A new vision for lower carbon farming?

Signalling its long term commitment to greenhouse gas mitigation, the Greenhouse Gas Action Plan invited a range of stakeholders - policymakers, industry, supply chain representatives, scientists and farmers – to debate the potential of different lower "carbon" farming[1] futures. This document describes the outputs of that workshop.

Where is agriculture now?

The Greenhouse Gas Action Plan (GHGAP) demonstrates the commitment of the agriculture industry in England to playing its part in tackling climate change by reducing its greenhouse gas (GHG) emissions by 11% (three million tonnes CO_2e) by 2020. This is in addition to the almost 20% reduction achieved since 1990. A Defra review in 2012 confirmed that the GHGAP is on track to meet its 2020 target[2].

The GHGAP commitment was made in the knowledge that the nature of agricultural GHG emissions is very different from other sectors of the economy. For agricultural systems nitrous oxide and methane are the main GHGs. Determining these emissions is much more complicated than measuring carbon dioxide, and they are bound up in highly complex and imperfectly understood natural soil and animal microbial processes. These processes are not directly controllable by human intervention, and furthermore they are subject to seasonal and annual variability as a function of the weather, crop yield, *etc*.

What's next? – What others expect

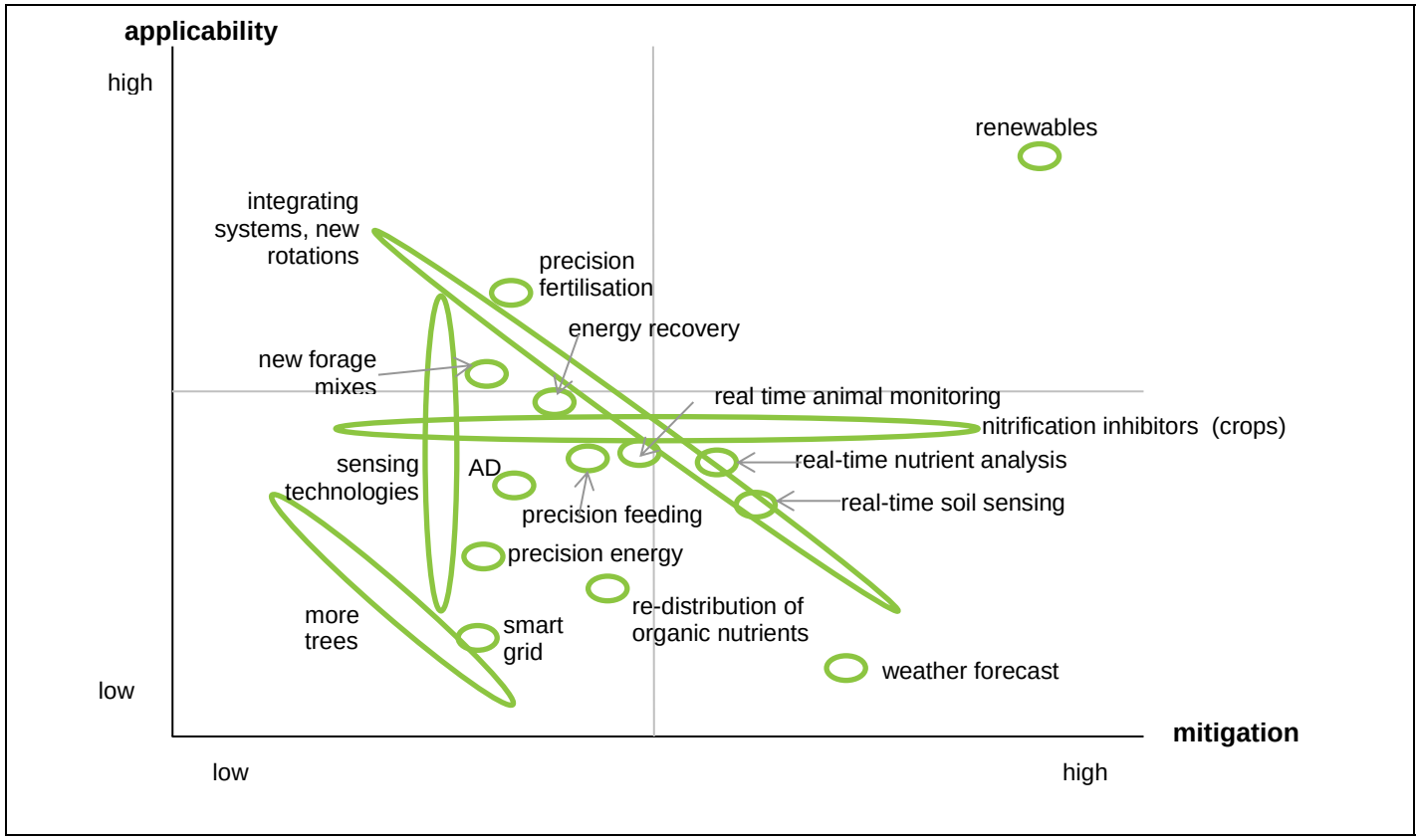
The independent Committee on Climate Change is looking for a 20% reduction in GHGs from UK agriculture by 2030 on the road to its expected very ambitious target for farming of 70% fewer emissions by 2050. Its abatement options include avoiding nitrogen excess, use of more nitrogen-efficient pasture and crop plants, improved genetics in beef and dairy, more maize silage for dairy and anaerobic digestion for pigs and poultry.

