Agricultural Statistics and Climate Change

3rd Edition
July 2012

defra
Department for Environment
Food and Rural Affairs

Contents

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National Statistics

The following statistics are “National Statistics” (official statistics that comply with the National Statistics code of practice).

Section 1: Emissions from agriculture

1.1, 1.2, 1.3, 1.4

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2.5 (excluding age at which cattle under 4 years are slaughtered, longevity and fertility and animal health)
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The underlying data used for the exploratory analysis in this section are from the Farm Business Survey which is categorised as National Statistics.

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No data in this section are National Statistics

Further information on National Statistics can be found on the UK Statistics Authority website.

http://www.statisticsauthority.gov.uk/

Introduction

This is the third edition of Agricultural Statistics and Climate Change. Previous editions were published in December and July 2011. This edition includes the latest results from the 2012 Farm Practices Survey and the 2011 British Survey of Fertiliser Practice. Other charts and tables have also been updated where new data are available.

In line with the requirements set out in the Climate Change Act 2008 and as part of international obligations, the UK Government is committed to adopting policies that will reduce greenhouse gas (GHG) emissions across the economy by at least 80%, from 1990 levels, by 2050. Agriculture will need to play its part in this reduction, but is more complex than other sectors in that action to reduce GHG emissions has to be considered in the context of long-term policy debates around food security, land use and natural resources. A decline in agricultural activity in the UK may well lead to a decline in domestic GHG emissions (and vice versa), but such activity is also driven by a complex interaction of subsidies, regulation, and international markets, as well as by producer, retailer and consumer preferences. As in other sectors, it would not make sense to drive down emissions from UK agriculture by relying more on the import of products that are at least as GHG intensive: this would effectively export the emission effect of food consumption, causing “carbon leakage”.

However, there are measures that farmers can adopt now that would drive down greenhouse gas emissions at minimal or no extra cost. The Government believes that it is right for the agricultural industry to take responsibility for reducing its emissions and, rather than resort to regulation, has encouraged an industry partnership to lead in tackling the challenge. The Agriculture Industry GHG Action Plan: Framework for Action (published in February 2010) outlined how reductions could be made through more resource-efficiency, generally involving simple changes in farming practice. The industry partnership published a Delivery Plan in April 2011[1], setting out how it will begin to implement the Action Plan and the first annual progress report was produced in April 2012[2]. This draws together information on the knowledge transfer and other activities undertaken by the partners responsible for delivering the action plan and also includes initial proposals for a next stage of delivery against the industry’s target.

The individual sector-bodies are also taking action to drive down emissions through environmental product roadmaps[3]. The Dairy, Beef and Lamb, and Pig meat product roadmaps all encourage farmers to employ better management techniques and farming practices.

During 2012, Defra has been carrying out a review of progress in reducing GHG emissions from agriculture, in consultation with a range of interested organisations. The review goes beyond an assessment of the industry-led action plan to consider the impact of other policies on the uptake of farm practices that may help to reduce GHG emissions. It is due to conclude in the Autumn. A paper explaining the scope of the review and summarising the work done in the first six months is available via the Defra website at: http://www.defra.gov.uk/environment/climate/sectors/agriculture/

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[1] Meeting the Challenge: Agricultural Industry GHG Action Plan – Delivery of Phase I: 2012 – 2012’ was published on 4 April 2011, by the Industry Delivery Partners Group
[2] http://www.nfuonline.com/Our-work/Environment/Climate-change/GHGAP-report-April-2012
[3] Testing the Water - The English Beef and Sheep Environmental Roadmap
http://www.eblex.org.uk/publications/corporate.aspx
Dairy Roadmap - our route towards environmental success, DairyCo. 9 May 2011
http://www.dairyco.net/news/press-releases/may-2011/dairy-industry-on-route-to-environmental-success.aspx
Advancing together - a roadmap for the English Pig industry - The British Pig Executive (BPEX). 27 April 2011
http://www.bpex.org.uk/environment-hub/climate-change/PigIndustryRoadmap.aspx

To support the industry's efforts, the Government funded a year long pilot project to trial different methods of delivering integrated environmental advice (including on how to reduce GHG greenhouse gas emissions) to farmers, with the aim that this will eventually lead to more widespread delivery of practical advice. The Integrated Pilot Project final report was published on Defra's Science and Research website – see project FF0204 at http://randd.defra.gov.uk/

Advice provision remains important to improve farm practices and one of the key actions in Defra's Business Plan (May 2012) is to "*publish plans for a streamlined framework of advice, incentives and voluntary initiatives to enable farmers and land managers to be more competitive and yield better environmental results*". This work is being taken forward in the context of commitments made in the Natural Environment White Paper (published June 2011), and Defra is reviewing how advice and incentives for farmers and land managers are used, with an aim of creating a more integrated, streamlined and efficient approach that is clear and which yields better environmental results.

As part of this work, there are plans in place to establish prioritised environmental messages and assess the effectiveness of voluntary and industry-led approaches, such as the GHG Action Plan. Voluntary and industry led approaches are key to delivery, and Defra will be looking to identify examples of best practice which can be used to encourage both effective environmental outcomes and efficient farm businesses.

The Government continues to carry out work to improve the science base: in partnership with the Devolved Administrations, the Government is investing £12.6 million, over a four and half year period, to strengthen our understanding of on farm emissions. When complete, this work to develop the UK agricultural GHG inventory should enable greater precision in reporting GHG emissions from the sector, so that positive changes made to farming practices to reduce GHG emissions will be properly recognised in the inventory.

Purpose of this publication

This publication brings together existing statistics on agriculture in order to help inform the understanding of agriculture and GHG emissions. It summarises available statistics that relate directly and indirectly to emissions and includes statistics on farmer attitudes to climate change mitigation and uptake of mitigation measures. It also incorporates statistics emerging from developing research and provides some international comparisons. For a more detailed overview please see the Summary section.

Updates

It is planned to update this third edition of Agricultural Statistics and Climate Change in 2013.

Data Sources

Data sources are shown on charts/referenced in footnotes. The Appendix gives links to methodology details of the original data sources and also confidence intervals for data in Section 3.

Geographic coverage

Climate change mitigation in agriculture is a devolved issue, and Defra has policy responsibility for England. This publication aims to provide measures based on England, however this is not always possible and in some instances measures are GB or UK based.

Comparisons over time

Data series are shown from 1990 onwards. In some instances comparable data is not available from 1990, and in these cases the closest available year is shown. In summarising the data 'long term' and 'short term' comparisons are made[4].

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[4] Here, long term refers to comparisons back to 1990 or the closest year, and short term refers to changes within the last 5 years.

Summary

The diagram at Figure 1 illustrates a framework covering all the statistics within this publication and explains how they interconnect.

Table 1 provides a summary of the statistics structured around this framework. Symbols have been used to provide an indication of what the measures mean for GHG intensity (GHGs emitted per litre of milk or tonne of crop or kilogramme of meat produced). However, it is important to note that the choice of symbol reflects only those statistics immediately available and assumes all other things are equal. These statistics do not therefore provide a complete explanation of intensity: the main gaps are outlined under 'further developments'.

clear improvement	✓	little or no change	≈
clear deterioration	✗	insufficient or no comparable data	. . .

Table 1: Summary

Recorded Emissions
The methodology to derive agricultural sector emissions is predominantly based on the number of livestock animals and the amount of nitrogen based fertiliser applied. There are a variety of important factors which influence emissions which are not captured in the current methodology, and research is underway to better reflect the position which will be delivered in 2015. This limitation needs to be considered when interpreting agriculture's contribution to total emissions and changes over time.

- In 2010, agriculture was the source of 9% of total greenhouse gas emissions (GHG) in the UK, 80% of nitrous oxide emissions, and 44% of methane emissions.
- From 1990 to 2010, nitrous oxide emissions and methane emissions both fell by 20%.
- Since 1990 the numbers of cattle and sheep in the UK have fallen significantly (by 2.2 million and 12.8 million respectively) and this explains the majority of the fall in recorded methane emissions.
- Since 1990 the overall application rate for nitrogen fertiliser has also fallen substantially (for GB, all crops and grass, from 138kg/ha in 1990 to101kg/ha in 2011), and this explains the majority of the fall in nitrous oxide emissions. The estimates of soil nitrogen balances show an overall decline over the last 20 years and this will be associated with a lower risk of all forms of nitrogen loss to the environment.

The following summary is based on national level statistics given in this publication (details of exact geography for intermediate outcomes are given in Section 2). Gaps in the statistics are noted under 'further developments'.

Intermediate outcomes relating to GHG intensity (intensity = GHG emitted per litre of milk or tonne of crop or kilogramme of meat produced)

		Long term[5]	Short term
Total factor productivity of agriculture, UK:		✓	≈ (since 2009)
Comments	*Total Factor Productivity provides an aggregate picture of the efficiency by which the industry turns inputs into outputs, although is not a measure of GHG intensity. Productivity has improved over the longer term; provisional figures for 2011 show a small increase compared to 2010.*		
Dairy - national level statistics indicate the following changes in GHG intensity:		≈ (since 1992)	✓ (since 2008)
Comments	*The ratio of milk produced to compound and blend feed production provides a proxy measure for the emissions intensity of the dairy sector. This measure has not changed since 1992 levels, fell from 2005 to 2008 following a rise in the mid 90s, and is little changed from 2008 to 2011. Information from the BCMS Cattle Tracing System does not show any significant change in longevity or fertility over the last 5 years, although on-farm mortality for calves has fallen overall since 2007. This suggests that, all other things being equal, the overall improvement in mortality may have provided a reduction in the intensity of emissions in the shorter term.*		
Further developments	Understanding of GHG intensity would be improved by more information on: calving interval; age at first calving; lactation number; liveweight; further information on feed and grazing.		
Beef - national level statistics indicate the following changes in GHG intensity:		...	✓(since 2006)
Comments	*Since 1990 average carcase weights have increased. There is little evidence of a departure in these trends in recent years. At the same time, the age at which animals are being slaughtered has been at a similar level. This suggests that, all other things being equal, the intensity of GHG emissions has improved. The median age of the beef herd is little changed since pre BSE and FMD restrictions, although overall longevity has increased due to changes in the overall distribution of age of cattle, illustrated through changes in the inter quartile range. For beef cattle age 6 months and above there has been little change in on-farm mortality since 2002. Although there have been fluctuations in on-farm mortality risk of beef calves (<6 months) there has been an overall decrease since 2006. The figures suggest that, all things being equal, the overall improvement in mortality and increase in longevity will have provided a reduction in the intensity of emissions in the short term.*		
Further developments	Understanding of GHG intensity would be improved by more information on: Calving interval; age at first calving; farming system; age and weight at slaughter; fat score; feed and grazing.		
Sheep - national level statistics indicate the following changes in GHG intensity:		✓	✓(since 2005)
Comments	*Overall carcase weights for lambs have increased since 1990, and this has occurred across the year, suggesting that lambs are not being slaughtered older, but are being finished at greater weights. Longevity and fertility of the ewe flock has improved since 2005 (based on the surviving lamb percentage) and is currently above 1990 levels. Together these factors suggest that there will have been a reduction in the intensity of emissions from this sector both in the short and longer term.*		
Further developments	Understanding of GHG intensity would be improved by more information on: inputs; age at which lambs are slaughtered; longevity of the breeding flock; measures of animal health		

[5] Unless otherwise stated long term trend data measured from 1990.

Intermediate outcomes relating to GHG intensity (intensity = GHG emitted per litre of milk, kg of grain, kg of meat produced) continued			
		Long term[4]	Short term
Pigs - national level statistics indicate the following changes in GHG intensity:		✗	≈ (since 2009)
Comments	*Carcase weights have increased consistently since 1990, though data on feed conversion ratios suggest that this increase has been achieved by proportionally more feed, which may have increased emissions intensity. Sow fertility and post weaning mortality have shown improvements over the last 5 years, both have a desirable impact on the intensity of emissions. Pre weaning mortality remains high, and is little changed since 2006, which is when data are available from.*		
Further developments	Understanding of GHG intensity would be improved by more information on: Further productivity measures (rearing feed conversion ratio , average live weight and feed per sow)		
Poultry - national level statistics indicate the following changes in GHG intensity:		. . .	. . . (since 2006)
Comments	*Defra has limited information from national level datasets for the poultry sector. From information which is available the underlying trend in feed conversion for 'table birds' has increased marginally since 2001, however, these changes are well within the year on year changes.*		
Further developments	*Understanding of GHG intensity would be improved by more information on: Information on housing type and system*		
Cereals - national level statistics indicate the following changes in GHG intensity:		✓	≈ (since 2009)
Comments	*The GHG intensity of cereal production has reduced significantly over the last 20 years, through improved yields for similar amounts of nitrogen based fertiliser. Average application rates increased slightly in 2010 (following lower usage in the previous couple of years) and 2011 rates have remained at a similar level. It is likely that the low application rates in 2008 and 2009 were in response to higher fertiliser prices. Data on organic manures, specifically slurry, suggest there could be scope to reduce emission intensity further by adopting alternatives to broadcast application which currently the most widespread practice.*		
Further developments	Information on nitrogen use for other crops including fodder crops, hay and maize; consider location and weather on the impact of emissions; separate nitrogen balances for arable and livestock.		

Uptake of mitigation measures		
		Current level[6]
Nutrient management	**Farms with nutrient management plans**	
	Cereal farms	87% (2012)
	General cropping farms	82% (2012)
	Percentage of farms which 'regularly' test nutrient content of soil (at least every 5 years)	
	Cereal farms	96% (2012)
	General cropping farms	93% (2012)
	Percentage of farms which 'regularly' test pH of soil (at least every 5 years)	
	Cereal farms	96% (2012)
	General cropping farms	96% (2012)

[5]Unless otherwise stated long term trend data measured from 1990.

[6]The small sample size in the 2012 Farm Practices Survey means it is hard to infer significance in the trends between 2011 and 2012 at the disaggregated level shown. A comparison of the 2 years, shown with the confidence intervals, can be found at: http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-environ-fps-fps2012dataset-120607.xls

Uptake of mitigation measures continued		
		Current level[6]
Nutrient management	**Percentage of farms with a manure management plan**	
	Cereal	78% (2012)
	General cropping	82% (2012)
	Pigs and poultry	75% (2012)
	Dairy	90% (2012)
	Grazing livestock (LFA)	66% (2012)
	Grazing livestock (lowland)	65% (2012)
	Proportion of farms who regularly test the nutrient content of manure (at least every 5 years)	
	Cereals	33% (2012)
	General cropping	44% (2012)
	Pigs and poultry	44% (2012)
	Dairy	30% (2012)
	Grazing livestock (LFA)	7% (2012)
	Grazing livestock (Lowland)	10% (2012)
	Timing of fertiliser application: percentage of nitrogen applied in Feb and March (results from the British Survey of Fertiliser Practice, GB)	
		37% (2011) 9% percentage point increase on 2010
	Percentage of farms which check and calibrate the spread pattern of their fertiliser spreaders at least annually.	
	Cereal farms	89% (2012)
	General cropping farms	89% (2012)
	Percentage of farms which check and correct the rate of fertiliser for the fertiliser type at least annually.	
	Cereal farms	97% (2012)
	General cropping farms	95% (2012)

[6] The smaller sample size in the 2012 Farm Practices Survey means that the confidence intervals are very wide making it is hard to infer significance in the trends between 2011 and 2012 at the disaggregated level shown. A comparison of the 2 years, shown with the confidence intervals, can be found at:
http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-environ-fps-fps2012dataset-120607.xls

Uptake of mitigation measures continued		
		Current level[6]
Livestock	**Percentage of farms which "always" use a ration formulation programme or nutritional advice from an expert when planning the feeding regime of their livestock**	
	Dairy	59% (2012)
	Grazing livestock (LFA)	10% (2012)
	Grazing livestock (lowland)	17% (2012)
	Dairy breeding: percentage of farms which 'always' use bulls with high Profitable Lifetime Index	30% (2012)
	Beef breeding: percentage of farms which "always" use bulls with high Estimated Breeding Value	
	Grazing livestock (LFA)	17% (2012)
	Grazing livestock (lowland)	26% (2012)
	Lamb breeding: percentage of farms which "always" use rams with high Estimated Breeding Value	
	Grazing livestock (LFA)	11% (2012)
	Grazing livestock (lowland)	19% (2012)
	Percentage of farms with more than 80% of their temporary grassland planted with clover mix	
	Dairy	34% (2012)
	Grazing livestock (LFA)	47% (2012)
	Grazing livestock (lowland)	47% (2012)
	Percentage of farms with more than 80% of their temporary grassland planted with a high sugar grasses	
	Dairy	30% (2012)
	Grazing livestock (LFA)	8% (2012)
	Grazing livestock (lowland)	27% (2012)
	Percentage of livestock farms with a Farm Health Plan	77% (2012)

[6] The small sample size in the 2012 Farm Practices Survey means that the confidence intervals are very wide making it is hard to infer significance in the trends between 2011 and 2012 at the disaggregated level shown. A comparison of the 2 years, shown with the confidence intervals, can be found at:
http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-environ-fps-fps2012dataset-120607.xls

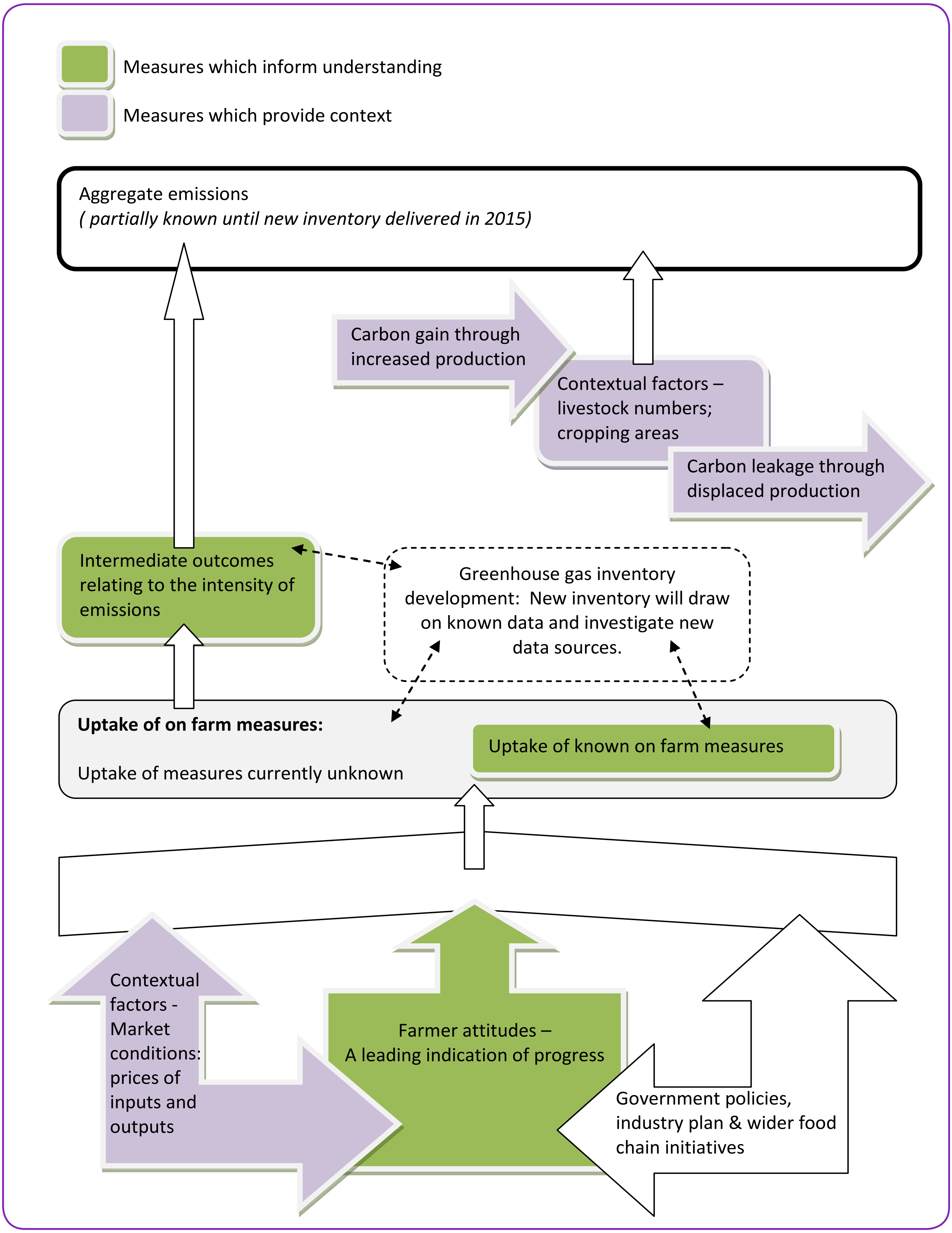
Uptake of mitigation measures continued		
		Current level[6]
Manure and Slurry storage	**Percentage of livestock farms (with facilities to store slurry) with a slurry separator**	8% (2012)
	Percentage of farms with covered slurry stores (for holdings with livestock)	
	Slurry stored in a tank	12% (2012)
	Slurry stored in a lagoon	0% (2012)
	Slurry in another type of store	19% (2012)
Anaerobic Digestion[7]	**Percentage of farms which process slurries for anaerobic digestion in England**	
	Cereals	0.3% (2012)
	Dairy	0% (2012)
	Percentage of farms which process other feedstocks for Anaerobic Digestion in England	
	Cereals	0% (2012)
	Dairy	0.4% (2012)

Farmers attitudes and views		
	Current level	**Changes**
Percentage of farmers claiming to take action to mitigate climate change (results from Farming Futures Survey, England).	53% (2011)	5 percentage points increase on 2010
Percentage of farmers wanting to measure their carbon footprint (results from Farming Futures Survey, England).	34% (2011)	No statistically significant change since 2010.
Understanding of emissions from agriculture – percentage of farmers highlighting nitrous oxide as a greenhouse gas (results from AC0222, England).	12% (2010)	Not available in 2011

[6] The small sample size in the 2012 Farm Practices Survey means that the confidence intervals are very wide making it is hard to infer significance in the trends between 2011 and 2012 at the disaggregated level shown. A comparison of the 2 years, shown with the confidence intervals, can be found at:
http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-environ-fps-fps2012dataset-120607.xls

[7] More information on the uptake of AD by farm type is given in the Farm Practice Survey statistical notice at
http://www.defra.gov.uk/statistics/foodfarm/enviro/farmpractice/

Figure 1: A framework for monitoring progress



Section 1 Emissions from agriculture

UK agricultural recorded sector emissions

For the UK, between 1990 and 2010:

- Total greenhouse gas emissions from agriculture are estimated to have fallen by 20% to 50.7 million tonnes CO_2 equivalent[8] in 2010.
- Emissions of methane reduced by 20% to 18 million tonnes CO_2 equivalent.
- Emissions of nitrous oxide reduced by 20% to 28.6 million tonnes CO_2 equivalent.
- Emissions of carbon dioxide reduced by 21% to 4.1 million tonnes CO_2 equivalent.

Drivers of emissions

Drivers of **recorded** sector emissions: The methodology currently used to report agricultural sector emissions is predominantly based on the number of livestock animals and the amount of nitrogen based fertiliser applied. A variety of important factors influence emissions which are not captured in the current methodology (see "Other drivers of emissions" below for details); research[9] is underway to better reflect the position. The results of this research will be incorporated into an upgraded greenhouse gas inventory for agriculture to be delivered in 2015.

Other drivers of emissions: There are other factors which are not captured in recorded emissions, but which are likely to affect the true level of emissions. For example, some areas of farming practice will have an impact, e.g. timing of fertiliser application, efficiency of fertiliser use, feed conversion ratios, genetic improvements. Some of these relate to efficiency: there have been productivity gains in the sector, through more efficient use of inputs over the last twenty years and some of these gains will have had a positive impact, though some may have had a negative impact on emissions. Soil moisture and pH are also highly important to soil emissions. On a national basis these drivers are expected to have a subtle, but significant impact, rather than a dramatic impact on the true level of emissions over the period. On a regional basis, the drivers of soil emissions are likely to have a more dramatic impact for some land use types.

[8] Carbon dioxide (CO_2) equivalents use CO_2 as a standard unit for reference allowing comparison of emissions from various greenhouse gases. They show the amount of carbon dioxide that would give the same warming effect as the greenhouse gases being emitted.

