



Promoting GHG activity and productivity

Progress report and
Phase III strategy and activities
April 2016



"We offer this Plan as a serious statement of intent and a commitment to reduce our industry's GHG emissions" (2011)

Over the next 35 years, the global food system will have to feed more people with less environmental impact. Our British farmers and growers will need to adapt to the changing conditions at the same time as reducing greenhouse gas (and ammonia) emissions. Agriculture has a unique emissions profile and there is a limit beyond which it will not be biologically possible to make further emissions reductions. Therefore the challenge of reducing them whilst increasing food, feed, fuel and fibre production is huge.







Our coalition of agricultural industry partners launched our Greenhouse Gas Action Plan in 2011 to meet the climate change challenge without compromising domestic production. It is too simple, and not a solution, to produce less and import more. This simply “exports” our emissions to other parts of the world. So our work has focused on how farmers, across all sectors and farming systems, can be supported to improve productivity to help reduce greenhouse gas emissions intensity.

Agriculture makes a big contribution to mitigating climate change by storing carbon in soils and vegetation and by generating renewable energy. We have been set a target of reducing our emissions by three million tonnes of CO₂ equivalent per year by 2020. Our estimates suggest that the emissions reduction potential of land-based renewable energy within our industry could outweigh this target by a factor of three. We know that farming is part of the solution.

We consider that our response is anything but “business as usual”. We know that this will not be a short nor smooth journey but we are in this for the long-term.



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Executive Summary

The Greenhouse Gas Action Plan (GHGAP¹) is the principal mechanism for delivering the farming industry's commitment to a reduction in annual emissions from agriculture in England of three million tonnes CO₂-equivalent (Mt CO₂e), as set out in the Low Carbon Transition Plan, by the third carbon budget period (2018 – 2022). Our robust partnership established in 2010 aims to raise the bar on improvements in productivity and resource use efficiency amongst farmers and growers to reduce GHG emissions per unit of production and deliver our absolute emissions reduction target.

In 2014, Total Income From Farming (TIFF) was around two and three quarters higher than it was in 2000, but is still around 30% below its peak in 1995. Total factor productivity is estimated to have risen by 6.0% in 2014 following two years of poor productivity after the wettest year on record (since 1910) for England. Whilst 2013 was generally unremarkable, there were some significant weather events notably the unseasonably late snowfalls which affected hill farms. Although 2014 provided one of the wettest starts to the year the conditions across the entire year were conducive to good crop growth leading to record cereal yields. 2015 was the warmest year on record across the world and from late autumn a succession of Atlantic storms brought exceptional rainfall to the north and west of the UK.

GHGAP progress 2012-2015

During phase II we had significant successes (see diagram on following page). The addition of new GHG mitigation training to the FACTS (fertiliser adviser) course, the introduction of a Feed Advisers Register and the take up of CPD schemes by farmers themselves have done much to improve the professionalism and productivity of the industry. Continued penetration of precision nutrient management techniques on the back of robust planning and increasing interest in soil management and organic matter to deliver productivity have since 1st April 2013 been facilitated by greater local engagement as a result of coming under the CFE's national and local co-ordination and delivery umbrella. Adoption of high sugar grasses as appropriate to the farming system and tackling chronic/sub-clinical infections and illnesses will have contributed to improving GHG footprints of ruminants. Farmers and growers have enthusiastically diversified into renewable energy, helping to lower their own emissions and de-carbonise the rest of the UK economy.

We have benefitted from the support and openness of the GHG Research Platform² and look forward to incorporating the wealth of knowledge from its research into the next phase of our work. The resource and effort put into the MIN-NO project³ by a number of GHGAP partners bore fruit. Emissions due to nitrogen fertiliser use on UK arable land were shown to be more than half the current IPCC default and it identified that farmers already using abated nitrogen fertilisers and following good practice can do little more than to continue to fine-tune their overall nutrient management for optimum efficiency.

Signalling our long term commitment to greenhouse gas mitigation, our workshop on future emissions reduction potential in 2014 made the most of the wide-ranging expertise across the UK. We identified a number of potential mitigation measures, recorded many questions which still need answering and put forward recommendations for policymakers and research.



¹ <http://www.cfeonline.org.uk/home/about-us/greenhouse-gas-action-plan/>

² <http://www.gheplatform.org.uk/>

³ <http://www.adas.uk/News/ambitious-research-shrinks-ghg-footprint-of-uk-arable-products>

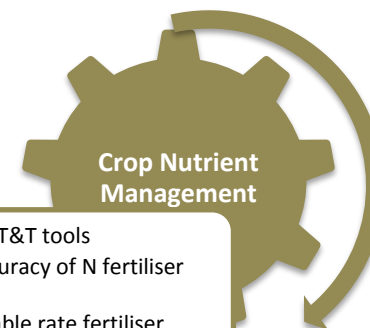
GHGAP Successes



- >2,500 FACTS advisers trained in mitigation
- >1,150 Feed advisers join FAR
- Pig sector exceeds its 2020 GHG target
- >1,100 farmers sign up to DairyPro



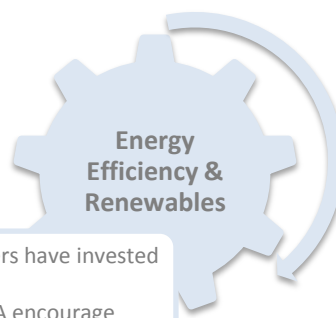
- T&T introduce Feed Plan
- greater adoption of high sugar grasses
- reduction in dietary protein levels in dairy herds



- 18% livestock farmers use T&T tools
- >60% farmers improve accuracy of N fertiliser application to lower GHGs
- >60% contractors use variable rate fertiliser application
- >6,000 farmers attend CFE Resource Protection & Efficiency events



- increase in grassland soil sampling
- ~ 100 advisers/year take soil and water CPD
- greater interest in cover crops



- > 1/3 of farmers have invested in renewables
- phase 2 of CCA encourage energy efficiency in horticulture by >20%



- increase in % of dairy herd covered by mastitis control plan
- pig herd health continues to improve
- 74% livestock farmers have a farm health plan

However, we have been unable to achieve some of our objectives for reasons beyond our control. In particular, our hopes for a Farm Efficiency Hub have not been realised due to the lack of secure long-term funding options and government spending cuts which removed support for the key IT system of our pilot hub. Strategic co-ordination and communication remain the cornerstones of our long-term commitment to work more effectively together and with others. Our vision is for clear and consistent messages tailored to the target audience, brought to life by practical demonstration and individual experiences.

Significant next steps

We are publishing our key activities focused on the next two years. Other areas of work are likely to be added to this list in time.

Objective	Example outcome
Management skills and advice To continually improve the professionalism of the industry. Advisers, farmers and growers acquire new knowledge and improve management and business skills. GHGAP support and activity aims to fill in any remaining gaps in CPD and to enhance skills with latest scientific updates.	
Produce an economic roadmap for implementation of technically feasible GHG and ammonia reductions from manures and slurries.	Technologies and practices promoted or implemented on-farm.
Intro of 'Developing Beef Expertise' and 'Developing Sheep Expertise' CPD programmes for beef and sheep consultants.	Well-trained and experienced consultants and advisers available and in demand by farmers.
Crop nutrient management To optimise productivity, the cropping sectors will target continuous improvements in the accuracy of in-field measurement and application. In the livestock sectors, support will be provided for better manure management and the take-up of integrated nutrient management planning.	
Publish new AHDB Nutrient Management Guide.	Nutrient management tools updated with the latest science to enable improved decision making.
Promote new fertiliser spreading testing scheme.	All spreaders - disc, boom and pendulum - are tested to the same standard.
Increase manure management planning in beef sector.	Campaign reverses apparent downturn in planning.
Promote improved application of manures and sensing applications.	Greater market penetration for precision technologies.
Soil and land management Good soil management underpins a productive and sustainable farming system. Selecting appropriate management systems alongside an assessment of the capability of the land can help reduce GHGs. Soils are also a significant store of carbon and so present an opportunity for mitigation.	
Promote Healthy Grassland Soils to address soil structure, drainage and nutrients.	Online resources and events in demand by livestock farmers.
Livestock nutrition To improve understanding of the energy and protein requirements of livestock. Better planning of feed grown on-farm and what may need to be bought in. Integration of feed and fertiliser strategies. Improvements in feed conversion efficiency.	
Assess impact of tailored feed advice to 1000 farm businesses.	Professional advice delivers demonstrable financial and mitigation benefits.
Next generation feed advice.	GHG Research Platform results incorporated into FAR.
Beef Feed Efficiency Project.	Infrastructure for the measurement of feed efficiency in beef cattle delivered.
Livestock health and fertility Animal health is fundamental to efficient livestock production so herd health planning and tackling endemic disease/chronic illnesses are essential.	
Implement Sheep KPI project to encourage body condition scoring of ewes.	Ewe body condition scoring is adopted as a tool to manage optimum ewe nutrition.

Since its inception, the GHGAP has pressed the case for a set of indicators which would robustly reflect the breadth of industry progress. It is our belief that we need this evidence to allow a critical assessment of our success. We need greater granularity/detail to, for example, identify what farmers are investing in and understand barriers to productivity improvements.

It makes no sense that the industry, government and its independent advisers assess and report on industry progress using three different indicator sets. So after many false starts over the past five years, the GHGAP believes that the building blocks are finally in place for a collectively owned approach.

This report has identified the below, bolstered by case studies of individual farms, as a starting point for such an indicator set:



This is a significant piece of work for our partnership but strategically important. We know there are many others active in this space e.g. the Sustainable Intensification Research Platform, the new Agri-Metrics Centre and the Productivity Evidence Review and we need better visibility of these initiatives.

1. Priority Area Progress

This document reports on the GHGAP's progress from 2012-2015 for each of our priority areas, using the following structure:

- Key indicators of progress, GHGAP activity and direction of travel
- Reflections on longer-term trends
- Case studies demonstrating change at the farm scale
- Identification of key next steps for phase III (2016-2020)

It also summarises our next steps, in particular the work we aim to undertake on indicators of progress to give both farmers and policymakers confidence that the good work that the industry is doing is visible.




As in earlier phases of our work, our overall approach will be responsive to changes in policy, scientific developments, and farming circumstances. Defra's current review of the GHGAP, the publication of the revised inventory in 2016/17 and the CCC's projections for the 5th carbon budget are likely to have a significant influence on our activities.



Management skills and advice

The GHGAP encourages continuing professional development (CPD). Survey data suggests that the majority of arable-orientated farms receive input from a professional adviser/agronomist (e.g. BASIS, FACTS) or business adviser. Up to 20,000 conversations a week are held on arable farms. The coverage is less significant in livestock areas. This is because livestock farmers are more frequently advised from a wider range of sources i.e. animal nutrition consultants and more often by feed supply industry advisers. It is through these channels that we are exploring where further potential gains for GHG mitigation can be achieved, as part of professional integrated advice provision. The introduction of proficiency standards for feed advisers plays a new and significant part. Accredited farmer training is also an important and developing area, delivered by AHDB sectors, LEAF, LANTRA, colleges etc. where the link between resource efficiencies and GHGs is being communicated.

Progress on management skills and advice

Indicator	Desired outcome	GHGAP activity to support indicator	Current situation and longer-term trends	Supporting survey evidence	Assessment of progress 2012- 2015 ⁴
Numbers of crop nutrition advisers trained in NUE ⁵ and GHG mitigation.	<ul style="list-style-type: none"> Practising FACTS⁶ Qualified Advisers proficient in GHG-related advice. Increasing awareness and uptake of nutrient use efficiency by farmers. 	GHG mitigation added to new FACTS training course in 2012, driven by the GHGAP.	<p>All practising advisers (>2500) wishing to retain professional status took necessary training.</p> <p>350 advisers chose not to meet the new standard by Dec 2014 and resigned their professional status.</p>	<p>> 75% of farms sought farm business advice in 2011/12⁷.</p> <p>AIC Value of Advice⁸ showed how £200m each year is spent on enhancing professional competence aligned with latest government policy and R&D.</p>	
Numbers of animal feed advisers completing core levels of competence.	<ul style="list-style-type: none"> Vast majority of practising feed advisers with core competency in feeding efficiencies and mitigation of impacts including GHGs. Increasing awareness of mitigation amongst advisers. 	Feed Advisers Register (FAR ⁹) introduced in 2013, driven by GHGAP.	<p>1168 practicing advisers joined FAR from 2013-2015 and completed their competence.</p> <p>230 did not maintain their FAR status due to retirement etc. Prior to the GHGAP there was no formal proficiency standard for feed advisers.</p>	As above.	
Continued improvements in sector GHG footprints.	<p>2000kg of pig meat produced per sow per year¹⁰.</p> <p>Marketable yields of potatoes improve by 5% over 5 years with more efficient use of inputs to maximise returns¹¹.</p>	AHDB sector calculators, roadmaps; LEAF Global Impacts ¹² .	<p>2012-2013: The top third indoor pig businesses exceeded the target; the industry average was 1800kg at the end of 2012.</p> <p>In 2014, the pig sector was on track to meet its target.</p> <p>Dairy herds completed second year of AHDB (Dairy)</p>	Circa 60% of farms in 2015 reporting taking mitigation action. Larger farms more likely to be taking action than smaller farms ¹³ .	

⁴ Unless otherwise stated. A report of GHGAP activity from 2010-2012 is available [here](#).

