

## Introduction and key messages

1. Agricultural emissions: trends and drivers
2. Progress against indicators
3. Incentives to reduce agricultural emissions – the policy framework
4. Land use, land use change and forestry



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# Chapter 6: Progress reducing emissions from agriculture

## Introduction and key messages

In this chapter we present the latest evidence on emissions in agriculture, which accounted for around 9% (51.2 MtCO<sub>2</sub>e) of UK greenhouse gas (GHG) emissions in 2011. We also consider the Land use, land use change and forestry (LULUCF) sector, which is a net carbon sink, absorbing 3.3 MtCO<sub>2</sub>e in 2011.

Our key messages are:

- In 2011 agriculture emissions remained unchanged from 2010 at 51.2 MtCO<sub>2</sub>e. This is the second year in a row that emissions did not follow the trend in recent years of declining agricultural emissions, which have fallen by 8% since 2003.
- Agricultural output increased by 2.5% in 2011 implying an improvement in carbon intensity. Within this, carbon intensity of livestock output improved due to increased milk yields and reduced use of fertiliser on pastureland. Crop output also increased but this was accompanied by a larger rise in nitrous oxide emissions from higher fertiliser use on arable land and soil incorporation of crop residues. This suggests the carbon intensity of crops worsened.
- Defra has now published an indicator framework to monitor progress in reducing emissions. It will be important to continue to monitor progress and develop the evidence base, and if the indicators suggest progress is not being achieved then a review should be implemented before the planned 2016 date.
- It is important to put in place measures to monitor the effectiveness of the industry-led GHG Action Plan in influencing the uptake of less carbon-intensive farming practices. In addition, the cereals and oilseeds roadmap should set targets as to how the sectors will contribute to emission reductions.
- Any review on progress towards reducing emissions from agriculture should also consider a range of policy options, including continuing with the current voluntary approach, and policies that would provide stronger incentives for farmers.

We set out the analysis that underpins these messages in four sections:

1. Agricultural emissions: trends and drivers
2. Progress against indicators
3. Incentives to reduce agricultural emissions – the policy framework
4. Land use, land-use change and forestry

## 1. Agricultural emissions: trends and drivers

Emissions data for agriculture lag that of other sectors due to the high proportion of non-CO<sub>2</sub> emissions which take longer to collate. This chapter therefore reports on trends and drivers for 2011.

A complete assessment of progress in reducing emissions in the sector cannot currently be made due to the uncertainties over measuring emissions and current framing practices. Until these uncertainties are resolved we will continue to assess high-level progress in reducing emissions, as set out in section 2.

### Emissions trends

At 51.2 MtCO<sub>2</sub>e in 2011, emissions in the agriculture sector accounted for 9.3% of total greenhouse gas emissions in the UK (Figure 6.1).

- Over half of agriculture emissions (53%) are due to agricultural soils, while enteric emissions – arising from the digestive process of cattle and sheep – account for another 30% of emissions. The remaining emissions are split between stationary and mobile combustion emissions (9%) and waste and manure management (8%) (Figure 6.2).
- Nitrous oxide (N<sub>2</sub>O) accounts for 57% of emissions in the sector, with a further 35% coming from methane and the remaining 8% from carbon dioxide (CO<sub>2</sub>).

Data in this year's inventory has been revised upwards for the entire time series so 2010 emissions are now 1% higher than quoted in last year's inventory (50.7 MtCO<sub>2</sub>e). One of the main reasons for the change was the upward revision in the land area of cultivated histosols (organic soils). Based on the revised series, overall agricultural emissions in 2011 remained unchanged from the previous year. However, there were marginal changes in emissions across the range of sources and gases:

- While emissions from enteric fermentation and waste and manure management declined slightly, emissions from agricultural soils and stationary and mobile combustion increased marginally.
- A breakdown by gas shows that while N<sub>2</sub>O and CO<sub>2</sub> emissions increased, methane emissions declined. All of these changes were very small.

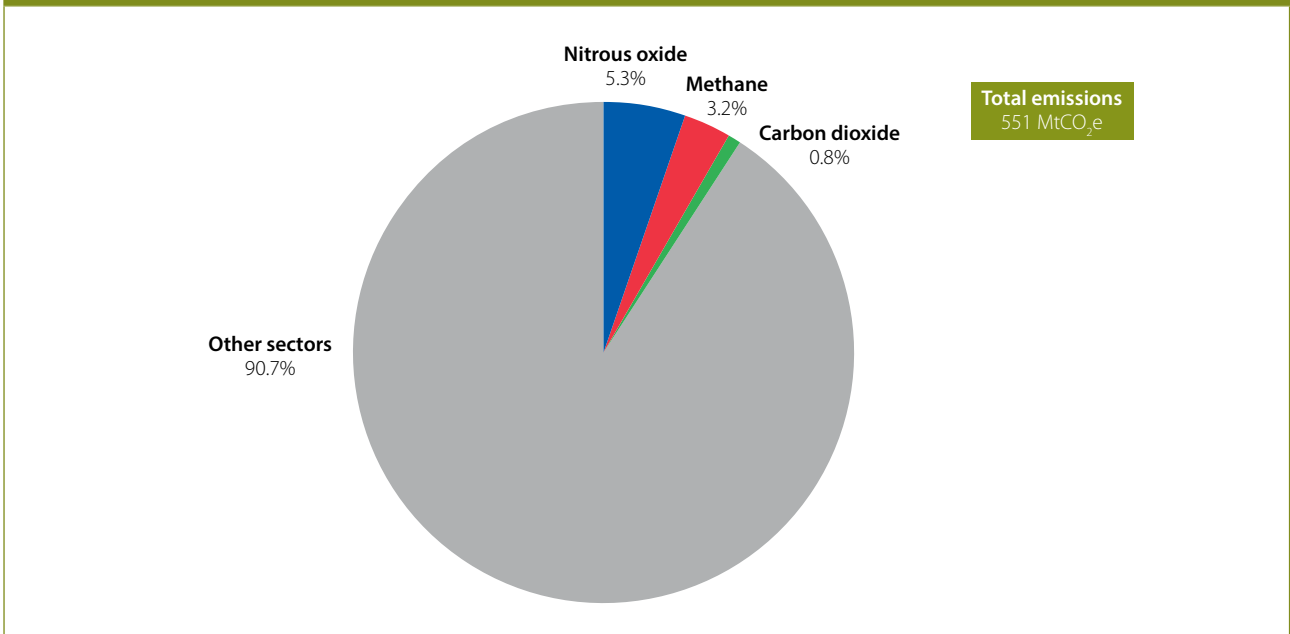
2011 is the second year in a row that overall emissions did not follow the longer-term trend of declining emissions (Figure 6.3):

- Since 1990, agricultural emissions have fallen by 20% from 63 MtCO<sub>2</sub>e, with reductions across all sources: agricultural soils (19%), enteric fermentation (18%), wastes and manure management (23%) and stationary and mobile combustion (19%).
- In the period since 2003, emissions for the sector have fallen by 8.5% (from 55.9 MtCO<sub>2</sub>e), with the reduction in soil emissions accounting for over half of the decline.

Due to reductions that occurred before 2010, emissions are on track to meet our emissions indicator for a 10% decline (compared to 2007) by the end of the first budget period in 2022.

Given the lack of progress in reducing emissions in the past two years, it is important to understand emissions drivers to assess whether any progress has been made in implementing measures to reduce emissions intensity.

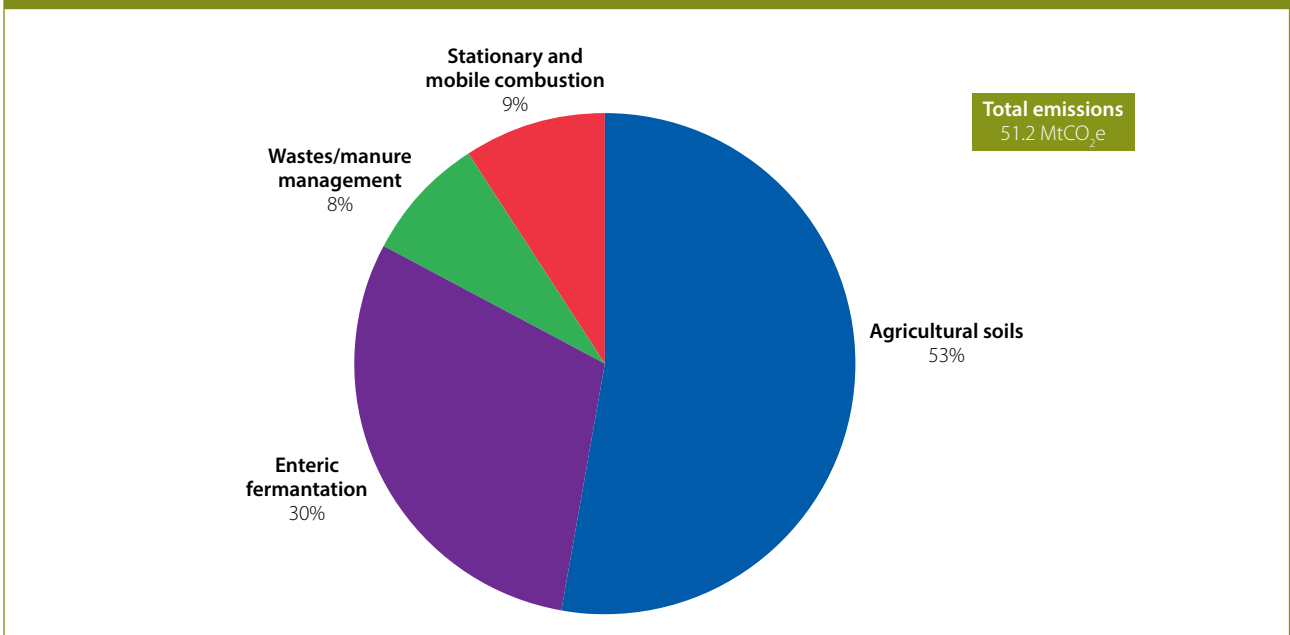
**Figure 6.1: GHG emissions from agriculture in the context of total UK emissions (2011)**



Source: NAEI (2013).