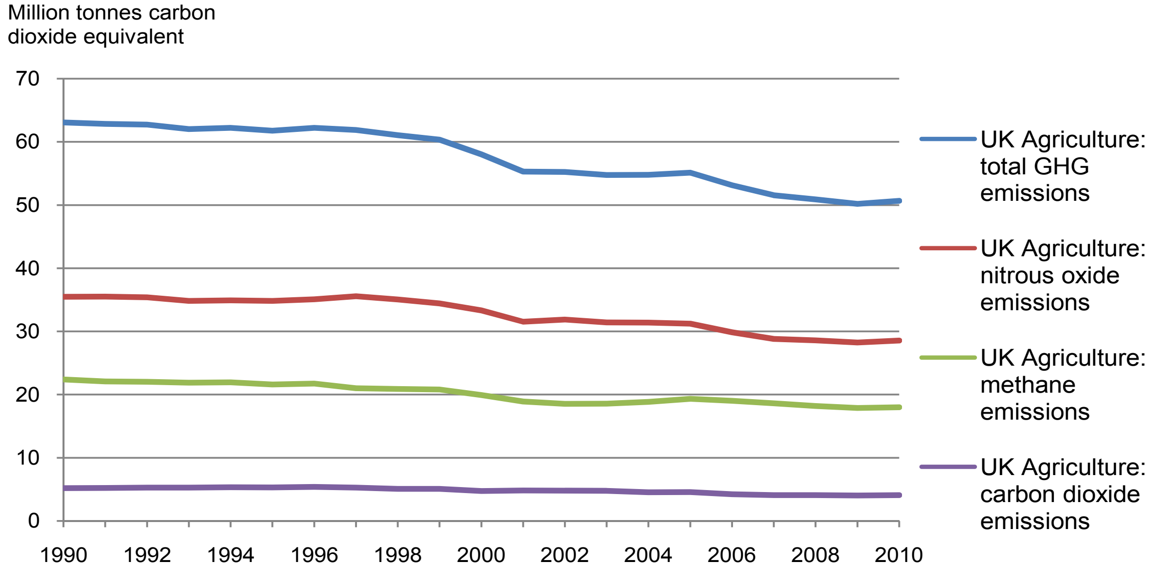
Carbon dioxide equivalent estimates are derived by applying a factor of 21 for methane, and 310 for nitrous oxide. These factors are in accordance with international reporting. These factors denote methane as having a 100-year global warming potential 21 times more powerful than carbon dioxide, and nitrous oxide 310 times more powerful.

[9] www.ghgplatform.org.uk

1.1 Total emissions

The chart below provides an overall picture of the level of recorded greenhouse gas (GHG) emissions from agriculture. In 2010, agriculture was the source of 9% of total GHG emissions in the UK (44% of total methane emissions, 80% of total nitrous oxide emissions and 0.8% of total carbon dioxide emissions).

Greenhouse gas emissions from UK agriculture



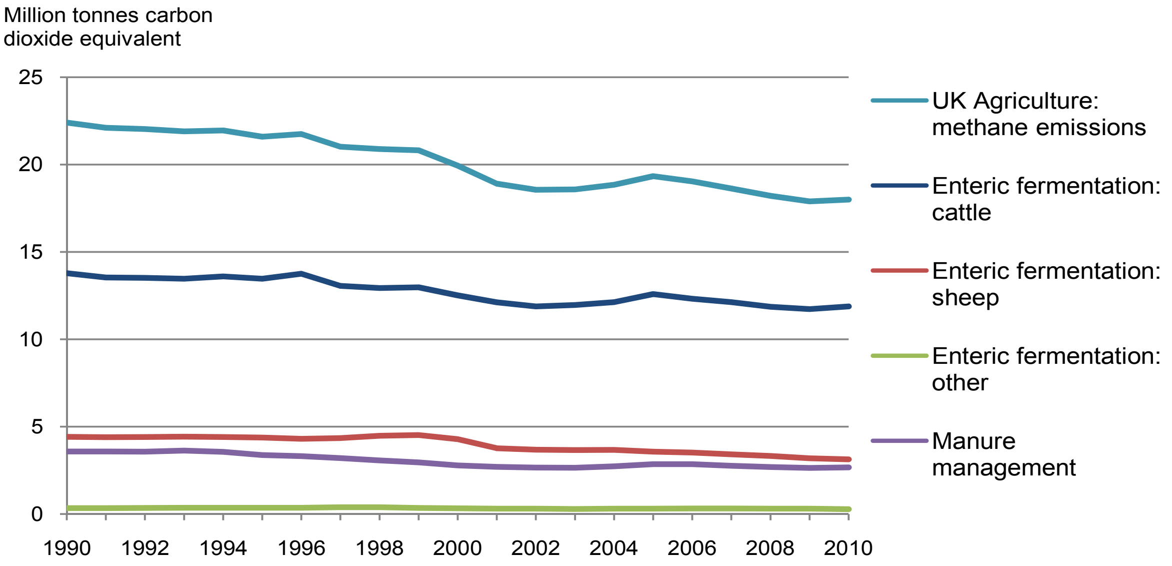
Source: DECC

1.2 Methane emissions

Agriculture is estimated to have been the source of 44% of the UK's methane (CH_4) emissions in 2010. CH_4 is produced as a by-product of enteric fermentation and from the decomposition of manure under anaerobic conditions. Enteric fermentation is a digestive process whereby feed constituents are broken down by micro-organisms into simple molecules. Both ruminant animals (e.g. cattle and sheep), and non-ruminant animals (e.g. pigs and horses) produce CH_4, although ruminants are the largest source per unit of feed intake. When manure is stored or treated as a liquid in a lagoon, pond or tank it tends to decompose anaerobically and produce a significant quantity of CH_4. When manure is handled as a solid or when it is deposited on pastures, it tends to decompose aerobically and little or no CH_4 is produced. Hence the system of manure management used affects emission rates.

Since 1990, the numbers of cattle and sheep in the UK have fallen significantly and this explains the majority of the fall in recorded CH_4 emissions. Measures relating to the greenhouse gas intensity of agriculture are explored in Section 2.

Emissions of methane from UK agriculture by source



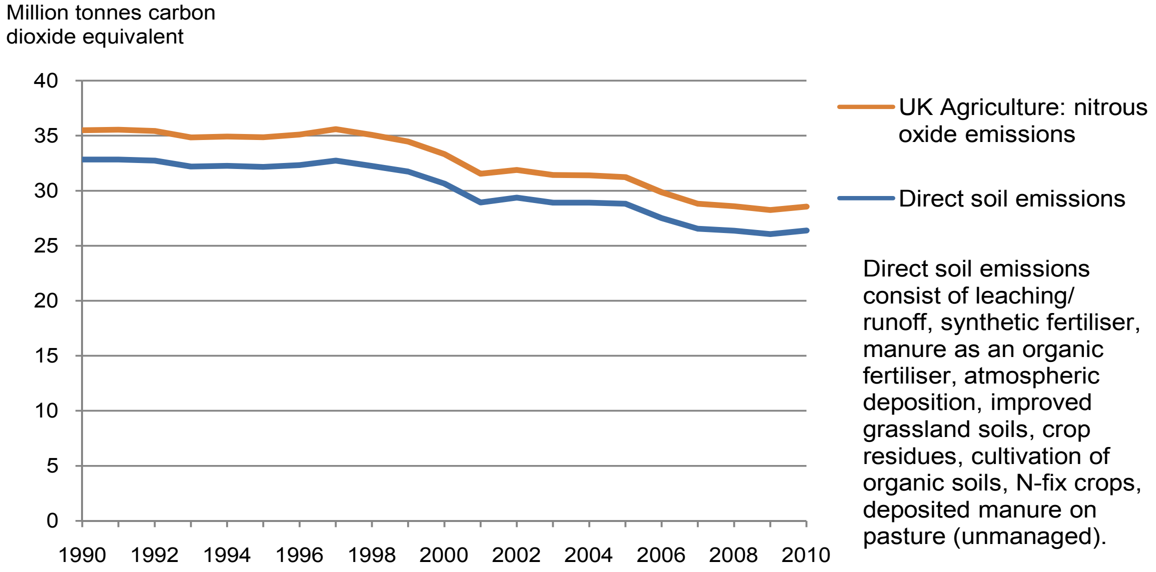
Source: DECC

1.3 Nitrous oxide emissions

Direct emissions of nitrous oxide (N_2O) from agricultural soils are estimated for the following: use of inorganic fertiliser, biological fixation of nitrogen by crops, ploughing in crop residues, cultivation of histosols (organic soils), spreading animal manures on land and manures dropped by animals grazing in the field. In addition to these, the following indirect emission sources are estimated: emission of N_2O from atmospheric deposition of agricultural nitric oxide (NO_x) and ammonia (NH_3) and the emission of N_2O from leaching of agricultural nitrate and runoff. Also, N_2O emissions from manures during storage are calculated for a number of animal waste management systems.

The overall application rate for nitrogen fertiliser has fallen substantially over the last twenty years. Whilst arable application rates have remained relatively stable over the last twenty years, grassland application rates have reduced and this explains the majority of the fall in recorded N_2O emissions. Over this period, wheat yields have increased, suggesting that the UK is producing more cereals for the same amount of nitrogen. Further measures relating to this are covered in Section 2.

Emissions of nitrous oxide from UK agriculture by source



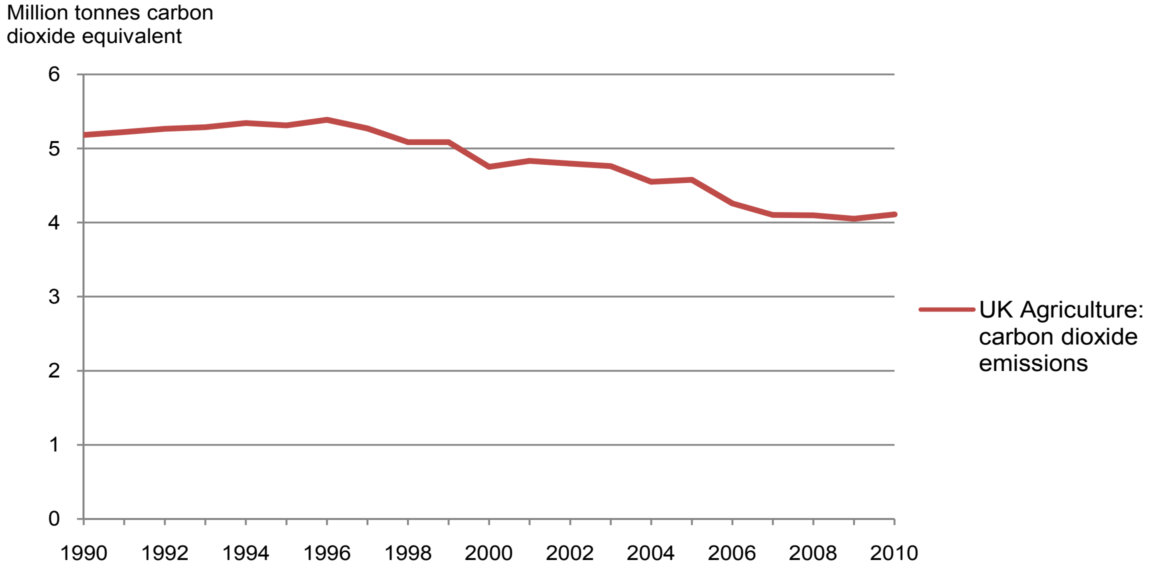
Direct soil emissions consist of leaching/runoff, synthetic fertiliser, manure as an organic fertiliser, atmospheric deposition, improved grassland soils, crop residues, cultivation of organic soils, N-fix crops, deposited manure on pasture (unmanaged).

Source: DECC

1.4 Carbon dioxide emissions

Only around 1% of carbon dioxide (CO_2) emissions in the UK are attributed to agriculture, these relate mainly to fuel use. Since 1990 there has been an overall decline in recorded CO_2 emissions from agriculture.

Emissions of carbon dioxide from UK agriculture

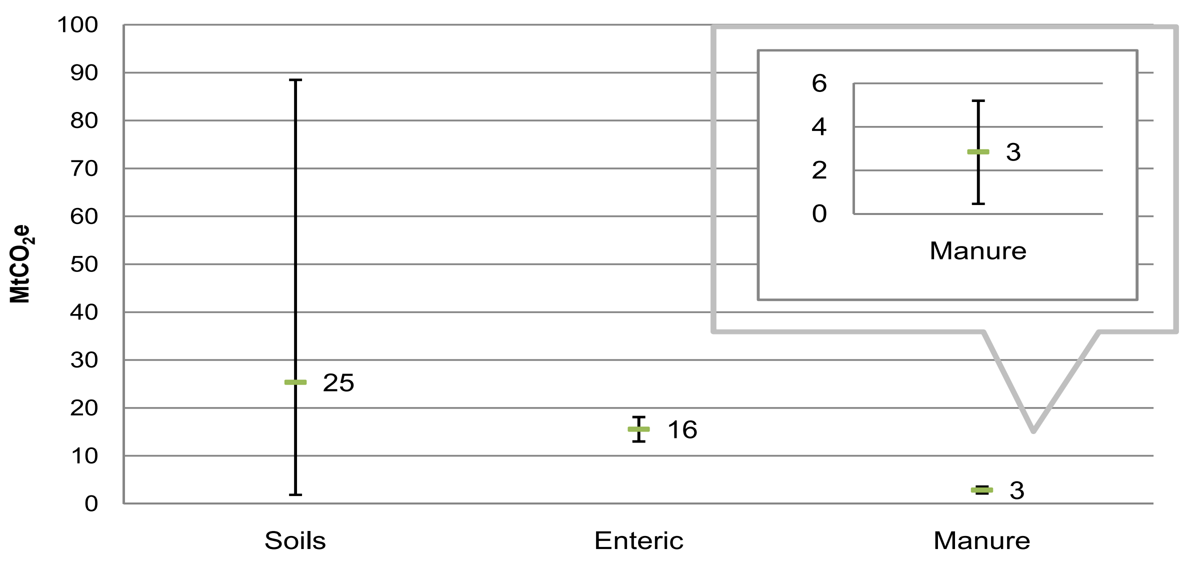


Source: DECC

1.5 Uncertainty in emissions[10]

There are relatively large uncertainties in estimating agricultural emissions as they are generated by heterogeneous natural systems for which we do not have precise measures. The chart below illustrates the uncertainties in the current methodology. Uncertainties around N_2O emissions are particularly large. These uncertainties incorporate spatial and temporal variation in emissions factors (e.g. soil texture variations etc), and more structural uncertainties relating to the way the farming industry and biological processes are represented in the current model. Some of these uncertainties are already understood to some extent, whilst others will require further research under the current inventory improvement programme. Research to improve the inventory will make the position clearer, by unpicking some of the regional and sectoral variation and by providing more accurate measures of key emissions factors. However it will not be possible to remove all uncertainty.

Emissions uncertainty - 95% confidence intervals



Section 2 summarises a range of statistics which provide an indication of changes in the intensity of emissions from agriculture in terms of the quantity of greenhouse gas per unit of output.

[10] UK Greenhouse Gas Inventory Report (MacCarthy et al., 2011)

Section 2 Intermediate outcomes and contextual factors

This section provides statistics and commentary on some of the key intermediate outcomes and, where possible, proxy measures for greenhouse gas (GHG) intensity, i.e. GHG per tonne of crop or litre of milk or kilogramme of meat produced (sections 2.1, 2.2 and 2.4 to 2.10). Some examples of the intermediate outcomes covered are productivity, animal longevity and fertility, application rates of manufactured nitrogen and soil nitrogen balances.

The section also covers some of the main contextual factors, such as crop areas, numbers of breeding livestock, prices of agricultural inputs (e.g. animal feed and fertiliser) and prices of agricultural products received by farmers (sections 2.3, 2.11 and 2.12). Crop areas and the number of breeding livestock provide information about the overall levels of activity, whilst prices help to explain some of the drivers for changes in activity.

Background Information

Farmers can decrease their GHG intensity (GHG produced per tonne of crop or litre of milk or kilogramme of meat produced) and make a positive contribution to climate change mitigation by:

- improving the efficiency and effectiveness of nitrogen use in cropping systems,
- improving the efficiency of feed conversion in livestock systems,
- storing manures in ways that reduce emissions, and
- protecting and enhancing carbon stores in soils and trees.

It is important to recognise that decreasing the GHG intensity of production may not necessarily reduce total UK GHG emissions: all other things being equal, this would increase the competitiveness of the sector, making it more able to compete in international markets, possibly encouraging an increase in the numbers of livestock or area under crops, which in some circumstances might result in an overall increase in UK agricultural emissions, even where unit intensity has decreased. However, as noted in the introduction, agricultural activity in UK emissions has to be viewed in the broader policy context, including the demand for food. Avoiding action to reduce emissions in the UK could result in "carbon leakage", where production moves abroad. This would not reduce global GHG emissions and could put pressure on sensitive landscapes or habitats.

Improved nitrogen use efficiency in cropping systems can be achieved through improved crop nutrient management; for example by:

- ensuring that the nutrient balance is right to ensure maximum uptake by the crop,
- ensuring that the correct quantity of nitrogen is applied to match crop needs,
- ensuring that nutrients are applied to the crop at the right time and in a manner most likely to ensure uptake (e.g. using band spreaders),
- minimising nutrient requirements through selecting the right crop, cultivar and nutrient regime for its intended end use (e.g. bioethanol crops and lightly grazed pasture don't need high nitrogen).

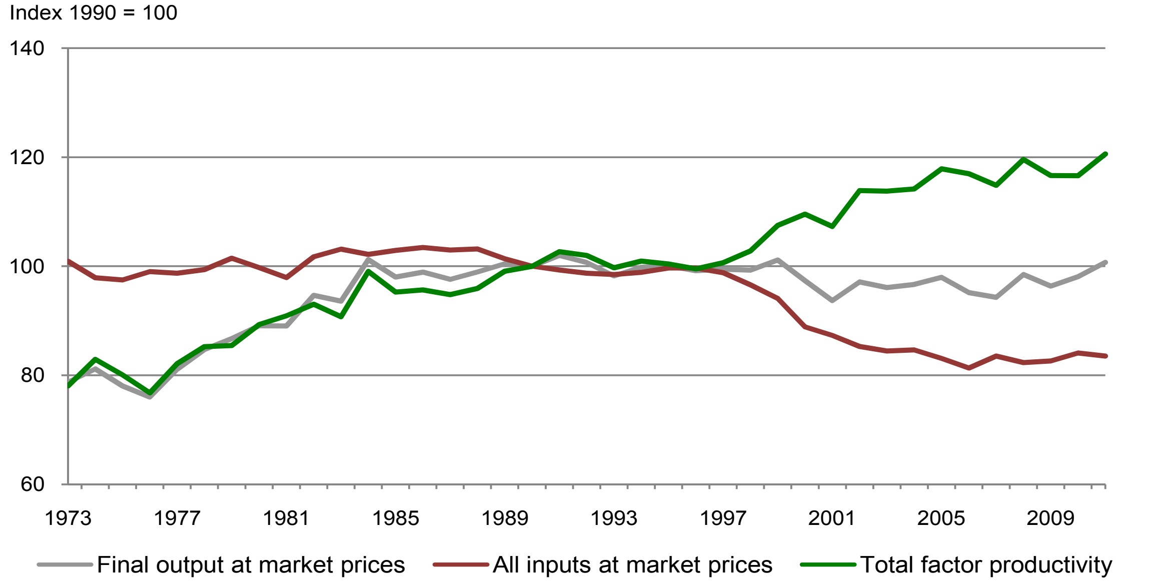
Improved feed conversion can be achieved in livestock systems by:

- ensuring that livestock diets are well-matched to animal needs,
- providing better quality diets,
- breeding animals that produce more offspring or milk and that are less likely to suffer from lameness or mastitis,
- ensuring all animals are healthy (e.g. not subject to endemic diseases and conditions such as Bovine Viral Diarrhoea, liver fluke, mastitis or lameness which reduce yields).

2.1 Headline measures of agricultural input, output and productivity[11]

This section provides a brief summary of headline measures of input, output and productivity, in other words, the change in how efficiently the agricultural industry uses resources. In the chart below this is represented by "total factor productivity". Total factor productivity measures the volume of agricultural output per unit of input, where the input measure includes fixed capital and labour and covers all businesses engaged in farming activities, including specialist contractors.

Total factor productivity, UK



Source: Defra statistics

Trends

Total factor productivity has risen consistently since the early 1970s. Over the earlier part of this period productivity rises were linked to increases in the volume of final output which rose by around 25%, while since the late 1990s reduced inputs have been a driving factor. Some of the change in productivity, though not all of it, will have a bearing on GHG intensity, and this is explored below.

[11]Measuring productivity is not straightforward and comparisons need to be interpreted carefully because of both practical problems in obtaining robust data and because performance is often shaped by factors outside farmers' control, such as climate, topography and location. These are estimates of an underlying reality, based on statistical surveys, administrative data, forecasts and models. Volatility in the price and volume of inputs and the limitations of the data used to generate the estimates has led to lesser certainty in the results in recent years. Defra are working on methodological changes to improve the quality of the results and these may lead to revisions. Users should use these estimates of total factor productivity to assess the overall pattern of change over time, to discern whether the level of total factor productivity has increased or decreased over time, and if it has, how quickly or slowly the increase or decrease has occurred.

2.2: Drivers of change in productivity in the context of greenhouse gas emissions

Table 2 shows the main agricultural outputs and inputs based on volume indices[12]. This broadly illustrates the main drivers of change in the headline measures. Animal feed forms the greatest contribution to inputs, and is the only main input to have shown an increase in volume since 1990. The expected reduction between 2010 and 2011 is linked to price pressures from high cereal prices. Some inputs are more clearly related to GHG intensity (animal feed, fertiliser, energy) than others (maintenance, equipment), whilst others are unlikely to be associated with emissions (other goods and services).

This information is useful for providing an aggregate picture of the productivity of the industry. However, in the context of emissions this information has its limitations, but it can help inform understanding when used together with information from the rest of this publication. Productivity gains may be related to overall improved GHG intensity given that fertiliser and energy inputs have decreased, however the increase in animal feed is likely to have offset some of this improvement.

Table 2 Main drivers of change in productivity

Volume indices 1990=100

		1990	2000	2005	2010	2011
Headline measures						
Output		100	97.4	97.9	98.0	100.7
Input		100	88.9	83.1	84.1	83.5
Total Factor Productivity		100	109.6	117.9	116.6	120.6
Main outputs	Approx. contribution to output (based on 1990 - 2011 average)					
Output of cereals	12%	100	111.9	98.7	95.9	97.9
Output of vegetables and horticultural products	10%	100	79.6	76.2	73.6	72.5
Livestock output primarily for meat	28%	100	94.6	94.0	91.9	94.6
Milk	17%	100	94.6	94.3	90.8	92.3
Main inputs	Approx. contribution to input (based on 1990 - 2011 average)					
Energy	6%	100	91.3	74.7	82.4	81.5
Fertiliser	8%	100	77.6	64.2	55.4	57.0
Animal feed	25%	100	103.6	109.3	115.5	108.5
Maintenance	9%	100	82.1	75.0	81.6	80.7
Equipment	10%	100	91.6	84.7	87.4	90.1
Other goods and services	18%	100	97.0	96.2	93.9	93.7

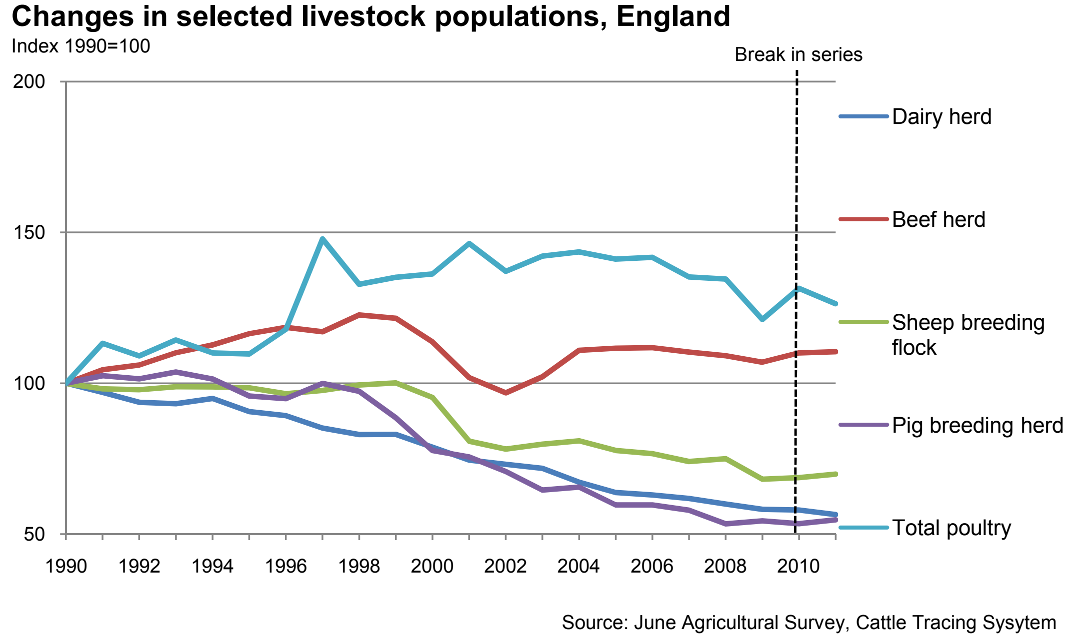
Source: Defra statistics

[12] Volume indices are calculated by taking a weighted average of volume relatives (volume relatives are the volume in year n / volume in year n-1) using the monetary values of components of the aggregated index as weights.