⁵ NUE= nitrogen use efficiency

⁶ FACTS was set-up in 1994 <https://www.basis-reg.co.uk/Schemes/FACTS/About-FACTS>. Independently accredited by BASIS.



⁷ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/181719/defra-stats-foodfarm-enviro-fps-statsrelease-autumn2012edition-130328.pdf

⁸ <https://www.agindustries.org.uk/latest-documents/value-of-advice-project-report/>

⁹ <https://www.feedadviserregister.org.uk/home/>

¹⁰ The Two Tonne Sow campaign

¹¹ <http://www.ahdb.org.uk/publications/documents/PotatoCouncilDivisionalPlan2013-16-Draft.pdf>

			<p>C footprinting study indicating a 5% reduction in emissions per litre of milk compared with the previous year's sample.</p> <p>At least 10% reduction of C footprint of horticulture businesses by Mar 2014. Baseline established for some key horticultural crops including tomato, bulbs and lettuce.</p>		
Numbers of farmers undertaking CPD.	Increasing professionalism across industry ¹⁴ .	<p>For example:</p> <ul style="list-style-type: none"> AHDB (Dairy) development of DairyPro from 2012. AHDB (Pork) support for the Pig Industry Professional register from 2013¹⁵. 	<p>1198 signed up to DairyPro scheme since 2012 (495 students).</p> <p>The Pig Industry Professional Register had 520 members in Oct 2015, up from 370 in Oct 2012.</p>		
Number of GHGAP partner events/ activities supporting improved resource use efficiency.	<ul style="list-style-type: none"> GHGAP's 15 on-farm actions provide guidance for information exchange. Latest knowledge presented to farmers and advisers. 	<p>For example:</p> <ul style="list-style-type: none"> 300 events run by AHDB (Beef and Lamb) attended by >5000 farmers/y. In 2012-14 AHDB (Dairy) had face-to-face meetings with > 4,300 farmers. Development of online videos by AHDB¹⁶ (Pork), LEAF. 	<p>2014-2015: 69% of attendees at AHDB (Beef and Lamb) events adopted a post-event action and 74% of these observed it had made a financial difference to their business¹⁷.</p> <p>2012-2013: Of 133 AHDB (Beef and Lamb) events helping producers better prepare their animals to market specifications, 96% of attendees implemented practical ideas.</p>	<p>Circa 60% of farms in 2015 reporting taking mitigation action. Larger farms more likely to be taking action than smaller farms¹⁸.</p>	

¹² <http://cereals.ahdb.org.uk/tools/carbon-footprinting-decision-support-tool.aspx>, <http://beefandlamb.ahdb.org.uk/returns/tools/sheep-carbon-footprint-tool/>, [http://www.nfuonline.com/sectors/dairy/dairy-news/the-dairy-roadmap/what-is-the-dairy-roadmap/](http://www.nfuonline.com/sectors/dairy/dairy-news/the-dairy-roadmap/what-is-the-dairy-roadmap/http://www.nfuonline.com/sectors/dairy/dairy-news/the-dairy-roadmap/what-is-the-dairy-roadmap/), http://www.leafuk.org/resources/000/733/200/Sustainability_report.pdf, <http://www.leafuk.org/resources/001/073/124/leaf-sustainability-ebrochure-2015-b2.pdf>

¹³ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/449266/agriclimate-6edition-30jul15.pdf

¹⁴ A GHGAP ambition <http://www.cfeonline.org.uk/ghgap-delivery-plan-2010-2012/>

¹⁵ <http://www.dairypro.co.uk/> launched to help develop technical abilities, increase understanding of industry issues and advance personal skills. Membership data from BASIS. <https://www.pipr.org.uk/> The Pig Industry Professional Register was established to recognise professionalism in the pig industry and encourage lifelong learning. It was launched in 2007. Latest membership data from City & Guilds.

¹⁶ <http://practicalpig.ahdb.org.uk/outdoor-breeding/general-care/record-keeping>, <https://www.youtube.com/watch?v=AUU9stPmTI4&feature=youtu.be>

¹⁷ Better Returns Programme annual survey. All events are assessed using feedback forms on the day. In addition BRP undertakes a post event survey six months after attending the event, asking producers if they adopted any new ideas as a result of the meeting, and if it improved their financial returns.

¹⁸ FPS 2015

Review of management skills and advice

National level indicators of on-farm practice

The industry commitment to improving the efficiency of crop management began in the early 1990s (Figure 1). Management skills for and on arable farms are now high.

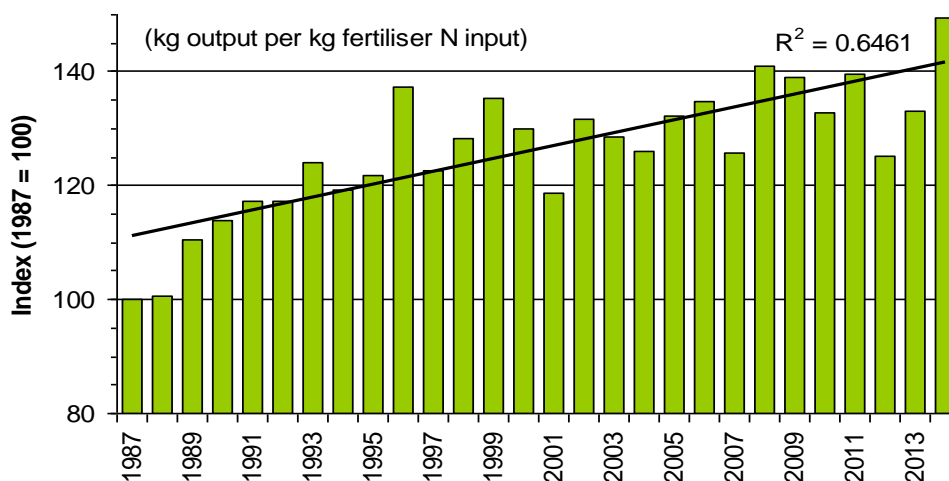


Figure 1: The continual improvement in the apparent efficiency of nitrogen fertiliser for arable crop through improving crop management skills and advice, as illustrated = reducing GHG intensity of production

Similarly N inclusion rates in feeds for animal production have shifted downwards since 1999 reflecting improvements in animal feeding and health and welfare (Figure 2).

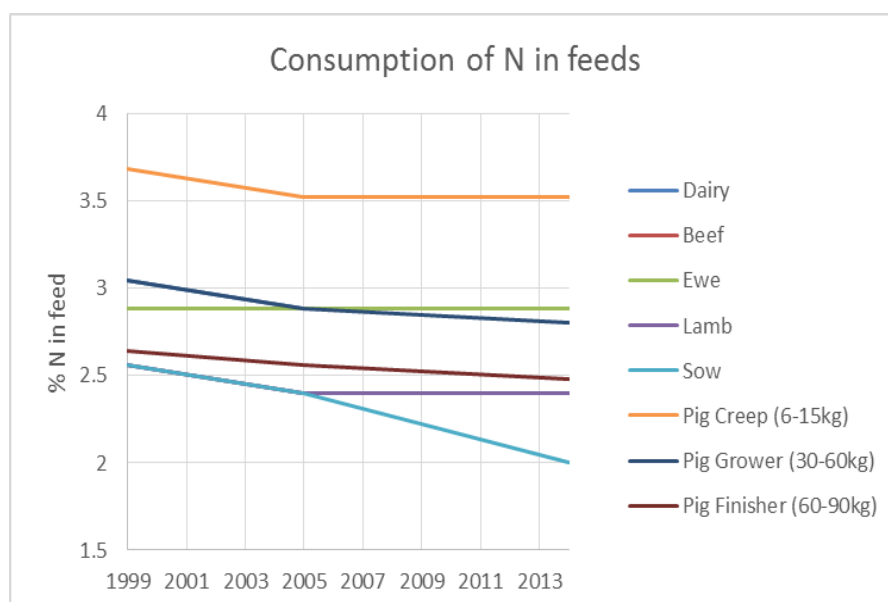


Figure 2: Trends in N concentration in animal feeds (AIC and Defra Statistics)

In general, livestock farms focus on animal rearing and on nutrition and health management. For cattle and sheep, grass and forage nutrition can be secondary considerations but the most productive farms will be paying a high level of attention to both.

We estimate that 60% of technical, face-to-face advice is provided by professional business advisers from the supply trade industry, 35% by self-employed/company consultants and those working for agronomy groups etc. and 5% from AHDB staff with an on-farm presence, and other professionals.

Around 10% of professional qualifications are taken by farmers. These farmers (mainly arable) are choosing to develop their own skills so that they do not have to rely on an external source or they use their skills in a two-way discussion with their adviser.

GHGAP activity

The GHGAP has driven the uptake of GHG mitigation knowledge by the suite of industry initiatives which aim to support the improving long-term trend. The increasing professionalism amongst advisers is of significant note:

- dedicated commitment from feed advisers who have developed their competence to help livestock farmers implement GHGAP actions
- specific CPD training for crop nutrition advisers on nitrogen-use efficiency and the GHGAP's on-farm actions

The AIC's 'Value of Advice' report¹⁹ sought to evaluate the scope and influence of the advice available and explain how policy developments, including GHG mitigation are a key part of the annual CPD of advisers and an effective conduit for GHGAP messaging. The value of face-to face locally targeted advice is also proven through Defra's Catchment Sensitive Farming evaluation programme.

Working with farmers to improve management skills and advice

Feed Adviser on the Feed Advisers Register (FAR), who manages 12,500 dairy cows plus est. 4,000 followers and approx. 2,000 beef animals

In this particular case the advice related to 250 dairy cows. "I focus on improving forage quality during harvesting and particularly storage along with forage budgeting to maximise efficient utilisation. Diet formulation was designed to optimise rumen health and efficiency, and promote dry and transition cow management strategies to ensure freshly calved cows are able to utilise the production diet and achieve target milk output.



My farmer client and I take a holistic view when it comes to managing dry cow management and nutrition. We introduced a heat detection system and new fertility targets to reduce calving interval. We introduced better grassland species and fodder beet into the rotation to improve output from farm grown feeds.

Herd milk yields increased from 8,500 litres to 10,500 litres with better fertility (CI down from 400 to 396 days). Major improvement in transition cow health (reduced incidence of ketosis, metritis, DA's). Significant improvements in forage harvesting and utilisation through better education and budgeting created more consistent and better balanced rations.

¹⁹ <https://www.agindustries.org.uk/latest-documents/value-of-advice-project-report/>

DairyPro member: Robert Pryce-Jones, dairy farmer

Robert farms near Welshpool with around 200 Holstein Friesian cows that are mostly year-round calving. "Before I joined Dairy Pro last year, I was already attending lots of training and development events, so being in the programme hasn't changed this."



"However, it's valuable proof of development for third parties," says Robert. "In particular, having a staff member involved in a professional development register is now a recommendation of the Red Tractor Assurance scheme."

Robert says he's only been registering activity through Dairy Pro for 12 months but will pass on all new knowledge to his staff. "I employ fully trained herdspeople and there's a protocol for every job, so Dairy Pro will fit in well with this."

FACTS Qualified Adviser (FQA) 'know how' improves nitrogen use efficiency

Knowing your way around the fertiliser industry's standard crop nutrition 'bible' *The Fertiliser Manual* (RB209) is key to fine-tuning nitrogen management strategies. A FQA has the knowledge to help translate available farm data into field specific recommendations. A group of agronomists in the south west analysed grain sample data for farmers, and reviewed them against total fertiliser applications. Grain nitrogen and sulphur levels were measured to enable advice to be given. FQA Mark Tucker was called on to help interpret the relationship between grain sample data and N requirements.



FQA Mark Tucker

The *Fertiliser Manual* gives the target % grain nitrogen for a winter wheat crop then uses tables to arrive at amounts of additional N required. The south west study revealed that 10% of samples indicated over-fertilisation, while 90% indicated under fertilisation. According to the calculation from the grain-N results around 90kg N/ha extra was required to satisfy crop N demand. The data also showed that 60% of samples were expressing sulphur deficiency. This information enables agronomists to make further adjustments to crop nutrition so improving overall nitrogen use efficiency.

GHGAP reflections

The improvements in farm management skills in crop and animal production and the quality of professional advice continue to grow strongly and are, we believe, contributing to better productivity and lower GHG intensities. Farmers continually push the boundaries of their knowledge and that of their adviser to do better. The greatest scope for improvement lies in the management of grass and forage, the focus of industry's Tried & Tested resources and targeted effort.

The biggest single barrier to making additional reductions in nitrous oxide (and ammonia) is the lack of finance or incentive and appetite for improved efficiency in manure management and field application. Capital investment in storage structures for animal manures and slurries, animal housing design and in the accuracy of manures spread to land is needed. The industry proposes an Economic Plan of Action in support of the GHGAP with a particular emphasis on the needs of the livestock sector.

Defra recognises that its sector-specific indicators to assess mitigation progress are also not always ideal. For example for dairy, the indicator is the ratio of dairy cow feed production to milk production but Defra recognises that the picture is complex²⁰. As we describe later in this report we aim to undertake a significant piece of work in phase III, working with Defra and the Committee on Climate Change to identify a robust indicator set of progress.