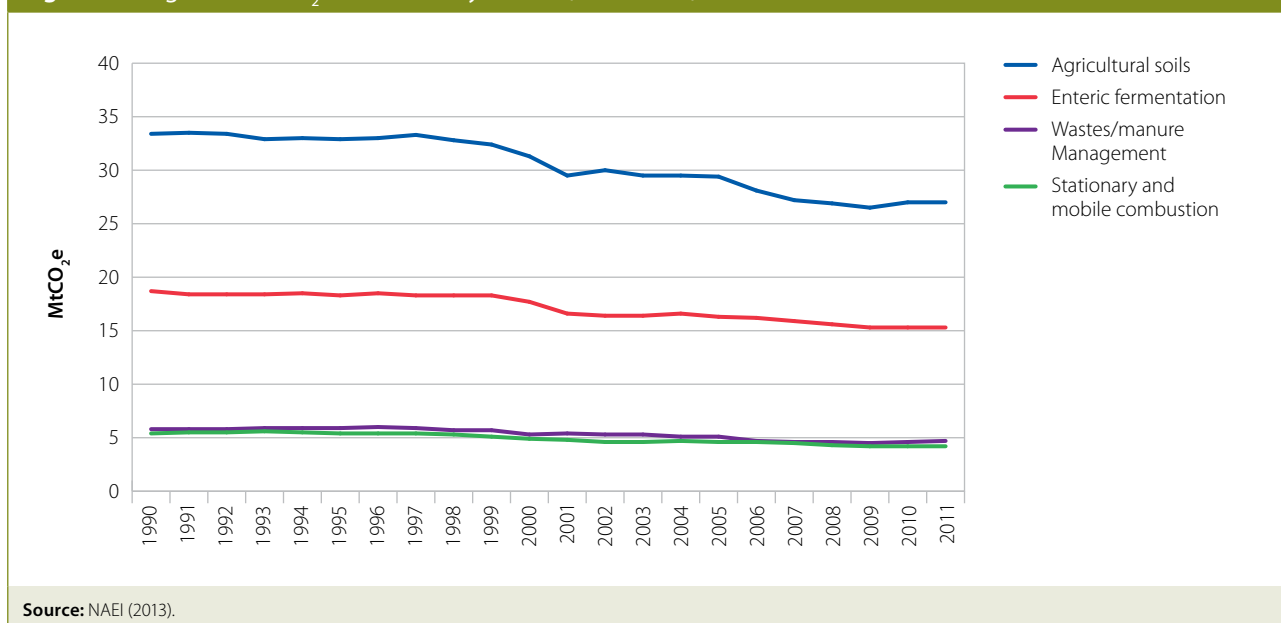
Notes: Emissions from other sectors excludes international aviation and shipping sectors.

**Figure 6.2: Agriculture emissions by source (2011)**



Source: NAEI (2013).

Figure 6.3: Agriculture CO<sub>2</sub>e emissions by source (1990-2011)



### Emission drivers – nitrous oxide

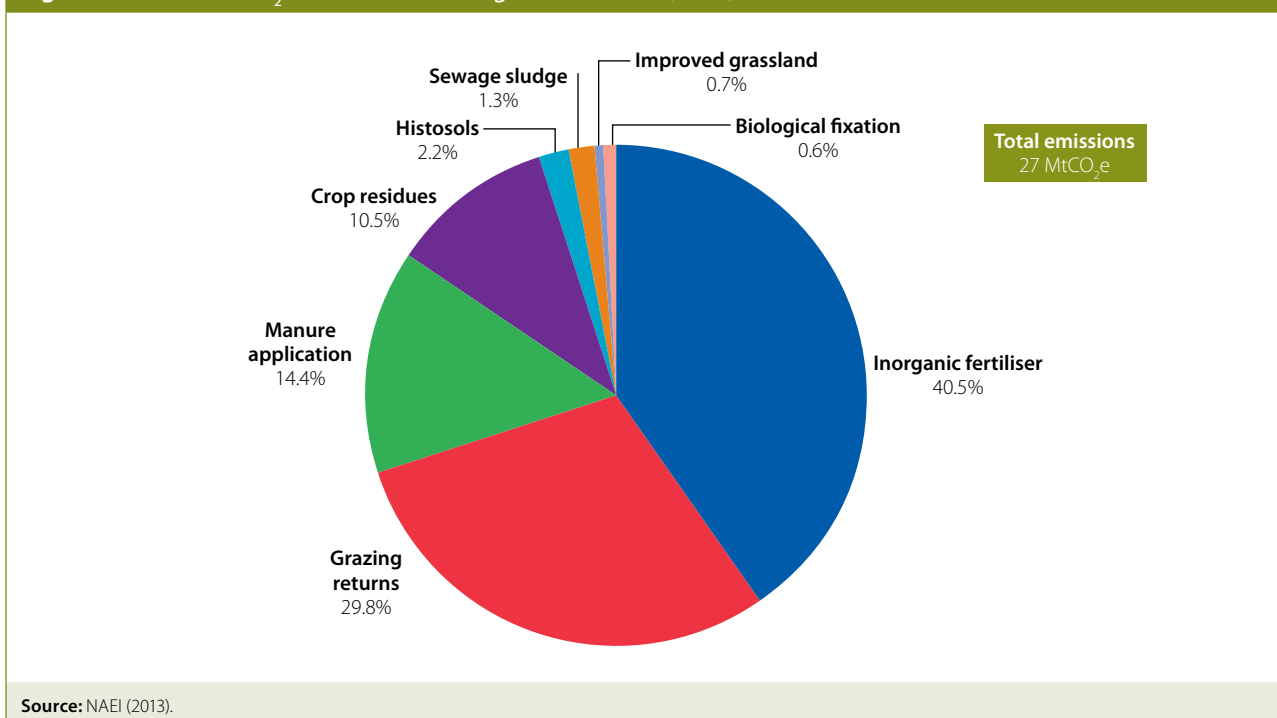
N<sub>2</sub>O emissions in agriculture occur from two main sources – soils and manure management, with the former accounting for over 90% of the emissions. N<sub>2</sub>O from agricultural soils comprise many sources, and within these, there have been year-on-year changes that help explain the overall marginal increase in N<sub>2</sub>O emissions in 2011 (Figure 6.4):

- The application of inorganic fertiliser on cropland and pastureland is the single largest source of N<sub>2</sub>O emissions from soils (40.5%) and fertiliser-related emissions declined by 1% in 2011.
- Manure deposited by grazing livestock on pastureland (i.e. grazing returns) accounted for over a quarter of N<sub>2</sub>O emissions. Emissions from this source declined 1% on the previous year.
- These reductions were offset by increased emissions from the ploughing in of crop residues (e.g. cereal straw and stubble) left over from arable harvests and the application of sewage sludge.

The impact of a slight increase in N<sub>2</sub>O emissions combined with a much higher growth (2.5%) of overall agricultural output implies a reduction in the N<sub>2</sub>O emissions intensity of agricultural output by 2.3%.

It is also useful to disaggregate the data between crops and livestock to assess whether improving emissions intensity was observed for both types of farming activities:

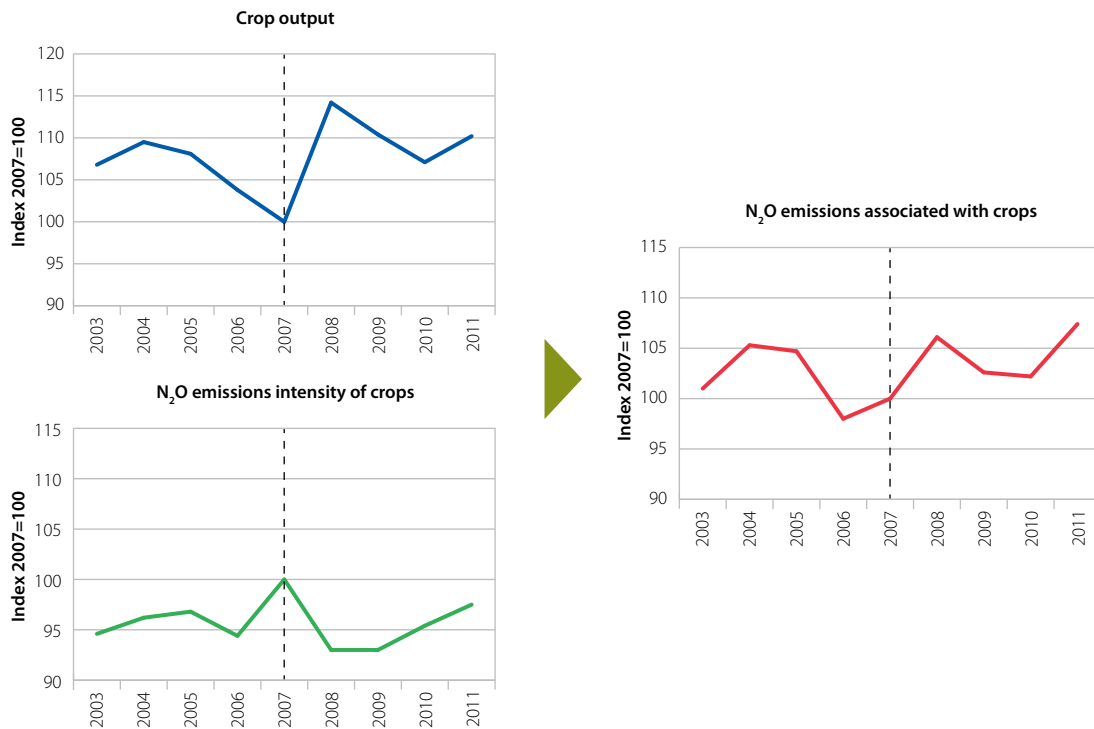
Figure 6.4: Source of N<sub>2</sub>O emissions from agricultural soils (2011)