2.3 Contextual factor: livestock numbers and areas of key crops and grasses

Indices of breeding livestock

Rationale
Trends in livestock numbers are given here to illustrate the position of the basic drivers of emissions. GHG intensity is explored in the sections which follow.



Note: Cattle population changes are based on the June Agricultural Survey up to 2004 and Cattle Tracing System data from 2005 onwards. Dairy and beef herds are cows and heifers that have calved.

Estimates for 2010 onwards are not directly comparable to earlier years. This is due to (1) a large number of inactive holdings being removed from the survey register following the 2010 census and (2) the introduction of a survey threshold. Further details can be found in the June Survey methodology report at: http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-landuselivestock-june-junemethodology-20120126.pdf

Trends
There has been a long term downward trend in the number of dairy cows since the introduction of milk quotas in 1984.

The beef (or suckler) herd increased during the 1990s linked to headage based payments for suckler cows and switches from milk production. Changes to subsidy schemes in 2000 and the 2001 Foot and Mouth (FMD) outbreak led to substantial reductions in the number of beef cows. However, numbers recovered to some extent and have remained relatively stable since the most recent CAP reforms in 2004.

The sheep breeding flock showed little overall change during the 1990s, largely due to quota limits. As for the beef herd changes to subsidy schemes in 2000 and the 2001 FMD outbreak resulted in a substantial reduction in numbers. Since the latest reforms to the CAP in 2004 there has been a gradual decline in numbers, although there has been some increase since 2009, linked to improved prices.

The breeding pig population shows an overall downward trend, particularly since the mid 1990s. This is due to a number of factors including problems with disease, high feed prices and the strength of Sterling.

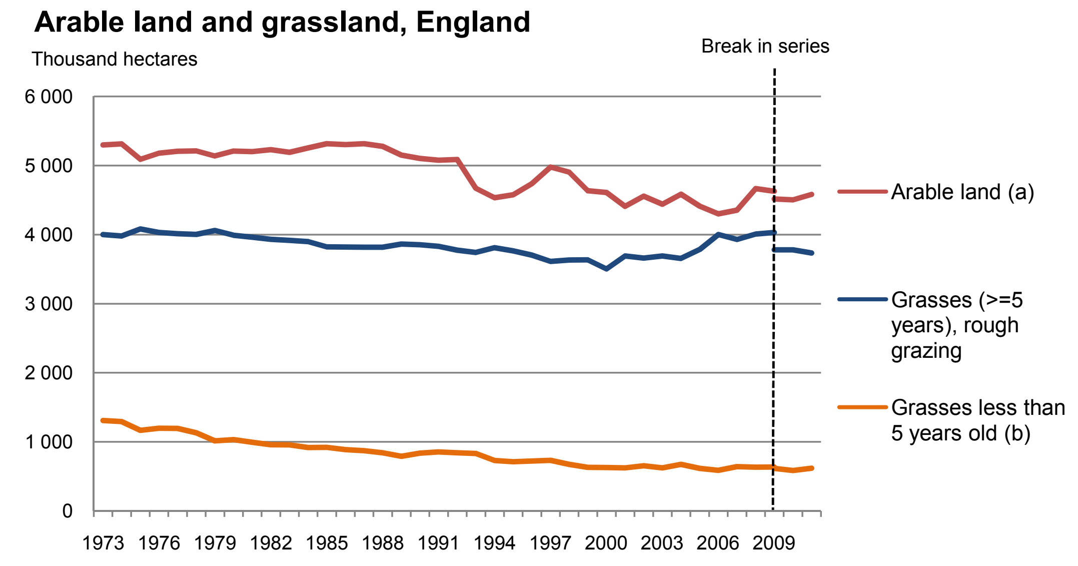
Poultry numbers generally increased between 1990 and 2004, but have since tended to decline influenced by a number of factors; rising input costs (in particular feed but also lighting, heating and labour) have led to reduced profit margins or even losses with some producers leaving the industry. The introduction of new legislation (preparation for conventional cage ban in 2012 and the Integrated Pollution Prevention Control rules) over the period has also increased input costs. Outbreaks of Avian Influenza between 2006 and 2008 may also be an influencing factor.

2.3 Contextual factor: livestock numbers and areas of key crops and grasses (continued)

Crops and grasses

Rationale

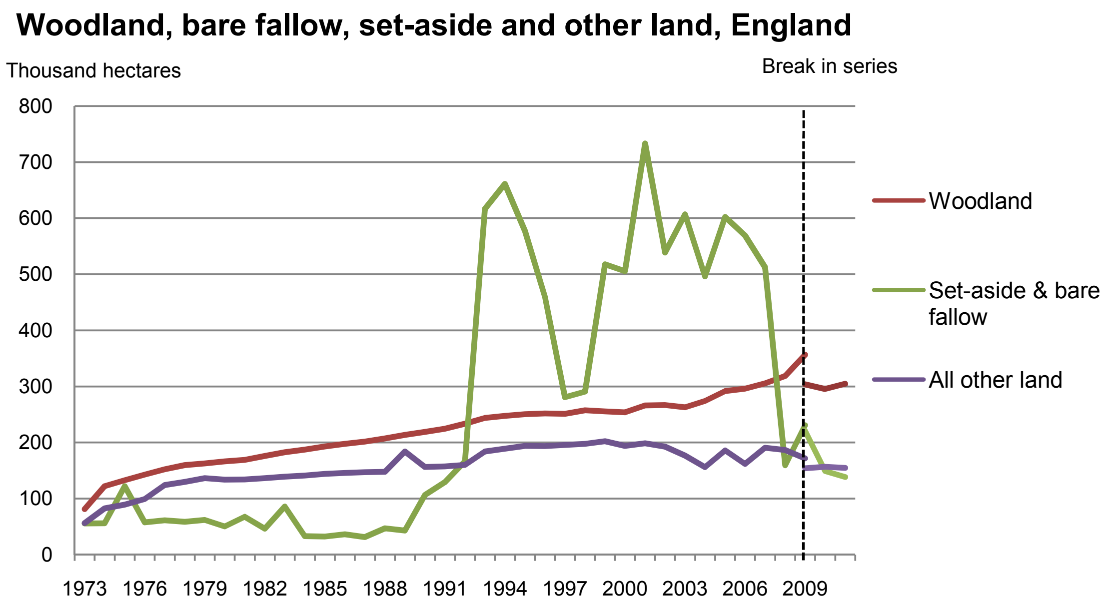
Trends in crop and grass areas are given here to illustrate the basic drivers of emissions. The quantity of nutrients applied to land is dependent on the type of "crop" grown (this includes grass).



Source: Defra, June Agricultural Survey

(a) Excludes fallow and set-aside land. Includes grasses less than 5 years old.

(b) Grasses less than 5 years old are shown separately for information and are also included in arable land total.

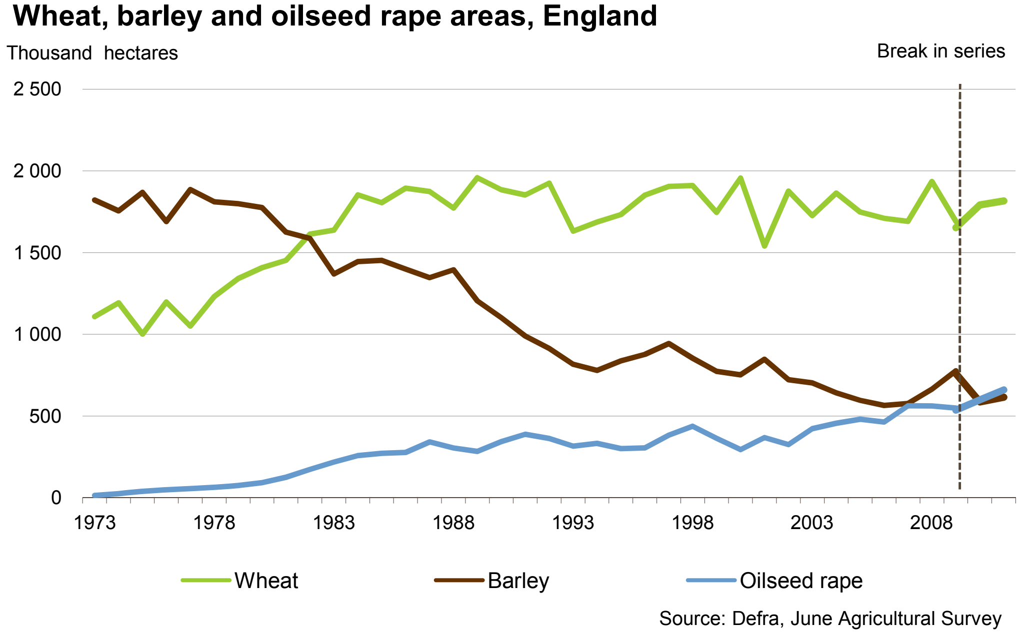


Source: Defra, June Agricultural Survey

Section 2 - Intermediate outcomes and contextual factors

2.3 Contextual factor: livestock numbers and areas of key crops and grasses (continued)

Crops and grasses (continued)



Estimates for 2010 onwards are not directly comparable with earlier years. This is due to (1) a large number of inactive holdings being removed from the survey register following the 2010 census and (2) the introduction of a survey threshold. Further details can be found in the June Survey methodology report at:

http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-landuselivestock-june-junemethodology-20120126.pdf

Trends

The area of cropped land increased in 2008 due to the removal of set-aside requirements. There was a gradual increase in the area of permanent grassland (>= 5 years) from 2000 which reached a peak in 2008. The reasons for this are unclear. However, it could in part be due to increased coverage of land on agricultural holdings, rather than actual increases of grassland area on existing holdings. Following the FMD outbreak in 2001 an increased number of farms were registered with holding numbers for animal health and disease control purposes. The introduction of the Single Payment Scheme (SPS) in 2005 may also have resulted in an increase in registered holdings and may also have led to some reclassification of grassland by farmers within the June Survey in response to requirements for recording grassland within SPS.

The main crops grown in England are wheat, barley and oilseed rape – current areas planted are reasonably stable with all cereals accounting for ca 27% of agricultural land (around 2.5 million hectares). Following the abolition of set-aside in 2008, cropped areas increased (by 14%). The increase was also driven by high global cereal prices as farmers responded by planting more wheat.

Of the other crops, the area of (primarily forage) maize increased from 116 thousand hectares in 2000 to 147 thousand hectares in 2011. Whilst there have been some fluctuations across this period, the overall trend is upwards.

Within this section we have shown that there have been changes in the number of livestock and changes in agricultural land use in England. This has had an impact on the total level of emissions. Additionally, any changes in productivity may have had an impact on the intensity of emissions - that is, the amount of greenhouse gas per tonne of crop or litre of milk or kilogramme of meat produced. Because it is currently not possible to calculate emissions on farms directly, proxy measures are required to help understand intensity; these include for example, milk produced per unit of feed. Sections 2.4 to 2.10 consider proxies for intensity and some other key measures.

2.4 Dairy

Since the introduction of milk quotas in 1984 there has been a significant reduction in the number of dairy cows in England overall, an important driver in the reduction in greenhouse gas (GHG) emissions. It is not possible to calculate emissions on farms directly. For this reason proxy measures have been developed which are associated with emissions; these include output per unit of feed, longevity, fertility and mortality. In this section we explore productivity in the dairy sector and how this relates to GHG intensity.

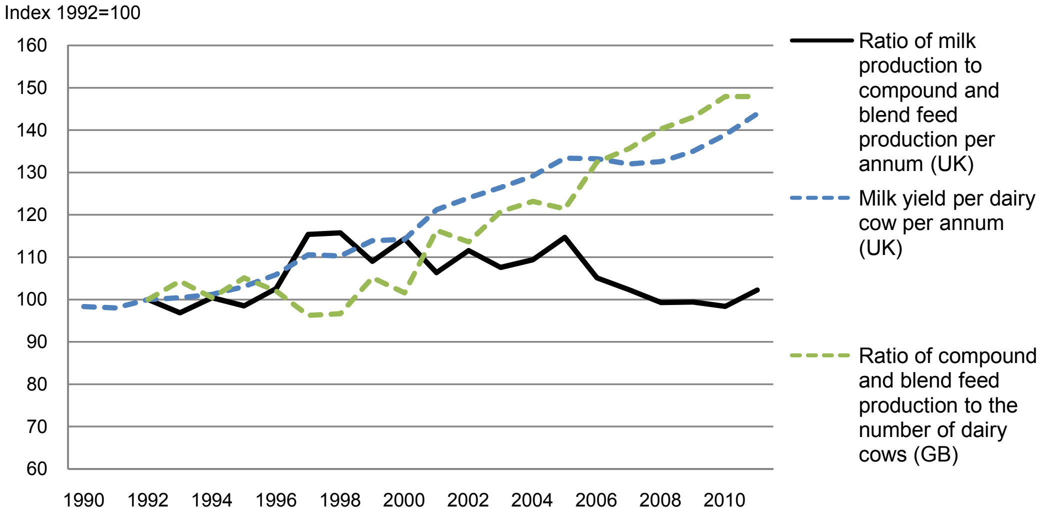
2.4.1 Dairy: Efficiency of output

Ratio of milk production to dairy cow compound and blend feed production

Rationale

Trends in milk yields provide a headline measure of the productivity of the dairy sector. However to derive a measure of emission intensity it is necessary to understand trends in the quantity of inputs (such as feed) required to achieve higher milk yields. The ratio of milk produced to compound and blend feed production is a proxy measure for the emissions intensity of the dairy sector.

Ratio of milk production to dairy cow compound and blend feed production per annum, GB and UK



Source: Defra statistics

Section 2 - Intermediate outcomes and contextual factors

2.4.1 Dairy: Efficiency of output (continued)

Table 3: Gross margins from dairy herds grouped by farm performance band, England

(£/head unless otherwise stated)	2009/10			2010/11		
	Low performers (bottom 25%)	High performers (top 25%)	All	Low performers (bottom 25%)	High performers (top 25%)	All
Average herd size	57	230	131	49	239	132
Forage area (per head)	0.7	0.5	0.6	0.7	0.5	0.5
Yield (litre per cow)	5602	8020	7393	6079	8214	7711
Price (pence per litre)	22	26	25	24	26	25
Milk sales	1242	2051	1832	1441	2123	1952
Calf sales & transfers out	96	90	92	85	88	85
Miscellaneous output	2	0	1	12	14	14
Less herd depreciation	-185	-200	-195	-220	-200	-201
Enterprise output	1154	1940	1729	1319	2025	1850
Variable costs						
Concentrates	433	560	531	524	558	549
Conc/litre(pence)	8	7	7	9	7	7
Coarse fodder	17	23	22	30	30	29
Vet and medicine costs	56	77	71	70	80	78
Other livestock costs	155	150	149	187	165	164
Forage variable costs	83	90	90	82	80	82
Fert/litre (pence)	1.1	0.7	0.8	0.9	0.6	0.7
Total variable costs	744	899	863	894	913	902
Gross margin/cow	**410**	**1041**	**866**	**425**	**1112**	**948**
Variable costs pence/litre	13	11	12	15	11	12

Source: Farm Business Survey

Trends
The ratio of aggregate milk production to compound and blended feed is currently at levels similar to the early 1990s, and has been on an overall downward trend since 2005. This ratio increased in the mid 1990s and this may have been due to a combination of consolidation in the feed manufacture sector, resulting in reduced levels of production, and some effects as a consequence of the abolishment of the Milk Marketing Board in 1994.

Examining the individual components of the index, average milk yields have been on an upwards trend; the amount of compound and blended feed per dairy cow has also increased over this same period.

Data from the Farm Business Survey indicates that the average milk yield for high performers was around 40% higher than for the low performers in both 2009/10 and 2010/11. Concentrate feed and fertiliser cost per litre of milk is lower for the high performers. This may be a reflection of the volume used or could indicate more competitive purchasing. Also influencing the higher margins of the high performers is the more favourable price per litre of milk they achieved in both years. The overall gap between the high and low performers has changed little between the 2 years but longer term trends[13] suggest that in terms of gross margin per cow, the gap has widened over time.

[13]For longer term trends see Section 2.4 of 2nd Edition of Agricultural Statistics and Climate Change at: http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-enviro-climate-climatechange-120203.pdf

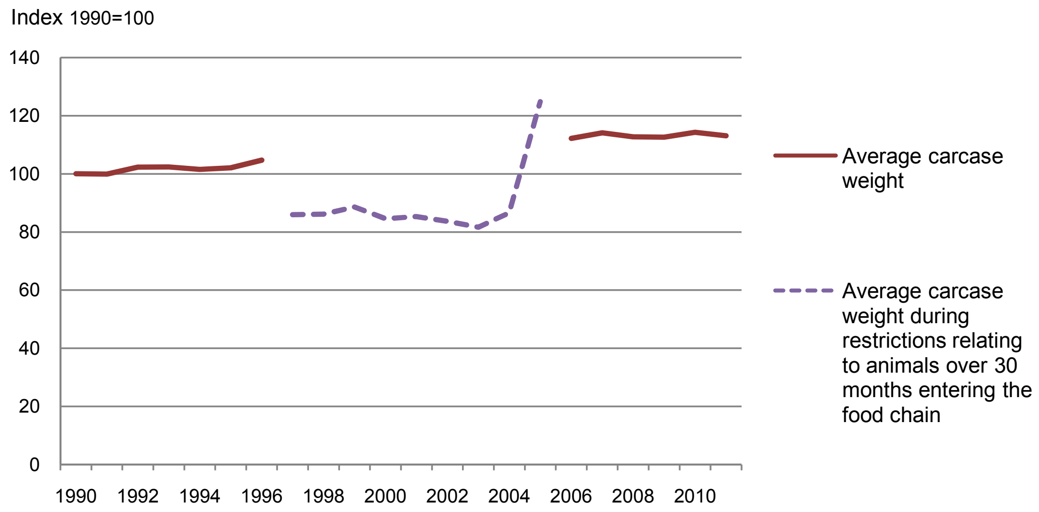
2.4.1 Dairy: Efficiency of output (continued)

Weight of cull cows

Rationale
Live weight can also be used as a measure of efficiency since all other things being equal, a heavier cow will produce milk more efficiently than a lighter one. Limited information is currently available on live weight. Here we consider the carcase weights of cull cows (cows culled at the end of their productive life) as a proxy for live weight. The chart below gives indexed carcase weights of cull cows for both dairy and suckler cows since 1990, these are derived from slaughter statistics.

Note: it is not possible to distinguish between dairy and beef cows from the slaughter statistics.

Cull cow carcase weights, UK



The much lower carcase weights between 1997 and 2005 (shown by the dashed line) are due to restrictions prohibiting beef from animals aged over thirty months from entering the food chain.

Source: Defra statistics

Trends
Changes in the proportion of suckler and dairy cows will influence this trend since there are relatively fewer dairy cows now than 20 years ago, and dairy cows are heavier than suckler cows. However, despite this, cull cows are heavier now than in the 1990s.

Figures since 2006 (by which time the restrictions prohibiting beef from animals aged over thirty months from entering the food chain had been lifted) do not show a clear increase in weights. Milk yields have increased more so than the carcase weight of cull cows.

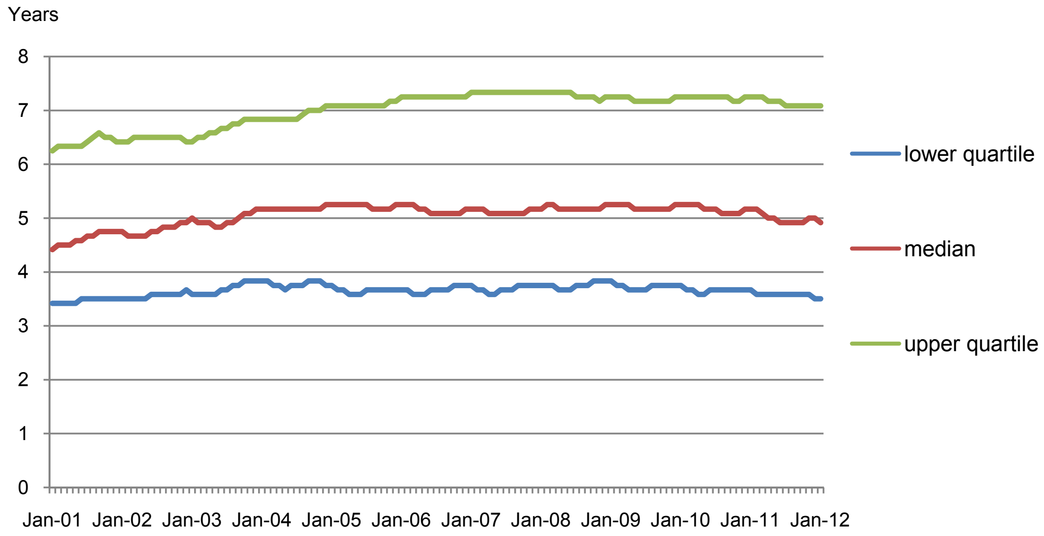
2.4.2 Dairy: longevity and fertility

Age of dairy herd (breeding animals) and calf registrations per cow (at present data is only available for all dairy and beef animals[14])

Rationale
Increased fertility rates and longevity of breeding animals will help secure reductions in GHG emissions as fewer replacement females will be required to deliver the same level of production and this would also reduce an 'overhead' cost of milk production.

The chart below shows the median age and inter quartile range of female cattle aged 30 months and over.

Age of female dairy cattle aged over 30 months, monthly data, GB



Source: Defra, RADAR Cattle Tracing System

Trends
The median age of the dairy breeding herd (cows aged over 30 months) has increased overall since 2001 and has been relatively stable since 2004 although there has been a slight reduction over the last two years. This initial rise is thought to be due to a recovery following the 2001 Foot and Mouth Disease (FMD) outbreak and changes to restrictions associated with Bovine Spongifom Encephalopathy (BSE) (where Over Thirty Month scheme and Older Cattle Disposal scheme impact on the trends). The current situation shows little to suggest any significant increase in age of breeding herds above levels prior to FMD and BSE restrictions.

The inter quartile range (IQR) is given to assess the spread of the age of cattle. An increase in longevity will be demonstrated by an increase in the median or an increase in the IQR, such that the upper quartile increases by more than the lower quartile. The IQR for dairy cattle ages has been stable since 2007.

Further information on the distribution of dairy cows by age in months can be found at (ii) at the Appendix.

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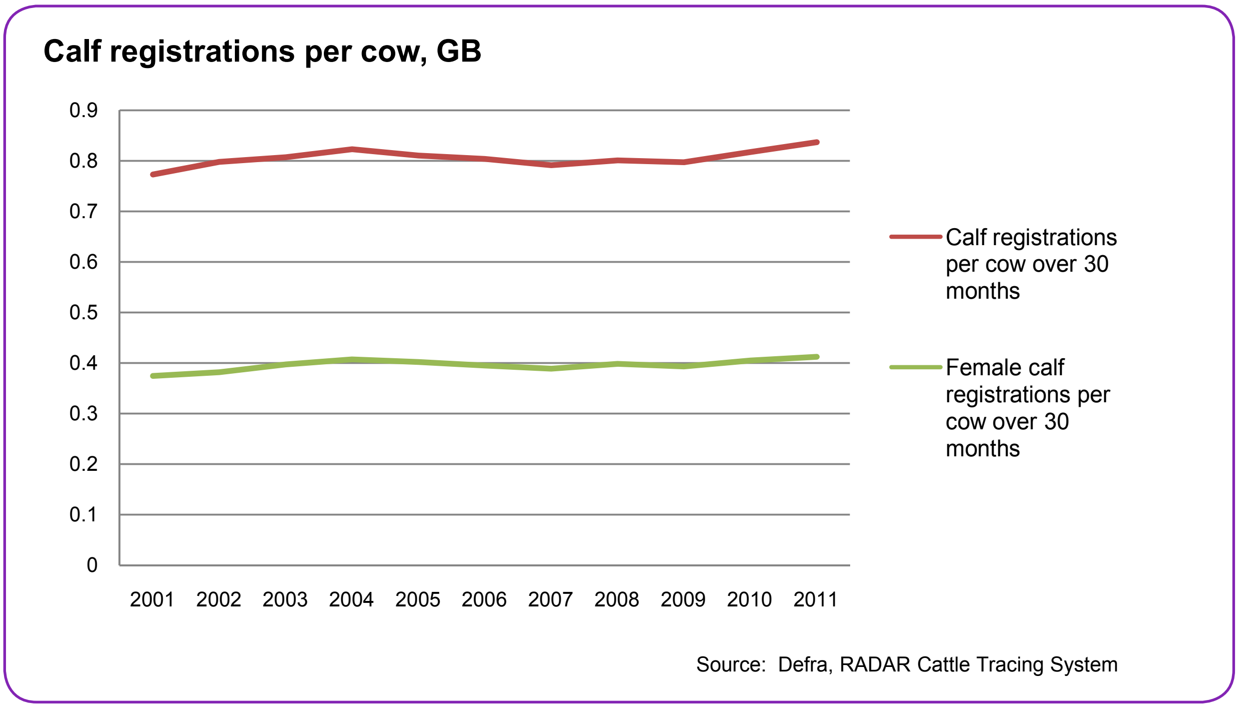
[14] No distinction is made between dairy and beef animals. Male dairy calves are under reported in CTS and in the 'Calf registrations per female cow over 30 months' measure the number is modelled on beef calf registrations. The approach taken is consistent with Agriculture and Horticulture Development Board (AHDB) methodology.