Significant next steps

What	Who	When	Actions	Measures of success*
Economic roadmap for technically feasible reductions in GHGs (and ammonia) from manures and slurries in storage and in animal housing.	GHGAP SG in collaboration with Defra and other economic and scientific experts.	2016-2018	Understand relationship between technology, cost and emissions reduction for different farm types. Identify mechanisms (policy, incentives) to encourage take-up of key technologies.	Technologies and practices promoted or implemented on-farm.
Introduction of 'Developing Beef Expertise' CPD and 'Developing Sheep Expertise' programmes for beef and sheep consultants ²¹ .	AHDB (Beef and Lamb) in collaboration with BIAC.	2015-2016 (beef) 2016-2017 (sheep)	Development of programme. Recruitment of consultants to and delivery of the programme.	<ul style="list-style-type: none"> Well-trained and experienced consultants and advisers available to the beef and sheep industry. Consultants are in demand by farmers.

*likely quantitative evidence for these outcomes includes:

- publication of the economic roadmap
- publication of the CPD programmes and numbers of consultants trained

²⁰ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/449266/agriclimate-6edition-30jul15.pdf The dairy indicator considers production of feed rather than overall dry matter consumption but perhaps more importantly it does not attempt to assess the consumption of concentrates produced by on-farm mixing, or of grazed or conserved forage



²¹ <http://beefandlamb.ahdb.org.uk/returns/developing-beef-expertise/> The programme will consist of five two-day meetings that will be held from Dec 2015 to Dec 2016 and focus on selection for slaughter and key performance indicators, feed efficiency and bull selection, grass and forage, health and building design and rationing and feeds

Crop nutrient (and crop health) management



Good nutrient management is important for all farm sectors. For the cropping sector, the industry is focussing on the continuous improvement in the accuracy of in-field measurements and good soil management, to optimise returns on inputs. Farmers tend to be proactive and responsive to new tools and technologies and up-to-date advice. The potential efficiency gains in the livestock sectors are likely to come mainly from concerted efforts to improve manure management and in the take-up of integrated nutrient management planning (linked to animal feeding practices). Industry has an existing and sophisticated network for co-ordinating and targeting its activities through the Tried & Tested campaign in partnership with Catchment Sensitive Farming. The GHGAP benefits from this existing dedicated and collaborative approach.

Progress on crop nutrient management

Indicator	Desired outcome	GHGAP activity to support indicator	Current situation and longer-term trends	Supporting survey evidence	Assessment of progress 2012- 2015 ²²
% farms with nutrient management plan.	<ul style="list-style-type: none"> Uptake of recognised plans to maximum feasible by farm type. Understand acreage limit. 	FACTS, Tried and Tested (T&T); AHDB review of RB209; LEAF Sustainable Farming review ²³ .	<p>>60% farms have a plan which cover >76% farmed area. Includes >80% arable farms which cover >90% arable area.²⁴</p> <p>There has been a 9% increase in nutrient planning since 2009. The uptake on arable farms is near its maximum potential.</p>	<p>Improving accuracy of nitrogen fertiliser was third in the list of actions taken by >60% farmers to reduce GHGs²⁵.</p> <p>Over 1500 RDP grants totalling >£13m awarded for nutrient management²⁶.</p> <p>62% LEAF Marque certified businesses in England in 2014 used nutrient balance sheets as part of their plan.</p>	
% livestock farms using T&T management tools.	<ul style="list-style-type: none"> To stimulate appreciation and use of planning tools by first time users. To increase uptake of plan over time. 	T&T introduced in 2009 with focus on grazing livestock.	<p>18% use T&T planning tools equivalent to 16% land area.</p> <p>Gradual increase in uptake since 2012.</p>	Action taken by grazing livestock farms is lower than for arable, other cropping and dairy farms. However it is recognised that not all enterprises are motivated by lowering input costs – half the N applied to land is organic N and other incentives for better management are needed.	
% farms with a manure management plan.	Increasing efficiency in use of organic nitrogen on grass and crops.	T&T and all relevant GHGAP partners.	<p>63% farms have a plan, covering 76% farmed area.</p> <p>Whilst overall take-up shows no change from 2014, it has decreased from 76% in 2012²⁷. This is due to change in the beef sector.</p>	<p>Although manure management planning in some sectors has decreased, there has been a very small increase in testing/assessing/ calculating manure nutrient content.</p> <p>>80% of LEAF Marque certified businesses in England integrate manure and nutrient management plans.</p>	Sector specific

²² Unless otherwise stated. A report of GHGAP activity from 2010-2012 is available [here](#).



²³ T&T <http://www.nutrientmanagement.org/home/>; <http://www.ahdb.org.uk/projects/CropNutrition.aspx> AHDB has committed £95,000 to independently review information in the current RB209 as well as nutrient management research released since the last edition was published in 2010; LEAF sustainable farming review <http://www.leafuk.org/leaf/farmers/lfr eb>

²⁴ Farm Practice Survey 2015

²⁵ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/449266/agriclimate-6edition-30jul15.pdf

²⁶ Farming and Forestry Improvement Scheme. Round 3 in 2014 included funding for soil mapping and soil analysis software which we have considered under Soil and Land Management.

²⁷ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/431938/fps-ghg2015-statsnotice-03june15.pdf

<p>Penetration of precision nutrient management techniques.</p>	<ul style="list-style-type: none"> Increasing efficiency in the use of all nutrients leading to improved nitrogen use efficiency. Greater but appropriate use of precision techniques. 	<p>1st GHGAP/National Association of Agricultural Contractors (NAAC) 2014 survey; AHDB (Potatoes; Cereals and Oilseeds).²⁸</p>	<p>GHGAP/NAAC survey suggests that amongst contractors and farmer-contractors GPS used by ~ 90% and variable rate fertiliser spreaders by ~60%.</p> <p>16-22% of farm holdings using GPS, soil mapping or variable rate application in 2012, up from 13/14% in 2009²⁹.</p>	<p>Most farms make some use of agricultural contractors but <25% of labour requirements except for largest cereals farms. Large livestock farms more likely to use contractors than smaller ones. Smaller cropping farms use contractors more than large ones. Large numbers of farms also gaining income from contracting, but this is generally at a low level.³⁰</p> <p>The two most common reasons cited by farmers for using precision techniques were to improve accuracy (76%) and reduce input costs (63%). Over 40% of holdings improving efficiency of manure/slurry application.</p>	
<p>Numbers of fertiliser spreaders tested.</p>	<ul style="list-style-type: none"> Increasing number of fertiliser spreaders tested annually. Even application of nitrogen spread. 	<p>AEA in collaboration with T&T.</p>	<p>National Spreader Testing Scheme introduced 2015.³¹</p>		
<p>Use of clover in grassland.</p>	<ul style="list-style-type: none"> Improving productivity and reducing farm expenditure by maximizing on farm forage potential. 	<p>AHDB (Dairy) and AHDB (Beef and Lamb)</p>	<p>In 2015, 74% of livestock holdings indicated that a proportion of temp grass sown with a clover mix. 29% sown all temporary grass with a clover mix³².</p> <p>This is unchanged since 2012.</p>	<p>The most common frequency for reseeding clover swards in 2015 was 3 to 5 years.</p>	

²⁸ GHGAP/NAAC survey 80 respondents, covering ~100,000ha <http://www.nfuonline.com/science-environment/climate-change/supply-and-demand-precisely-delivers-ghg-reduction/>; AHDB (potatoes) <http://potatoes.ahdb.org.uk/events/somerset-precision-farming-field-vegetables-and-potatoes>; AHDB (cereals and oilseeds) <http://cereals.ahdb.org.uk/media/547589/pf-meeting-report-royston-1114-final.pdf>

²⁹ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/181719/defra-stats-foodfarm-enviro-fps-statsrelease-autumn2012edition-130328.pdf

³⁰ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/370275/agrianalysis-contracting-04nov14.pdf

³¹ <http://www.aea.uk.com/news/aea-to-launch-national-spreader-testing-scheme-at-tillage-live>

³² https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/431938/fps-ghg2015-statsnotice-03june15.pdf

Review of crop nutrient management activity
National level indicators of on-farm practice

Improvements in nutrient management through adoption of nutrient planning tools and methods in the last five years have been about 20% - as a result of targeted activity in the grazing livestock sector (Figure 3).

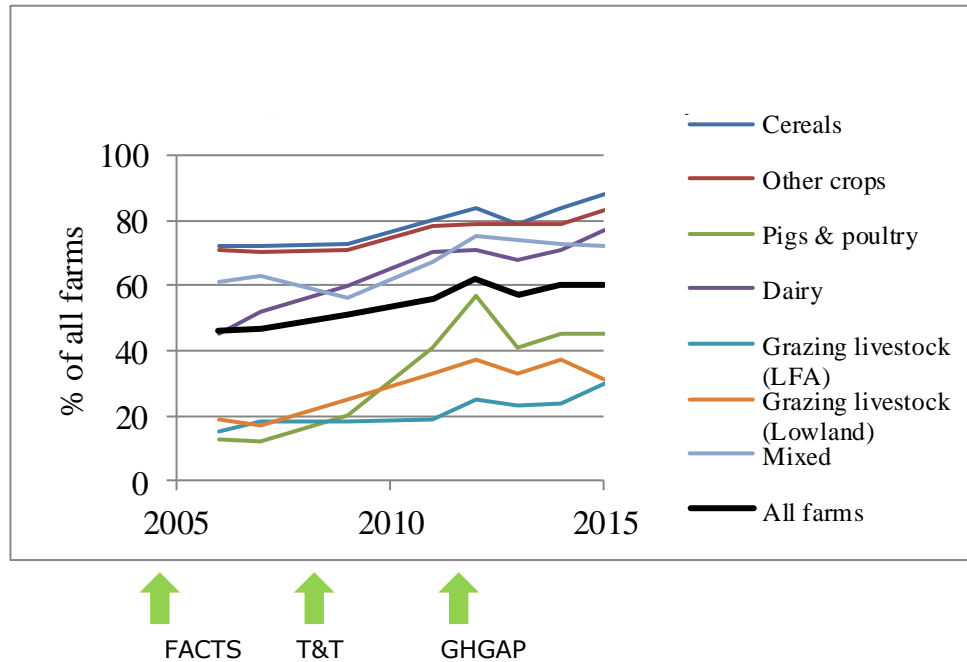


Figure 3: Possession of a nutrient management plan

GHGAP activity

The GHGAP has built on existing collaborative effort, working in synergy with the Tried & Tested (T&T) campaign to promote the use of nutrient management plans, including guidance for feed planning (see livestock nutrition section) and manure management. The emphasis has been on making good the gap in information provision to farmers who do not have access to professional advice.

It is reasonable to assume that the 18% of farmers using the resources disseminated by the T&T campaign, from 2009, are doing so as a direct result of the joint activities of T&T and GHGAP. The GHGAP has benefited considerably from joining the CFE umbrella of initiatives. From 2013 to June 2015, the CFE network delivered 373 events on resource protection and resource use efficiency. These would have specifically addressed the GHGAP’s priorities of soil and land management and crop nutrient management. In 2013/2014, 6428 farmer engagements were achieved across 347 events.

The AHDB has taken ownership of updating the national fertiliser recommendations (RB209). This forms part of an ambitious and collaborative programme of work being overseen by an AHDB-led UK Partnership for Crop Nutrient Management, which looks to publish a new nutrient management guide as early as 2017. This is strategically important for the GHGAP as plans for updating recommendations will be intrinsically bound into a UK research and knowledge transfer strategy for nutrient management.

Working with farmers to improve crop nutrient management

Using T&T nutrient management plan – Rob Kynaston, Shropshire

Rob is a Shropshire dairy farmer and LEAF member who also grows arable crops. He thinks Tried & Tested's four step nutrient management plan is important and that a FACTS qualified adviser can help. In an [online video](#) Rob shows:



- How he gets his spade out and digs a soil sample.
- A good example of good soil structure and a healthy mix of grass and clover.
- A slatted slurry system and further discussion on types of manure storage.
- His fertiliser spreading methods and why he checks his tyre pressures and calibrates machinery to ensure an even spreading.

Rob believes that attention to detail in the four step plan helps him use nutrients efficiently and economically to improve cost savings and avoid damage to the environment. His experience demonstrates how to optimise yield using the right product, in the right quantity, at the right time and in the right place.

GHGAP reflections

Industry resource and effort will continue to focus on the needs of grazing livestock farmers to improve their overall nutrient management through integration of feed, manures and fertiliser nutrient resources. The aim is to reduce the nutrient surplus on any field or farm and improve nutrient use efficiencies, reducing nitrogen loss and GHGs. The limiting factors are still time and management skill and we have been disappointed by the apparent decrease in manure management planning by the beef sector. We will seek to redress this in the next phase.

Significant next steps

What	Who	When	Actions	Measures of success
Publish AHDB Nutrient Management Guide.	Led and funded by AHDB with contributions from a wide range of partners.	2017 (1 st revision) 2019 (further revisions).	Annual review of plan for research and KT. Review KT tools available and work to present the information in appropriate formats.	Fertiliser Manual (RB209) and other tools regularly updated with the latest science to enable improved decision making.
Promote new fertiliser spreading testing scheme ³³ .	AEA, T&T.	2016 onwards.	Scheme included in T&T communications. Uptake monitored and reported annually by AEA.	All spreaders- disc, boom and pendulum - are tested to the same standard.
Increase manure management planning in beef sector.	GHGAP.	2016-2020.	Understand reasons for apparent downturn in manure management planning. Plan and implement campaign to increase take up.	Campaign reverses apparent downturn in planning.
Promote accurate application of manures and sensing applications.	AEA, AIC members and livestock sectors of AHDB.	2016 onwards.	Collate case studies of benefits and encourage take-up. Identify particular technologies requiring incentivisation.	More market penetration for precision technologies where appropriate mechanisms for incentivising particular technologies in place.