- Following the adverse weather that reduced crop output in 2010, more favourable conditions in 2011 saw output growing by 2.8%. In tonnage terms, barley growth was particularly strong at 4.6%, while wheat grew by 2.5%. However, growth in crop-related emissions of 5% was faster than growth in output, implying an increase in N<sub>2</sub>O emissions intensity of crops. This is the second successive year this has occurred (Figure 6.5). This was due to a number of factors, including a 1% increase in the intensity of inorganic fertiliser use on cropland, and higher emissions arising from crop residues. The increase in total crop dry matter production resulted in a larger amount of crop residues available for incorporation into soils.
- For livestock, N<sub>2</sub>O emissions from grasslands declined by 6.2% while output increased by 2.7%, implying an improvement in emissions intensity in 2011. The decrease in emissions was driven by a 10% decrease in the application of inorganic fertiliser per hectare of grasslands. With the price of inorganic fertiliser rising in 2011, farmers switched from grass to less fertiliser intensive feeds such as maize silage. Another contributory factor was the 2% decline in cattle numbers which supported a 1% reduction in N<sub>2</sub>O emissions from both grazing returns and manure management. These factors led to a 9% improvement in N<sub>2</sub>O emissions intensity for livestock (Figure 6.6).

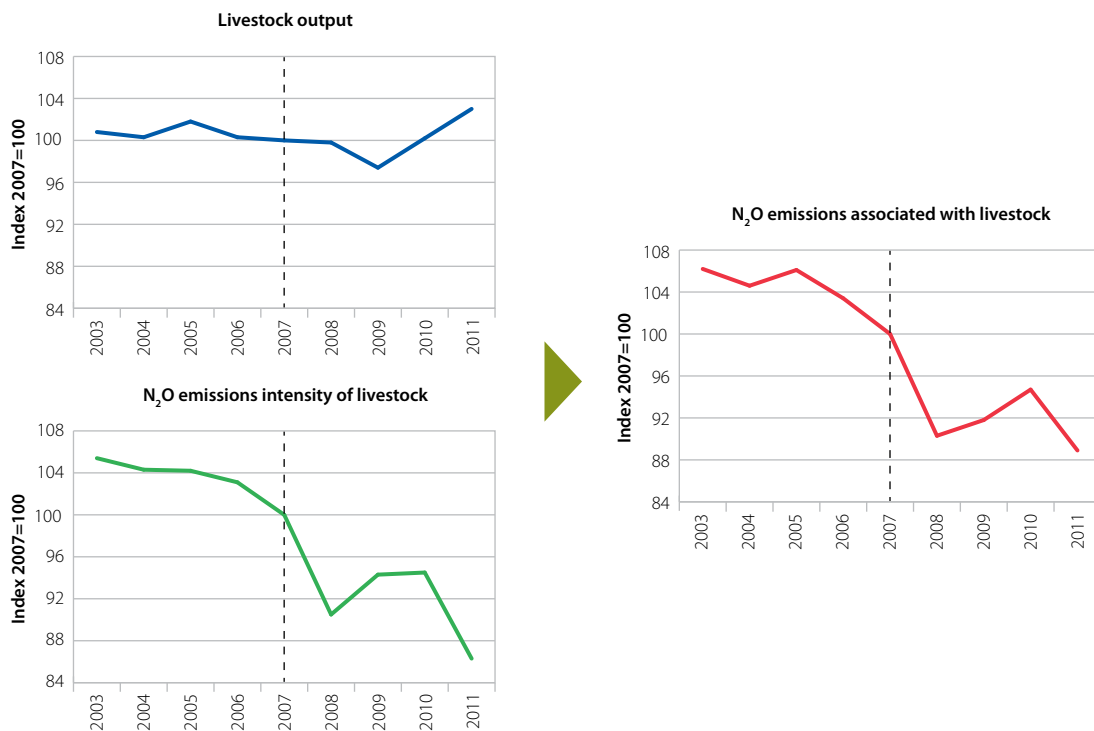
The annual changes in inorganic fertiliser use on grasslands and arable land in 2011 reflects the long-term trend: an overall decline in the application rate on grasslands due to declining cattle and sheep numbers. Meanwhile rates for arable use in 2011 returned to levels previously observed before the historic high fertiliser price in 2008 and 2009 (Figure 6.7).

**Figure 6.5: Crop output, N<sub>2</sub>O emissions associated with crops and emissions intensity of crops (2003-2011)**



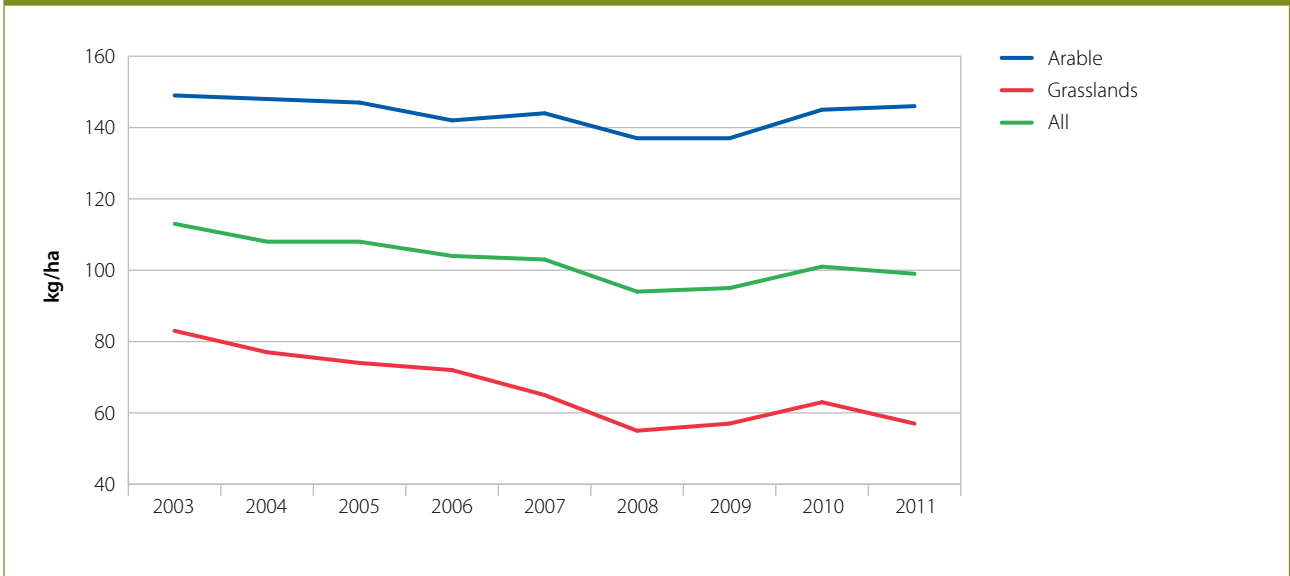
Source: NAEI (2013), Agriculture in the UK (AUK) 2011, CCC calculations.  
Notes: Base Year (2007) = 100.

**Figure 6.6: Livestock output, N<sub>2</sub>O emissions associated with livestock and emissions intensity of livestock (2003-2011)**



Source: NAEI (2013), AUK 2011, CCC calculations.  
Notes: Base Year (2007) = 100.

**Figure 6.7: Fertiliser use (2003-2011)**

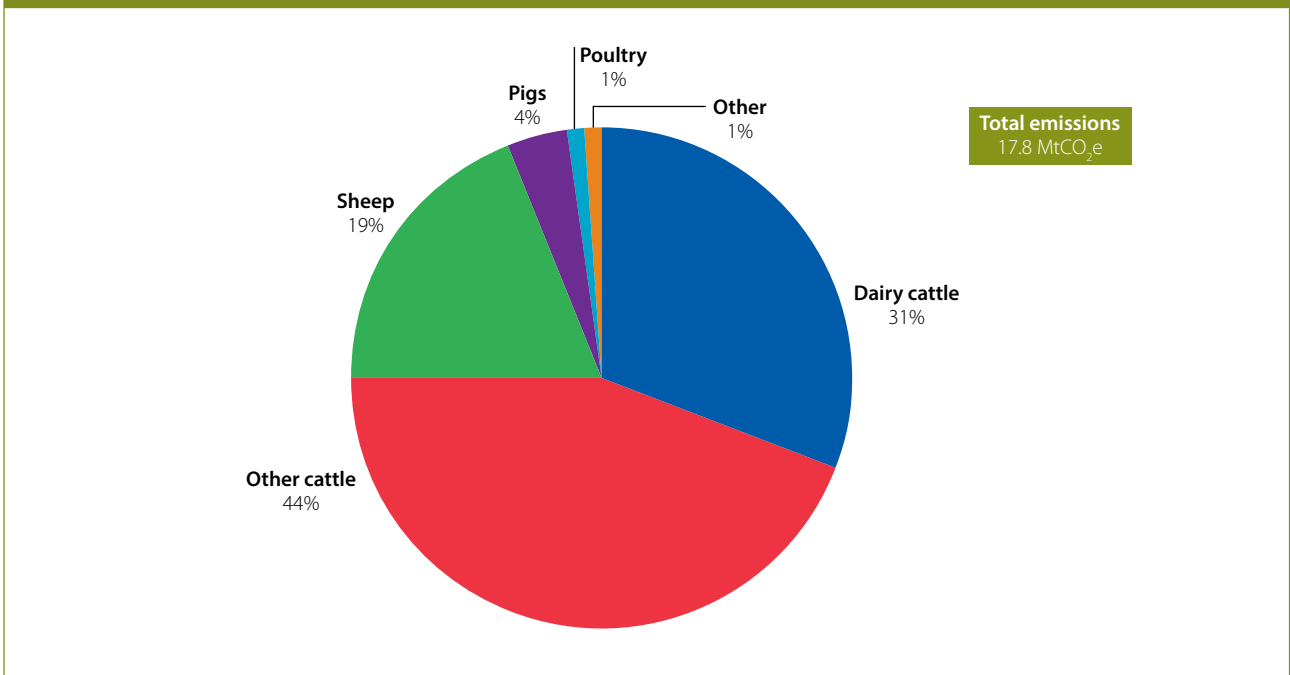


Source: British Survey of Fertiliser Practice (2012).