2.4.2 Dairy: longevity and fertility (continued)



Trends

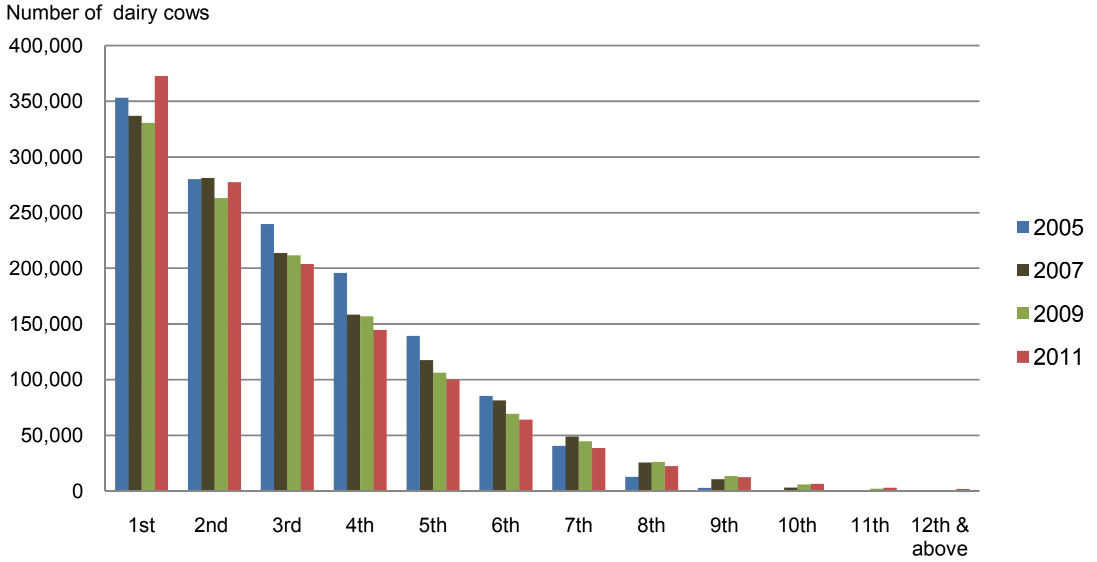
Overall the numbers of calf registrations per cow have remained relatively stable over the 10 year period for which data are available. Initial indications suggest a recent increase in the number of calf registrations per cow, but it is too early to interpret this as a change in the longer term trend.

2.4.2 Dairy: longevity and fertility (continued)

Number of calvings

Increased fertility should help secure reductions in GHG emissions as all things being equal fewer breeding females would be required.

Number of calvings by dairy cows, GB 2005 - 2011



Source: Defra, RADAR Cattle Tracing System

Trends

The chart above shows the number of calvings by dairy cows in 2005, 2007, 2009 and 2011.

In 2011, 1.25 million dairy cows had calves compared to 1.35 million in 2005. Of these, the proportion of dairy cows that calved for the first time (the effective replacement rate) was 30% in 2011 compared to 26% in 2005, while the proportion calving for a second time remained virtually unchanged between 2005 and 2011 at around 22%.

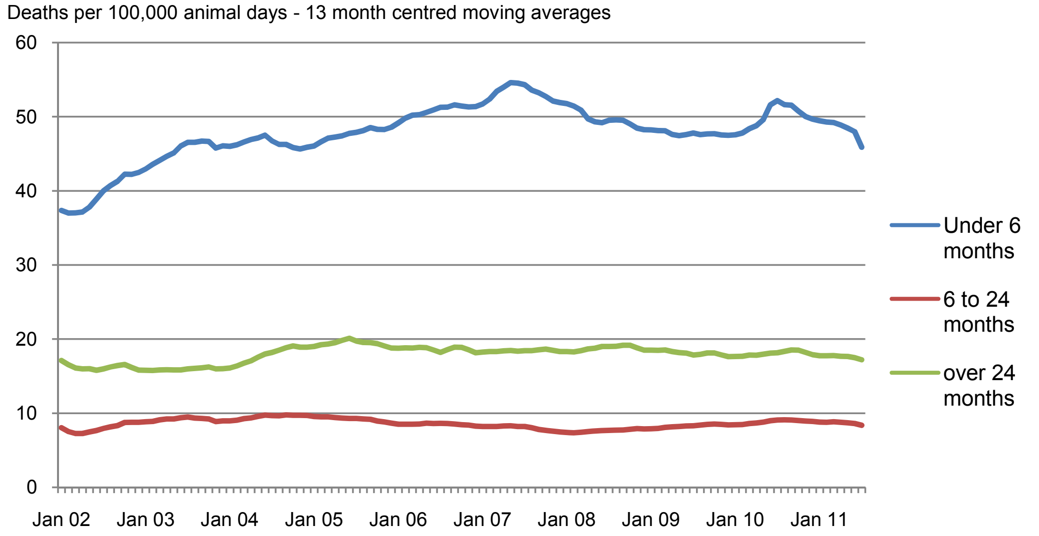
Data from 2011 suggest a slight decrease in the number of dairy cows having 3 or more calves compared to the previous years.

2.4.3 Dairy: animal health

On-farm mortality risk

Rationale
Reductions in on-farm mortality[15] will lead to less wastage. Reduced disease will lead to greater productivity. For cattle, overall mortality may be a better indicator than the incidence of specific diseases for which we do not have full data.

On-farm mortality risk for dairy cattle, GB



Source: Defra, RADAR Cattle Tracing System

Trends
There was an overall reduction in on-farm mortality risk for registered dairy calves (under 6 months) between 2007 and early 2010. This was followed by an increase during 2010. It is not clear why this increase occurred as there were no obvious causes, such as a disease outbreak or adverse weather conditions. Levels have now dropped back to below those seen at the start of 2010. For dairy cattle age 6 to 24 months and those in the over 24 month category there has been little change in on-farm mortality since 2009.

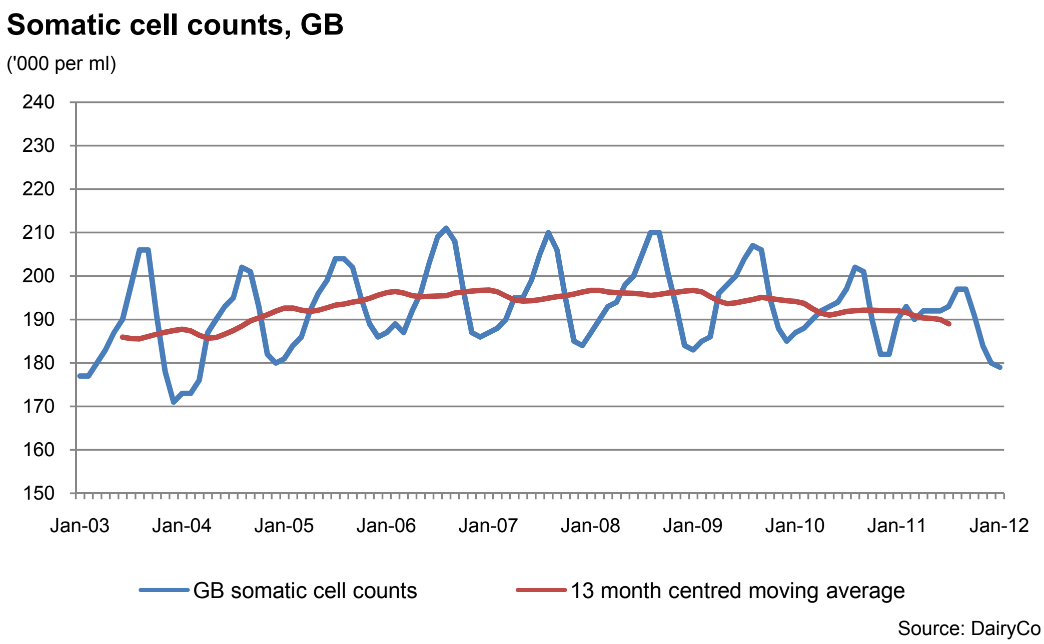
[15] On-farm mortality rate is defined as the number of deaths per 100,000 days at risk on agricultural premises. It is calculated using the number of calf deaths divided by the number of calf days in the period. The number of calf days in the period represents 1 day for each animal each day. For example, if 5 animals were present on a location for 20 days the sum of the animal days would be 100. Conversely, if 20 animals were present on a location for 5 days the sum of the animal days would also be 100. This means, for any specified risk to the cattle in an area, that areas with a high density of cattle can be compared directly with areas with a low density of cattle.

On-farm mortality was calculated by only analysing premises that were registered as being an agricultural premise. Therefore, this data excludes deaths at slaughter houses.

2.4.3 Dairy: animal health (continued)

Somatic cell counts in the dairy herd

Rationale
Low counts of somatic cells in milk indicate a healthy, well managed dairy herd. High counts of somatic cells normally indicate a mastitis infection or udder damage often caused by faulty milking machines or improper use of milking equipment. A high cell count can mean reduced productivity.



Trends
The trend in the somatic cell count increased from 2003 to 2006 then remained reasonably stable before decreasing from 2009. A "healthy" somatic cell count range is generally accepted to be between 50,000 and 250,000.

2.4.4 Dairy: manure management

The system of manure management is relevant to the control of environmental risks to air and water including ammonia.

For dairy farms using solid manure systems the 2012 Farm Practices Survey (FPS) reported that:

- 70% had facilities to store solid manure in heaps on a solid base, virtually unchanged from 2011. Incidence increased by farm size ranging from 52% of small dairy farms to 75% of large dairy farms. Overall just 2% were covered.
- 64% could store solid manure in temporary heaps in fields, again little changed from 2011.

For dairy farms with slurry based systems the 2012 FPS reported that:

- 46% had facilities to store slurry in a tank, little changed from 2011. Of these around 8% were covered.
- 50% could store slurry in lagoons, again no change on 2011. There is some variation between farm sizes, ranging from 27% of small dairy farms to 57% of large dairy farms.
- 8% had facilities to store slurry in another type of store and of these 8% were covered.

Note: some farms have more than one type of storage system.

2.4.5 Dairy: summary

The ratio of milk produced to compound and blend feed production is currently at similar levels to those seen in the early 1990s although there have been fluctuations in production levels during this period. With respect to milk production, reduced cow numbers (see section 2.3) have been partially offset by increased milk yields, which have steadily increased over the past few years. More recently, milk production increased following a period of higher prices (see section 2.11).

Information from the Farm Business Survey indicates that concentrate feed and fertiliser cost per litre of milk is lower for the top 25% of performers. This may be a reflection of the volumes used or could indicate more competitive purchasing. Further details of economic and GHG performance in the dairy sector can be found in Section 4 of the 2nd Edition of Agricultural Statistics and Climate Change at:
http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-enviro-climate-climatechange-120203.pdf

Over the last 5 years, the average age of breeding animals has been stable at around 5 years, and calf registrations have been fairly constant at around 0.8 per breeding cow (note due to data availability this is for both dairy and beef cattle). There have been fluctuations in the on-farm mortality risk for registered dairy calves (under 6 months) but levels are currently at the lowest since 2007. For dairy cattle aged 6 to 24 months and those over 24 months levels of on-farm mortality have remained relatively stable over the last 3 years following reductions earlier in the decade. Somatic cell counts have also been stable over recent years, reducing slightly since 2010. Taking all these factors into consideration suggests that there may have been a reduction in the intensity of GHG emissions.

2.4.6 Dairy: further developments

Current statistics provide a partial picture of the relevant drivers of GHG emissions, for example, it is not possible to calculate milk production per kg live weight. The following measures have been proposed as potential factors for inclusion in the new agricultural GHG inventory. Not all of the proposed measures can feasibly be populated with robust data in the short term; although some of the data are collected through the Cattle Tracing System there are significant complexities in extracting it from its current format.

- Calving interval (reasons why intervals are longer than expected)
- Age at first calving
- Number of lactations
- Live weight split by beef and dairy
- Herd replacement rate (via lactation number)
- Number of calves available for finishing as beef
- Calving season
- Grazing days
- Percentage of milk from grass
- Reasons for culling

2.4.7 Dairy: notes on data collection methodology and uncertainty

Milk production and feed production

i) The data on compound and blended feed production shown here are from the survey returns of all of the major GB animal feed companies. Data on raw material use, stocks and production of the various categories of compound animal feed are recorded. The major producers typically cover 90% of total animal feed production surveyed each month. The remaining smaller companies are sampled annually in December for their figures in the preceding 11 months. Sampling errors of the production estimates are small. Links to the survey methodology are given in the Appendix.

ii) On-farm production of animal feed is not covered here, nor are transfers between farms or exports of compound feed, however, trade in compound feeds in UK are not significant (unlike trade in raw ingredients used to produce compound feeds).

iii) The ratio of feed to cows in the underlying data indicates 6 to 9kg per cow per day for six months of the year over the entire series. This is considered to be consistent with practice in the dairy sector.

iv) Milk production given here are aggregated data from surveys run by Defra, RERAD, DARDNI on the utilisation of milk by dairies. Links to the survey methodology are given in the Appendix.

Information from the Cattle Tracing System

v) The CTS is an administrative dataset and all cattle in GB are included in the dataset. Thus estimates shown here are based on the full cattle population. Links to the methodology are given in the Appendix.

Farm Business Survey

vi) Where the sample size is relatively small, confidence intervals can be quite large, and care needs to be taken with interpretation of the significance of the differences. A link to information on the Farm Business Survey methodology is given in the Appendix.

2.5 Beef

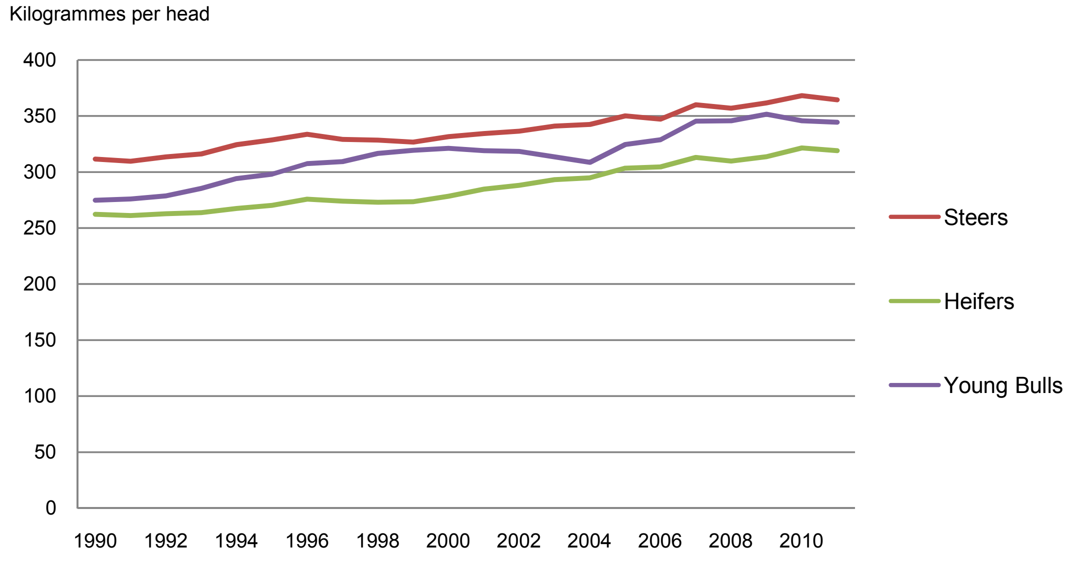
2.5.1 Beef: efficiency of output

Weight at slaughter

Rationale

More efficient finishing[16] has the potential to reduce emissions and increase productivity. It is desirable for average carcase weights to increase, though not at the expense of increased intensity of emissions, that is greenhouse gas (GHG) emissions per kilogramme of meat produced.

Cattle: average home killed dressed carcase weights from main sources, UK



Source: Defra Slaughterhouse Survey

Trends

Since 1990 there has been an overall increase in the average carcase weight of prime beef cattle. There is little evidence of a departure from these trends in recent years and figures for 2011 show little variation from 2010.

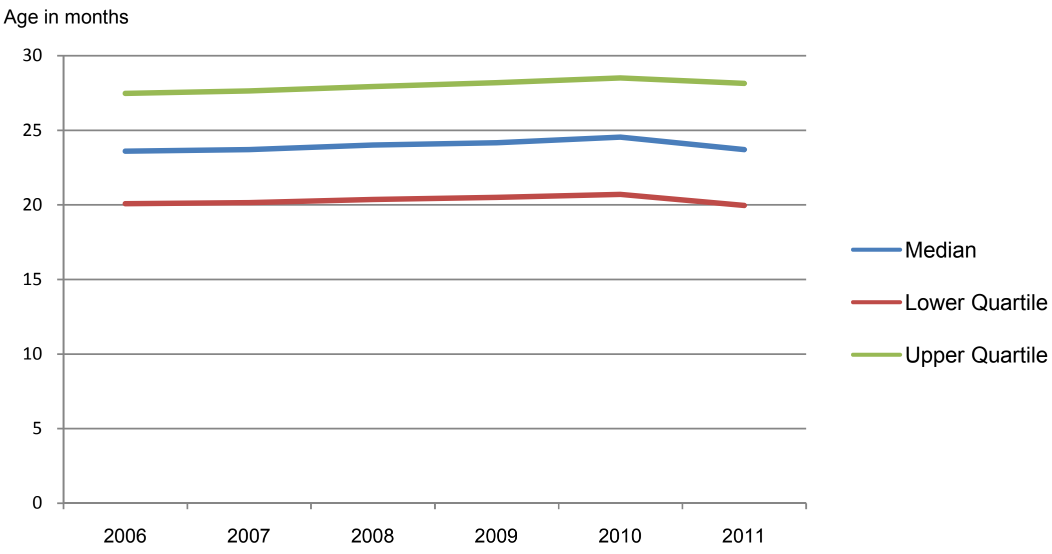
[16] Finishing is the feeding process used prior to slaughter for cattle or sheep intended for meat production.

2.5.1 Beef: efficiency of output (continued)

Age at which cattle under 4 years are slaughtered

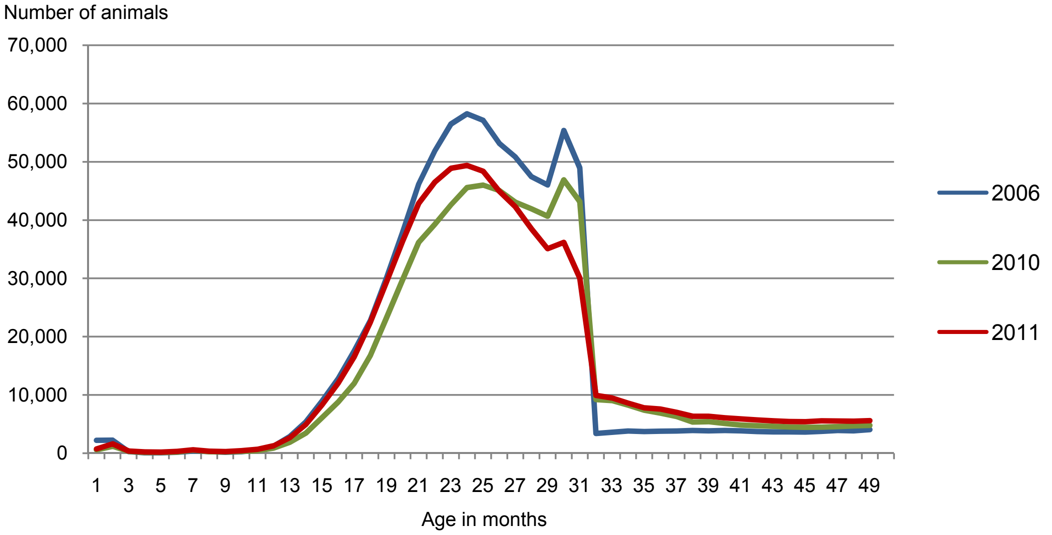
Rationale
Both the average meat produced per age of animal (see previous page), and the age of cattle at slaughter are factors in determining emissions. Considering these jointly helps to inform understanding of the emissions intensity. Here we consider the median as a measure of age at slaughter. It is also of interest to understand the spread in ages, the lower and upper quartiles provide a measure of this.

Age at which female cattle under 4 years died in slaughterhouses, GB



Defra, RADAR Cattle Tracing System

Age at which female cattle under 4 years died in slaughterhouses, GB 2006, 2010 & 2011

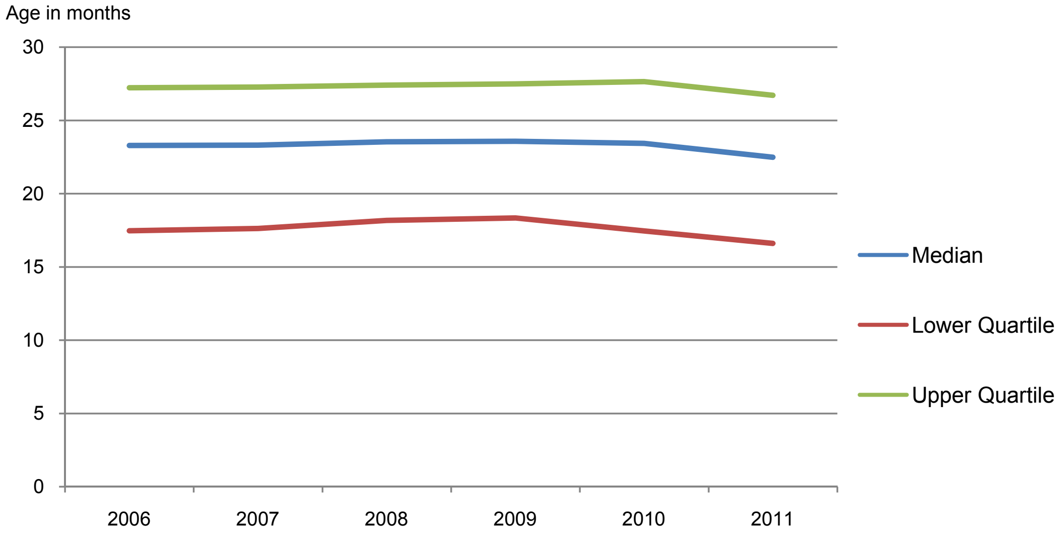


Defra, RADAR Cattle Tracing System

This chart is included to provide more details of the age at which animals have been slaughtered over the last 6 years.

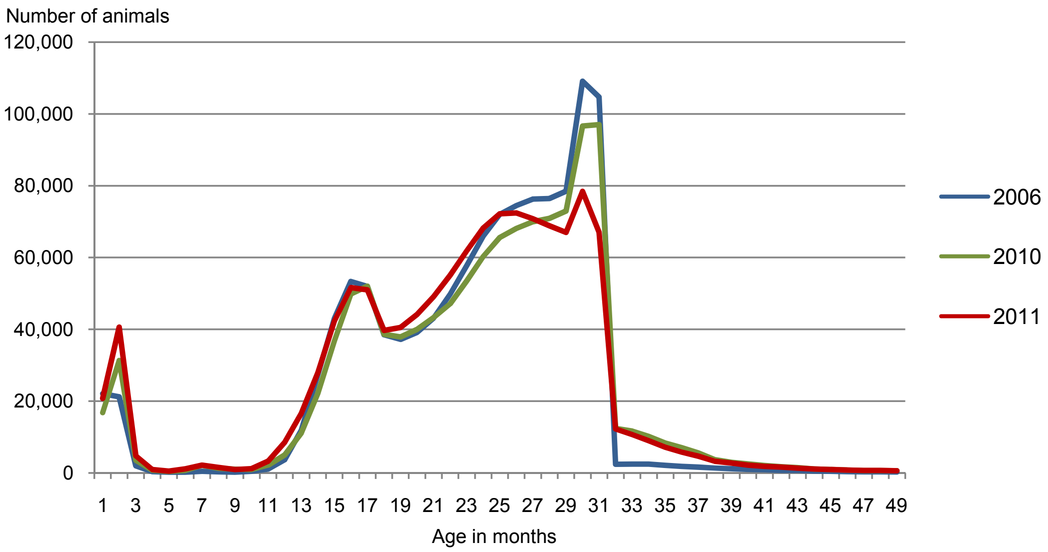
Age at which cattle under 4 years are slaughtered (continued)

Age at which male cattle under 4 years died in slaughterhouses, GB



Defra, RADAR Cattle Tracing System

Age at which male cattle under 4 years died in slaughterhouses, GB 2006, 2010 & 2011



Defra, RADAR Cattle Tracing System

As for females above, here the distribution of the age at which male cattle were slaughtered in 2006, 2010 and 2011 is shown.