*likely quantitative evidence for these outcomes includes:

- Publication of revised fertiliser manual.
- Numbers of fertiliser spreaders tested.
- Numbers undertaking manure management planning.
- Numbers utilising or hectares covered by appropriate precision technology.




³³ <http://www.nsts.org.uk/spreader-testing?mr=641>



Soil and land management

Good soil management underpins a productive and sustainable farming system. Selecting appropriate management systems and approaches alongside an assessment of the capability of the land can help reduce GHGs. Soils are also a significant store of carbon and so present an opportunity for mitigation. Including soil carbon in discussions with livestock farmers in particular, presents a more complete picture of the emissions and removals from their systems. GHGAP Partners have put in place several initiatives to tackle the gap in knowledge on soil management.

Progress on soil and land management

Indicator	Desired outcome	GHGAP activity to support indicator	Current situation and longer-term trends	Supporting survey evidence	Assessment of progress 2012- 2015 ³⁴
Numbers of soil tests.	<ul style="list-style-type: none"> Increasing numbers of grassland soil samples. Maintenance of arable soil testing levels. 	AHDB (Beef and Lamb, Cereals and Oilseeds); T&T; FACTS; LEAF Sustainable Farming Review ³⁵	<p>Grassland samples 59,455 in 2015. 85% of farmland is currently sampled.</p> <p>Grassland samples up from 38,269 in 2012.³⁶</p>	<p>In 2012 ~68% of farms tested nutrient content and 70% tested pH at least once every 5 years.³⁷</p> <p>Over 85% of LEAF Marque certified crop area in England in 2014 has regularly analysed soil nutrient and pH.</p>	
Numbers interested in soil and water issues.	<ul style="list-style-type: none"> Increasing interest in soil management. Sharing knowledge with farmers. 	AIC advisers and all other professional advisers.	<p>927 'qualified' through BASIS Soil and Water CPD.</p> <p>Approx. 100 advisers per year have taken the course since 2011.³⁸</p>		
Adoption of catch/cover crops.	<ul style="list-style-type: none"> Site-appropriate use and management of cover crops. To minimise N loss and benefit soil structure. 	CFE delivery for GHGAP; AHDB (Cereals and Oilseeds); ORC; LEAF ³⁹ .	<p>Anecdotal evidence from industry reports and experts of greater interest and adoption of cover cropping.</p> <p>In future we will examine the opportunity to report on cover crop seed sales.</p>		

³⁴ Unless otherwise stated. A report of GHGAP activity from 2010-2012 is available [here](#).


³⁵ AHDB (beef and lamb) <http://beefandlamb.ahdb.org.uk/wp/wp-content/uploads/2015/01/Soil-testing060114.pdf> , AHDB (cereals and oilseeds) <http://cereals.ahdb.org.uk/press/2015/july/29/interpreting-test-for-soil-health.aspx> Tried & Tested www.nutrientmanagement.org.uk LEAF Sustainable Farming Review <http://www.leafuk.org/leaf/farmers/LSFR.eb>

³⁶ PAAG (UK Professional Agricultural Analysis Group)

³⁷ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/181719/defra-stats-foodfarm-envirom-fps-statsrelease-autumn2012edition-130328.pdf

³⁸ <http://www.harper-adams.ac.uk/short-courses/97/basis--soil-and-water-management>

³⁹ CFE <http://www.cfeonline.org.uk/events/event-details/?ngageid=53613>, AHDB (cereals and oilseeds) <http://cereals.ahdb.org.uk/press/2015/june/12/got-it-covered-cover-crop-pros-and-cons-defined-by-ahdb.aspx>, ORC http://www.organicresearchcentre.com/?go=Research%20and%20development&page=Crop%20production&i=projects.php&p_id=35 , LEAF <https://www.youtube.com/watch?v=jAGs2l76IGY>

<p>Adoption of soil protection measures.</p>	<ul style="list-style-type: none"> • Reduced compaction. • Reduced erosion. • Reduced anaerobic denitrification and N₂O emissions. 	<p>CFE delivery for GHGAP; AHDB (Potatoes); AHDB (Pork); LEAF.⁴⁰</p>	<p>Anecdotal evidence suggests a positive trend in the use of tracks, low pressure tyres, reduced tillage and controlled traffic systems to improve soil quality.</p> <p>Over 40,000 hectares of farmland in England are managed under a voluntary soil-related environmental measure.⁴¹</p>	<p>In 2012 the majority undertaking a soil structure survey prior to cultivation or any other husbandry activity did so only where there was obvious compaction. The proportion using low pressure set-ups has reduced slightly from 2008.⁴²</p> <p>77% of LEAF Marque certified businesses in England in 2014 assess field conditions for risk of soil degradation prior to operations being carried out.</p> <p>75% livestock farmers always take action to reduce stocking rates when fields are excessively wet.⁴³</p> <p>Anecdotal evidence suggests increasing interest and practice of 'min-till' and 'no-till'.</p>	
<p>Status of field drainage systems.</p>	<ul style="list-style-type: none"> • Stemming the decline in UK drainage investment. • Promoting integrated approach - all drainage systems work best in tandem with good soil structure. 	<p>AHDB field guide.⁴⁴</p>	<p>In 2012, 62% improved drainage to reduce compaction compared with 48% in 2008.⁴⁵</p>		<p>Insufficient evidence</p>

⁴⁰ AHDB (potatoes) http://potatoes.ahdb.org.uk/sites/default/files/publication_upload/Soil%20Management%20for%20Potatoes%20updated%202013.pdf and <http://potatoes.ahdb.org.uk/publications/strategic-potato-farm-spot-%E2%80%93-round>, AHDB pork <http://pork.ahdb.org.uk/environment-buildings/water-soil-and-air/sub-soiling-and-removing-soil-compaction/>

⁴¹ CFE <https://www.cfeonline.org.uk/home/>

⁴² https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/181719/defra-stats-foodfarm-envirom-fps-statsrelease-autumn2012edition-130328.pdf

⁴³ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/431938/fps-ghg2015-statsnotice-03june15.pdf

⁴⁴ <http://cereals.ahdb.org.uk/media/725158/g68-ahdb-field-drainage-guide.pdf>

⁴⁵ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/181719/defra-stats-foodfarm-envirom-fps-statsrelease-autumn2012edition-130328.pdf

i Review of soil and land management activity

National level indicators of on-farm practice

The UK soil laboratories Proficiency Testing Scheme started in 2010, supporting industry initiatives with the provision of data. The circa 250,000 soil samples regularly analysed (2013-14 data) are equivalent to an average 53 ha/sample. If fields are sampled on average every four years, this is equivalent to around 13 ha/sample. This is an encouraging intensity of sampling and consistent with the 71% of farms that reported regular soil analysis in the Farm Practice Survey. These farms represented 85% of agricultural land area.

GHGAP activity

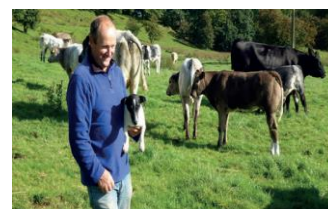
The GHGAP has benefited considerably from joining the CFE umbrella of initiatives. From 2013 to June 2015, the CFE network delivered 373 events on resource protection and resource use efficiency. These would have specifically addressed the GHGAP's priorities of soil and land management and crop nutrient management.

Working with farmers to improve soil and land management

Focus on soil fertility – Richard Clegg, Cumbria

In 2013, working with AHDB (Beef and Lamb), Richard started a grassland improvement programme⁴⁶ in order to increase productivity and in particular to produce more meat from grass.

A combination of soil testing and lime applications led to noticeably higher grass yields and more targeted fertiliser applications. After analysing the soil, Richard changed to a 26:10:0 fertiliser rather than a 25:5:5. This new product supplied all the phosphate needed for the year and there was no requirement for potash. Farmyard manure was utilised in autumn or spring depending on soil conditions.



Richard has saved approximately £11/t on fertiliser. Following the new management practice the fields have recovered well from the winter with earlier grazing by stock, even allowing for the milder spring. The mowing meadows produced 30 more bales of silage in 2014 year than the previous year. In summer 2015, nine of the fields were soil sampled again to assess the impact of the liming which showed that the pH of fields across the farm had improved.

Improving organic matter – John Renner, Northumberland

John adds a lot of organic matter to the fields of his LEAF Demonstration farm both to improve soil structure and for the nutrients it provides. 20t/ha of farmyard manure is applied in some years, depending on other factors.



A few years ago John started putting land into grass leys and he has seen significant benefits to soil structure and organic matter levels. He sees his best yields in the second year following grass in the rotation. Sheep are now included in the farm to graze the pasture. They also provide manure for the farm. John feels the greatest benefits of his improved soil regime were felt after 6 years. Further benefits are now being seen as a result of grass leys. Low ground pressure tyres are used throughout the farm and tramlines are sub-soiled out every year.

⁴⁶ One of AHDB (Beef and Lamb)'s Focus Farms.

ii GHGAP reflections

Interest in soils and soil management across the industry is at an all-time high. Turn out at events, experimentation with cover crops, adoption of controlled traffic farming and the number of articles in the farming press point to greater appreciation of and action on soil management.

However soil management choices have to be balanced against the other decisions facing farmers and growers like managing weeds or harvesting during the extreme weather of 2012.

iii Significant next steps

What	Who	When	Actions	Measures of success*
Promote Healthy Grassland Soils to address soil structure, drainage and nutrients.	AHDB (Dairy) and AHDB (Beef and Lamb).	2015 - 2020	Make information e.g. videos, Grasslands Soil guide, available online. Run events at appropriate times of the year to encourage take-up of information.	Numbers accessing online resources and attending events.

*likely quantitative evidence for these outcomes includes:





- Numbers attending events

Livestock nutrition



Understanding the energy and protein requirements of livestock are critical to achieving production targets alongside planning what will be grown on-farm and what may need to be bought in. This provides an opportunity to integrate feed and fertiliser strategies. Improving feed conversion efficiency will reduce the emissions of methane and nitrous oxide. Animal health and nutrition are also inextricably linked. Tackling feeding efficiency, working together on an industry standard ruminant feeding plan to fill a gap in delivery and finding alternatives to soya have been the focus of our work.

Progress on livestock nutrition

Indicator	Desired outcome	GHGAP activity to support indicator	Current situation and longer-term trends	Supporting survey evidence	Assessment of progress 2012- 2015 ⁴⁷
% herd covered by animal feeding plans/advice/ complete rations.	T&T fills gaps in feed planning/advice, mainly in beef and sheep sector.	T&T, AHDB (Dairy); AHDB (Beef and Lamb) and AHDB (Pork). ⁴⁸	Ration formulation/ feed planning adopted by: a) 90% dairy herd, at least at a basic level. b) 95% pig herd, 95% of poultry flock. c) ~ 40% beef and sheep.	50% of pig diets and 90% of poultry fed on complete diet specifically formulated by feed supplier.	
Percent inclusion of nitrogen in feed diets by species.	Increase in efficiency of protein nitrogen (N) converted into meat/milk (better matching of N supplied to N required).	AHDB (Dairy); AHDB (Beef and Lamb); AHDB (Pork) and AIC members. ⁴⁹	~30% of farmers are improving nitrogen feed efficiency to deliver GHG mitigation. This is unchanged since 2013. ⁵⁰		
Adoption of high sugar grasses (HSG).	Greater adoption of HSG as appropriate to the farming system.	AHDB (Dairy) and AHDB (Beef and Lamb).	In 2015 HSG sown on 62% of holdings with temporary grass. ⁵¹ Half of grass area < 5yrs old now sown with HSG.	The most common frequency for reseeding HSG swards in 2015 was 3 to 5 years. ⁵²	
Levels of KE activity to improve grassland management.	Increasing interest in making the most out of grass.	AHDB (Dairy) and AHDB (Beef and Lamb) grazing clubs.	From Feb 2014 – March 2015, 4000 dairy and 5000 beef and lamb subscribers to monthly newsletter.		Too early to assess
Use of co-products in livestock diets. consecutive	Increasing utilisation as appropriate across the livestock sectors.	AHDB sectors. ⁵³	5% of pig units use liquid co-products from food industry. Inclusion rates of co-products in rations above 40% in 2014. ⁵⁴		

⁴⁷ Unless otherwise stated. A report of GHGAP activity from 2010-2012 is available [here](#).

