
- Wheat – grain yield will generally increase due to higher atmospheric carbon dioxide. Warmer temperatures mean that it will mature up to one month earlier avoiding the impact of summer heat waves.
- Sugar beet – yield set to increase, but sensitivities to extreme weather events mean that variation in yield between years will be greatly increased.

The project has been extended to look at the economic effects of these extreme events at the sectoral level.

Changes to agricultural management under extreme events - likelihood of effects and opportunities nationally (Chameleon) (CC0361; end date 31/3/2008)

The project has determined the key extreme events that farmers and agricultural experts feel most affect farm businesses and identified how these may change under climate change. The responses to the events in terms of both reactive and proactive adaptations have been explored in consultation with farmers across the UK. From this consultation process and a review of modelled adaptations and existing adaptations used outside of the UK, a range of most practical and worthwhile adaptations have been selected for more detailed analysis and costing.

The project is now looking at the costing process, which will consider both the existing practices within which any changes must fit and a current and a selection of future policy drivers that may affect their cost effectiveness.

The Defra Climate Change Research and Innovation Adaptation Network (AC0302; end date 30/09/2008)

The purpose of this project is to foster the transfer of relevant overseas knowledge and experience to the UK. The project is fostering research partnerships with relevant UK farming and food interests, drawing on input from other relevant climate zones.

Ecosystem services for climate change adaptation in land management (AC0308; end date 31/8/2008)

The aim of this project is to examine the potential for agricultural land management to provide ecosystem services that support adaptation to climate change.

Website links

More information about the R&D projects listed above is available at:

<http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=Detail&Completed=0&FOSID=33>.

The Stern Review on the economics of climate change is available at:

http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm

The Strategy for Sustainable Farming and Food, and the associated Forward Look document are available at:

<http://www.defra.gov.uk/farm/policy/sustain/index.htm>

The UK Climate Change Programme, and more information about the Climate Change Bill, are available at:

<http://www.defra.gov.uk/environment/climatechange/uk/ukccp/index.htm>

ANNEX A

Figure 1: Sources of UK agricultural methane and nitrous oxide emissions (calculated as carbon equivalents): 2005

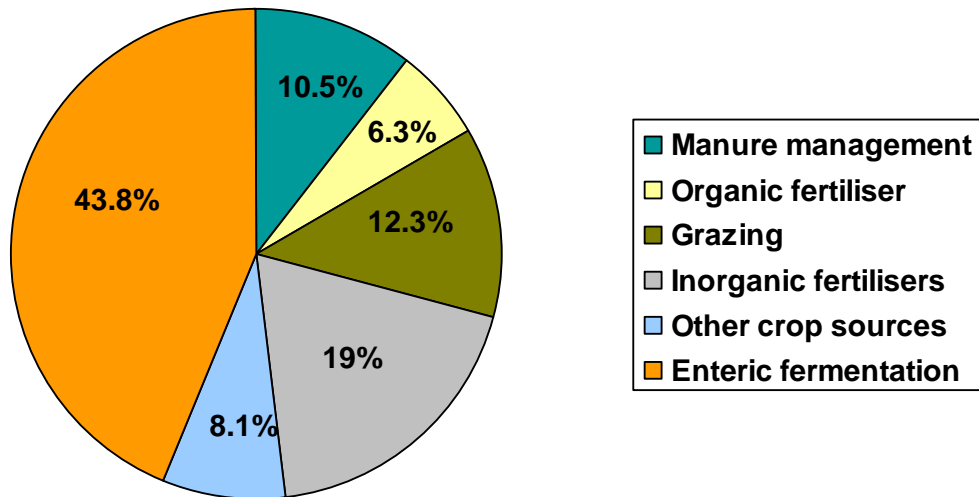


Figure 2: Methane emissions by source: 1990-2005

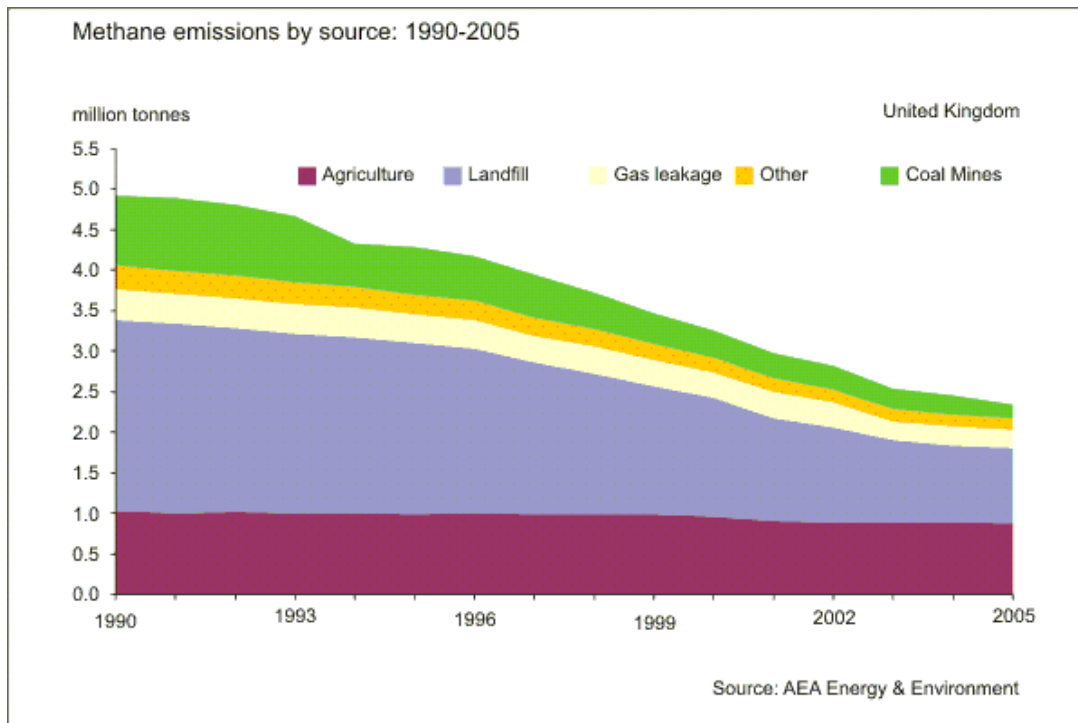


Figure 3: Nitrous oxide emissions by source: 1990-2005