Trends
The average age at slaughter of both male and female cattle (under 4 years old) has remained virtually unchanged since 2006 although a slight decline was seen in 2011, particularly in male cattle. There has been some increase in the number of animals slaughtered beyond 30 months as meat from older animals is now allowed to enter the food chain, but there is still a significant dip around 30 months. The overall increase in average carcase weights, with little change in the age at slaughter suggests the intensity of GHG emissions may have improved marginally since 2006.

2.5.1 Beef: efficiency of output (continued)

Table 4: Gross margins from cattle and beef (£ per head), England

	Finished cattle from calves and stores from the dairy herd				Finished cattle from calves and stores from the suckler herd			
	2005/06 (SGM)	2009/10 (SGM)	2009/10 (SO)	2010/11 (SO)	2005/06 (SGM)	2009/10 (SGM)	2009/10 (SO)	2010/11 (SO)
Average herd size: finished cattle	124	152	156	170	70	96	111	116
Finished livestock sales	239	427	455	544	621	774	855	990
Other cattle/ throughput	70	150	140	47	-34	131	117	-40
Less herd depreciation /calf & store cattle purchases	-75	-199	-222	-203	-348	-537	-598	-581
Enterprise output	**234**	**378**	**373**	**388**	**240**	**367**	**375**	**369**
Variable costs								
Concentrates	102	148	151	190	82	122	131	166
Coarse fodder	8	5	6	7	5	6	6	6
Vet and medicine costs	9	11	11	11	9	11	10	12
Other livestock costs	28	44	47	56	46	54	54	68
Forage variable costs	22	37	37	34	26	39	36	32
Total variable costs	169	244	251	298	167	232	238	283
Gross margin/Standard output per cow	**65**	**135**	**122**	**90**	**73**	**135**	**137**	**87**

Source: Farm Business Survey

The table above shows a comparison of gross margins for beef cattle in 2005/06 and 2010/11 based on standard gross margin (SGM) typology and in 2009/10 and 2010/11 based on standard output (SO) typology. Data for 2009/10 have been presented on both bases to provide an indication of the impact of the methodology change[17]. Figures are for £ per head and have not been adjusted to reflect price changes due to inflation.

Data from the Farm Business Survey suggests that across this period there have been increases in total variable costs for finished calves and stores from both the dairy herd and the suckler herd. The largest increases in input costs were seen in concentrates and “other” livestock costs (which include bedding, marketing deductions, haulage etc) Enterprise output also rose for calves from both the dairy and suckler herd between 2005/06 and 2010/11 which more than offset the increased costs, leading to an increase in gross margin for both categories. However, between 2009/10 and 2010/11, there were reductions in gross margins for finished cattle and calves from both the beef and dairy herds.

[17] Further details of the revised typology and its effect on the Farm Business Survey sample may be found at: http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-farmmanage-fbs-reviseclass_111221.pdf

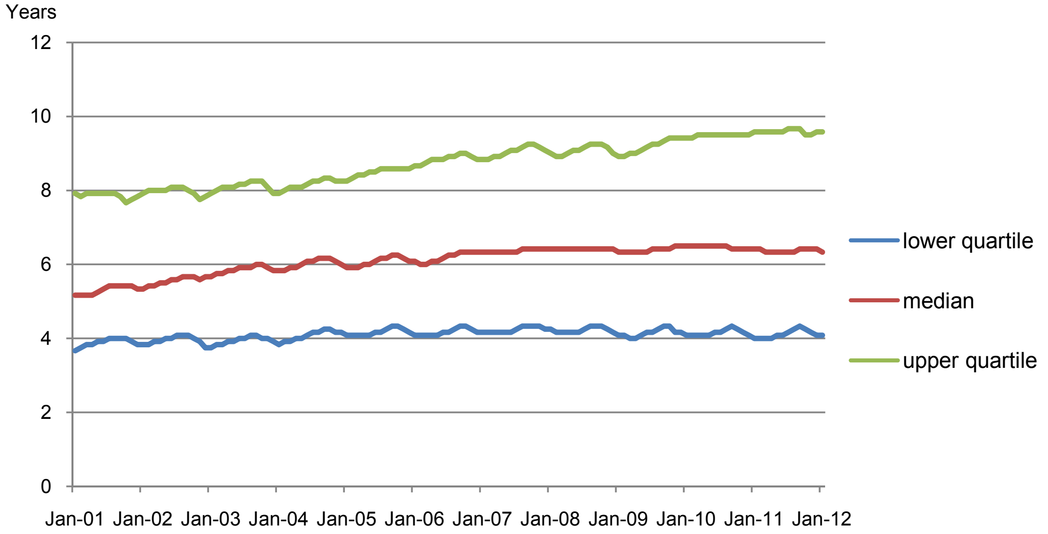
2.5.2 Beef: longevity and fertility

Age of beef herd (breeding animals)

Rationale
Increased fertility rates and longevity of breeding animals will help secure reductions in GHG emissions as all things being equal fewer breeding females would be required.

In the following chart, we consider the median average age and inter quartile range of female cattle aged 30 months and over.

Age of female beef cattle aged over 30 months, monthly data, GB



Source: Defra, RADAR Cattle Tracing System

Trends
The median age of the beef breeding herd (cows aged over 30 months) has increased since 2001 but has remained relatively stable since 2007. This rise is thought to be due to a recovery following Foot and Mouth (FMD) and changes to restrictions associated with Bovine Spongiform Encephalopathy (BSE) (where Over Thirty Month scheme and Older Cattle Disposal scheme impact on the trends). The data do not suggest any significant increase in the age of breeding cattle above levels prior to FMD and BSE restrictions.

The inter quartile range (IQR) is given to assess the spread of the age of cattle. Increased longevity in the beef breeding herd will be demonstrated by an increase in the median or an increase in the IQR, such that the upper quartile increases by more than the lower quartile. The IQR for beef cattle ages has increased since 2007 and the upper quartile has changed more than the lower quartile implying an increase in the overall longevity.

For distribution of beef cows by age in months please see (iii) at the Appendix

2.5.2 Beef: longevity and fertility (continued)

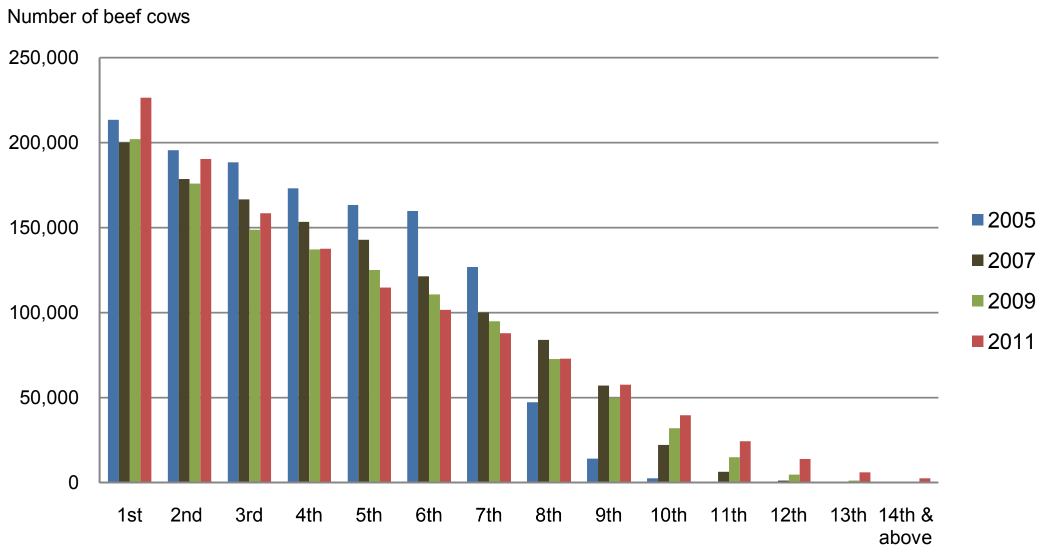
Calf registrations per cow (at present data is only available for all dairy and beef animals)

See section 2.4 Dairy. The overall levels have remained relatively stable with no major upward or downward trend.

Number of calvings

Rationale
Increased fertility should help secure reductions in GHG emissions as all things being equal fewer breeding females would be required.

Number of calving by beef cows, GB 2005 - 2011



Source: Defra, RADAR Cattle Tracing System

Trends
The chart above shows the number of calvings by beef cows in 2005, 2007, 2009 and 2011.

In 2011 1.23 million beef cows had calves compared to 1.28 million in 2005. Of these the proportion of beef cows that calved for the first time (the effective replacement rate) was 19% in 2011 compared to 17% in 2005, while the proportion calving for a second time remained unchanged between the same years at 15%.

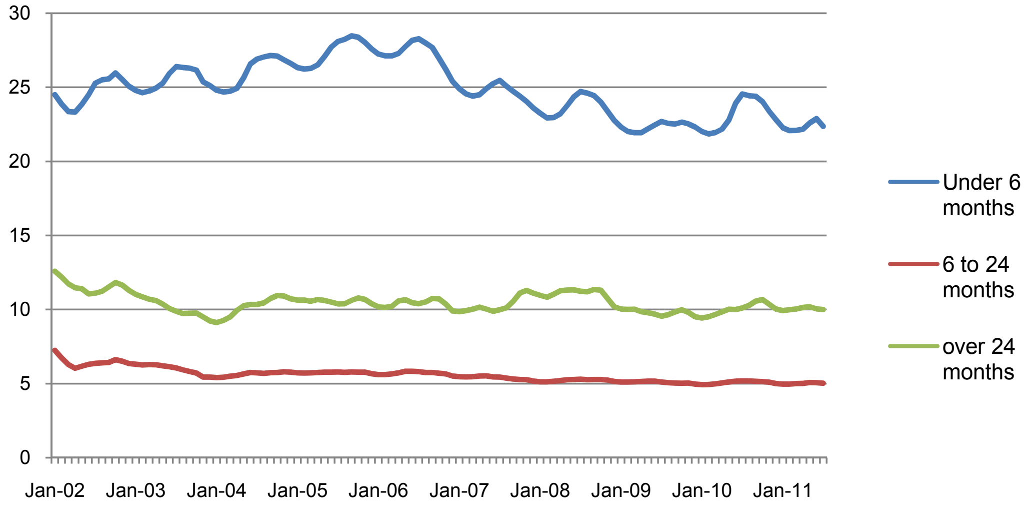
The proportion of beef cows calving for the first time in 2011 was similar to 2010, but higher than in the period 2005-2009, suggesting an increased replacement rate.   In recent years there has also been an increase in the number and proportion of beef cows calving at least 8 times from 5% in 2005 to 18% in 2011. This trend suggests increased longevity within the breeding herd.

2.5.3 Beef: animal health

On-farm mortality risk

Rationale
All other things being equal, reductions in on-farm mortality[18] will lead to fewer animals required for food production. Reduced disease should also lead to greater productivity. For cattle, overall mortality may be a better indicator than specific disease levels (for which we do not have full data in many cases).

On-farm mortality risk for beef cattle, GB
Deaths per 100,000 animal days - 13 month centred moving averages



Source: Defra, RADAR Cattle Tracing System

Trends
Although there have been fluctuations across the period, there has been an overall reduction in the on-farm mortality risk of registered beef calves (under 6 months) since 2006. For beef cattle age 6 months and above there has been little change in on-farm mortality since 2002.

[18] On-farm mortality rate is defined as the number of deaths per 100,000 days at risk on agricultural premises. It is calculated using the number of calf deaths divided by the number of calf days in the period. The number of calf days in the period represents 1 day for each animal each day. For example, if 5 animals were present on a location for 20 days the sum of the animal days would be 100. Conversely, if 20 animals were present on a location for 5 days the sum of the animal days would also be 100. This means, for any specified risk to the cattle in an area, that areas with a high density of cattle can be compared directly with areas with a low density of cattle.

On-farm mortality was calculated by analysing only premises that were registered as being an agricultural premise. Therefore, this data excludes deaths at slaughter houses.

2.5.4 Beef: manure management

The system of manure management is relevant to the control of environmental risks to air and water including ammonia.

For grazing livestock farms the 2012 Farm Practices Survey (FPS) reported that:

- 46% of lowland grazing livestock farms had facilities to store solid manure in heaps on a solid base, while for grazing livestock farms in less favoured areas (LFA) the proportion was 66%. These results are virtually unchanged from 2011. In both cases around 12% of the stores were covered.
- 62% of lowland grazing livestock farms had facilities to store solid manure in temporary heaps in fields. For LFA grazing livestock farms the proportion was 44%. Both results show little change from the 2011 FPS.
- 20% of LFA grazing livestock farms had facilities to store slurry in tanks, of these 15% were covered, again similar to 2011. 7% of lowland grazing livestock farms were able to store slurry in a tank, information on the proportion of these that were covered are not available for reasons of data confidentiality.

2.5.5 Beef: summary

Since 1990, average carcase weights have increased. There is little evidence of a departure from these trends in recent years, while at the same time the age at which animals are being slaughtered has remained at a similar level. The median age of the beef herd has changed little since pre Bovine Spongiform Encephalopathy (BSE) and Foot and Mouth Disease (FMD) restrictions, though overall longevity has increased due to changes in the overall distribution of age of cattle, illustrated through changes in the inter quartile range. There has been an overall reduction in the on-farm mortality risk of registered beef calves (under 6 months) since 2006. For beef cattle age 6 months and above there has been little change in on-farm mortality since 2002. Calving numbers suggest that more beef cows are productive for longer. Considering all these factors together suggests that, all other things being equal, the intensity of GHG emissions has marginally improved.

2.5.6 Beef: further development

Current statistics provide a partial picture of the relevant drivers of GHG emissions. The following measures have been proposed as potential factors for inclusion in the new agricultural GHG inventory. Not all of the following can feasibly be populated with robust data in the short term: although some of the data are collected through the Cattle Tracing System (CTS) there are significant complexities in extracting it from its current format.

- System including winter forage from maize or grass silage or hay and concentrate level
- Housing period, which can vary incredibly from year to year
- More information on combining age and weight at slaughter
- Fat score at slaughter
- Calving interval
- Grassland management including legume use

2.5.6 Beef: notes on data collection methodology and uncertainty

i) Carcase weights given here are from the Defra Slaughter house surveys. These surveys cover all the major slaughter houses, and are subject to small sampling errors. Links to the survey methodology are given in the Appendix.

Information from the Cattle Tracing System

ii) The CTS is an administrative dataset and all cattle in GB are included in the dataset. Thus estimates shown here are based on the full cattle population. Links to the methodology are given in the Appendix.

Farm Business Survey

iii) Where the sample size is relatively small, confidence intervals can be quite large, and care needs to be taken with interpretation of the significance of the differences. A link to information on the Farm Business Survey methodology is given in the Appendix.

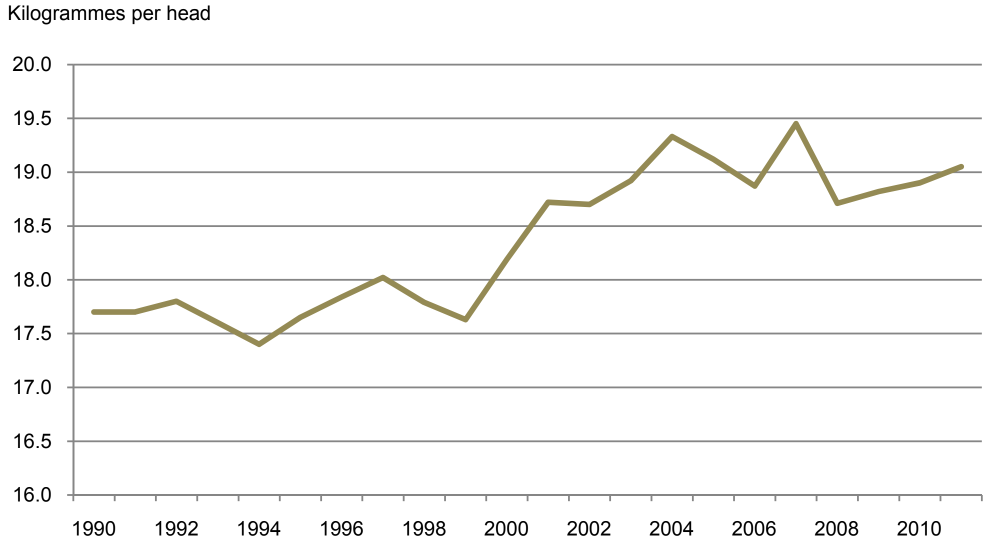
2.6 Sheep

2.6.1 Sheep: efficiency of output

Weight at slaughter

Rationale
Higher growth rates have the potential to reduce emissions and increase productivity. It is desirable for average carcase weights to increase through higher growth rates (achieved through measures such as feed efficiency, breeding) and not at the expense of increased intensity of greenhouse gas (GHG) emissions (where intensity is GHG emitted per kilogramme of meat produced).

Average dressed carcase weight for sheep and lambs, UK



Source: Slaughterhouse surveys, Defra, The Scottish Government, DARD (NI)

Note: excludes ewes and rams

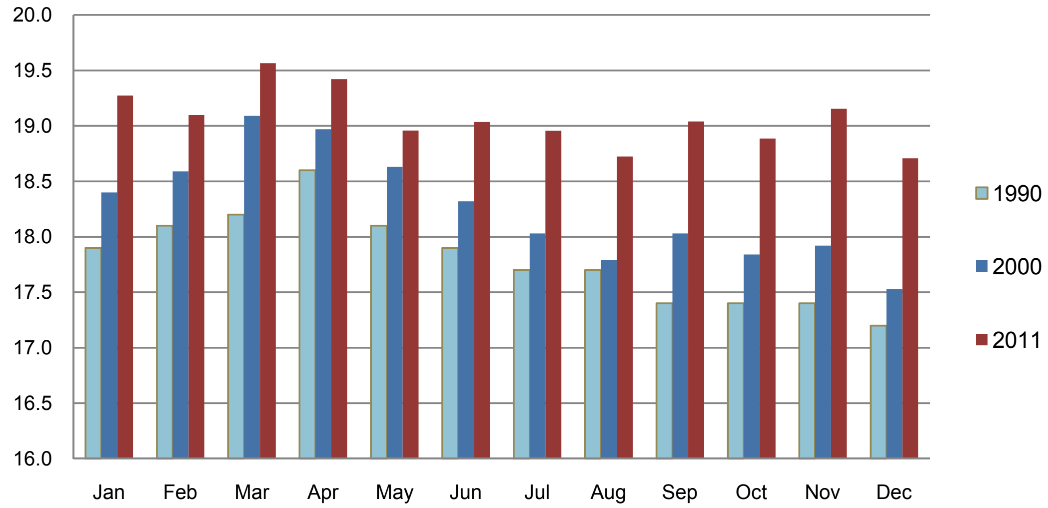
2.6.1 Sheep: efficiency of output (continued)

Monthly distribution of slaughter weights and marketing pattern

Rationale
All other things being equal, an increase in the annual average slaughter weights as a consequence of lambs being slaughtered later will not improve the intensity of emissions. The charts below show the distribution of slaughter weights throughout the year and the marketing pattern (the proportion of lambs slaughtered per month) which can help give an indication of the age at which animals are slaughtered.

Dressed carcase weight for sheep, UK

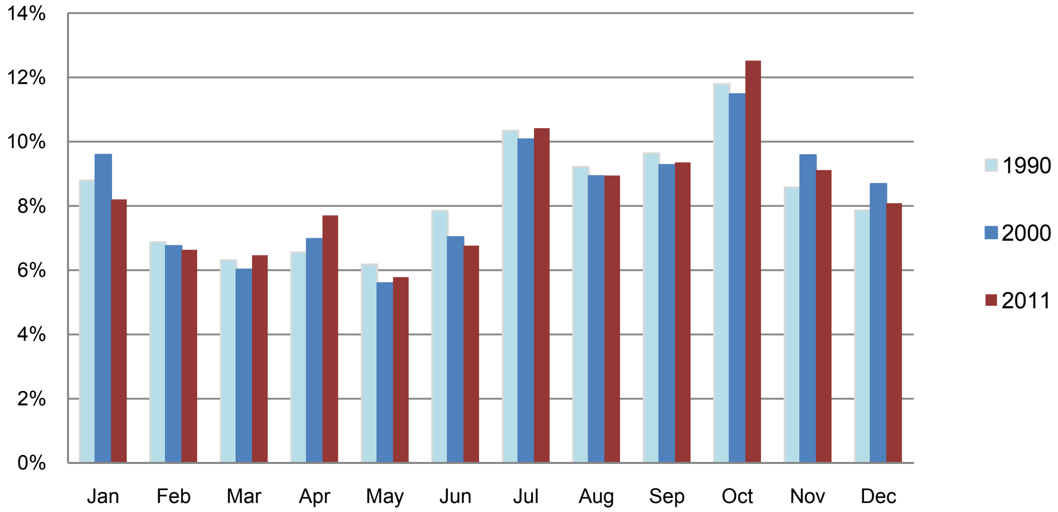
Kilogrammes per head



Source: Slaughterhouse surveys, Defra, The Scottish Government, DARD (NI)

Monthly marketing pattern for sheep, UK

Per cent



Source: Slaughterhouse surveys, Defra, The Scottish Government, DARD (NI)

2.6.1 Sheep: efficiency of output (continued)

Monthly distribution of slaughter weights and marketing pattern (continued)

Trends
There has been a trend towards increased carcase weight over the last twenty years which will in part be driven by farmers finishing to greater weights to achieve better prices. In 2001 FMD had a big effect in the uplands[19] leading to a significant reduction in the proportion of lighter lambs finished in the uplands. This will have also have had an effect on the rise in carcase weights post FMD but is not the sole reason for the overall increase.

Increased carcase weights could have been achieved by animals being slaughtered older and this would be demonstrated by a change in the marketing pattern. However the increase in carcase weights has taken place across the year, whilst the proportion of animals slaughtered has not changed significantly. Also the percentage of lambs being slaughtered between July and October has remained at the same level since 1990 which also suggests that lambs are not getting slaughtered older.

Table 5: Gross margins from breeding ewes (£/head), England

	Lowland breeding ewes				LFA breeding ewes			
	2005/06 (SGM)	2009/10 (SGM)	2009/10 (SO)	2010/11 (SO)	2005/06 (SGM)	2009/10 (SGM)	2009/10 (SO)	2010/11 (SO)
Number of animals	251	247	258	271	283	375	409	507
Forage area (hectares per head)	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2
Finished livestock sales	49	73	75	82	19	29	35	41
Store sales	8	15	11	7	12	22	18	13
Other lamb throughput	6	13	12	14	14	16	17	21
Miscellaneous revenue	0	1	1	2	0	1	0.7	1
Less flock depreciation	-4	-9	-9	-10	4	-8	-10	-10
Enterprise output	59	92	90	94	49	60	61	66
Variable costs								
Concentrates	12	15	15	17	7	11	10	11
Coarse fodder	2	2	1	2	2	4	3	4
Vet and medicine costs	5	6	6	6	4	5	5	5
Other livestock costs	8	10	10	11	6	6	6	8
Other crop costs	4	7	9	8	2	3	3	4
Total variable costs	31	42	40	44	21	28	28	33
Gross margin/ewe	**27**	**50**	**50**	**50**	**28**	**31**	**33**	**33**

The table above shows a comparison of gross margins for breeding ewes in 2005/06 and 2009/10 based on standard gross margin (SGM) typology and for standard output (SO) typology[20] in 2009/10 and 2010/11. Data for 2009/10 have been presented on both bases to provide an indication of the impact of the methodology change. Figures are for £ per head and have not been adjusted to reflect price changes due to inflation.