⁴⁸ <http://beefandlamb.ahdb.org.uk/returns/feeding-club/>

⁴⁹ http://dairy.ahdb.org.uk/media/864752/411098_fs2_protein_review_branded.pdf , <http://beefandlamb.ahdb.org.uk/wp/wp-content/uploads/2014/11/brp-manual-12-Improving-ewe-nutrition-for-better-returns-281114.pdf>

⁵⁰ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/431938/fps-ghg2015-statsnotice-03june15.pdf

⁵¹ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/431938/fps-ghg2015-statsnotice-03june15.pdf

⁵² Changing to HSGs leads to 20% less methane per kg of liveweight gain (e.g. in lamb) compared to conventional grass (IBERS)

⁵³ <http://pork.ahdb.org.uk/media/73412/ria-26-advances-in-co-products.pdf>

⁵⁴ Positive Progress – An Update on the Roadmap for the environmental sustainability of the English Pig Industry, BPEX 2014

Review of livestock nutrition activity

National level indicators of on-farm practice

35-40% of all farms with livestock used a ration programme or took expert advice always or most of the time (Figure 4). Among farm types, dairy farms showed the greatest uptake (80%). Grazing livestock farms which would include sheep rely significantly less on bought-in feeds and advice. The lower uptake of 40% for pig and poultry farms is explained by the fact that the ration provided by the feed supplier is a complete diet requiring less/no on-farm decision-making as compared to ruminant species which rely on a dietary mix of bought-in feed and grass and other forage.

The use of ration programmes or expert advice increases with farm size. Therefore, the percentage of total numbers of cattle, pigs and poultry actually managed according to a ration plan or advice will be much higher than the 35-45% implied by national indicators such as shown below:

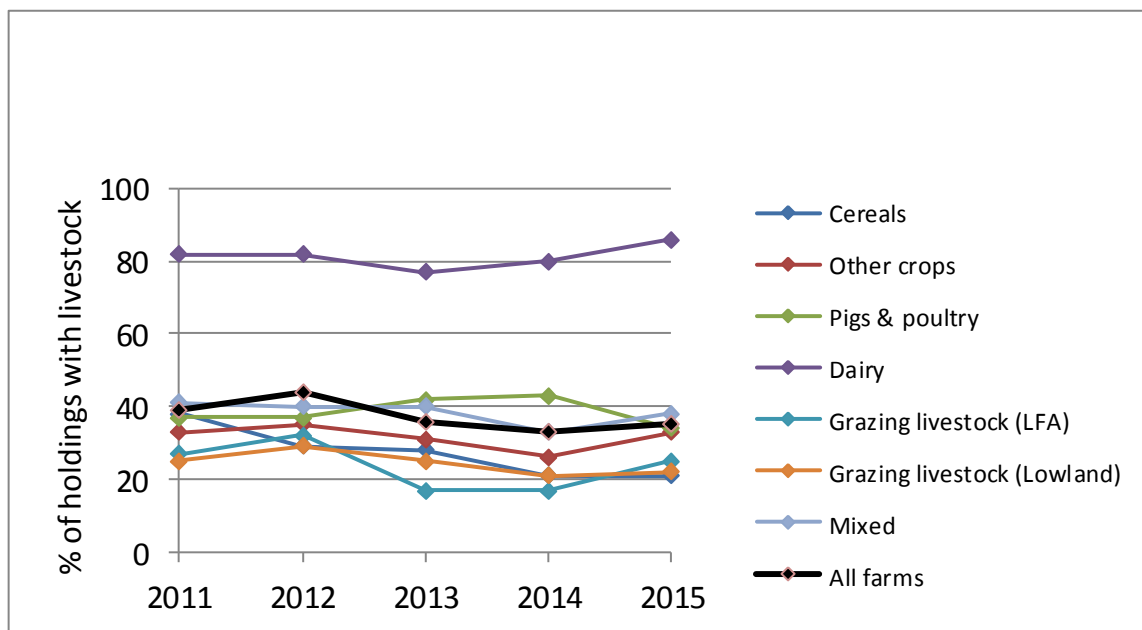


Figure 4: Holdings using ration formulation or expert advice always or mostly (FPS 2015)

Expert opinion from AIC Feed suppliers is that 70% of the dairy herd is fed according to diet formulation and advice specific to species/age/other requirements. In dairy herds which rely on a mix of home grown forages and purchased feeds for their nutrition, there has been a reduction in dietary protein levels, despite increases in milk yields, which will result in lower N₂O (and NH₃) emissions. Pig and poultry systems are distinctly different. 95% of the pig herd and 95% of the poultry flock receive complete tailored diets formulated specifically for the age profile of the herd/flock.

Soya inclusion rates have halved in the last decade and now account for only 10% of the diet. There has been a corresponding increase in the use of home-grown proteins.

Co-products and by-products from the food and drink manufacturing sector and now, increasingly from the biofuels sector to provide feed. This represents efficient recycling and off-setting of raw ingredient use. Not only are the nutritional value of these products utilised, rather than wasted, but food manufacturing costs are also reduced. It is estimated that the UK bio-ethanol industry will produce around one million tonnes of co-products a year - Distillers Dried Grains with Solubles (DDGS) which are high in protein (more than 30%). It is believed these will be of suitable quality and available in sufficient quantity potentially to make up a significant amount of finishing pig rations. This will substantially offset cereal grain and protein meal (soy) use.

GHGAP activity

AIC has established a Feed Sustainability Committee in response to the GHGAP and associated developments in the UK, Europe and internationally. This indicates a level of serious commitment and proactivity by the feed industry.

The European feed industry sourcing guidelines for responsible soya were published in August 2015 and AIC has committed to monitor the volume of sustainable soya entering the UK, according to the guideline criteria, to demonstrate the commitment of the industry to reduce emissions.

Working with farmers to improve livestock nutrition

Integrating nutrient management and feed management – Stephen Hobbs, Bucks

Stephen Hobbs, a LEAF and Red Tractor certified beef farmer in Buckinghamshire, says that “Adopting the Tried & Tested feed plan⁵⁵, helps me with my integrated farm management by creating a ‘whole farm’ approach.” This plan, “...fits nicely between the original booklet ‘Nutrient Management Plan’ and ‘Think Manures’ booklet. It really is the meat in the sandwich.”

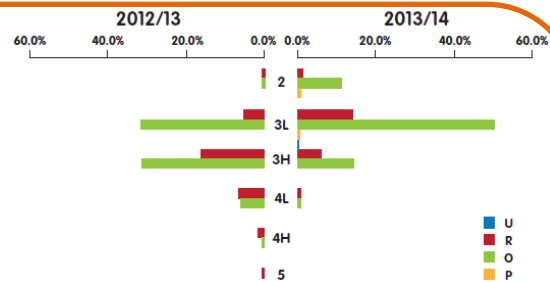


Tried & Tested Feed Planning for Cattle and Sheep

This easy to follow and practical tool attempts to help farmers to get the nutrient balance right. It is crucial for generating an efficient and profitable system that has minimal detrimental impact on the environment and reduce greenhouse gas emissions. Assisting farmers to improve the efficiency of their operations by integrating the use of all nutrients within their production system is a primary objective of all farming organisations supporting this too.

Improving Lamb Selection, Mark Graham and Ian Thompson, North York Moors

Mark’s upland farm runs 1,000 Swaledale ewes, with some lambs sold for breeding or housed in November for finishing on concentrates so they are ready for the January to May lamb market.



Mark was concerned about the deductions applied to his lambs in 2012/13 for being over-fat. AHDB (Beef and Lamb) helped him monitor lamb performance more closely as he finished them in 2013/14 to improve overall returns. Mark improved lamb selection by weighing and handling more often. The aim was to increase the number of lambs achieving target grades, whilst reducing the level of carcass deductions.

The number of lambs finishing within target fat class increased from 37.6% in 2012/13 to 78.8% in 2013/14. This resulted in abattoir deductions reducing from £2.93 in 2012/13 to £1.81 per lamb in 2013/14, giving Mark an additional £1.12 per lamb.

Weight checks – Joe Blackstone, Midland Pig Producers

Joe Blackstone and his team were prompted to review their procedures after attendance at an AHDB (Pork) event. He said: “We’ve recently made an improvement from 11 to 12 piglets weaned per litter and the event prompted us to check with the nutritionist that the sows’ nutrition is correct for the amount of piglets we are weaning now.



“Also, the discussion about making sure sow weight loss during lactation is no more than 7% was a good reminder for us to weigh sows as they enter and leave the farrowing house, so we can monitor weight and adjust diets if needed. We’ve done that at times in the past but will now try to do it regularly.”

⁵⁵ <http://www.nutrientmanagement.org/what-we-do/tools/feed-planning-for-sheep-and-cattle/>

ii GHGAP reflections

It is the GHGAP's belief that it is the quality and tailored nature of advice coupled with the continuous development in the quality and types of feeding materials which lead to fine-tuning of animal nutrition and consequently reduces GHG's. The science of protein synthesis and precision-feeding with lower carbon feed and forages will become increasingly important for the GHGAP's strategy. However the scope for further major changes in reductions of nitrogen levels across all species will be marginal.

Activities incentivised by the supply chain are not always sufficiently transparent due to commercial sensitivities, which makes knowledge of their existence and reporting by the GHGAP difficult. However, we have come across a good example of supermarkets incentivising their farm suppliers to sow high sugar grasses to claim the 20% lower methane value in their meat and dairy products. We will seek more examples.

iii Significant next steps

What	Who	When	Actions	Measures of success
Assess impact of tailored feed advice to 1000 farm businesses.	FAR with GHGAP support.	From 2017	Collect case study information. Analyse case studies for financial and mitigation impact and publish results	Professional advice brings demonstrable financial and mitigation benefits to livestock business.
Next generation feed advice.	GHGAP and FAR.	From 2017	Identify relevant research from GHG research platform. Examine existing competencies and update as required.	GHG Research Platform results incorporated into FAR.
Beef Feed Efficiency Project.	AHDB (Beef and Lamb).	2015 - 2018	Agree industry-wide protocols for measuring feed efficiency. Define a "blueprint" for recording facilities on commercial farms. Install facilities for measuring feed efficiency on commercial units and report on data collected. Establish a network for national feed intake recording.	Infrastructure for the measurement of feed efficiency in beef cattle delivered. Feeding efficiency incorporated into breed improvement programmes.

*likely quantitative evidence for these outcomes includes:



- GHG mitigation delivered by feed advisers



Livestock health, fertility and genetics

Animal health is fundamental to efficient livestock production and is inextricably linked to nutrition and fertility. Livestock with sub-clinical disease such as BVD, Johnes, lameness and mastitis are less efficient reproducers and converters of feed into milk and meat and so have higher GHG emissions per unit of production. Clinical lameness and mastitis impact on efficiency even more and infertility increases stock replacement rates; a major contributor to the GHG footprint on livestock farms – the lower the replacement rate, the fewer youngstock are kept and the less GHGs are emitted.

Progress on Livestock health and fertility

Indicator	Desired outcome	GHGAP activity to support indicator	Current situation and longer-term trends	Supporting survey evidence	Assessment of progress 2012- 2015 ⁵⁶
BPEX Pig Health Scheme (BPHS) trends.	<ul style="list-style-type: none"> Continued decrease in conditions. Raise awareness of pig producers and veterinarians of subclinical disease. 	AHDB (Pork).	For example prevalence of pleurisy has fluctuated over the years but the trend since Q1 2013 is downwards and there's been a slow decline in milk spots in livers ⁵⁷ .	Sow productivity (clean pigs marketed per sow per week) continues upward trend. The trend towards outdoor production may have offset some of the productivity gains seen since 2010. Pre-weaning mortality reduced in 2014-2015 ⁵⁸ .	
Breeding herd performance increased by three pigs weaned per sow per year.	Breed +3 campaign:	AHDB (Pork).	In the first nine months of 2013, average combined indoor and outdoor performance increased from 23.05 to 23.66 for top third indoor and outdoor herds.		Awaiting latest results
% dairy herds addressing chronic/sub-clinical infections/ diseases (using mastitis control and lameness as exemplars).	Continued increase in herd numbers covered by relevant plans.	AHDB (Dairy) ⁵⁹ and ORC SOLID project. ⁶⁰	<p>Mastitis control plan:</p> <ul style="list-style-type: none"> 170 'plan deliverers' in place; 15% of Britain's cows covered by a plan and 2,000-2,500 herds have completed at least a component of the plan. Healthy feet programme. 120 registered mobility mentors. <p>Mastitis: by the end of 2011, 970 farms had enrolled at different stages of implementation and around 10% of the national herd covered.</p> <p>Healthy Feet programme in 2011 had over 140 farms registered (37,000 cows) and around 70 trained providers.</p>	<p>Median age of dairy breeding herd has gradually declined over last 5 years. Numbers of calf registrations per cow relatively stable over past 10 years. No change in the levels of mortality. Continued decrease in somatic cell count⁶¹.</p> <p>Average rate of lameness on dairy farms is 32% and research suggests that the Healthy Feet Programme can reduce this to 25%. It also shows that dairy farmers know there is a problem, can identify the technical and attitudinal barriers to control and feel that a target for the national rate could be 10%.⁶²</p>	

⁵⁶ Unless otherwise stated. A report of GHGAP activity from 2010-2012 is available [here](#).