### Emission drivers – methane

Over 90% of methane emissions are accounted for by cattle and sheep with enteric fermentation being the main source. Pigs and poultry account for 5% of emissions, which mainly arise from waste and manure management (Figure 6.8).

**Figure 6.8: Source of methane emissions by animal (2011)**



Source: NAEI (2013).



In 2011, methane emissions declined by 0.5% driven by a 2% reduction in cattle numbers. Despite the reduction in the number of animals, livestock output increased in 2011 by 2.7%, with beef up 3.4%, milk up 1.7% and sheep and lamb meat up 6%. These two factors imply a reduction in methane intensity of 3.2% (Figure 6.9).

Improving methane emissions intensity can be partly explained by improving livestock productivity:

- Average milk yields increased by 3.5% in 2011, with the average dairy cow producing in excess of 7,500 litres for the year. The longer-term improvement is 14% since 2003 (Figure 6.10).
- Average dressed carcase weights for clean sheep and lamb increased by 0.5% in 2011 due to good grazing conditions. Although the average dressed carcase weight of beef and veal fell slightly (down 0.6%), high feed prices saw cattle sent to slaughter early which could indicate a fall in methane emissions per unit of output. Over the longer-term weights for beef and veal have increased by 8% since 2003 (Figure 6.11).

**Figure 6.9: Total livestock output, methane emissions and methane emissions intensity of output (2003-2011)**

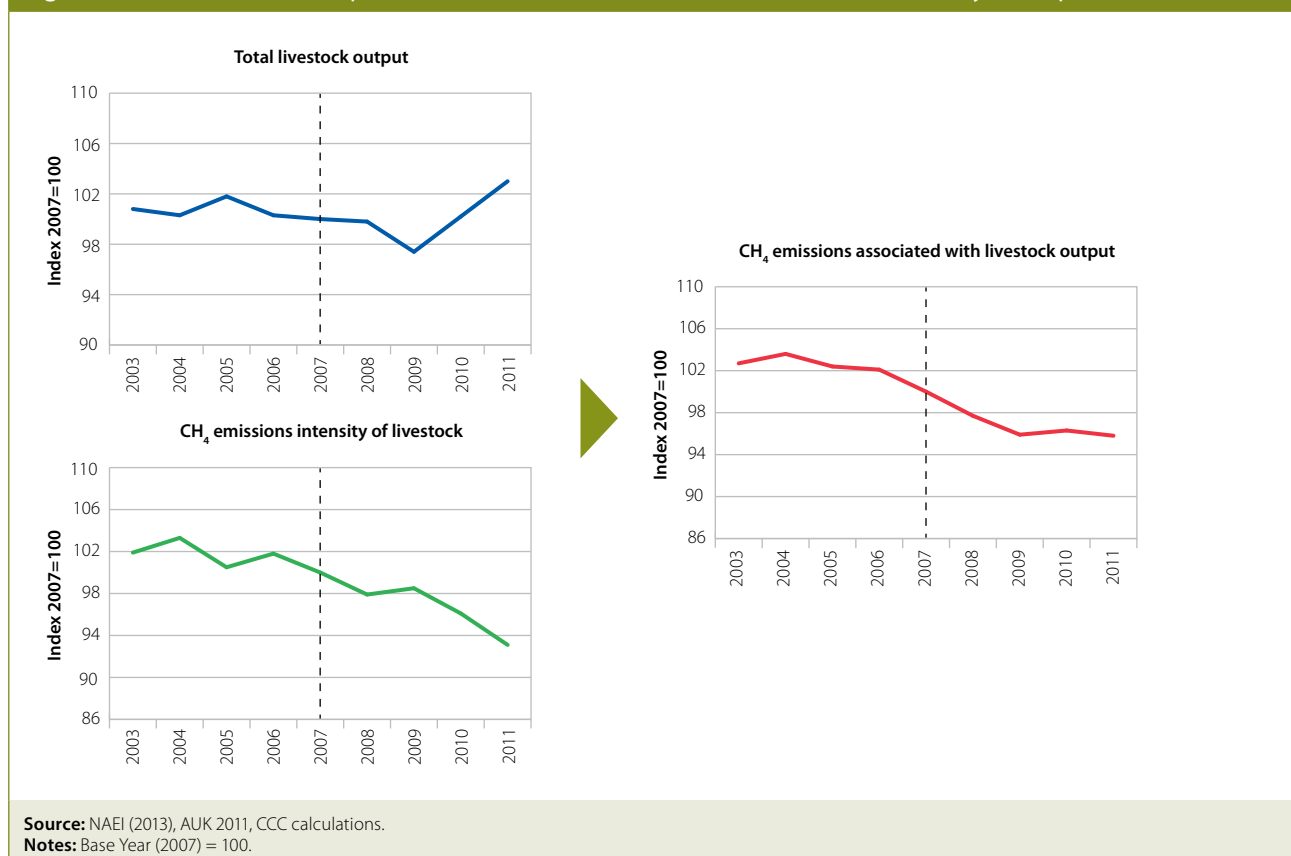
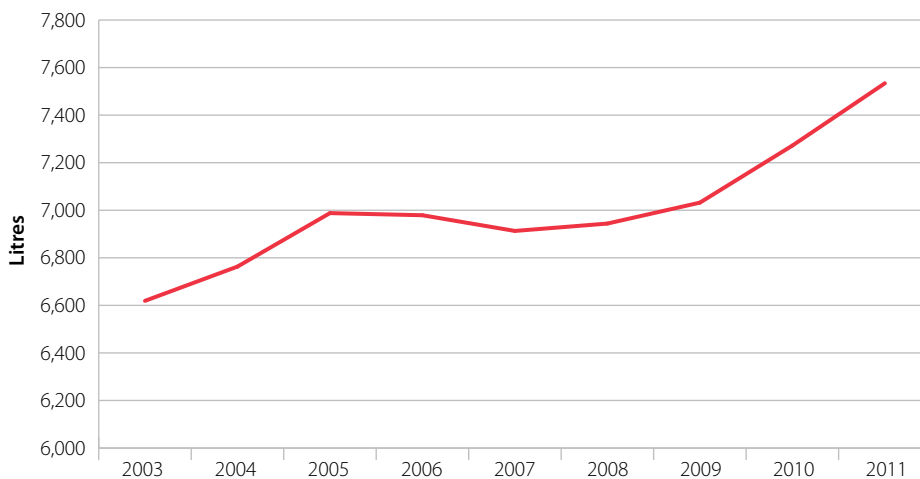
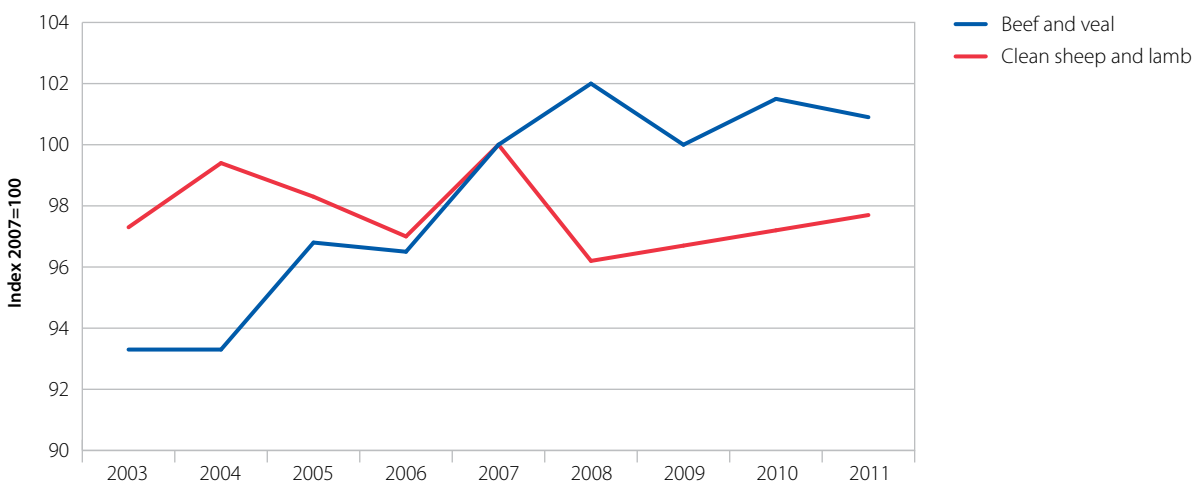


Figure 6.10: Milk output per dairy cow (2003-2011)



Source: AUK (2011), NAEI (2013).

Figure 6.11: Index of average dressed carcass weight per animal (2003-2011)



Source: AUK (2011).  
Notes: Base Year (2007) = 100.

However, yield alone is not a perfect indicator of changes in emissions intensity. It is important also to consider the feed conversion ratio (FCR)<sup>1</sup>, and, where applicable, other measures (e.g. fertility rates and on-farm mortality) for a more accurate assessment of emissions intensity:

<sup>1</sup> FCR measures the amount of feed required to produce an extra kg of meat or litre of milk. An increase in the FCR could imply greater methane emissions if the increase in feed is lost as carbon via enteric emissions if not properly digested and used for growth.