[19] Source: June Agricultural Survey. A regional breakdown can be seen in the Observatory Programme Indicators (indicator B12) at: http://www.defra.gov.uk/statistics/foodfarm/enviro/observatory/programme-indicators/

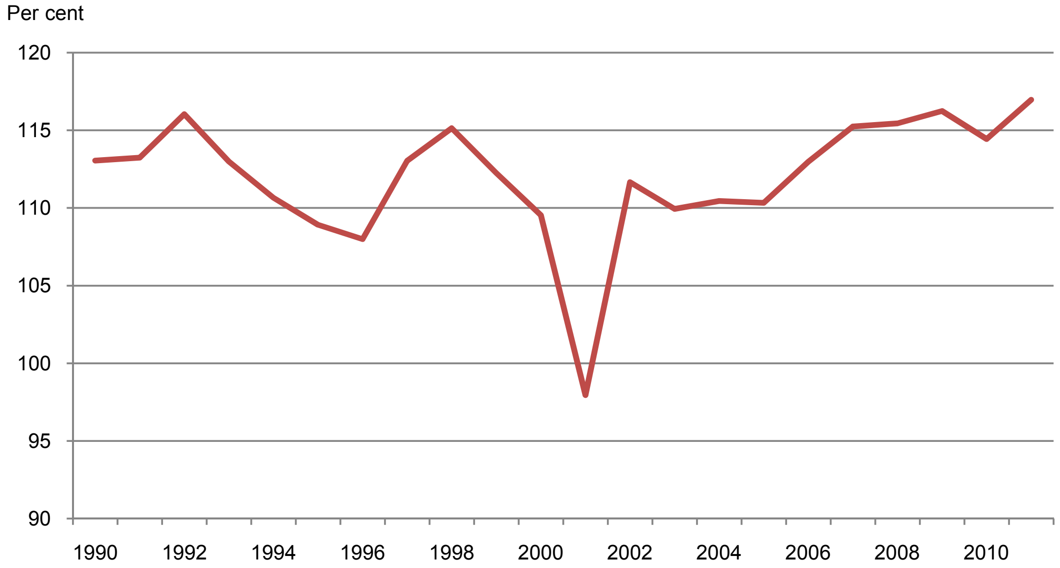
[20] Further details of the revised typology and its effect on the Farm Business Survey sample may be found at: http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-farmmanage-fbs-reviseclass_111221.pdf

2.6.2 Sheep: longevity and fertility

Surviving lamb percentage

Rationale
Increased fertility rates and longevity of breeding animals could help secure reductions in GHGs because it should mean that fewer breeding females will be required. By assessing the "surviving lamb percentage" (based on populations and slaughter statistics) it is possible to gain an overall indication of both the productivity of the ewe flock and lamb survival and all other things being equal an increase will represent an improvement in emissions intensity.

Surviving lamb percentage, GB



Source: Defra statistics, AHDB survey of auction markets

Definition of the surviving lamb percentage

The lambing percentage is calculated as (A + B)/(C+D)*100, where

A: Number of lambs at June (source June Survey)
B: Number of lambs born after December, but slaughtered before June (i.e. new season lamb slaughter), source: AHDB and Defra slaughter stats
C: Number of breeding ewes at December (source December Survey)
D: Number of ewe lambs put to the ram at December (source December Survey)

Trends
After lower levels in the mid 1990s and a dip in 2001 due to the FMD outbreak there has been a slight upward trend in recent years and in 2011 favourable weather conditions helped maintain this trend. Note: the survival of lambs is dependent on weather conditions, and this needs to be considered when interpreting year on year changes.

2.6.3 Sheep: summary

Carcase weights for lambs have increased since 1990, and this has occurred right through the year, suggesting that lambs are not getting slaughtered at an older age but are being finished[21] at greater weights. This change can be explained as a result of a combination of productivity gains, restrictions on the movement of the animals during the FMD outbreak and the reduction in lighter lambs in the uplands. The percentage of lambs being slaughtered between July and October has remained at the same level since 1990 which also suggests lambs are not getting slaughtered later. Trends over the last 5 years suggest that ewe flock fertility and lamb survival have improved in recent years with 2011 seeing the highest surviving lamb percentage of the period since 1990.

2.6.4 Sheep: further developments

Current statistics provide a partial picture of the relevant drivers of GHG emissions. The following are the most relevant pieces of information which are currently not included here. Not all of the following can feasibly be populated with robust data in the short term.

- More information on the age at which lambs are slaughtered. This would be about providing more detail than is currently available. A survey of sheep producers, conducted on behalf of Defra, took place in June 2012 with the aim of gaining a more accurate picture of the age at which lambs are slaughtered. Results of this study will feed into UK estimates of GHG emissions for sheep and lambs.

- Measures of the longevity of breeding flock. This information represents an important gap. It is not clear if this could be populated with data in the short term.

2.6.5 Sheep: notes on data collection methodology and uncertainty

i) Carcase weights given here are from the Defra Slaughter house surveys. These surveys cover all the major slaughter houses, and are subject to small sampling errors. Links to the survey methodology are given in the Appendix.

Farm Business Survey

ii) Where the sample size is relatively small, confidence intervals can be quite large, and care needs to be taken with interpretation of the significance of the differences. A link to information on the Farm Business Survey methodology is given in the Appendix.

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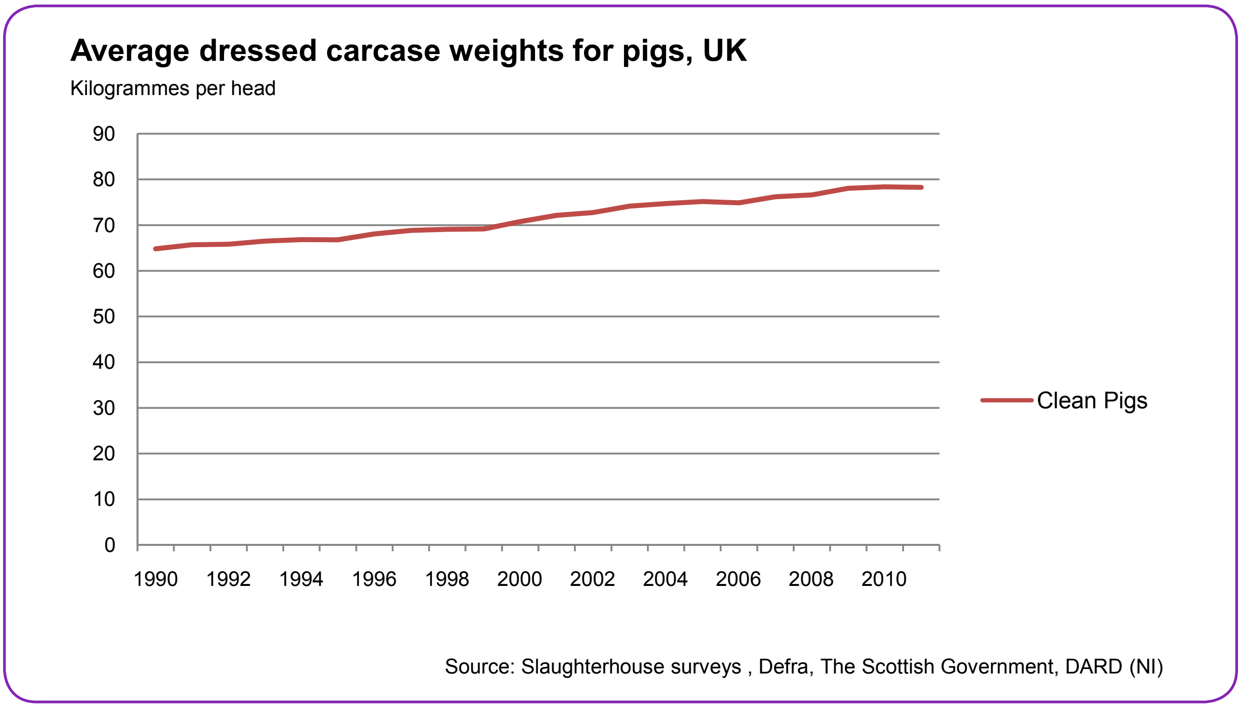
[21] Finishing is the feeding process used prior to slaughter for cattle or sheep intended for meat production.

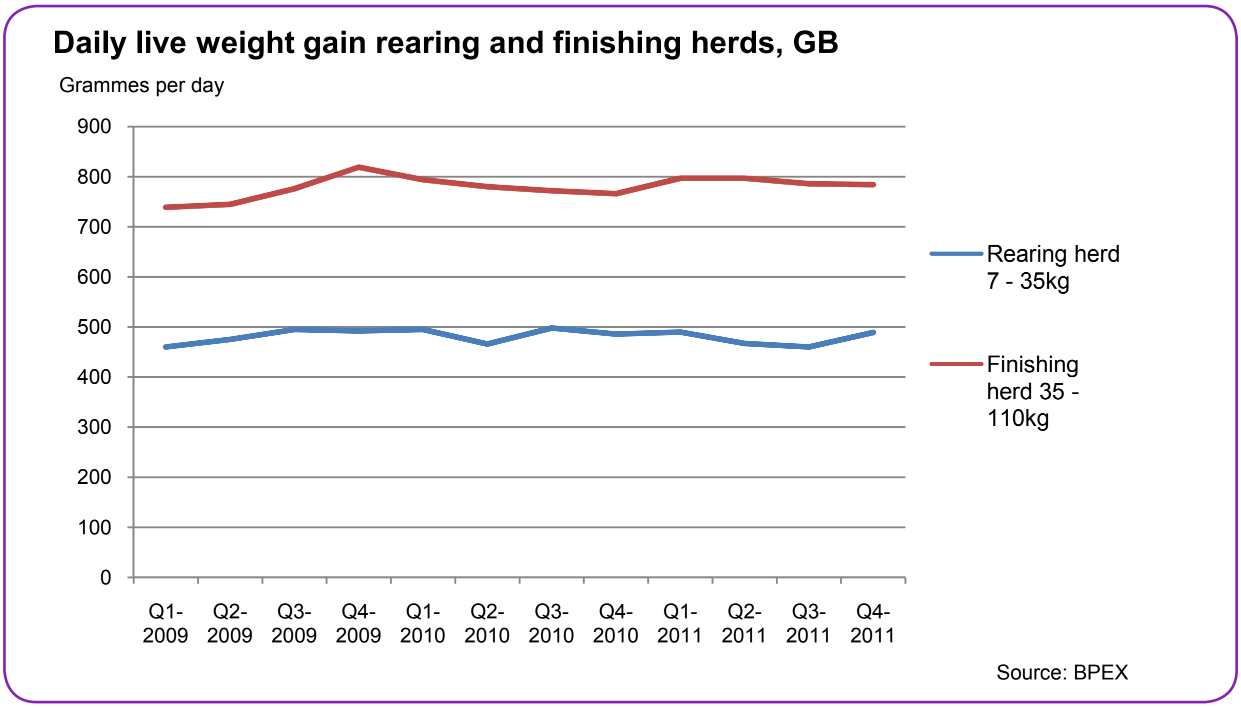
2.7 Pigs

2.7.1 Pigs: efficiency of output

Weight at slaughter

Rationale
More efficient finishing has the potential to reduce emissions and increase productivity. It is desirable for average carcase weights to increase though not at the expense of increased intensity of emissions.





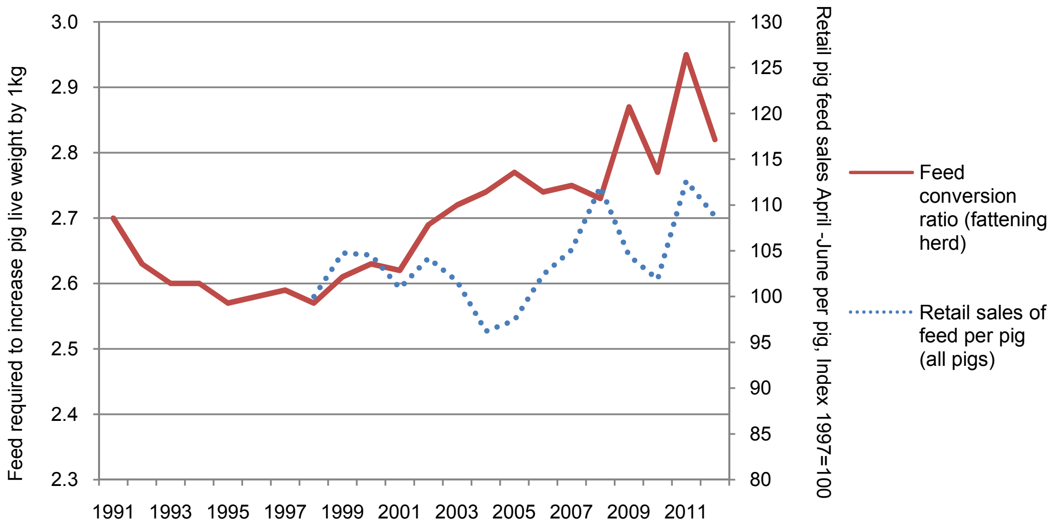
Trends
Average carcase weights have increased consistently since 1990. Increases in daily live weight gain were seen in both the rearing and finishing herd during 2009. Since then levels have remained relatively stable.

2.7.1 Pigs: efficiency of output (continued)

Feed conversion ratio of fattening herd and live weight gain of rearing and finishing herds

Rationale
More efficient use of feed has the potential to reduce emissions.

Feed conversion ratios for pig fattening herd, GB



Source: feed conversion AHDB, retail pig feed sales Defra surveys, pig population June Survey

Trends
The feed conversion ratio (FCR) for the fattening herd has increased since the mid 1990s albeit with some recent fluctuations. This suggests that the increase in carcase weights could have been achieved through more feed per kilogramme of meat produced. This would imply a reduction in feed efficiency (thus all other things being equal increased emissions). Several factors could explain this including achieving and maintaining heavier weights and disease.

A crude measure of retail sales of feed per pig suggests the rate of increase in this average is below the rate of increase in average carcase weights, and this would suggest that feed efficiency has improved. However, this measure has limitations and the FCR provides a more reliable indication of the position

2.7.1 Pigs: efficiency of output (continued)

Table 6: Gross margins from breeding sows (£/head), England

	2005/06	2009/10		2010/11
	(SGM)	(SGM)	(SO)	(SO)
Average herd size: breeding sows	254	129	143	118
Enterprise output	**1065**	**2320**	**2368**	**2318**
Variable costs				
Concentrates	519	1205	1221	1386
Vet and medicine costs	35	66	69	69
Other livestock costs	85	147	141	153
Heating			3	1
Total variable costs	639	1420	1434	1609
Gross margin/pig	**425**	**900**	**934**	**709**

Source: Farm Business Survey

The table above shows a comparison of gross margins for breeding sows in 2005/06 and 2009/10 based on standard gross margin (SGM) typology and for standard output (SO) typology[22] in 2009/10 and 2010/11. Data for 2009/10 have been presented on both bases to provide an indication of the impact of the methodology change. Figures are for £ per head and have not been adjusted to reflect price changes due to inflation.

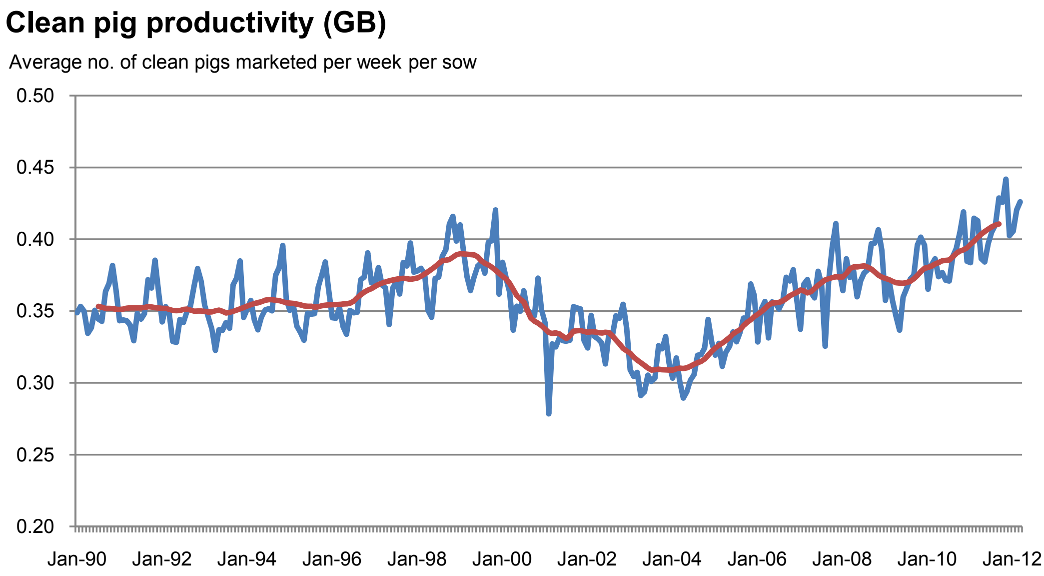
Data from the Farm Business Survey indicates that total variable costs more than doubled across the period largely due to increased expenditure on concentrates. Enterprise output also more than doubled across the period but the increase was less than that of the variable costs.

[22] Further details of the revised typology and its effect on the Farm Business Survey sample may be found at: http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-farmmanage-fbs-reviseclass_111221.pdf

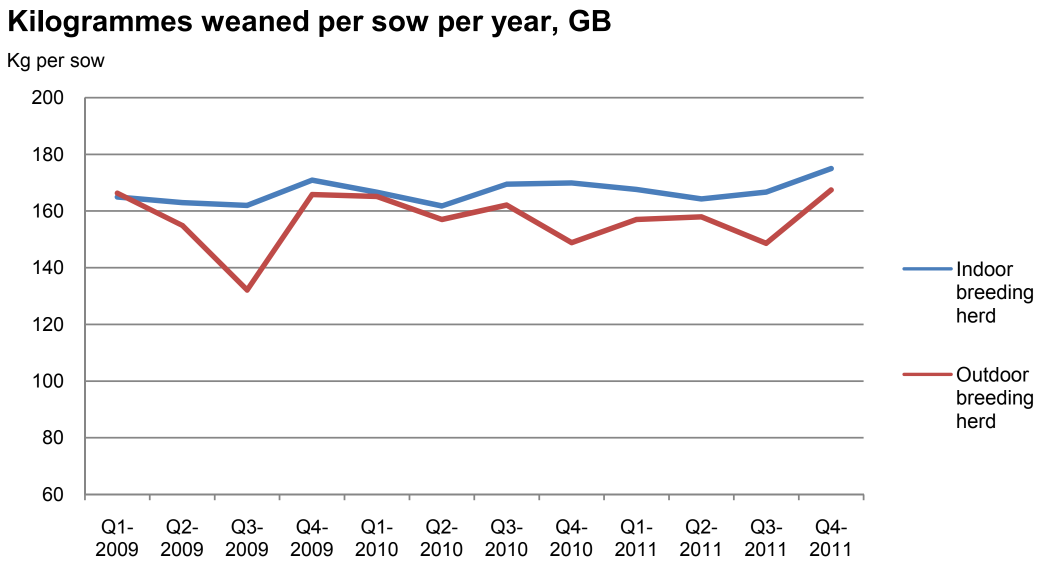
2.7.2 Pigs: animal health and fertility

Pig productivity (fertility and mortality)

Rationale
Comparing pig marketings with breeding herd populations allows an assessment of pig survival and productivity whilst considering changes in the weight of weaned piglets per sow allows an assessment of sow fertility.



Source: Agricultural surveys , Defra, Slaughterhouse surveys, Defra, The Scottish Government, DARD (NI)



Source:BPEX

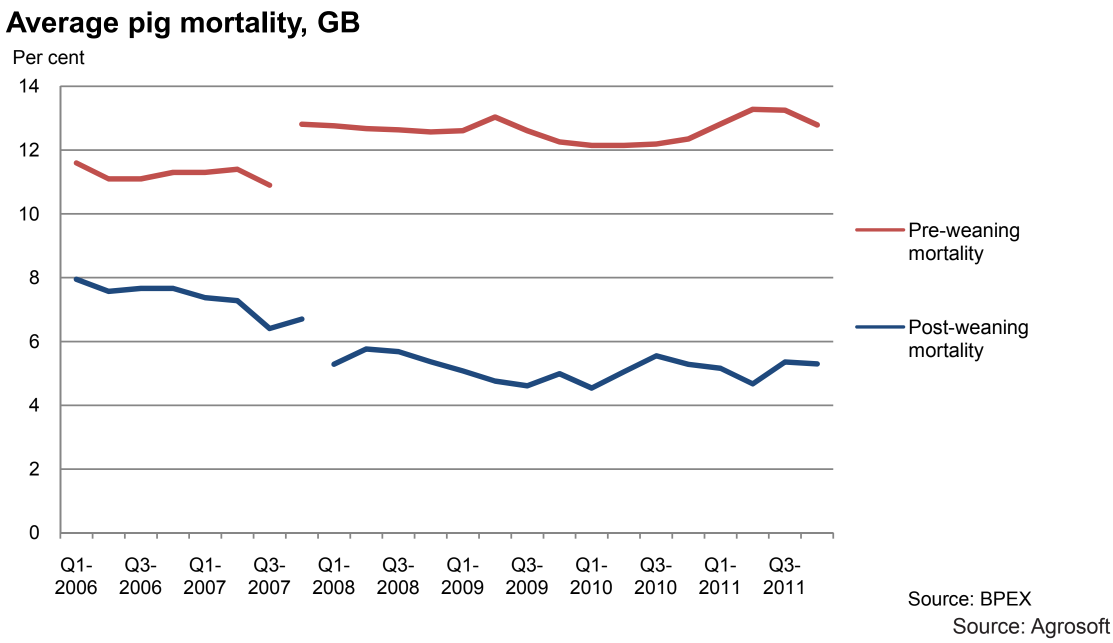
Trends
Clean pigs marketed per sow per week dip around 2003/04 but there has been a gradual upward trend since and current levels exceed the previous high points of the late 1990s. Disease will have influenced this trend, for example swine flu in 2000 and Foot and Mouth Disease (FMD) in 2001 - both of which contributed to a decrease. Additionally, non-notifiable pig wasting diseases were prevalent from the late 1990s, though these are considered to have been brought under better control since 2004.

The increased proportion of sows which are kept outdoors may have offset some of the productivity gains seen in recent years and the second chart above illustrates the variation in kilogrammes weaned per sow per year in the outdoor breeding herd.

2.7.2 Pigs: animal health and fertility (continued)

Mortality

Rationale
All things being equal, reductions in mortality will lead to fewer breeding animals required for food production.



Note that the break in the series indicates a change in methodology, including a change in the sample.

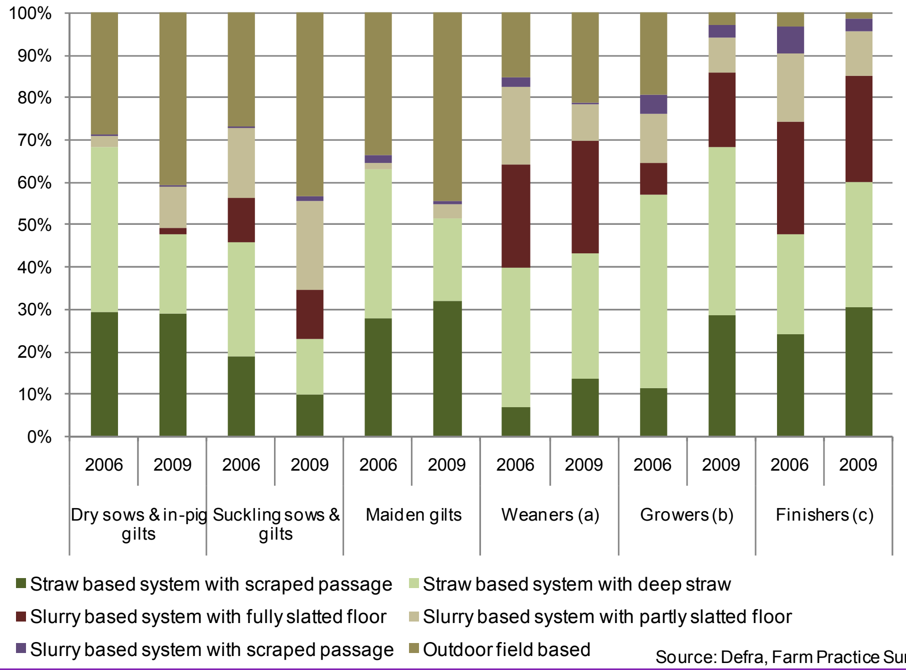
Trends
Data from BPEX suggests that there does not appear to have been much change in pre weaning mortality over the last 5 years.

The step change evident in the chart is associated with a change in the sample size which increased from Q4 2007 for breeding herd and from Q1 2008 for the rearing and feeding herd. It is possible that there have been some reductions in post-weaning mortality over the period, although changes to the sample at the end of 2007 mean it is difficult to interpret the overall trend. More recently there has been little change.

2.7.3 Pigs: housing and manure/slurry management

The housing system used - e.g. the type of manure/slurry management, whether pigs are kept outdoors and systems which relate to length of time to finish can have an effect on the levels of GHG emissions, and for the later, emission intensity.