⁵⁷ <http://pork.ahdb.org.uk/media/73481/2015-q1-report.pdf>



⁵⁸ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/449266/agriclimite-6edition-30jul15.pdf

⁵⁹ <http://dairy.ahdb.org.uk/resources-library/technical-information/health-welfare/mobility-score-instructions/#.Vizpomcnz3s>, <http://dairy.ahdb.org.uk/resources-library/technical-information/health-welfare/dmcp-mastitis-recording-form/#.Vizp02cnz3s>

⁶⁰ [http://www.organicresearchcentre.com/?go=Research and development&page=Livestock&i=projects.php&p_id=21](http://www.organicresearchcentre.com/?go=Research+and+development&page=Livestock&i=projects.php&p_id=21) to improve animal health and welfare, productivity and product quality in low input and organic systems

⁶¹ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/449266/agriclimite-6edition-30jul15.pdf

⁶² <http://www.reaseheath.ac.uk/businesses/rada/technical-information/livestock/#toggle-id-1>

<p>% farms having a herd health plan.</p>	<ul style="list-style-type: none"> Continued increase in numbers of farms having a plan. Increased emphasis and inclusion of BVD and Johnes control in plans. 	<p>AHDB sectors and ORC.⁶³</p>	<p>In 2014, 74% of livestock farmers had a Farm Health Plan (FHP). ~70% were completed with the help of a vet or adviser. 44% use it on a routine basis to inform disease management decisions.⁶⁴</p> <p>In 2011, 71% of livestock farmers had a FHP. ~ 65% were completed with the help of a vet or adviser. 41% use it on a routine basis to inform disease management decisions.</p>	<p>Of those with a FHP, 82% were using it routinely or when they could. However, a further 7% felt that they should be doing so. Just over half of livestock farmers undertake training for animal health and welfare and disease management.</p> <p>Almost 1,800 RDP animal health and welfare grants totalling £11.5m awarded.</p>	
<p>Use of EBVs/ PLIs.⁶⁵</p>	<ul style="list-style-type: none"> Increased use of the EBV and PLI system in breeding on-farm as appropriate. Increased proportional use of health and welfare parameters in EBV and PLIs, such as lameness and mastitis. 	<p>AHDB (Dairy) Breeding+; AHDB (Beef and Lamb) Better Returns Programme.</p>	<p>The proportion using bulls or rams with a high EBV when breeding beef cattle or lambs in 2015 is 58% and 56% resp. These accounted for 66% of beef cattle and 64% of lambs at June 2014. 21% of livestock holdings always used bulls with a high PLI when breeding dairy cows.⁶⁶</p> <p>However not all breeds have EBVs.</p>		

In future we would like to consider reporting on the number of farms using fertility improvement plans and youngstock health.

⁶³ http://www.efrc.com/?i=events.php&event_id=310

⁶⁴ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/336173/fps-ghg2014-statsnotice-24jul14.pdf

⁶⁵ EBV – Estimated Breeding Value; PLI – Profitable Lifetime Index

⁶⁶ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/431938/fps-ghg2015-statsnotice-03june15.pdf

i Review of livestock health and fertility activity

National level indicators of on-farm practice

At a national level the industry generally is in the early stages of integrated improvement plans. Herd Health Planning has been around for a long-time, but is only just beginning to develop from a tick box exercise to management practice.

The whole livestock system is multi-factorial – if the balloon is squeezed at one bit, it bulges elsewhere, so if there's a focus on lameness, attention to mastitis might fall off. This is why breeding improvements are so important, because they bring the opportunity to address all issues at the same time. However, this takes a long time. For example, industry is now realising the benefits of incorporating health issues like lameness and mastitis into PLI.

GHGAP activity

Focus on advancing livestock health and fertility has concentrated on improving genetic resilience and the widespread application of Farm Health Plans or Fertility Improvement Plans. Progress has been static over recent years but advancements in livestock nutrition and support from industry and Government-led R&D should help to reinvigorate future progress.

Additional gains in productivity can be made particularly by improving health and take up of genetic traits to convert nutrients to protein as effectively as possible.

Working with farmers to improve livestock health and fertility

Reducing lameness, Tim Kelsey, North Yorkshire

Tim's lowland farm has 600 Mule, Suffolk cross and Charollais cross ewes, with all lambs finished and sold liveweight. An increasing lameness problem led Tim to investigate the causes and put a plan in place to address it.



Within the study flock, each ewe was turned over, assessed, diagnosed and treated. They were re-examined at three to four week intervals to track their progress. Lamé ewes had their ear tag number recorded to aid monitoring. In addition photos were taken of the feet from the most affected ewes as they healed.

Tim says: "I had always trimmed the ewes' feet as part of my yearly routine, as well as treating them when they were obviously lame. But this investigation has shown me that it is important to treat all cases as soon as possible, to get on top and stay on top of lameness and that routine trimming, although something we have been taught to do historically, is actually not the right thing to do."

Increasing suckler herd efficiency, Neil Flower, Derbyshire

Neil Flower's upland farm runs 70 pedigree and crossbred suckler cows selling most on supermarket Angus schemes. Neil had seen increasing problems with heifer infertility, over-fat cows and a long calving interval. These factors were creating inefficiencies such as poor weaning weights and low numbers of calves reared. To support Neil, herd performance data was analysed and a plan devised to monitor cow and heifer body condition and cow/calf weights at weaning.



As a result of the analysis, Neil is taking action to reduce the calving period by removing the bull after 12 weeks. To help address the issue of poor heifer fertility, it was decided to calve replacements at two years of age, rather than leave them until they were two-and-a-half to three years of age, as they were tending to become over-fat. Neil's investigation showed that the heaviest cows did not necessarily produce the heaviest calves and that there is much variation within a herd. Assessing efficiency in terms of kg of calf produced per kg of cow, showed a variation from 32% for the least efficient cow, to 52% for the most efficient. This confirmed to Neil that the cows he had selected to cull were in fact some of the least efficient cows in the herd.

ii GHGAP reflections

The unusually wet weather of 2012 had adverse consequences on livestock health. For example there was an increase in liver fluke diagnoses in 2013. AHVLA identified two incidents of a severe form of rumen fluke infection in young cattle in SW England in 2012. This is the first time this severe form has been diagnosed in cattle in GB⁶⁷.

It is our opinion that, for this priority area, national level indicators like herd replacement rate, youngstock mortality, insemination and calving/lambing rates are either not really recorded at a national scale or do not present the complete picture. We will seek to address this during our work on indicators.

iii Significant next steps

What	Who	When	Actions	Measures of success
Sheep KPI project, encouraging body condition scoring of ewes.	AHDB (Beef and Lamb).	through 2016	Workshops and wider communications promote use of body condition scoring as a tool to optimise ewe nutrition. Use data to identify measurements all commercial farmers could take by EID ⁶⁸ .	Ewe body condition scoring is adopted as a tool to manage optimum ewe nutrition. Measurements made possible by EID are identified.

*likely quantitative evidence for these outcomes includes:

- Numbers attending workshop
- Identification of measurements possible by EID

⁶⁷ <http://beefandlamb.ahdb.org.uk/wp/wp-content/uploads/2013/06/CHAWG-Annual-Report-2014.pdf>




⁶⁸ Electronic Identification (EID) uses a microchip, or electronic transponder, embedded in a tag, bolus or implant to identify a farm animal.



Energy efficiency and renewable generation

CO₂ emissions from energy and fuel use by agriculture are low, accounting for only 1% of the UK's emissions. However energy efficiency offers business benefits, particularly for the more energy intensive sectors – pigs, poultry and horticulture. Low carbon energy services present real diversification opportunities, whilst both lowering our own emissions and helping to decarbonise the energy that the UK uses throughout the economy. We believe that the emissions reduction potential of renewable energy within our industry could outweigh our emissions reduction target by a factor of three.

Progress on energy efficiency and renewables

Indicator	Desired outcome(s)	GHGAP activity to support indicator	Current situation and longer-term trends	Supporting survey evidence	Progress 2012-2015 ⁶⁹
% of farmers with renewable energy installations.	<ul style="list-style-type: none"> Avoided/offset energy related CO₂ emissions. Increasing interest and deployment by farmers. 	NFU Farm Energy Service, ADAS resolved renewables, CLA. ⁷⁰	<p>Best estimates suggest over one-third of farmers have invested in renewables.⁷¹</p> <p>In 2011, 30% of farmers generating and intending to supply renewables⁷². Only 5% of holdings were producing renewable energy in 2010⁷³, increasing to 16% in 2011/12.⁷⁴</p>	Number of calls to NFU Farm Energy Service about renewables decreased from 500/year in 2012/13 to 380 in 2014/15. Although numbers have decreased, the nature of the calls has changed. Focus now on improving system efficiency or addressing system performance.	
Number of AD installations on-farm.	<ul style="list-style-type: none"> Avoided energy related CO₂ emissions. Increasing interest and deployment by farmers. 	NFU Farm Energy Service and work with ADDBA and REA; AHDB (Pork) research. ⁷⁵	In 2015, 160 on-farm installations processing majority farm feedstocks ⁷⁶ . Over 250 AD plants in UK in total.	Defra surveys suggest only 0.9% of holdings were processing slurries in 2014 ⁷⁷ . Little changed since 2011 (0.6%) and 2012 (0.4%). Unfortunately whilst 3.1% in 2011 planned to process in future, this reduced to 1.9% in 2012 and 1.2% in 2014.	
% of farmers investing in energy efficiency.	<ul style="list-style-type: none"> Avoided energy related CO₂ emissions. Increasing interest from and deployment by farmers. 	AHDB (Potatoes) Storecheck 2015; AHDB (Hort) Growsave incl. LED lighting economics calculators 2015; NFU Farm Energy Service and contracting admin of Climate Change Levy, AHDB (Dairy) guide in 2013; LEAF Sustainable Farming Review ⁷⁸	<p>Fuel use trends since 2012 variable, due to extreme rainfall in 2012.</p> <p>However since 1990 volume of fuel used generally decreased, and with output largely similar, the volume of fuel/unit output has fallen.⁷⁹</p> <p>Climate change agreements: In 1st target period (2012-2014) of phase 2, median energy efficiency measure for Hort. improved by 22% and output also increased - but new scheme unattractive to pigs and poultry.</p> <p>1st phase of CCAs (2000-2009) accelerated engagement in energy efficiency and all sectors exceeded targets.⁸⁰</p>	<p>In 2013, 2014 and 2015 improving energy efficiency was second in the list of actions taken by ~67% of farmers to reduce GHGs.⁸¹</p> <p>129 RDP energy efficiency grants £1m.</p>	

⁶⁹ Unless otherwise stated. A report of GHGAP activity from 2010-2012 is available [here](#)

⁷⁰ <http://www.nfuonline.com/membership/farmer-grower/member-services/farm-energy-service/>, <http://www.resolved-developments.uk/>, [Renewable Energy | CLA](#)

⁷¹ NFU confidence survey 2014 (> 550 NFU members were interviewed by telephone between Oct-Nov 2014. Between 50 and 132 interviews for each farm sector and the overall results have been weighted to represent the proportions of main farm types in England and Wales) and Farm as Power Station survey, 2013 (700 farmers surveyed). Range 32% (NFU survey) – 38% (Farm as Power Station survey).

⁷² NFU-NatWest survey, 2011, of over 400 farmers and growers about the take up of renewable energy production and generation

⁷³ Farm practice survey 2011

⁷⁴ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/203900/fps-ghg2013-statsnotice-30may13.pdf

⁷⁵ <http://pork.ahdb.org.uk/research-innovation/research/environment/pig-carcass-bioreduction-using-anaerobic-digestion-ad-stage-2/>

⁷⁶ <http://www.biogas-info.co.uk/resources/biogas-map/>. Farm feedstocks = manures, discards, crops.

⁷⁷ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/336173/fps-ghg2014-statsnotice-24jul14.pdf

⁷⁸ <http://potatoes.ahdb.org.uk/storage/expert-advice-services>, <http://www.growsave.co.uk/>, <http://www.fecservices.co.uk/ccl/>, <http://dairy.ahdb.org.uk/resources-library/technical-information/business-management/energy-efficiency-on-farm/#.VjNfzWcz3s>

⁷⁹ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/449266/agriclimate-6edition-30jul15.pdf

⁸⁰ Farm Energy Centre, *pers.comm.*, 2015

⁸¹ Farm Practice Survey 2015 <https://www.gov.uk/government/statistics/farm-practices-survey-february-2015-greenhouse-gas-mitigation-practices>. There are key differences which reflect the nature of the business.

i Review of energy efficiency and renewables

National level indicators of on-farm practice

The uptake and level of investment in both on-farm renewables and energy efficiency continues to increase, as supported by evidence collected by the NFU and other stakeholders. Although in place before the GHGAP, the introduction of Climate Change Agreements clearly incentivised engagement and investment in energy efficiency. Therefore it is disappointing that additional complexity in the new phase of scheme has led to the disengagement of the pigs and poultry sectors.

Renewable energy is clearly now reaching way beyond the 'early adopters' and becoming part of mainstream agricultural business activity. The majority of these tens of thousands of farm installations are thought to be producing for or supplying mostly on-site energy needs, but a significant minority (more than 1,000 farm businesses) are exporting electric power and fuels to other users – through the electricity and gas grid networks, and as fuel feedstocks such as grains, straw, wood chip, miscanthus and other energy crops.

The NFU estimates⁸² that farmers own or host a substantial stake in the UK renewable energy sector:

- over half of UK solar power (4,700 MW from around 600 solar farms, and 500 MW from over 12,000 PV rooftops)
- over half of anaerobic digestion capacity (about 150 installations)
- one-third of commercial renewable heat installations (about 4,000 projects)
- two-thirds (8,200 megawatts) of British wind power, including around 2,000 small and medium farmer-owned turbines

GHGAP activity

GHGAP partners publish information on energy efficiency and renewable energy technologies, updates about government incentive schemes and online commentaries. Although some of the GHGAP partners work on energy efficiency is of long standing, new initiatives like AHDB (Potatoes) Storecheck have been introduced as a contribution to delivering the GHGAP's strategy.