- In the dairy sector, the ratio of dairy cow compound and blend feed to milk production has been on an upward trend since 2005 indicating that the rate of increase in feed has risen more than the rate of increase in average milk yields. This would imply reduced feed efficiency and increasing emission intensity. However in 2011, there was an improvement of 3% for dairy cattle. (Figure 6.12).
- Measuring the FCR for grazing livestock (beef cattle and sheep) is more complicated due to the difficulty in measuring the consumption of grass that make up a substantial volume of the diet. Therefore, alternative measures are required. The new indicator framework established by Defra to track progress in reducing emissions uses beef and sheep breeding regimes to assess changes in emissions intensity of grazing livestock (see Section 3).

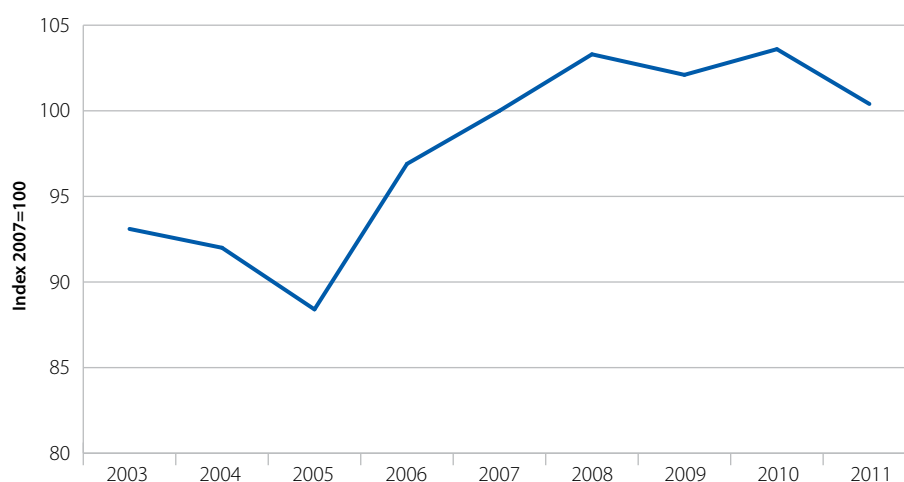
We note, however, that given the current uncertainty attached to calculating non-CO<sub>2</sub> emissions in the sector, it is unclear whether the required carbon intensity improvements are actually occurring. On-going work of the GHG R & D Platform (see Section 2) will eventually allow for an improved evidence base in which changes in emissions intensity can be calculated more accurately.

### Emission drivers – CO<sub>2</sub>

Machinery used in agriculture makes up the bulk of CO<sub>2</sub> emissions in agriculture and accounts for 8% of GHG emissions in this sector. In 2011 CO<sub>2</sub> emissions rose for the second successive year:

- All of this increase comes from stationary and mobile machinery, which accounts for almost all of the CO<sub>2</sub> emissions.
- Emissions from machinery are still 13% lower compared to 2003.

**Figure 6.12:** Ratio of compound and blend feed production to milk production per annum – GB (2003-2011)



**Source:** AUK (2011).  
**Notes:** Base Year (2007) = 100.

In line with reductions elsewhere in the economy, there is a potential for further CO<sub>2</sub> savings in agriculture by improving energy efficiency and more use of renewable fuel. From April this year, the Renewable Transport Fuels Obligation was extended to cover fuels used for non-road mobile machinery. Suppliers are now obliged to supply a proportion of sustainable biofuels for each litre of fuel used by tractors and other mobile farming machinery.

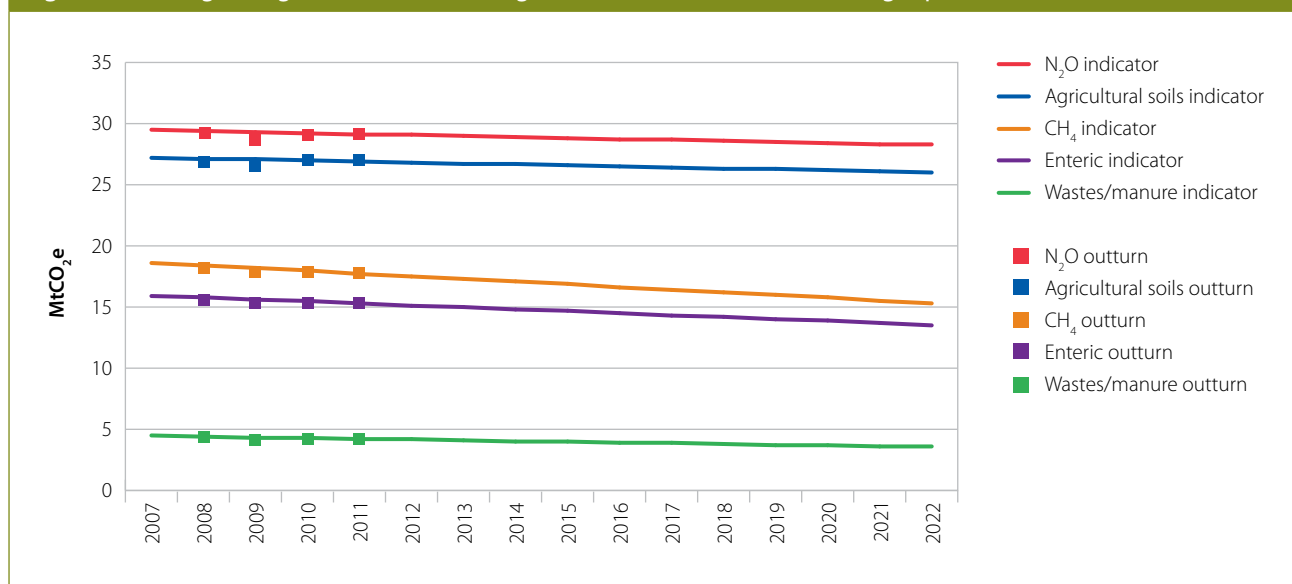
## 2. Progress against indicators

In our 2009 Progress Report we set out our preliminary indicators to track progress in reducing non-CO<sub>2</sub> emissions in the agriculture sector, consistent with the Government's ambition of 3 MtCO<sub>2</sub>e of savings by 2020 (scaled up to 4.5 MtCO<sub>2</sub>e for the UK) compared to 2007. The set of indicators comprise trajectories for reductions in emissions (by gas and source) and for changes in carbon intensity and productivity improvement:

- Average agricultural non-CO<sub>2</sub> reductions of 10% by 2022 relative to 2007 levels.
- Average improvements in soil emissions intensity of 5% by 2022 relative to 2007 levels through improvements in fertiliser efficiency in arable and pasture.
- Average improvement in livestock emissions intensity of 18% by 2022 relative to 2007 levels, through improvements in productivity (e.g. meat yields).

Although overall emissions have been flat since 2009, emissions reductions achieved in previous years mean that the level of emissions is still consistent with our indicator trajectory (Figure 6.13). Going forward, a reduction of 0.7% is required each year to achieve the 4.5 MtCO<sub>2</sub>e of savings by 2022. Given the lack of progress in the past two years it is important that an effective monitoring framework is in place and appropriate action is taken to get back on track should this be required.

**Figure 6.13:** Progress against indicators for agriculture to end of the third budget period (2007-2022)



Source: NAEI (2013), CCC calculations based on LCTP ambition.

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Since last year's Progress Report, Defra published its own framework of indicators for monitoring progress in reducing emissions by 2022 (see Section 3). In light of this it remains to be seen whether our own indicators continue to be appropriate, especially with regard to measuring changes to the carbon intensity of livestock given that looking at meat yields alone may not be sufficient. We will return to this for next year's progress report.

An accurate assessment of progress is not possible given the significant uncertainties in the way agricultural emissions are currently calculated. This is because the current inventory uses standard, rather than UK-specific, emissions factors that do not reflect regional differences in soil and climate, for example. The inventory also fails to take account fully of current farming practices that could already be reducing emissions. This means that both the current level of emissions and emissions reduction potential is highly uncertain.

On-going work funded by Defra and the devolved administration governments will establish an improved method for calculating the agriculture inventory that will be based on UK-specific emissions factors. The revised inventory will also reflect the adoption of mitigation practices by UK farmers. Roll-out of the new inventory is scheduled for 2015.

### **3. Incentives to reduce agricultural emissions – the policy framework**

In November 2012, Defra published its review<sup>2</sup> on progress towards reducing emissions from agriculture in England. The review represented the Government's long standing commitment to assess the current voluntary approach to reduce agricultural emissions in England. The main points from the review relate to:

- i. An assessment of the ambition to reduce emissions by 2022
- ii. The establishment of an indicator framework to monitor progress
- iii. Future review of progress

We now look at each of these in turn.

#### **i. An assessment of the ambition to reduce emissions by 2022**

Government analysis looked at the 3 MtCO<sub>2</sub>e level of ambition in England by 2022 and concluded that it continues to remain credible. Furthermore, in response to a CCC recommendation for an assessment of whether existing policies and incentives were sufficient to realise the level of ambition, Defra undertook a mapping exercise of seven policies and concluded that the existing policy landscape is encouraging the adoption of farming practices to deliver abatement (Box 6.1).

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<sup>2</sup> '2012 Review of Progress in Reducing Greenhouse Gas Emissions from English Agriculture', (2012), Defra.