Proportion of pigs by type in each housing type 2006 & 2009, England



Source: Defra, Farm Practice Survey

Note
(a) Weaners were classed as pigs weighing up to 20kg in 2006 and those between 7kg and 30kg in 2009
(b) Growers were classed as pigs weighing between 20kg and 50kg in 2006 and between 30kg and 65kg in 2009
(c) Finishers were classed as pigs weighing over 50kg in 2006 and over 65kg in 2009

Trends
In terms of housing the FPS 2009 reported that around half of all pigs are housed in solid manure based systems, around a third in slurry based systems and the remainder outdoors. There is considerable variation in housing types across types of pig unit. For example growers and finishers are less likely to be kept in an outdoor environment. This is illustrated in the chart above.

In terms of manure and slurry management the FPS 2011 surveyed 243 holdings with pigs. From this relatively small sample it is difficult to draw a precise conclusion; however, they do provide an approximate indication that:

- 40 - 55% of pig holdings had storage facilities for solid manure on a solid base.
- 15 - 25% could store slurry in a tank; of these less than one fifthof tanks were covered (17% with CI +/-9%).
- Around 1 in 10 (13% with CI +/- 4%) could store slurry in a lagoon and 1 in 20 (6% with CI +/-3%) store slurry in another type of store. There is insufficient evidence to draw conclusions on the proportions with covers.

2.7.4 Pigs: summary

Carcase weights have increased consistently since 1990. However, data on feed conversion ratios suggests that this increase has been achieved by proportionally more feed which may have increased emissions intensity. Sow fertility and post weaning mortality have shown improvements over the last 5 years, both of which may have the effect of decreasing the intensity of emissions. Pre weaning mortality remains high, and is little changed since 2006, the earliest point for which we have data.

2.7.5 Pigs: further developments

Current statistics provide a partial picture of the relevant drivers of GHG emissions. The following are the most relevant pieces of information which are currently not included here. Not all of the following can feasibly be populated with robust data in the short term.

- More productivity measures such as: rearing feed conversion ratio; average live weight; feed consumed per sow. This would be about providing more detailed information than is currently provided in this section. Some data are available although currently for relatively short timescales. As more data are collected these will be included.

2.7.6 Pigs: notes on data collection methodology and uncertainty

i) Carcase weights given here are from the Defra Slaughter house surveys. These surveys cover all the major slaughter houses, and are subject to small sampling errors. Links to the survey methodology are given in the Appendix.

Farm Business Survey

ii) Where the sample size is relatively small, confidence intervals can be quite large, and care needs to be taken with interpretation of the significance of the differences. A link to information on the Farm Business Survey methodology is given in the Appendix.

BEPEX

iii) BEPEX data are taken from publicly available datasets published on their website. These are not official government statistics.

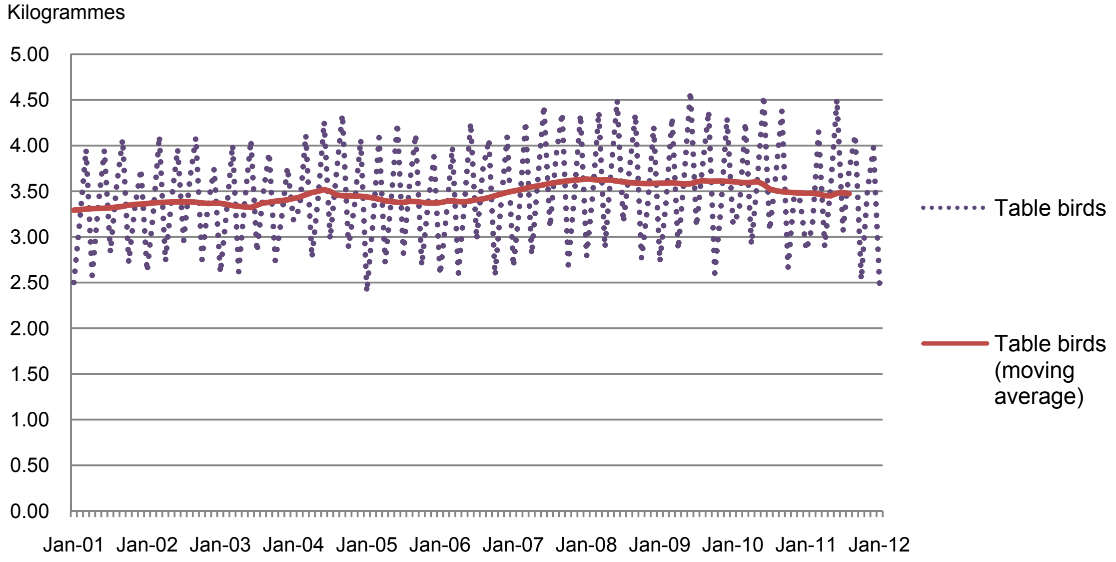
2.8 Poultry

2.8.1 Poultry: efficiency of output

Feed conversion ratio[23]

Rationale
More efficient use of feed has the potential to reduce emissions.

Kilogrammes of feed per kilogramme of poultrymeat, GB



Source: Defra, Hatcheries Survey, Integrated Poultry Unit Survey

Trends
The chart above shows that the overall moving average trend is relatively stable; a slight upward trend since 2007 has been largely reversed in 2010/11, although the change is well within the year on year variation.

2.8.2 Poultry: housing and manure management

Housing systems and type of manure management, for example use of in-house litter drying and incorporation time of manure, can have an effect on the levels of emissions. Whilst some data were collected as part of the 2009 Farm Practices Survey the implementation of the EU-wide ban on the keeping of hens in conventional cages at the beginning of 2012 means that this may no longer be reflective of the current situation.

2.8.3 Poultry: summary

Defra has limited information from national level datasets for the poultry sector. From information which is available the underlying trend in feed conversion for 'table birds' has increased marginally since 2001, however, these changes are well within the year on year fluctuation.

2.8.4 Poultry: further developments

Limited information is currently provided on the poultry sector. The main factors proposed for the inventory development relate to information on housing type and system. The feasibility of providing robust data in the short term is not clear at present.

[23] For data availability reasons the feed conversion ratio (FCR) shown is kilograms of feed per kilograms of meat based on carcase weights. The FCR is more usually expressed in relation to live weight. Carcase weight is approximately 75% of the live weight which would give a lower ratio feed per kilograms of meat produced

2.9 Land and nutrient use

Background information

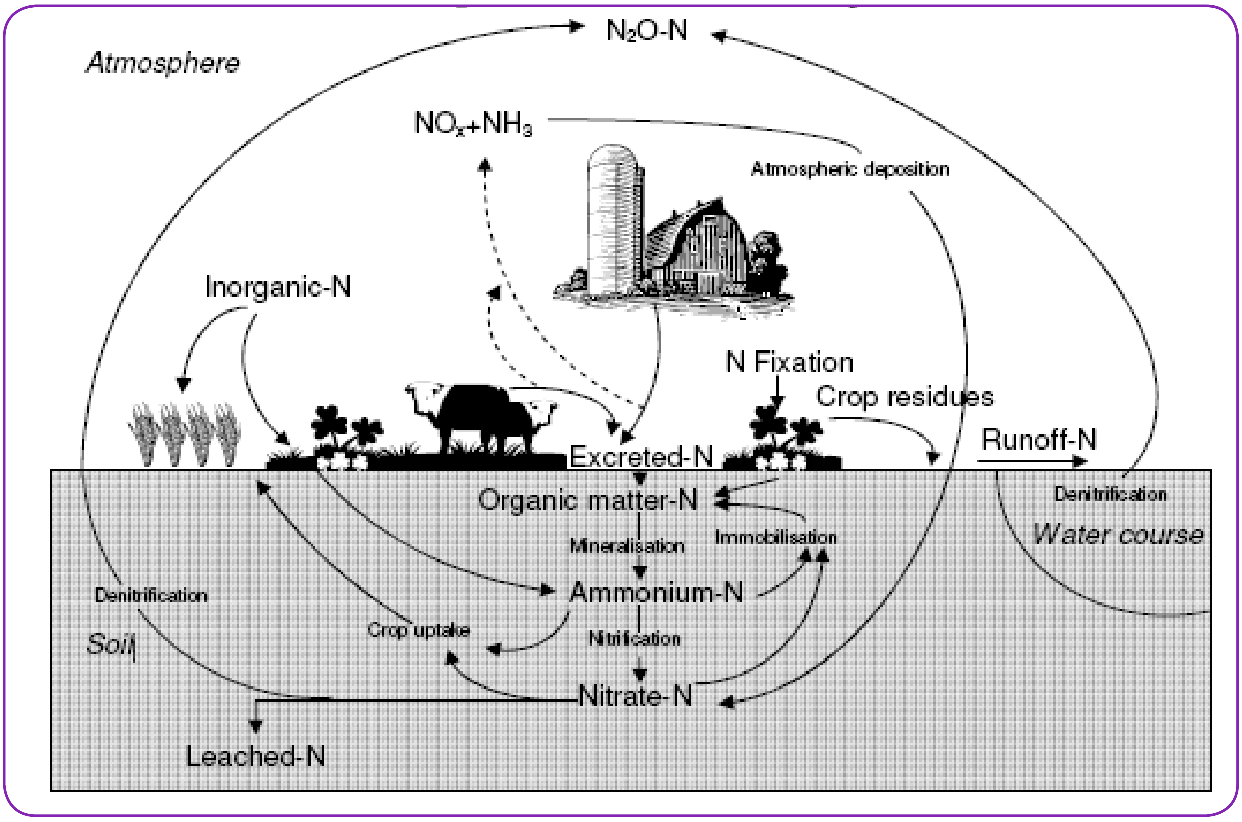
Inputs of synthetic or livestock derived nitrogen fertilisers are critical to maintain yields of food and fodder crops, but the yield benefits of nitrogen application can come at the expense of polluting losses to air and water and emissions of greenhouse gasses (GHG). Losses can be minimised by reducing the surplus in soils or reducing the risk of this surplus being lost to the environment through the uptake of best practice management techniques and on farm efficiency measures. This section covers the outcomes associated with the uptake of these practices through GHG intensity measures. Section 3 includes the uptake of specific management practices and efficiency measures.

GHG emissions from fertilisers principally arise directly from the soil as microbes break fertilisers down in the nitrification and denitrification processes (see Figure 2). These losses generally occur within the first few days of fertiliser application. However, significant losses also occur indirectly after nitrogen has leached from soils into water courses, or after gaseous loss as ammonia followed by deposition to soils. In both cases, there are detrimental impacts on biodiversity and human health.

A number of factors influence the level of GHG emissions resulting from fertiliser applications. These include land use, the soil nitrogen content before application, the organic carbon content of the soil, the soil moisture content, and compaction of the soil (the latter two are associated with reduced soil aeration). Not all of these are covered within this publication; the potential for these are covered under further developments at the end of this section.

Within this publication we focus on GHG intensity, though this could result in pollution swapping (for example, from nitrous oxide to water quality). A reduction in absolute levels of nitrogen would provide multiple environmental benefits.

Figure 2: Soil, Nitrogen and Emissions



2.9.1 Land and nutrient use: efficiency of output

Long term measure of change: Crop production per unit of manufactured N applied[24]

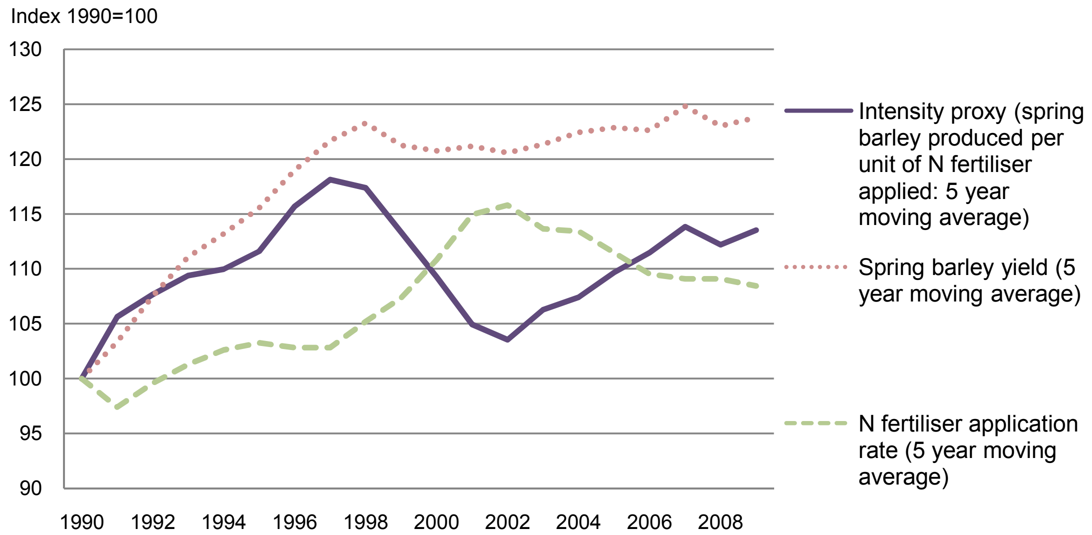
Rationale:
Trends in crop yields provide a headline measure of productivity. With respect to emission intensity it is necessary to understand trends in inputs (such as fertiliser) to achieve higher yields. The ratio of crops produced to nitrogen fertiliser applied provides a proxy measure for emissions intensity.

Random factors in crop production (such as the weather) also impact on yields, and so this measure is only suitable for monitoring change over the longer term (5 to 10 years). Application rates of nitrogen based fertiliser per hectare provide an indication of short term changes (year on year).

Wheat produced per unit of N fertiliser applied, England

Source: British Survey of Fertiliser Practice, Defra Cereal Production Survey

Spring barley produced per unit of N fertiliser applied, England



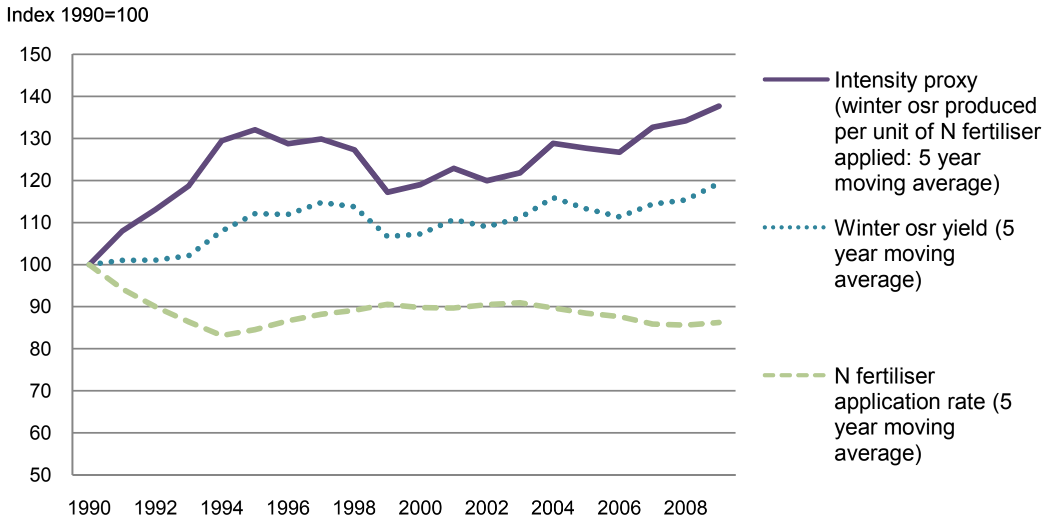
Source: British Survey of Fertiliser Practice, Defra Cereal Production Survey

[24] This measure does not include organic nitrogen from manure or slurry.

2.9.1 Land and nutrient use: efficiency of output (continued)

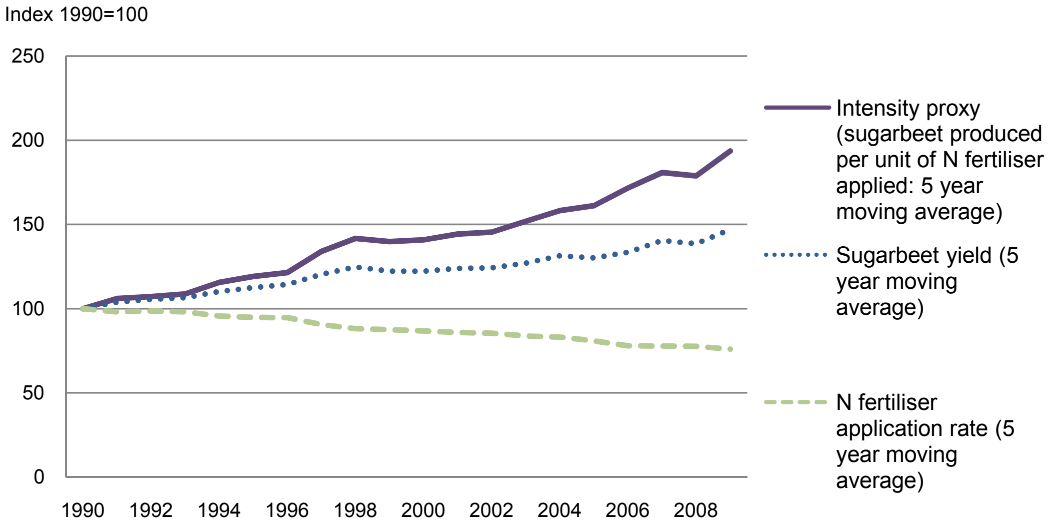
Long term measure of change: Crop production per unit of manufactured N applied[24] (continued)

Winter oilseed rape produced per unit of N fertiliser applied, England



Source: British Survey of Fertiliser Practice, Defra Oilseed Rape Production Survey

Sugarbeet produced per unit of N fertiliser applied, England and Wales



Source: British Survey of Fertiliser Practice, Defra Agricultural in the UK

For an illustration of the magnitude of the trend and irregular components of the time series for wheat please see (iv) at the Appendix.

[24] This measure does not include organic nitrogen from manure or slurry.

2.9.1 Land and nutrient use: efficiency of output (continued)

Long term measure of change: Crop production per unit of manufactured N applied[24] (continued)

Trends
The quantity of wheat produced per unit of nitrogen applied has been higher in recent years compared with 1990 levels. The trend in this measure was upwards until the late 1990s as yields increased with little increase in nitrogen application rates. Wheat yields have stabilised over the last decade, despite a brief period of increased nitrogen application rates between 2001 and 2005 resulting in a reduction in the quantity of wheat produced per unit of nitrogen applied in this period. Note: the measures referred to here are 5 year moving average trends which smooth the random year on year variation which is present in this time series. The latest year for which figures are available using this method is 2009. Any later estimates of the trend are less certain, since for year on year changes, the random component in the data series is more significant than the trend component.

Over the long term, wheat yields have increased and are currently 12% above 1990 levels, though the rate of increase has slowed considerably over the last decade. For wheat, nitrogen application rates per ha have been fairly constant over the last 20 years. There have been some short term changes in response to fertiliser prices which started rising significantly in autumn 2007. They remained high until summer 2009 leading to a fall in application rates, this was followed by a rise from 2009 to 2011.

The trends for production of spring barley and winter oilseed rape per unit of nitrogen applied are similar to those for wheat, while sugar beet has shown a consistent upward trend since 1990. These are illustrated in the charts above.

Latest position

There is variability in production from year to year due to weather, disease and pest pressure affecting yields. Early indications for 2012 are for a 1% increase in the area of winter wheat. The total barley area is also estimated to increase by around 1%; a reduction in the area in winter barley offset by an increased area of spring barley. The area of oilseed rape is anticipated to increase by 4%. However, there may be changes to both the cereal area taken to harvest and yields due to the effects of the early spring drought and the subsequent wet cool weather during April and early May which increased pest and disease pressure. In particular the poor maize drilling may encourage higher levels of whole crop cereal silage. Currently yield potential for cereal crops at the national level are described as “good”. These modest changes would not be expected to have a dramatic impact on the level of emissions.

[24] This measure does not include organic nitrogen from manure or slurry.

2.9.1 Land and nutrient use: efficiency of output (continued)

Short term measure of change: manufactured nitrogen application per hectare

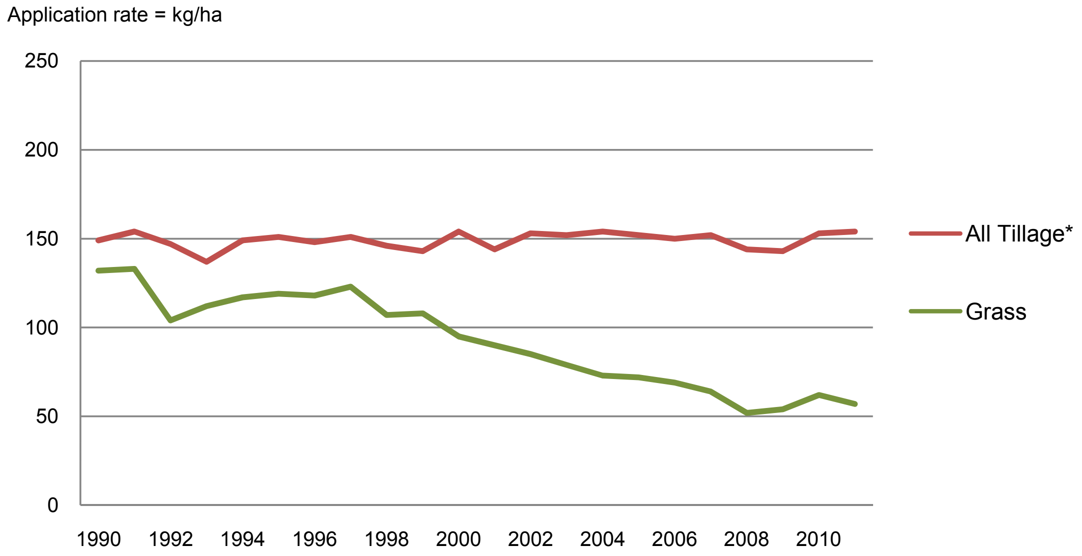
Rationale
Trends in average application rates provide a short term indication of (GHG) intensity (since they are less affected by random factors which impact on yields).

Trends
The overall application rate for nitrogen fertiliser has fallen substantially over the last 20 years. Whilst arable application rates have remained relatively stable, grassland application rates have reduced explaining the majority of the fall in recorded nitrous oxide emissions. As shown in the previous section, over this period cereal yields have increased, so more cereals are being produced for roughly the same amount of nitrogen applied.

More recently, the survey results show an increase in the overall application rate of nitrogen on all crops and grass in GB to 101kg/ha in 2011 (which is little change on 2010) from 97kg/ha in 2009 and 95kg/ha in 2008. It is likely that the low application rates in 2008 and 2009 were in response to higher fertiliser prices (which started rising significantly in autumn 2007 and remained high until summer 2009).

The 2010 and 2011 application rates appear to have reverted to the long-term trends; nitrogen rates on crops (150 kg/ha in 2011) have been roughly in the range 145-150kg/ha since the early 1980s. Overall application rates on grass (57kg/ha in 2011) have been declining over the same period from around 130kg/ha in 1990.