The renewable energy and energy efficiency industries themselves already advertise widely in the farming trade press. A number of Best Practice guidance documents have been agreed or prepared jointly between the agricultural trade associations and renewable energy trade associations (e.g. on solar farm site selection and management for agricultural benefit and biodiversity, on production of crops feedstocks for anaerobic digestion, etc.). The NFU has also taken an active role in policy development with government departments, e.g. the 2013/14 Solar PV Strategy, the 2011 AD Strategy.

Figure 5 demonstrates the shifting focus of farmer interest in different renewables technologies. The recent uplift in biomass calls to the NFU's Farm Energy Service reflects the growth of the Renewable Heat Incentive scheme, while the halving of calls on wind power may be a consequence of Feed-In Tariff depression and the growing difficulties of obtaining planning consent for this particular technology.

⁸² Based upon DECC statistics and industry feedback

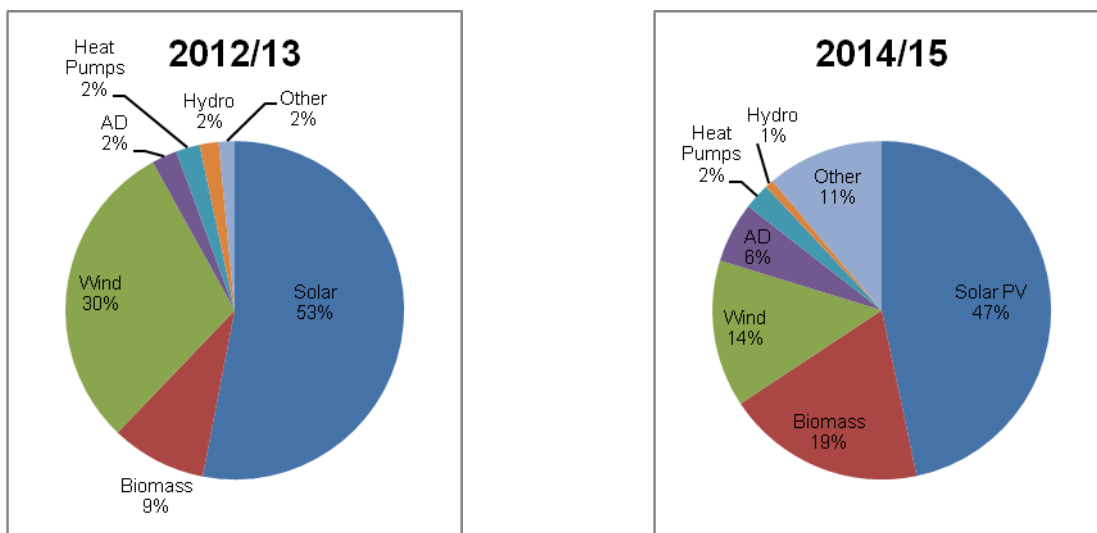


Figure 5: calls to the NFU Farm Energy Service

Working with farmers to improve energy efficiency and renewables generation

Integrating AD into dairy farming and processing - Stephen Temple, Norfolk

Copys Green Farm in Norfolk is a small/medium AD plant which is closely integrated into the farm business.

Generating 170 kilowatts of electric power and supported under the Feed-in Tariffs scheme, the installation also benefits from the Renewable Heat Incentive in supplying 190 kW of heat to nearby homes as well as to the creamery, which produces a number of handmade cheeses.

The AD plant utilises the dairy manure and slurry together with wholecrop maize grown using strip-tillage on the farm holding.



Integrating sheep farming, solar PV and biodiversity - Clive and Jo Sage, Dorset

Farmers Clive and Jo Sage continue to graze their Poll Dorset sheep under the modules of a 4.8-megawatt solar farm, established in 2012 by developer British Solar Renewables on 11 hectares of pasture.

The solar farm was designed to have very low visual impact locally, with an agreement to ensure livestock grazing throughout the 25-year lifetime of the project.

Bird and owl boxes were installed by the developer as part of the biodiversity enhancement plan for the site.



Integrating energy efficiency and renewables - Jon Hammond, East Midlands

The Hammond family are founder members of Sherwood Produce, an eight member producer group farming 6,500 hectares across the East Midlands, supplying to major retailers as well as manufacturing and food service customers. Doing the LEAF audit (now replaced by the LEAF Sustainable Farming Review) was a catalyst to developing the farm's energy policy.



They've introduced inverters for the boreholes and cold stores, use light sensors and produce a range of farm grown sustainable fuels to reduce our carbon footprint. They can now run five vehicles and produce power for the packing plant on pure plant oil.

ii GHGAP reflections

As described in the 2012 GHGAP report, the greatest range of benefits, including GHG mitigation, is likely to be delivered by farmer-owned small and medium scale renewables projects. Optimal integration of renewable energy into farm businesses enables farmers to continue to perform agricultural functions and/or have an active role in project management. This requires consistent long-term energy policy which can reduce the project risk and cost of finance for relatively small-scale installations. Too many adjustments to energy policy measures reduce the confidence of investors and tend to favour only the largest scale of renewables projects, where farmers are likely to play a less active role.

Although we previously emphasised the potential for on-farm AD to deliver multiple environmental benefits, including the avoidance of methane emissions from uncovered slurry storage, this can only be realised if there is widespread uptake of improved technologies that divert a substantial proportion of animal manures towards anaerobic digestion⁸³. The government has implemented only limited measures that explicitly support small-scale on-farm AD, and the recent "flattening" of the Feed-in Tariff rates (originally raked in favour of smaller-scale plants) has diverted investment towards larger AD plants offering higher returns. The present situation, with a review under way of the FITs scheme and no indication of the likely level of future tariffs, is likely to cause complete paralysis in the on-farm AD supply chain once existing orders have been fulfilled.

iii Next steps

Despite the confusing energy policy landscape, parts of the renewable energy industry are maturing and becoming competitive with fossil fuels without subsidy, especially where they meet principally on-farm energy needs. While fossil fuel energy costs have fallen in the short term, the longer-term prospect of more price volatility still makes investment in energy efficiency and on-farm renewables a reliable bet. The next 2-3 years are likely to see a broadening range of financial packages offered to farmers (e.g. lease-to-buy deals), and the latest disruptive new technologies for battery electricity storage are likely to make inroads, particularly where they help solve associated problems such as grid connections.

Outputs from our 2014 workshop on mitigation potential beyond 2020 highlighted a number of energy efficiency options that required further exploration (see next section). From 2020-2030, energy recovery (re-using waste heat and reducing energy consumption) and smart grids (monitoring and adjusting farm energy supply and demand in real-time) could be areas of real opportunity. Beyond 2030, the potential for carbon dioxide-free agriculture (no fossil fuel use on farm) was considered a possibility.

At the time of writing this report, it has not been possible to identify specific areas of work for the next phase of the GHGAP. Whilst it is our intention to develop these in collaboration with the renewables industry and government we have started this process. For example we have identified a number of targets which we believe require 'incentivisation' to drive uptake by farm businesses:

- Small scale farm AD, by rewarding its multiple environmental benefits such as avoidance of methane emissions, improved nutrient management.

⁸³ Our Framework for Action (2010) highlighted the potential for anaerobic digestion (AD) to deliver multiple environmental benefits including low-carbon energy, abatement of greenhouse gas emissions and stimulation of good nutrient recycling. We set out its critical role in potentially delivering one-fifth of the abatement (by capturing methane lost from manures and slurries) required of the industry by 2020. This was based on an ambition of deploying 1000 farm-based anaerobic digesters by 2020.

- Combined slurry storage with AD – a promising new technology that presently does not fit well with the regulatory environment, *e.g.* Permitted Development, exemption from Environmental Permitting.
- Modular battery electricity storage, *e.g.* through non-tariff incentives such as Enhanced Capital Allowances, to maximise on-site use of self-generation.
- The Energy Technology List maintained by the Carbon Trust for Enhanced Capital Allowances needs to be easier to use, better structured (at present it is just a 'warehouse' list of technologies), and should be kept up to date with the latest and most policy-relevant technologies, *e.g.* complete farm anaerobic digestion systems, modular battery electricity storage systems. Thermal screens for glasshouses should be restored to the list as an 'insulation-like' product.
- Reduced-intensity land use such as perennial energy crops (SRC willow, miscanthus) are just starting to be incentivised by energy end users for heat and power, but their multiple environmental benefits deserve formal recognition under CAP greening measures such as Ecological Focus Areas.
- Energy-efficient behaviour change on farms needs incentivisation as well as investment in new technologies.

This is an approach we would like to repeat for the other priority areas.

2. GHGAP workshop on future emissions reduction potential: 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" farming⁸⁴ futures. This document describes the outputs of that 2014 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 CO₂e) 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 target⁸⁵.

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.

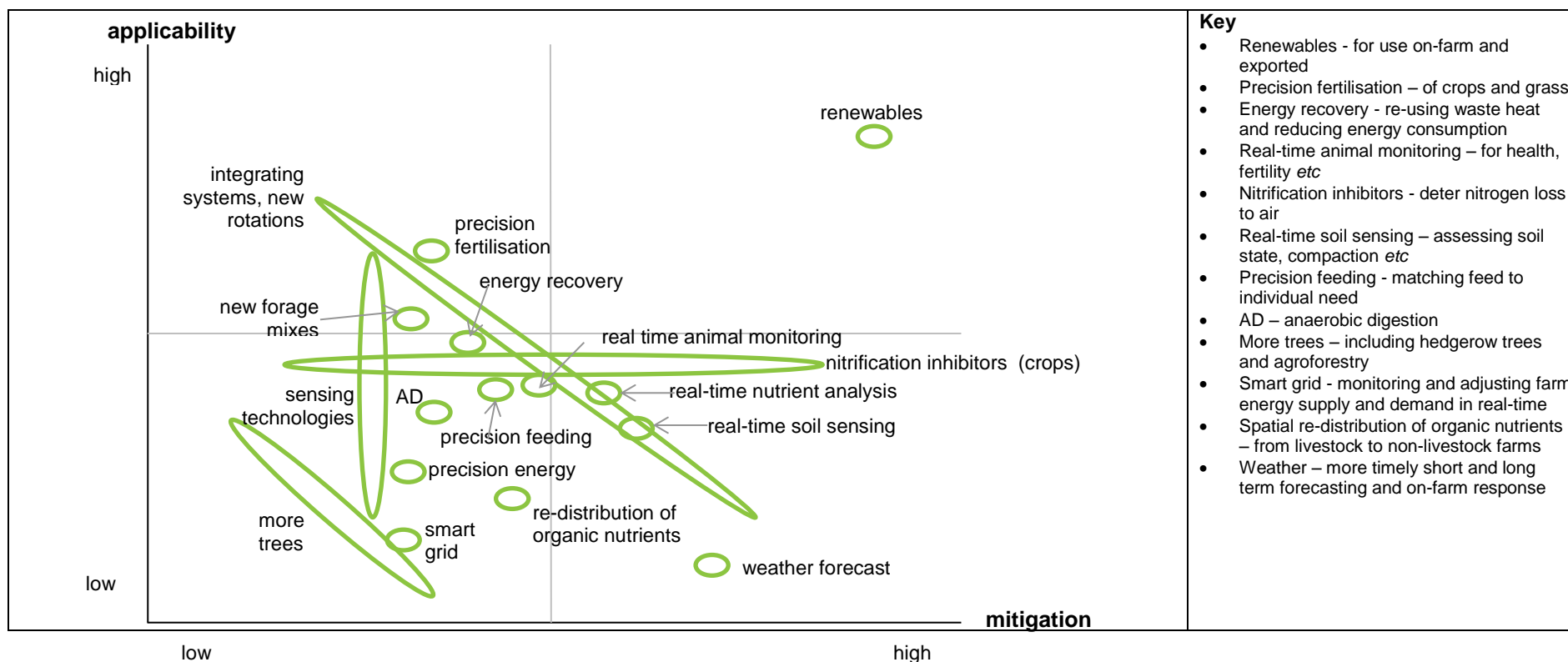
The Committee believes that there is scope for further abatement from nitrification inhibitors, improved drainage of agricultural land, and reducing carbon dioxide emissions from machinery to zero. It has also considered demand-side measures - reducing food waste, and dietary change with fewer meat and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

⁸⁴ Lower "carbon" farming covers all agricultural GHGs – nitrous oxide, methane and carbon dioxide

⁸⁵ [Defra 2012 review](#)

A new vision for 2020 – 2030?

On-farm mitigation measures were assessed according to their abatement potential on a scale of low⁸⁶ to high and their applicability (an arbitrary scale which includes considerations of cost and ease of implementation, farming system etc).



⁸⁶ 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 below⁸⁷:



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% respectively⁸⁸. There is also complementary interest in local scale renewable energy generation and recovery of fertilising and feed materials, and in fertiliser and feed additives.

⁸⁷ Font size has no relationship with mitigation potential or applicability. Smart grit are embedded sensors that signal the needs of soils, crops or stock

⁸⁸ 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)?