## Box 6.1: New analysis and mapping of policies

### Analysis of abatement potential in agriculture

In its analysis of the abatement potential in England, Defra found:

- A maximum technical abatement potential of 3.9 MtCO<sub>2</sub>e using measures that represent cost savings to farmers.
- Using survey data and expert judgement on implementation rates, the review found that of the 3.9 MtCO<sub>2</sub>e of potential abatement, 0.6-0.8 MtCO<sub>2</sub>e had already been saved by 2010.
- Using the Farmscoper<sup>3</sup> tool and the Scottish Agricultural College (SAC) Marginal Abatement Cost Curve (MACC) an additional 3.1-3.3 MtCO<sub>2</sub>e of emissions savings were available at zero or negative cost in 2010.
- Defra noted that the maximum potential of 3.9 MtCO<sub>2</sub>e represents an overestimate of the actual potential due to a number of factors, including the failure of the Farmscoper model to consider overlaps between different methods and the assumption that all farmers implement all cost saving measures fully. Based on these uncertainties, Defra considered that 3 MtCO<sub>2</sub>e remained a more plausible level of ambition.

### Mapping of policies against farm practices

The exercise mapped seven policies deemed to have most relevance to agricultural production, against farming practices able to deliver reductions in emissions:

- The strength of each policy in driving a particular mitigation method was assessed, and the analysis found that the strongest drivers overall were Catchment Sensitive Farming (CSF), Soils for Profits<sup>4</sup>, the environmental stewardship schemes under the Common Agricultural Policy and the Nitrate Vulnerable Zones (NVZs). The remaining policies were found to be less successful in incentivising the type of farming practices that would reduce emissions (e.g. Soil Protection Review, Silage, Slurry and Agricultural Fuel Oil (SSAFO) Regulations).
- Collectively, these policies were found to be important in supporting the adoption of farming practices and technologies that had delivered 0.6-0.8 MtCO<sub>2</sub>e worth of cost savings by 2010.
- Looking ahead, Defra also concluded that the existing policy landscape was well placed to support Industry in its efforts to deliver savings of 3 MtCO<sub>2</sub>e by 2022.

## An assessment of the voluntary approach to deliver emissions savings by 2022

In its review of the voluntary approach (GHG Action Plan) to deliver 3 MtCO<sub>2</sub>e, Government reiterated its support for industry to take the lead, and for the progress it had achieved to date (Box 6.2). However, Government also stressed that there were certain areas in which Industry could do more:

- Seek more engagement from the rest of the supply chain (e.g. processors and supermarkets) to increase their support for on-farm reduction.
- *'... set out the specific success criteria for how its novel approaches will encourage change and where appropriate, link the selected delivery approach to its key on farm actions'*

Industry has plans in place take on board these recommendations. They have already established good links with the Waste & Resources Action Programme's (WRAP) supply chain Product Sustainability Forum, which will be used as a mechanism for sharing the messages of the GHG Action Plan to supply chain organisations. With regards to setting out success

<sup>3</sup> The Farm Scale Optimisation of Pollutant Emission Reduction (Farmscoper) decision support tool evaluates the impact of specific mitigation methods on a wide range of environmental pollutants.

<sup>4</sup> The Soils for Profit (S4P) project works with farmers to help them improve their management of soils, nutrients, and manures.

criteria, Industry plan to work with the Campaign for the Farmed Environment's Evidence and Monitoring group and Defra to identify the most suitable indicators of on-farm practice. However, Industry and Defra<sup>5</sup> have noted the difficulty of attributing changes in on-farm practices directly to the GHG Action Plan due to the wide variety of existing factors (both voluntary and regulatory) that exert influence on farmers. On this basis, while Industry considers the Plan will help support emissions reduction, it is less sure how it can gauge its performance. We consider, however, that it is important for Industry to put in place measures to monitor the effectiveness of the Plan in influencing the uptake of less carbon-intensive farming practices.

Further to the above recommendations, we recommend that consistent with the livestock road maps, targets should be set as to how the cereals and oilseeds sector will contribute to emissions reductions.

#### Box 6.2: The second phase (2012-15) of the GHG Action Plan

The main highlights from the first year of the second phase of the GHG Action Plan include:

- The GHG Action Plan joined other industry voluntary initiatives under the umbrella organisation of the Campaign for the Farmed Environment (CFE)<sup>6</sup>. This will enable the GHG Action Plan to benefit from the CFE's extensive communications links and access to the technical expertise of the Evidence and Monitoring group, which will be used to support work to evaluate and agree key indicators of activity and progress for the GHG Action Plan.
- The move has also enabled the GHG Action Plan to secure the services of a part-time co-ordinator to take its work forward. This will include the testing of the Farm-Efficiency Hub with external advisors, which if all goes well, is expected to be launched within the year. The hub is intended to be main source of approved guidance and information for farmers and their advisors.
- The Home Grown Cereals Authority (HGCA) published an environmental road map that sets out how the cereals and oilseeds sector could contribute to the GHG Action Plan. The road map identified four main areas for reducing emissions through improving efficiency of nitrogen use, increasing crop yields, using alternative sources of nitrogen and reducing on-farm energy use and fossil fuel dependency. We recommend that the sector follows the approach of the livestock roadmaps by setting out how it intends to achieve emissions reductions with the setting of targets against each of the main areas identified.
- Industry's 'Tried and Tested' nutrient management team launched a new guide and tool<sup>7</sup> to support improved feed efficiency of cattle and sheep. In addition to supporting emissions reductions, improving the efficiency of feed can deliver additional benefits of improved animal health and profitability. In the first instance, it is planned to distribute the Tried and Tested feeding plan to around 10,000 farmers on request, and promote the plan through the supply chain for beef and lamb products.
- In the absence of any standard for advisors of animal feed nutrition, the Feed Adviser Register (FAR) was launched last month and will enable advisors to demonstrate professional competence. To be registered, advisors with less than a year of experience will have to undertake 12 months of supervised work, while continued membership will require verification of core competencies. FAR is the feed industry's contribution to the GHG Action Plan and advice will deliver benefits in terms of production efficiencies and reduced emissions.

<sup>5</sup> Defra (2013), 'Review of Partnership Approaches for Farming and the Environment Policy Delivery'.

<sup>6</sup> The Campaign is supported by a wide partnership of organisations that recognise the importance of voluntarily managing the farmed environment.

<sup>7</sup> 'Feed planning for cattle and sheep' (2013).

## ii. The establishment of an indicator framework to monitor progress

In our 2012 Progress Report, we noted that the evidence base for assessing progress in reducing emissions remained incomplete, and as such a framework of indicators and supporting data on farming practice should be established as a matter of urgency.

Defra has now established a framework that that will capture ten indicators, against which progress to reduce emissions will be measured. The indicators cover three broad themes: farmers' attitudes, the adoption of mitigation measures and indicators to measure the GHG emission intensity of production (Table 6.1). According to Defra, the uptake of mitigation methods set out in the indicator framework had produced savings of 1.2 MtCO<sub>2</sub>e by early 2012. Progress will be monitored annually, and the first year of data will be published this July. We will look at the results for next year's progress report.

**Table 6.1: Defra Indicators to monitor progress in reducing agricultural emissions**

Overarching Indicators	Description
1. Attitudes and knowledge	This indicator aims to measure awareness of the sources of emissions and intentions to change practice. Seven attitudinal questions were asked in this year's Farm Practice Survey, which included the following: <ul style="list-style-type: none"> <li>• How important do you feel it is to consider GHGs when taking decisions about your farm?</li> <li>• To what extent do you agree that reducing your farm's GHG emissions will contribute to your overall profitability?</li> <li>• Where on your farm do you think GHGs come from?</li> </ul>
2. Uptake of mitigation measures	Uptake of mitigation measures across five activity groups is being monitored: <ul style="list-style-type: none"> <li>• Nutrition management</li> <li>• Livestock nutrition</li> <li>• Livestock breeding</li> <li>• Land and soil management</li> <li>• Plants with improved nitrogen use efficiency</li> </ul>
3. Soil nitrogen balance	The soil nitrogen balance provides a measure of the total loading of nitrogen (inorganic and organic) on agricultural soils. A surplus implies pollutant losses to the environment.
Sector specific Indicators	Description
4. Feed conversion ratio for pigs	A reduction in the feed conversion ratio (FCR) implies improving carbon intensity through feed efficiency. In the last 10 years Defra note that the FCR has increased.
5. Beef and sheep breeding regimes	This indicator will track the percentage of farms using bulls or rams with a high Estimated Breeding Value (EBV). The EBV is an estimate of the genetic merit an animal has for a measured trait or characteristic. A selection of useful traits can improve productivity and efficiency thereby implying improving carbon intensity.



**Table 6.1: Defra Indicators to monitor progress in reducing agricultural emissions**

6. Dairy cow feed production to milk production	Increasing milk yields by a larger rate than an increase in feed input (dry matter) implies an improvement in feed efficiency and therefore a reduction in carbon intensity. However, as Defra points out the indicator requires further improvement as the quantity of dry matter feed produced will be determined by changes in the availability of other feeds such as on-farm feed and forage grass.
7. Feed conversion ratio for poultry	The quantity of poultry feed produced per kg of poultry meat (dressed carcase weight) is a proxy for carbon intensity. In the last ten years, the FCR has increased slightly implying a worsening of carbon intensity.
8. Cereals and other crops – manufactured fertiliser application	Increased use of nitrogen fertiliser (as measured here by the ratio of the weight of crops produced to the weight of the manufactured fertiliser applied) implies a reduction in carbon intensity. To avoid year-on-year fluctuations arising from random events (e.g. bad weather), the indicator will be based on a five-year moving average. The indicator will track five cereal crops (wheat, winter barley, spring barley, winter oil seed rape and sugar beet).
9. Slurry and manure	This indicator will track up-take of five measures that can minimise emissions through improving the handling and storage of manure and slurry. These include the installation of covers to slurry stores and the use of liquid/solid manure separation techniques.
10. Organic fertiliser application	This indicator will track up-take of five practices that can minimise emission from the use of organic fertiliser. These include the use of slurry injection application techniques and use of a manure spreader calibration.

Source: Defra.