The Committee believes that there is scope for further abatement from nitrification inhibitors, improved drainage of agricultural land, and reducing carbon dioxide emissions from machinery to zero. It has also considered demand-side measures - reducing food waste, and dietary change with fewer meat and dairy products consumed.

[1] Lower "carbon" farming covers all agricultural GHGs – nitrous oxide, methane and carbon dioxide
[2] Defra 2012 review

A new vision for 2020 – 2030?

On-farm mitigation measures were assessed according to their abatement potential on a scale of low[3] to high and their applicability (an arbitrary scale which includes considerations of cost and ease of implementation, farming system *etc*).



Key

- Renewables - for use on-farm and exported
- Precision fertilisation – of crops and grass
- Energy recovery - re-using waste heat and reducing energy consumption
- Real-time animal monitoring – for health, fertility *etc*
- Nitrification inhibitors - deter nitrogen loss to air
- Real-time soil sensing – assessing soil state, compaction *etc*
- Precision feeding - matching feed to individual need
- AD – anaerobic digestion
- More trees – including hedgerow trees and agroforestry
- Smart grid - monitoring and adjusting farm energy supply and demand in real-time
- Spatial re-distribution of organic nutrients – from livestock to non-livestock farms
- Weather – more timely short and long term forecasting and on-farm response

[3] Less than 10% of emissions from agriculture in England in 2007 (the baseline year for the GHGAP's emissions reduction target)

Additional mitigation measures beyond 2030 were fewer in number with generally less certainty about their applicability or mitigation potential. Options included nitrogen-fixing cereals, smart drainage, breeding for low-methane emitters and capturing methane from buildings during times when livestock are housed. Only the potential for carbon dioxide-free agriculture (no fossil fuel use on farm) and renewable energy export (to help decarbonise other sectors of the economy) were put forward with much confidence.

The entire range of options considered at the workshop is shown below[4]:

Reinforcing particular practices now and for the longer-term

Inevitably the discussion highlighted some practices which the GHGAP is already advocating and will continue to do so under its umbrella message of improving resource use efficiency and paying attention to detail. These included livestock health, soil management and soil testing, and more processing of manures including using anaerobic digestion.

Indirect emissions from fertilisers and feed – halved and quartered

The GHG footprints of nitrogen fertilisers and compound animal feeds produced in Europe have been reduced by 50% and 25% respectively[5]. There is also complementary interest in local scale renewable energy generation and recovery of fertilising and feed materials, and in fertiliser and feed additives.

[4] Font size has no relationship with mitigation potential or applicability. Smart grit are embedded sensors that signal the needs of soils, crops or stock

[5] Resulting from participation in EU Climate Change Agreements, Emission Trading limits and implementation of Best Available Techniques leading to improvements in energy efficiency and nitrous oxide abatement

Where are the gaps (in research, knowledge *etc*)?