<p>On-farm</p> <ul style="list-style-type: none"> • 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? 	<p>Data</p> <ul style="list-style-type: none"> • 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?
<p>Mitigation limits</p> <ul style="list-style-type: none"> • 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? 	<p>Advice and technology transfer</p> <ul style="list-style-type: none"> • 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?
<p>Supply chain</p> <ul style="list-style-type: none"> • 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? 	<p>Engineering and technology</p> <ul style="list-style-type: none"> • 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.	Polymakers, 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.	Polymakers	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.	Polymakers, 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 is funded to take this work forward to assess the potential for mitigation and implementation.	Polymakers 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.	Polymakers, Research Councils, Agri-tech, industry	Knowledge and expertise generated and demonstrated on-farm facilitates 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.

3. Next Steps

This section summarises the significant next steps to be undertaken by the GHGAP from 2016-2020. It focuses on activities in the next two years so other areas of work are likely to be added to this list in time. It also sets out the rationale for our work on indicators of progress.

What	Who	When	Actions	Measures of success
Economic roadmap for technically feasible reductions in GHGs (and NH ₃) from manures and slurries in storage and in animal housing.	GHGAP SG in collaboration with Defra and other economic and scientific experts.	2016-2018	Understand relationship between technology, cost and emissions reduction for different farm types. Identify mechanisms (policy, incentives) to encourage take-up of key technologies.	Technologies and practices promoted or implemented on-farm.
Introduction of 'Developing Beef Expertise' CPD and 'Developing Sheep Expertise' programmes for beef and sheep consultants. ⁸⁹	AHDB (Beef and Lamb) in collaboration with BIAC.	2015-2016 (beef) 2016-2017 (sheep)	Development of programme. Recruitment of consultants to and delivery of the programme.	<ul style="list-style-type: none"> Well-trained and experienced consultants and advisers available to the beef and sheep industry. Consultants are in demand by farmers.
Publish AHDB Nutrient Management Guide.	Led and funded by AHDB with contributions from a wide range of partners.	2017 (1st revision 2019 (further revisions)	Annual review of plan for research and KT. Review KT tools available and work to present the information in appropriate formats.	Fertiliser Manual (RB209) and other tools regularly updated with the latest science to enable improved decision making.
Promote new fertiliser spreading testing scheme. ⁹⁰	AEA and T&T.	2016 onwards	T&T scheme included in T&T communications. Uptake monitored and reported annually by AEA.	All spreaders - disc, boom and pendulum - are tested to the same standard.
Increase manure management planning in beef sector.	GHGAP Steering Group.	2016-2020	Understand reasons for apparent downturn in manure management planning. Plan and implement campaign to increase take up.	Campaign reverses apparent downturn in planning.
Promote accurate application of manures and sensing applications.	AEA, AIC members and livestock sectors of AHDB.	2016 onwards	Collate case studies of benefits and encourage take-up. Identify particular technologies requiring incentivisation.	More market penetration for precision technologies where appropriate. Mechanisms for incentivising particular technologies in place.
Promote Healthy Grassland Soils to address soil structure, drainage and nutrients.	AHDB (Dairy) and AHDB (Beef and Lamb)	2015 - 2020	Make information e.g. videos, Grasslands Soil guide available online. Run events at appropriate times of the year to encourage take-up of information.	Numbers accessing online resources and attending events?
Assess impact of tailored feed advice to 1,000 farm businesses.	FAR with GHGAP support.	From 2017	Collect case study information. Analyse case studies for financial and mitigation impact and publish results.	Professional advice brings demonstrable financial and mitigation benefits to livestock business.
Next generation feed advice.	GHGAP and FAR.	From 2017	Identify relevant research from GHG research platform. Examine existing competencies and update as required.	GHG Research Platform results incorporated into FAR.
Beef Feed Efficiency Project.	AHDB (beef and lamb)	2015 - 2018	Agree industry-wide protocols for measuring feed efficiency. Define a "blueprint" for recording facilities on commercial farms. Install facilities for measuring feed efficiency on commercial units and report on data	Infrastructure for the measurement of feed efficiency in beef cattle delivered. Feeding efficiency incorporated into breed improvement programmes.

⁸⁹ <http://beefandlamb.ahdb.org.uk/returns/developing-beef-expertise/> The programme will consist of five two-day meetings that will be held from Dec 2015 to Dec 2016 and focus on selection for slaughter and key performance indicators, feed efficiency and bull selection, grass and forage, health and building design and rationing and feeds

⁹⁰ <http://www.nsts.org.uk/spreader-testing?mr=641>

			collected. Determine genetic parameters for efficiency traits in one breed. Establish a network for national feed intake recording	
Sheep KPI project, encouraging body condition scoring of ewes.	AHDB (beef and lamb)	through 2016	Workshops and wider communications promote use of body condition scoring as a tool to optimise ewe nutrition. Use data to identify measurements all commercial farmers could take by EID	Ewe body condition scoring is adopted as a tool to manage optimum ewe nutrition. Measurements made possible by EID are identified.

Indicators of Progress

Since its inception, the GHGAP has pressed the case for a set of indicators which would robustly reflect the breadth of industry progress. It is our belief that we need this evidence to allow a critical assessment of our success. High level indicators like output *etc* will not adequately describe how improvements in productivity have been achieved. We need greater granularity/detail to really understand progress to:

- Identify what farmers are investing in
- Identify what R+D has been applied on-farm
- Provide robust local evidence of on-farm practice
- Identify barriers to productivity

We believe that we all (government, industry, regulators) need to better understand the status of the industry to improve the effectiveness of the activities required to deliver improvements in productivity. Current Defra surveys are invaluable but are unfortunately limited in scope and frequency to capture the different levels of data the industry requires to demonstrate progress.

It makes no sense that the industry, government and its independent advisers assess and report on industry progress using three different indicator sets. So after many false starts over the past five years, the GHGAP believes that the building blocks are finally in place for a collectively owned approach.

At a recent meeting, the GHGAP in collaboration with the GHG Research Platform and Defra statisticians identified clear actions to move the process forward, some key questions and fundamentals:

- There was universal agreement on the essential requirement for retaining good quality survey design representative of farming types and the importance of having a fully stratified appropriately weighted sampling approach to data gathering and analysis
- How do we bring together, for the longer-term, different datasets and achieve synergy in data collection, analysis, interpretation and use?
- How can we add value to existing surveys? *e.g.* including 1-2 more questions on soil texture and rainfall in Cropbench or adding to BSFP?
- Are we asking the right questions? The GHGAP offered to host a meeting to address this if there was demand

The GHGAP has just started down the road towards a collectively-owned and agreed set of robust indicators of progress. This report has identified the following, bolstered by case studies of individual farms, as a starting point for such an indicator set:

<p>Management skills and advice</p> <ul style="list-style-type: none"> • % FQAs undertaking additional mitigation training • % feed advisers proving competence and CPD • Continued improvements in the GHG footprint of sectors • Numbers of farmers undertaking sectoral CPD schemes • Number of GHGAP events/activities generically targeting resource use efficiency 	<p>Crop nutrient management</p> <ul style="list-style-type: none"> • % farms with nutrient management plan • % livestock farms using T&T • % farms using manure management plans • Uptake of precision nutrient management techniques • Number of fertiliser spreaders tested • Use of clover in grassland • N utilisation efficiency by crop
<p>Soil and land management</p> <ul style="list-style-type: none"> • Level of soil testing • Numbers undergoing soil and water CPD • Adoption of soil protection measures • Status of field drainage systems 	<p>Livestock nutrition</p> <ul style="list-style-type: none"> • % herds with a feeding plan • N conversion efficiency in diets by species • Appropriate adoption of HSG • Levels of KE activity on improving livestock nutrition • Volume of DDGS/co-products/food waste in livestock diets
<p>Livestock health and fertility⁹¹</p> <ul style="list-style-type: none"> • Pig Health scheme trends • % dairy herds addressing chronic/ sub-clinical infections/diseases/ illnesses (using mastitis control and lameness as exemplars) • % farms with a farm health plan 	<p>Energy efficiency and renewables generation</p> <ul style="list-style-type: none"> • Renewable energy installations • Number AD plants • Investment in energy efficiency

We look forward to developing this further, utilising the wealth of information in Defra surveys and elsewhere. It is a significant piece of work for our partnership but strategically important. We know there are others active in this space *e.g.* the Sustainable Intensification Research Platform, the new Agri-Metrics Centre and the Productivity Evidence Review. When we have better visibility of these initiatives we will be able to put in place the actions we need to deliver.

⁹¹ In future we will report on a new crop and livestock genetics priority

Annex 1: On-Farm Actions to Reduce Emissions

In order to encourage the continued reduction of GHG emissions from agriculture, it is important to achieve clarity about the on-farm practices that can increase production efficiency and realise GHG emissions reductions per unit production. Experts in the industry partnership organisations have identified a suite of actions to achieve such efficiencies, which are largely based on high-lighting key existing best practice guidance.

Actions for all farm types

1. **Skills, training and advice** - seek appropriate training in land management and the application of crop inputs. If professional advice is sought, use only professionally qualified individuals
2. **Soil management** - follow good practice: avoid and rectify soil structural problems (e.g. by reducing wheelings and poaching, by sub-soiling, mole draining, adding organic matter). Use soil cultivations appropriate for the soil type and cropping situation without restricting crop growth and nutrient uptake. Monitor and amend soil nutrient status and pH following regular soil sampling and analysis
3. **Land management risk assessment** - grow crops and locate high output grazing livestock systems on land with characteristics capable of supporting sustainable production (e.g. based on soil type and depth, droughtiness, slope). Review enterprises and cropping that may not be suited to the land (e.g. intensity of dairy stocking; fields for growing milling wheat, potatoes, and vegetables)
4. **Optimise crop and livestock performance** - select varieties and breeds suited to local conditions and market requirements, using the natural environment to best effect, taking a whole farm approach (integrated farm management)
 - **Consider selection of crop and animal breeds** which favour production efficiency and GHG mitigation
5. **Crop nutrition (underpinned by crop health)**
 - Plan fertiliser and manure applications to each crop to optimise the supply of all nutrients from all sources. Use standard recommendations, and prepare a nutrient and manure application plan for each crop in each year, allowing for nutrient balances within the rotation:
 - Make the most of the nutrient resources already available - account for the nutrients supplied from soils and manures.
 - Optimise the quantity of nitrogen that is applied as fertiliser and manure N - ensure that all other crop inputs (including other nutrients, lime and crop protection products etc.) are optimised so that unrestricted crop growth is achieved with a high efficiency of nitrogen utilisation. This will reduce the risk of using unnecessarily high nitrogen application rates.
 - Apply nitrogen from manufactured fertilisers and organic manures at times that match the crop uptake of nitrogen - avoid applying nitrogen when the soil is waterlogged, frozen or when the crop/grass is not growing. (Precise timings and recommended rates will be crop specific)
 - Apply nitrogen and other nutrients at the optimum rate and evenly to the target area. Check and calibrate each fertiliser spreader/sprayer annually before fertiliser is applied and use headland devices. (Consider benefits of GPS technologies, if appropriate). Estimate the weight/volume and rate of application of each type of manure applied to each field.
6. **Maximise marketable produce** - harvest/slaughter at optimum times. Handle livestock and crops to minimise losses and damage during transit, storage and processing
7. **Consider opportunities for energy efficiency and renewable energy generation** - in the efficient use and potential for on-site supply of electricity, heat and vehicle and heating fuels

8. Adopt land management practices/stewardship options which maximise environmental value, resource protection and carbon storage, e.g. buffer strips on compacted wet headlands offer potential GHG mitigation and carbon sinks

Livestock-specific actions

9. Skills, training and advice - consider additional benefit of using a ration formulation programme or nutritional advice from an expert when planning the feeding regime for your livestock

10. Manure treatment, storage and spreading - implement manure management practices that will reduce atmospheric emissions and water pollution during manure collection, storage and spreading. Use facilities and techniques which result in the best possible use of nutrients by a growing crop, including adequate slurry and dirty water storage capacity, slurry separation, anaerobic digestion, covered storage, low emission slurry spreading techniques and nutrient management planning

11. Housing - provide suitable housing and shelter for livestock appropriate to their needs and those of workers, including welfare, freedom from stress, minimising aerial and atmospheric pollutants, minimising disease pressures, providing optimum access to feed, water, light, shelter and warmth (where appropriate). Utilise materials which will withstand hard use but also do not harbour disease organisms and pathogens

12. Livestock nutrition - plan diets and feeding regimes to achieve desired productivity, efficiently making use of resources available including home grown crops and food industry origin co-products, carefully matching nutrient content and availability to animal requirements. Consider using feed technology and additives to improve feed use efficiency

13. Livestock health - maintain optimum health status of all livestock through proactive health planning and close monitoring of performance e.g. through weighing of stock to identify need for interventions. Consider the benefit of expert veterinary advice in health planning linked with the appropriate diet, feeding regime and housing for the breed

-consider vaccinations and anti-parasitics where appropriate (participation in health schemes may raise the value of breeding stock)

-prioritise health and welfare issues, and implement testing for diseases if advised

-implement biosecurity measures

14. Genetics and breeding policy - select for traits which will benefit the farming system. Target efficient production and satisfy market needs with respect to products and product quality:

- Use bulls with a high PLI or Profitable Lifetime Index when breeding dairy cows

- Use bulls/rams with a high EBV or Estimated Breeding Value when breeding beef cattle/lamb

15. Plan grassland management (and forage management) to meet production objectives - use clover mixes to reduce the need for nitrogen application, high sugar grasses