### iii. Future review of progress and new policy options

Defra has stated that it will not commit to a further review of progress until 2016 at the earliest, by which time it will be able to take stock of the new agricultural inventory and the completion of the second phase (2012-2015) of the GHG Action Plan. However, we support the intention to bring forward a review in the event that its indicators suggest that there is insufficient progress being made. On the basis of an improved evidence base, we also suggest that Defra widen the scope of any review to consider a range of policy options, including continuing with the current voluntary approach and policies which would provide stronger incentives for farmers. To date Defra has stated that it will not specify targets or trigger points for policy intervention.

## 4. Land use, land use change and forestry

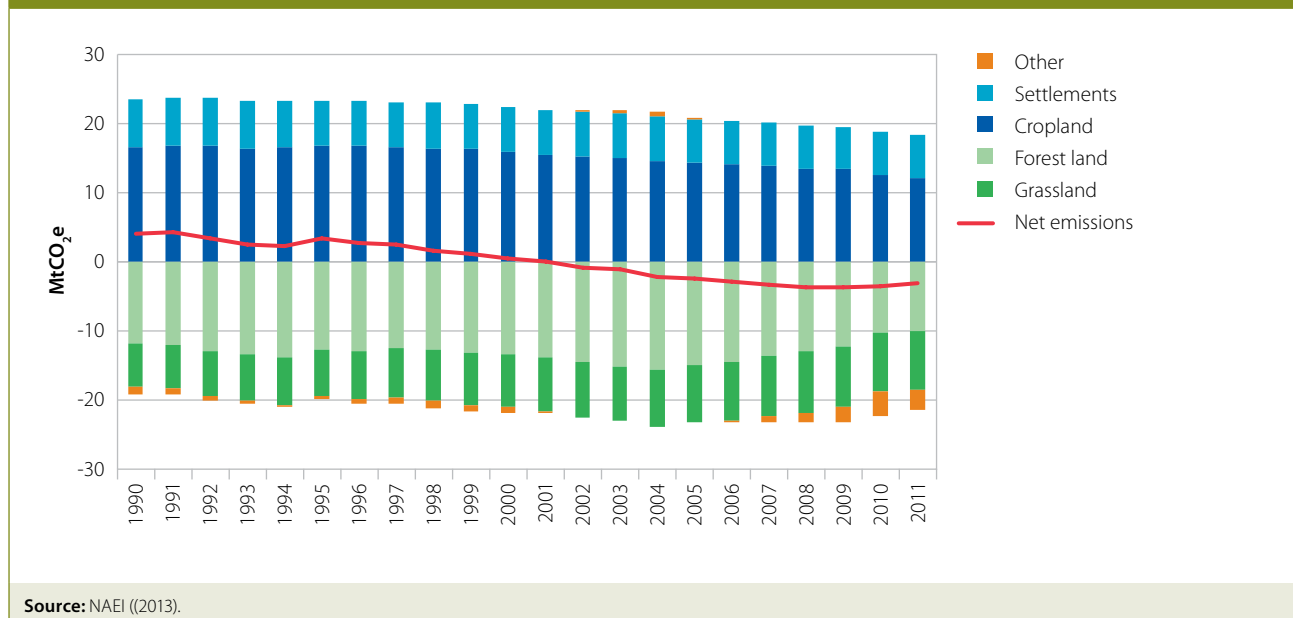
### Emissions trends

The Land use, land use change and forestry (LULUCF) sector continued to be a net carbon sink, absorbing 3.3 MtCO<sub>2</sub>e more than was emitted in 2011 (Figure 6.14). However, a 3% decline in the amount of carbon sequestered meant that for the second successive year net emissions increased, up 10% in 2011:

- Forestry is the single largest source of sequestration, accounting for just under half of the carbon absorbed in 2011. Grasslands accounted for a further 39% of sequestration. For both land types, net carbon absorbed declined in 2011 compared to the previous year.
- Over 60% of LULUCF emissions arise from cropland, but in 2011 levels declined by 4.1% driven by the reduction in emissions from land converted to cropland. The other significant source of net emissions is settlements, which produced a 1% increase in emissions due to the conversion of more land to settlements.

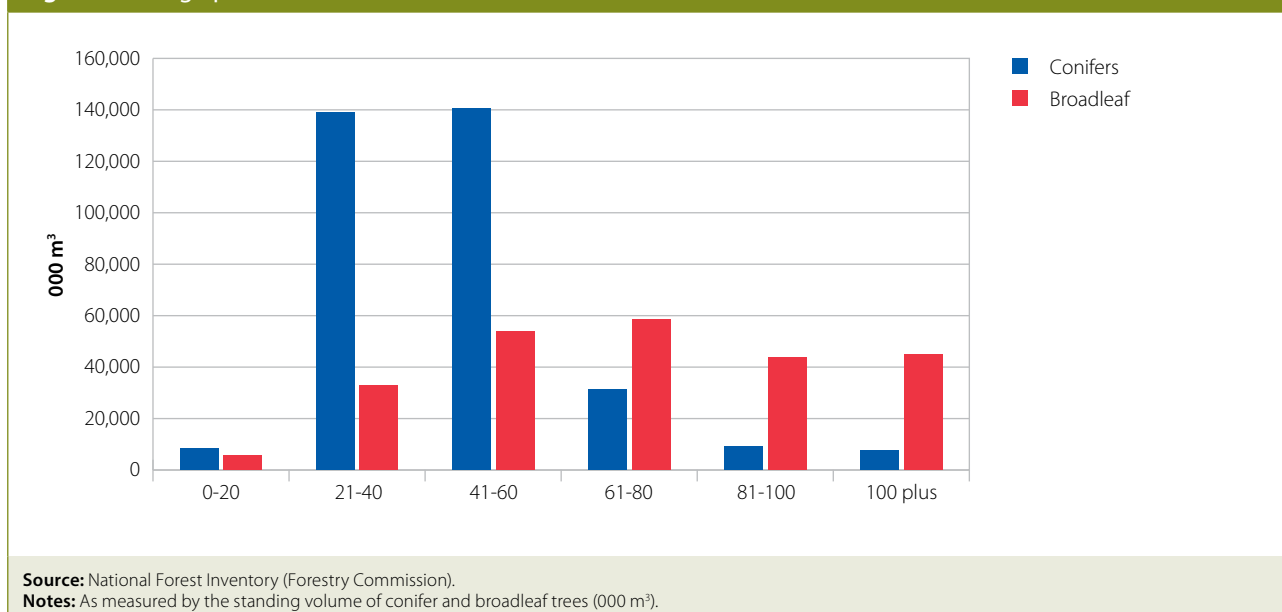
The increase in net emissions is due to the declining ability of existing forestry to absorb carbon due to the sharp fall in tree planting rates at the beginning of the 1990s. This is reflected in the age distribution of the standing volume of conifers and broadleaves, with only around 2% of the total volume less than 20 years of age (Figure 6.15). According to projections by DECC and the Centre for Ecology and Hydrology, under the worst case scenario, the LULUCF sector could become a net carbon emitter as early as 2013.

Figure 6.14: LULUCF emissions/removals (1990-2011)



Source: NAEI ((2013).

Figure 6.15: Age profile of GB woodland



## Opportunities to reduce land use emissions

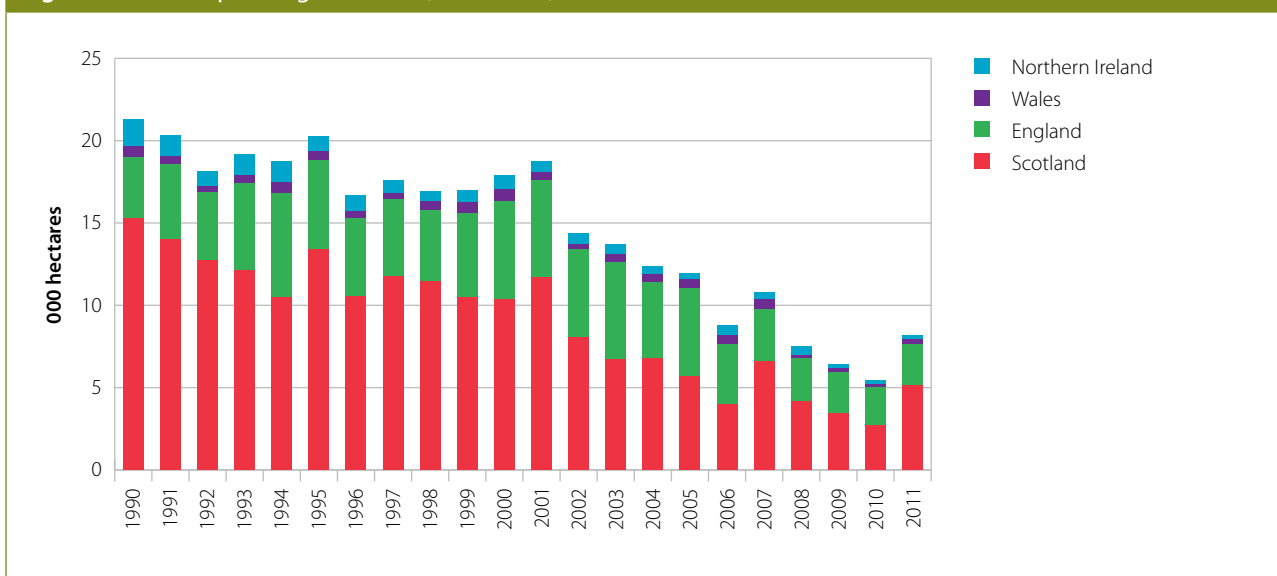
There is a range of options that can be employed to increase carbon sequestration and reduce the release of emissions in the LULUCF sector. This includes the expansion of woodland cover.