On-farm

- Legume v fertiliser debate is incomplete. Need to consider the fate of legumes in livestock and the impact on methane emissions
- Is there more to do on under-sowing crops with N-fixing plants? How can crop yield be maintained/ increased?
- How much benefit does organic matter really bring to yield and productivity?
- How to match feed to protein/nutrient requirement of the animal?
- Need a better understanding of crop nutrient requirement
- What do we do about urine patches which are hotspots of emissions?
- How effective are dietary additives in mitigating methane if they have no effect on rumen pH?
- One size doesn't fit all – how do we deliver flexibility and choice for diversity of farm businesses? There is enormous variability in emissions intensity that varies with context
- How do we deal with biological systems that never yield 100%?
- How do we deal with potential trade-offs with other environmental priorities?

Data

- How to robustly measure agriculture's mitigation progress?
- How robust is the link between farm profitability and greenhouse gas mitigation potential? Need real-life cost: benefit analyses
- Research has much to learn from on-farm use of existing technologies. How can use of farms as real-life laboratories/trial sites be made worthwhile for farmers?
- Do research and industry really know how to use the data from some sensors?
- What do we do with all the data and the potential for information overload – both on farm and in research?
- How far can we get in providing more timely and accurate weather forecasts to improve on-farm management when the weather is inherently variable and changeable?
- How to get free access to the UK's soils maps so that everyone can use them?

Where are the gaps (in research, knowledge *etc*)?

Mitigation limits • How far can a reduction in emissions intensity take UK farming? • What is the irreducible limit to emissions reduction recognising that UK farming will need to produce more food? • What is the mitigation potential for agriculture under the range of potential future climates?	**Advice and technology transfer** • What do the various organisations and administrations do about the absence of cross-(UK)-boundary advice? • What more can be learnt from overseas? • What do we do about the lack of varietal testing for high yielding low nitrogen-requiring varieties • Is there a need for a forage conservation centre to fill the long-term gap in knowledge and expertise?
Supply chain • What is the scope for food supply chain product specifications to help deliver on-farm mitigation? • Matching feed to animal need – how to get the feed supply chain and farmers to better understand each other's needs? • How do we resolve the possible quality v quantity (protein v yield) dilemma?	**Engineering and technology** • Can someone design a "compactometer"/penetrometer that is reliable and farmer-friendly to estimate soil compaction? • What's the scope for controlled traffic farming? How do we get compatible machinery and axle widths? • Could we ever measure actual on-farm emissions? • Is enough understood about the influences on and rates of technology uptake? • Is there enough technology transfer from other (non-ag) sectors of the economy? Do we need an X-prize for agriculture? • How feasible is mobile voice-recognition technology which sends data to a spreadsheet?

Recommendations

Recommendations	For whom	Intended outcomes
Recognition that mitigation in agriculture is different from other sectors of the economy.	Policymakers, other sectors.	Government policies which reflect the balance of objectives desired.
That the mitigation potential of agriculture cannot be considered in isolation from the impacts of a changing climate and from the need to produce food for a growing global population	Policymakers	Government policies which reflect the balance of objectives desired.
That agricultural mitigation costs (emissions) and benefits (C storage and renewable energy generation) are considered together	Policymakers, industry, lifecycle assessors	A more holistic and balanced view of the range of carbon flows into and out of farming systems
There should be a re-assessment of the influence of exchange rate and the UK's arable area	CCC	More realistic scenario of the impacts of a weakening Euro on wheat exports
That a consortium of researchers are funded to take this work forward to assess the potential for mitigation and implementation	Policymakers and Research Councils, GHGAP and researchers	A transparent multi-disciplinary assessment based on the latest evidence and expert opinion
That the gaps identified by the workshop are scrutinised and research and KT activities funded	Policymakers, Research Councils, Agri-tech, industry	Knowledge and expertise generated and demonstrated on-farm facilitate the development of a lower carbon industry
To investigate the opportunity for synergies between supply chain specification and agricultural mitigation	GHGAP and the Product Sustainability Forum	All parts of the supply chain working together to facilitate reductions in food and drink supply chain emissions

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