### Forestry

Woodland accounts for only 13% of the total UK land area, well below the EU average of 44%. On this basis, we reiterated in last year's progress report our recommendation first made in the Fourth Carbon Budget report, for an increase in UK tree-planting rates, equivalent to 10,000 hectares a year by 2030. Since then:

- In July 2012, the Independent Panel on Forestry, which was set up by Defra to look at the future direction of forestry and woodland policy in England, published its recommendations. With regards to expanding woodland area, the panel recommended Government commit to an ambition to increase woodland cover from 10% to 15% by 2060. This would entail a planting rate of 15,000 hectares a year.
- The panel's recommendation was based on a limited economic assessment and was deemed unsustainable by Defra and the Forestry Commission. Defra subsequently set a lower level of ambition of 12% by 2060, which equates to an annual average of 5,000 hectares. The ambition is contingent on private investment taking the lead and Government assuming an enabling role (e.g. developing new ways of encouraging growth and removing barriers).

**Figure 6.16: New planting in the UK (1990-2011)**



**Source:** Forestry Commission, Forest Service, grant schemes.

**Notes:** 1. Non-FC/FS figures are based on areas for which grants were paid during the year. Estimate of areas planted without grant aid are also included (where possible), although non-grant aided planting may be under-represented in the figures. Figures for grant-aided planting under Rural Development Contracts in Scotland relate to calendar years. 2. The planting season lies both sides of 31 March, and the weather can cause planting to be advanced or delayed. 3. Includes natural colonisation.

- Forestry is a devolved matter, and elsewhere targets have also been set to increase woodland area, although results to date have been mixed:
  - **Scotland:** a rural development scheme<sup>8</sup> to fund the ambition for an additional 100,000 hectares between 2012 and 2022 has already delivered positive results with planting rates nearly doubling in 2011 compared to the previous year. This accounted for most of the 50% increase in UK planting in the same year (Figure 6.16).
  - **Wales:** in our 2013 report on progress in reducing emissions in Wales<sup>9</sup>, we noted that Wales was still some way off from the 3,000 ha/year (2010-30) target, with levels reaching only 300 hectares in 2011.
  - **Northern Ireland:** with a target to double woodland cover to 12% by 2056, planting rates will have to increase to 1,700 ha/year, which is well above current rates of around 300 hectares.

If all these targets are met, they would be close to meeting the CCC recommendation for 2030. Therefore England, Wales and Northern Ireland should look to mirror the achievements made in Scotland by progressing plans to meet their own targets. We will continue to monitor progress in next year's progress report.

<sup>8</sup> The Woodland Creation Grant.

<sup>9</sup> CCC (2013) *Progress on reducing emissions and preparing for climate change in Wales*.

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## Key findings

- Agriculture emissions **remained unchanged** from 2010 at 51.2 MtCO<sub>2</sub>e, but given reductions in previous years, agriculture remains **on track** to broadly meet its contribution to meeting the first carbon budget.
- While an increase in inorganic fertiliser use on arable land contributed to a **worsening carbon intensity** of crops, a reduction in fertiliser use on grasslands supported an **improvement** in the carbon intensity of livestock products.
- We welcome the publication of Defra's indicator framework to monitor progress in reducing emissions. The indicators should be kept under review to ensure they remain **comprehensive and relevant**.
- Consistent with the livestock road maps, **targets should be set** as to how the cereals and oilseeds sector will contribute to emissions reductions.
- Industry should set out plans to assess the effectiveness of the Industry Action Plan to **provide confidence** that the voluntary approach is influencing farming practices and achieving emissions reductions.
- If needed, a review should be implemented before the planned 2016 date, and the Government should consider a range of policies that would provide **stronger incentives** for farmers.

Table 6.1: The Committee's agriculture indicators

AGRICULTURE		Budget 1	Budget 2	Budget 3	2011 trajectory	2011 outturn
Headline indicators						
Emissions (indicative % change from 2007 reflecting LCTP ambition scaled to UK)						
CO <sub>2</sub> e emissions		-3%	-6%	-9%	-2.5%	-2.2%
GHG emissions (% change in tCO <sub>2</sub> e against 2007)	N <sub>2</sub> O	-1%	-3%	-4%	-1.1%	-1.0%
	CH <sub>4</sub>	-6%	-12%	-18%	-4.7%	-4.1%
	CO <sub>2</sub> *	n/a	n/a	n/a	n/a	n/a
Source emissions (% change in tCO <sub>2</sub> e against 2007)	Soils	-1%	-3%	-4%	-1.2%	-0.8%
	Enteric fermentation	-5%	-10%	-15%	-4.0%	-4.2%
	Animal waste	-7%	-13%	-20%	-5.4%	-5.5%
	Machinery/fuels*	n/a	n/a	n/a	n/a	n/a
<b>Drivers**</b>						
tN <sub>2</sub> O emissions per thousand hectares of arable and managed pasture	2007 = 2.23	2.20	2.17	2.14	2.21	2.22
tCH <sub>4</sub> emissions per tonne of cattle and calf meat, dressed carcase weight	2007 = 9.06	8.60	8.14	7.69	9.06	8.84
tCH <sub>4</sub> emissions per thousand litres of milk	2007 = 0.41	0.40	0.39	0.36	0.34	0.40
tCH <sub>4</sub> emissions per tonne of sheep and lamb meat, dressed carcase weight	2007 = 11.23	10.42	9.62	8.81	10.75	10.41
tCH <sub>4</sub> emissions per tonne of pig meat, dressed carcase weight	2007 = 1.12	1.06	1.00	0.95	1.08	0.92
tCH <sub>4</sub> emissions per tonne of poultry, dressed carcase weight	2007 = 0.18	0.17	0.16	0.15	0.18	0.17

Table 6.1: The Committee's agriculture indicators					
AGRICULTURE	Budget 1	Budget 2	Budget 3	2011 trajectory	2011 outturn
<b>Supporting indicators</b>					
<b>Farming Practice</b>					
<b>Measures where greater confidence exists (e.g. proven technology, considered best practice, consistent abatement results) but uncertainty about baseline use.</b>					
Nutrient management – including improved mineral and organic N timing, separating slurry and mineral N, using composts, and making full allowance for manure N	% of hectares where measures are in place	Better evidence about current farming practice is required to develop full trajectories.			
Livestock management – including breeding for fertility and productivity	% of livestock of different production/fertility efficiency	Better evidence about current farming practice is required to develop full trajectories.			
Manure management	% of manure/slurry stored in covered tanks or lagoons	Better evidence about current farming practice is required to develop full trajectories.			
Anaerobic Digestion	Installed AD capacity using manures (MW)***	31	68	102	Less than 1% of holdings have AD (2011)
<b>Measures that require further evidence to establish appropriateness and effectiveness in UK and in regional contexts</b>					
Soil management (reduced tillage/drainage), nitrification inhibitors, and using more N-efficient plants (species introduction and improved N-use plants)	% of hectares where measures are in place	Not suitable for all hectares. Requires development of evidence base to resolve possible conflicts with other goals and to determine applicability, GHG benefits and costs under different conditions.			
Livestock management (including maize silage and dietary additives in form of propionate precursors or ionophores)	% of livestock consuming different diets and feed additives	Not suitable for all animals/farms. We will monitor the development of the evidence base around these measures, including applicability, net GHG benefits and resolution of possible conflicts with other sector goals.			
<b>Policy Milestones</b>					
Phase 2 delivery of GHG AP: • Roll-out of industry information hub • Establish baseline farming practice and framework to monitor progress		2013-14			Hub to be tested by external advisors 2013 On-going
Government policy review on voluntary approach (2012): • Development of policy options for intervention • Set triggers for intervention		End 2012 End 2012			Review decided not to set triggers nor consider policy options
On-going monitoring of voluntary approach: • Bring forward 2016 Review if progress off-track • Review should consider policy options for intervention		2013-2015			On-going

**Table 6.1: The Committee's agriculture indicators**

AGRICULTURE	Budget 1	Budget 2	Budget 3	2011 trajectory	2011 outturn
Development of smart inventory	Set milestones for delivery	2014 (1st phase)			Projects underway
<b>Other drivers</b>					
Crops/soils: Crop yields (e.g. cereals), cropping areas, N <sub>2</sub> O emissions per hectare of cultivated land, N <sub>2</sub> O emissions per unit of fertiliser use, output of product per unit of fertiliser use.					
Livestock: tCH <sub>4</sub> /tonne dressed carcase weight (cattle & calves), weight of carcase produced per day of age, calves produced per cow per year.					
General: We will monitor development of the evidence base and R&D support for the various mitigation measures. We will also track upcoming CAP reform negotiations (to be complete by 2014) and implications for farming practice and emissions.					
<b>LAND USE, LAND USE CHANGE AND FORESTRY</b>					
<b>Headline indicator</b>					
<b>Emissions (annual savings from carbon sequestration by 2030)</b>					
CO <sub>2</sub> sequestered					1 MtCO <sub>2</sub> e
<b>Supporting indicators</b>					
UK woodland planting					At least 21,000 hectares/year from 2015
<b>Policy Milestones</b>					
Development and implementation of a woodland creation programme					Government has set ambition for England of average rate of 5,000ha/year by 2060

\* CO<sub>2</sub> abatement potential not factored into first three budget periods.

\*\* Broadly consistent with LCTP ambition and industry roadmaps. UK Inventory at present will not fully capture reductions in emissions as a result of uptake of particular measures. Intensity indicators for budget periods assume constant output. Should output exceed assumed levels then lower intensities would be needed to deliver absolute emissions reduction.

\*\*\* Handling beef, dairy and pig manures and slurries.

\*\*\*\* 2007 baseline = 10.7 thousand hectares. Source: Forestry statistics 2010, figure 1.4.

**Note:** Numbers indicate amount in last year of budget period i.e. 2012, 2017, 2022.

**Key:** ■ Headline indicators ■ Implementation indicators ■ Milestones ■ Other drivers