Average nitrogen fertiliser application rates, England and Wales



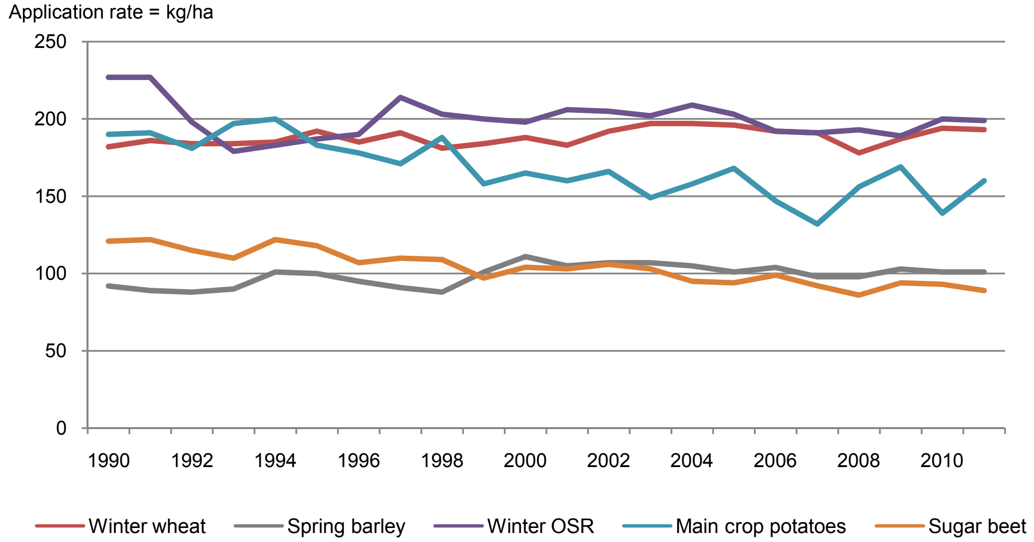
*All tillage includes crops but not bare fallow, set-aside or grassland

Source: British Survery of Fertiliser Practice

2.9.1 Land and nutrient use: efficiency of output (continued)

Short term measure of change: manufactured nitrogen application per hectare (continued)

Average fertiliser application rates, England and Wales



Source: British Survey of Fertiliser Practice

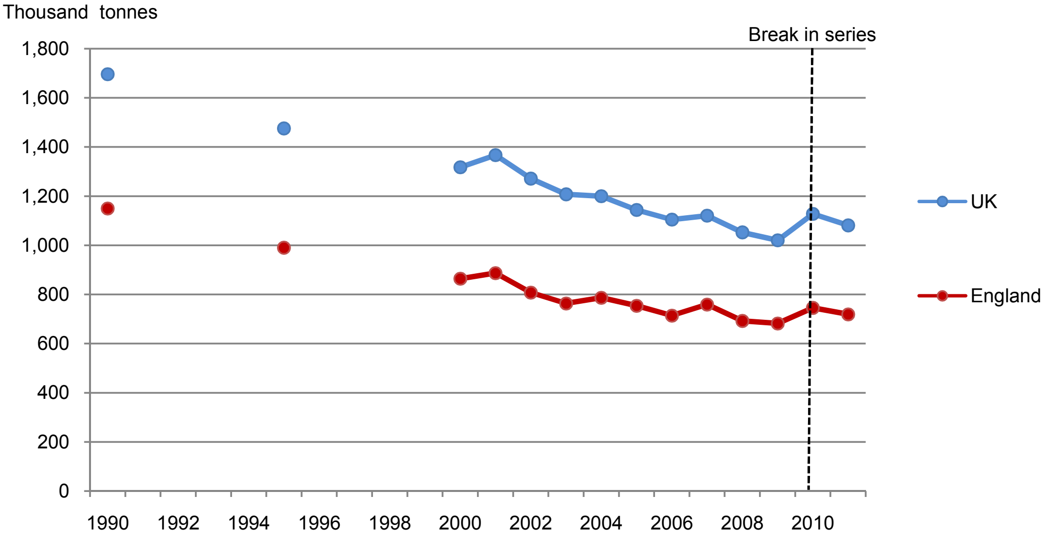
2.9.1 Land and nutrient use: efficiency of output (continued)

Soil nitrogen balance

The soil nitrogen balance provides a measure of the total loading of nitrogen on agricultural soils each year.

Rationale
The overall balance of nitrogen[25] provides a high level indicator of potential environmental pressure allowing comparisons over time and between countries. All other things being equal, more efficient use of synthetic and organic nitrogen fertiliser will be illustrated through a declining nitrogen balance which will in turn lead to a reduced risk of nitrous oxide emissions and other environmental pressures.

Nitrogen balance from agriculture, UK and England



Source: Defra statistics

Note: from 2010 in England, June Survey data for land and animals are collected only for commercial farms[26] which has resulted in a break in series.

Trends
The estimates of nitrogen balances show an overall decline over the last 20 years, and this will be associated with a lower risk of all forms of nitrogen loss to the environment.

Provisional estimates for 2011[27] suggest that the nitrogen balance for England was a surplus of 719 thousand tonnes. This is a decrease of 27 thousand tonnes compared to 2010 and a reduction of 145 thousand tonnes compared to 2000 and is in line with the longer term trend. The reduction between 2010 and 2011 has been driven by increased offtake from harvested cereals, a reduction in the nitrogen fixation from pulses (due to reduced planted areas) and reduced cattle populations. These have offset a small increase in inputs from inorganic nitrogen fertilisers.

The increase seen in the overall surplus in 2010 was largely due to an increase in fertiliser application rates to many crops in 2010. It is likely that lower applications rates in 2008 and 2009 were in response to higher fertiliser prices, which started rising significantly in autumn 2007 and remained high until summer 2009.

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25 The nitrogen balance includes all nitrogen inputs synthetic and organic, and off-takes, crop production and fodder production for livestock, including grass.
26 See http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-landuselivestock-june-junemethodology-20120126.pdf for information about the thresholds applied.
27 The latest estimates for UK soil nutrient balances can be found on the Defra website at: http://www.defra.gov.uk/statistics/foodfarm/enviro/observatory/research-projects/published-research/soil-projects/

2.9.2 Land and nutrient use: impact of farm performance

So far this section has focused on application of manufactured nitrogen. Organic manures are also an important source of nitrogen but data on the volume of manures applied are sparse. Historically, the British Survey of Fertiliser Practice (BSFP) has focussed on the application of manufactured fertilisers although in recent years it has also collected information on the use and movement of organic manures. However, it should be remembered that the underlying sample design is constructed to measure manufactured fertiliser usage and may not wholly represent the population of farmers using organic manures.

Organic manures applied to agricultural land may be produced on farm by livestock as slurries, farmyard manure (FYM) and poultry manures or imported from other sources such as treated sewage sludges (also called bio-solids) and some industrial 'wastes' such as paper waste or brewery effluent. Of the 1,429 farms in the 2011 BSFP around 70% (997) used organic manures on at least one field on the farm. Table 7 shows the percentage of farms using each type of manure in Great Britain, 2006 - 2011

Table 7: Percentage (%) of farms using each type of manure, GB 2006 - 2011

	None	Cattle FYM	Cattle slurry	Pig FYM	Pig slurry	Layer manure	Broiler/ turkey litter	Other FYM	Other
2006	30	59	19	2	1	2	2	3	3
2007	33	56	20	1	1	2	2	2	3
2008	31	55	18	3	1	2	3	5	4
2009	32	53	17	2	1	2	2	3	4
2010	33	53	17	2	1	2	2	4	4
2011	32	53	17	2	1	2	2	5	5

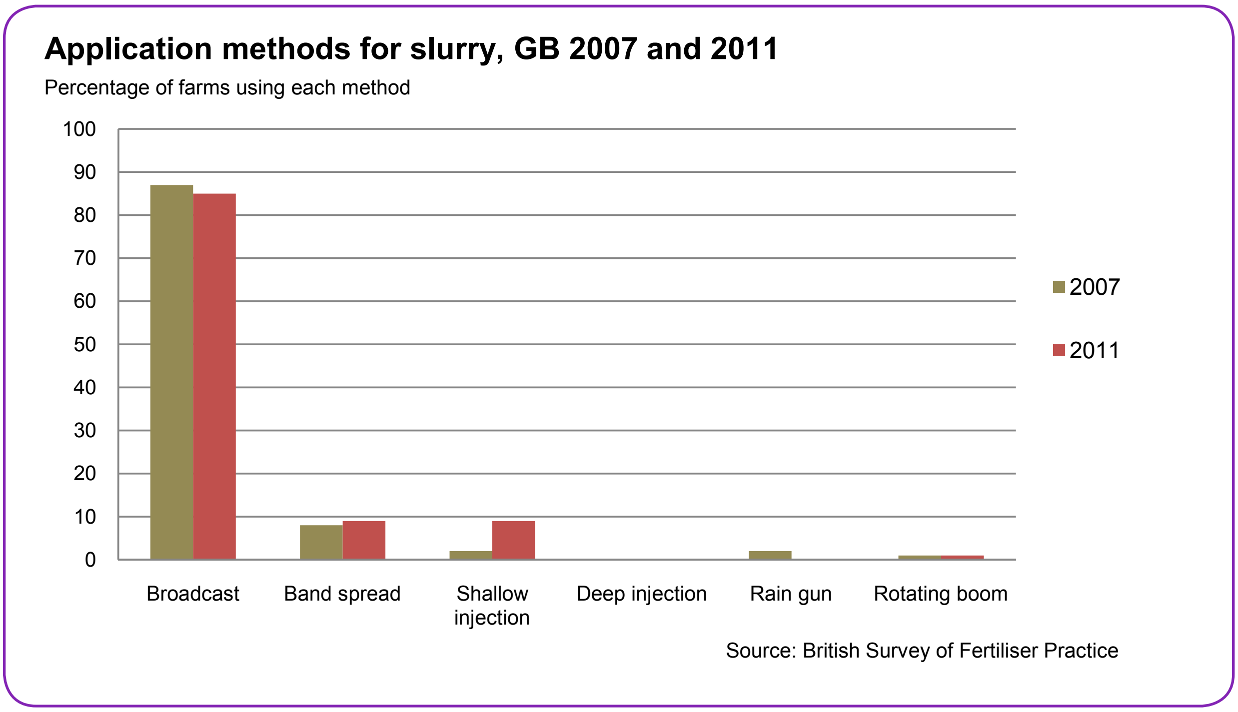
Source: British Survey of Fertiliser Practice

Cattle manure from beef and dairy farms is by far the largest volume of manure type generated in Great Britain. The percentage of farms using cattle FYM has declined by 6% since 2006, whereas the use of cattle slurry has remained more consistent over the period and was used on 17% of farms in 2011. Not all of the manure generated by a farm is necessarily retained for use by that farm and excess manure/slurry can be exported for use elsewhere. The BSFP indicates that less than 3% of farms export manure.

Methods of slurry application can have a bearing on GHG emissions; slurries can have high direct GHG emissions since the majority of the nitrogen content is in available forms. This high available nitrogen content can also make them prone to indirect emissions from ammonia losses. Certain methods of application, such as injection or use of a trailing shoe can help mitigate these losses.

Percentage of farms using each type of application method by slurry type, GB 2007 and 2011

The following chart compares the percentage of farms using each type of slurry application method in Great Britain in 2007 and 2011 (it should be noted that some farms may be using more than one method). The data serve as a guide only and reflect the proportion of farms adopting each application method (where slurry was applied). The data do not account for the area of each farm receiving slurry (or any variation in the rate at which slurry may have been applied using different application methods). Notwithstanding these considerations, it is clear that broadcast application is by far the most widespread method adopted.



If slurries are applied to land in the autumn and winter months they may also be associated with leaching losses. These indirect emissions from slurry can potentially be high unless careful storage and application management is in place. Table 8 shows the timing of applications of different organic manure types for 2011 (as a proportion of fields receiving applications of each manure). The crops have been classified as either “winter sown”, “spring sown” or “grass”. This segmentation highlights the prevalence of applications in August and September for winter sown crops (prior to drilling), whereas spring sown and grass fields are predominantly treated between November and April.

Table 8: Percentage (%) of fields receiving each organic manure type by sowing season and timing, GB 2011

	Cattle FYM	Cattle slurry	Pig FYM	Pig slurry	Layer manure	Broiler/ turkey litter	Other FYM	Bio-solids	Other non-farm
Winter sown									
August	27	13	62	36	31	55	32	36	61
September	49	28	28	25	51	7	54	54	21
October	17	28	11	4	7	28	14	3	9
Winter (Nov-Jan)	2	0	0	0	1	0	0	3	1
Spring (Feb-Apr)	4	31	0	34	9	0	0	0	2
Summer (May - Jul)	2	0	0	1	0	10	0	3	5
All on winter sown	100	100	100	100	100	100	100	100	100
Spring sown									
August	1	0	7	0	0	0	3	0	0
September	7	2	22	0	0	9	2	3	3
October	4	3	0	0	4	4	7	13	1
Winter (Nov-Jan)	7	13	8	20	22	0	16	3	28
Spring (Feb-Apr)	78	79	63	63	73	87	73	81	66
Summer (May - Jul)	3	1	0	17	1	0	0	0	2
All on spring sown	100	100	100	100	100	100	100	100	100
Grass									
August	5	5	0	0	0	8	11	4	12
September	8	1	16	0	3	5	15	0	0
October	9	2	0	0	0	0	3	0	37
Winter (Nov-Jan)	18	16	0	0	43	0	5	0	0
Spring (Feb-Apr)	45	53	64	83	45	51	48	96	17
Summer (May - Jul)	15	22	20	17	10	36	18	0	34
All on grass	100	100	100	100	100	100	100	100	100

Source: British Survey of Fertiliser Practice

2.9.3 Land and nutrient use: impact of farm performance

The table below shows a comparison of winter wheat gross margins per hectare for 2009/10 and 2010/11 for low and high performing farms.

Table 9: Gross margins per hectare of winter wheat, England

	2009/10			2010/11		
	Low (bottom 25%)	High (top 25%)	All	Low (bottom 25%)	High (top 25%)	All
Average crop area (ha)	14	142	59	14	167	68
Average yield (tonnes/ha)	6.8	9.0	8.6	7.1	8.7	8.3
Average price/tonne(£)	105	110	109	154	157	158
Crops sales	663	957	897	1,008	1,317	1,262
Straw	53	30	38	85	42	53
Total crops output	716	987	935	1,093	1,359	1,315
Variable costs						
Seed	73	55	58	59	52	54
Fertiliser	229	206	213	146	159	158
Crop protection	154	159	155	136	160	156
Other crop costs	38	29	31	33	29	31
Total variable costs	494	449	456	375	399	399
Gross margin	**222**	**538**	**478**	**718**	**960**	**916**

Source: Farm Business Survey

High performing farms have, on average, at least ten times the area of wheat than low performing farms and achieve greater yields. In 2009/10, input costs (including seed and fertiliser) per hectare were lower on high performing farms. However, in 2010/11 this was reversed mainly due to greater expenditure on crop protection and fertilisers on high performing farms.

2.9.4 Land and nutrient use: soil carbon

Soil carbon

The extent to which soil carbon sequestration can offset agricultural emissions in the UK is uncertain at present. It is known that soils can accumulate carbon as a result of some land use changes, for example through conversion of arable land to permanent grassland, or under appropriate management conditions, for example through increasing applications of organic materials (e.g. compost or other organic materials diverted from landfill and not previously spread to land) to arable soils. Such changes are temporary and sensitive to management practice.

Short term increases in soil carbon stocks have been estimated in EU funded programmes over time periods of 3-5 years using high tech measurements of carbon dioxide (CO_2) above the soil surface. There are large uncertainties associated with the methods employed in such studies, and overall the estimated rates of soil carbon increase were not significantly different from zero i.e. the results could have been due to chance alone because of the high variability of the measurements. Longer term studies measuring soil carbon concentrations over multi-decadal time periods seem to indicate that after any change in management, soil carbon will change to reach a new equilibrium concentration. This means that soils cannot indefinitely continue to store carbon, but rather tend to accumulate carbon rapidly at first before stabilising in the long term. Such changes occur in the order of 20 to 100 years, and are rapidly reversed if management reverts to the original practice. This is particularly true of grassland to arable conversions, so grass leys in crop rotations appear to have limited potential to sequester carbon on a permanent basis.

In comparison to many EU soils (particularly those of southern Europe), the UK tends to have fairly high soil carbon concentrations and whilst there are uncertainties surrounding the data on trends of soil carbon in the UK (with countryside survey data indicating no significant changes whilst the National Soils Inventory indicates losses of soil carbon) there is little evidence to support the conclusion that soil carbon sequestration can significantly offset UK emissions. There is some evidence to suggest that UK arable soils may be losing soil carbon, both through the National Soils Inventory data and in observational studies. Other evidence suggests that arable soils may now be reaching or are at a new lower equilibrium level following previous losses due to drainage and historic land use change.

There may be some scope to identify management practices to increase soil carbon concentrations in arable systems under UK conditions, or at least reduce further losses. In many parts of the world, minimal or zero tillage systems seem to result in increases in soil carbon concentrations, but under typical UK soils and climatic conditions results have been far less promising. Research on minimum tillage in the UK (and other parts of the world) indicates a redistribution of soil carbon with depth rather than large absolute increases in soil carbon sequestration. Unfortunately, for the soil types predominant in the UK compaction may be an issue under reduced tillage systems, with consequent increases in nitrous oxide emissions. Given the relative strength of nitrous oxide as a greenhouse gas these enhanced emissions are likely to exceed any benefit of soil carbon sequestration.

Defra is continuing research in this area, with a project re-examining the long term data on soil carbon trends. We will also be considering research to better quantify the emissions and removals of CO_2 resulting from land management.

2.9.5 Land and nutrient use: summary

The GHG intensity of cereal production has reduced significantly over the last 20 years through improved yields for similar amounts of nitrogen based fertiliser. In the short term, average application rates increased slightly in 2010 and 2011 following lower usage in the previous couple of years. It is likely that the low application rates in 2008 and 2009 were in response to higher fertiliser prices (which started rising significantly in autumn 2007, and remained high until summer 2009). Looking at use of organic nitrogen, cattle manure is the predominant source across farms in Great Britain although the percentage of farms using cattle FYM has declined by 6% since 2006. However, use of cattle slurry has remained more or less consistent. The 2011 BSFP indicated that the most popular means of slurry application was still broadcast suggesting there could be scope to reduce emission intensity and indirect emissions if other methods of application were adopted.

2.9.6 Land and nutrient use: further developments

The following are all areas considered to be relevant to understanding emissions related to land and nutrients.

- More information on the nutrient use for other crops including fodder crops, hay (and hay silage), maize (maize silage). Detailed information is not readily available and it is unlikely that further information will be available in the short term.

- More information on the impact of lime use. Application of lime can adjust the pH of soils and when applied to agriculture land can help neutralise soil acidity. Whilst production of lime is associated with CO_2 emissions application can in some conditions be responsible for uptake of CO_2. Information on application rates of lime is collected by the BSFP although the implications of this may not be available in the short term.

- Consider location and weather on the impact of emissions.
  In general, higher emissions are associated with warm wet soils which contain a source of organic carbon. Heavy or compacted soils with poorer drainage characteristics are also likely to have higher emissions. There is a gradient in the UK of higher emissions in the west of the country and lower emissions in the east due to patterns of rainfall and dominant soil textures[28].

  In terms of land use, grasslands are associated with higher emissions (as a percentage of nitrogen applied) than arable or horticultural land uses because they tend to be associated with imperfectly drained soils which are unsuited to arable cropping. Furthermore, the presence of livestock often results in compaction through trampling and hotspots of nitrogen deposition from faeces and urine. Potatoes, brassicas and sugar beet are associated with higher emissions (again as a percentage of nitrogen input) than cereals or oil seeds, potentially due to their relatively large residue inputs to soils. Cereal crops tend to have the lowest emissions, since modern varieties are adept at making use of the nitrogen applied[29]. Tillage may also reduce GHG emissions from cereal crops as it tends to aerate the soil.

  Data relevant to location, weather and land use will be explored through the inventory development project.

- Separate nitrogen balances for arable and livestock.
  Having separate nitrogen balances for different sectors would give a more complete picture of factors related to emissions for each sector. At present it is not possible to separate out the nitrogen balance between 'arable' and 'livestock' sectors, and this is not likely to be developed over the short term.

  The following provides some further issues relating to the application of synthetic and organic nitrogen.

  Nitrogen source is an important determinant of the emissions resultant from application. Research indicates that the direct emissions from various sources of synthetic fertilisers are not significantly different from each other[30]; however, urea fertilisers do have significantly higher ammonia emissions than nitrate based fertilisers. Therefore indirect emissions from urea are significantly higher, with associated implications for human health. Ammonium nitrate fertilisers can be associated with large leaching losses, but only if applied at inappropriate times of year. Beyond the farm gate, emissions from industrial Urea production are considerably lower than for ammonium nitrate, although the fertiliser industry continues to improve energy efficiency through installation of abatement technologies.

[28] Defra project AC0101 - An improved inventory of greenhouse gases from agriculture
[29] Skiba and Smith (2000) "The control of nitrous oxide emissions from agricultural and natural soils"
[30] Although the Defra NT26 project indicated that urea may have very slightly smaller direct emissions than ammonium nitrate, the overall variability in emissions makes it hard to draw definitive conclusions

Applications of fresh farm yard manure (FYM) to land may be associated with higher direct emissions than synthetic fertilisers, although storage of FYM tends to reduce direct emissions to levels less than or comparable with synthetic fertilisers. However, indirect emissions during manure storage can be significant.

Applications of slurries can have high direct GHG emissions since the majority of the nitrogen content is in available forms. The high available N content of slurries also makes them prone to indirect emissions from ammonia losses, although this can be controlled by appropriate application technologies, such as the use of a trailing shoe, injector or band spreader. Slurries may also have considerable indirect losses during storage, again principally through ammonia emissions. If slurries are applied to land in the autumn and winter months they may also be associated with significant leaching losses. As such indirect emissions from slurry can potentially be high unless careful storage and application management is in place.

- Uptake of inhibitors.

Inhibitor chemicals to reduce both direct and indirect emissions from fertiliser use have long been available to the farming industry, but uptake remains low because historically they have been perceived as costly options. Inhibitors exist to reduce ammonia emissions from Urea based fertilisers and therefore indirect GHG emissions, whilst nitrification inhibitors can reduce direct emissions of GHG from fertilisers. New protected fertiliser products which include inhibitor chemicals have come on the market in the EU over the past few years, and there may be potential to significantly reduce emissions if these prove successful in field trials currently being carried out under Defra project AC0213 (more details are given at (vi) in the Appendix).

It is not clear at present what reliable information is available on the uptake of inhibitors.

2.9.6 Land and nutrient use: notes on data collection methodology and uncertainty

British Survey of Fertiliser Practice

i) The reliability of estimates of manufactured nitrogen from the BSFP are quantified in the annual report. This states that in 2011: for winter wheat the GB mean application rate was 193kg/ha and standard error was 2.2kg/ha; for sugar beet the GB mean application rate was 89kg/ha and standard error 4.4kg/ha; for main crop potatoes the mean application rate was 163kg.ha and standard error was 7.7kg/ha. A link to the report including more on the methodology and sampling errors are given in the Appendix.

Cereal Production

ii) The reliability of the estimates of cereal yields are quantified in the Cereal Production Survey statistical notice. For wheat in 2011, the yield estimate for England was 7.7 tonnes per ha, and the 95% confidence interval was +/-0.1. Information on other crops are given in the statistical notice, and a link to this is given in the Appendix.

Soil Nitrogen Balance

iii) The soil nitrogen balances are compiled using a system which draws on many data sources combined with a set of coefficients. The level of uncertainty around the components of soil surface balances has been explored, although an overall level of uncertainty for the overall balances has not been derived. Much of the activity data has quantified low levels of uncertainty, though some of the factors are expected to have a large degree of uncertainty. Links to the methodology reports are given in the Appendix.

Farm Business Survey

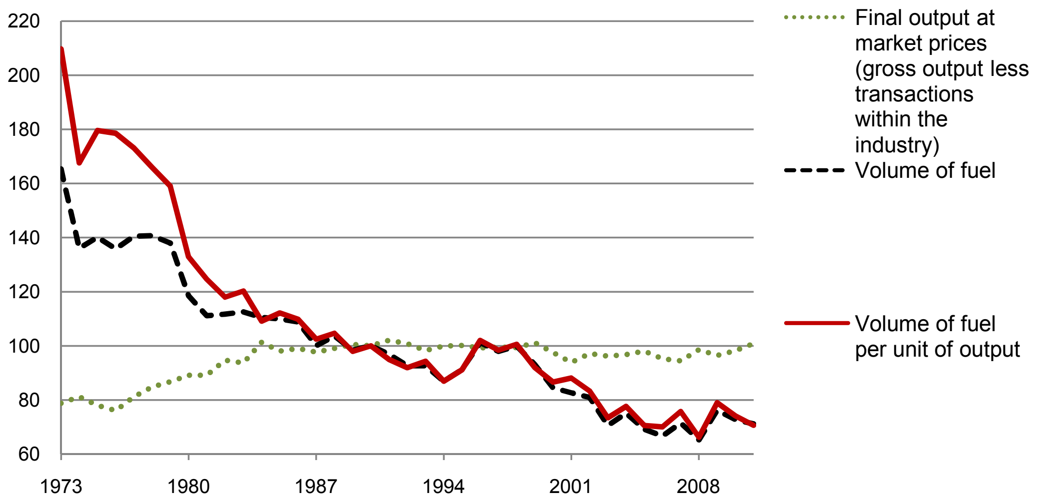
iv) Where the sample size is relatively small, confidence intervals can be quite large, and care needs to be taken with interpretation of the significance of the differences. A link to information on the Farm Business Survey methodology is given in the Appendix.

2.10 Fuel use

2.10.1 Fuel use in agriculture

Rationale
Modern agriculture is reliant on mechanisation. The fuel needed to power this is the main source of carbon dioxide from agriculture (though carbon dioxide only accounts for 9% of the GHG emissions from agriculture). The chart below has been updated with 2011 (provisional) figures.

Volume of fuels used in agriculture, UK
Index 1990=100



Source: Defra, Farm Business Survey

Trends

Since 1990 there has been an overall decrease in the volume of fuel[30] used, with some year on year variation. Additionally, total agricultural output is similar to 1990 levels, thus the volume of fuel per unit of output has fallen since 1990.

2.10.2 Fuel use: further developments

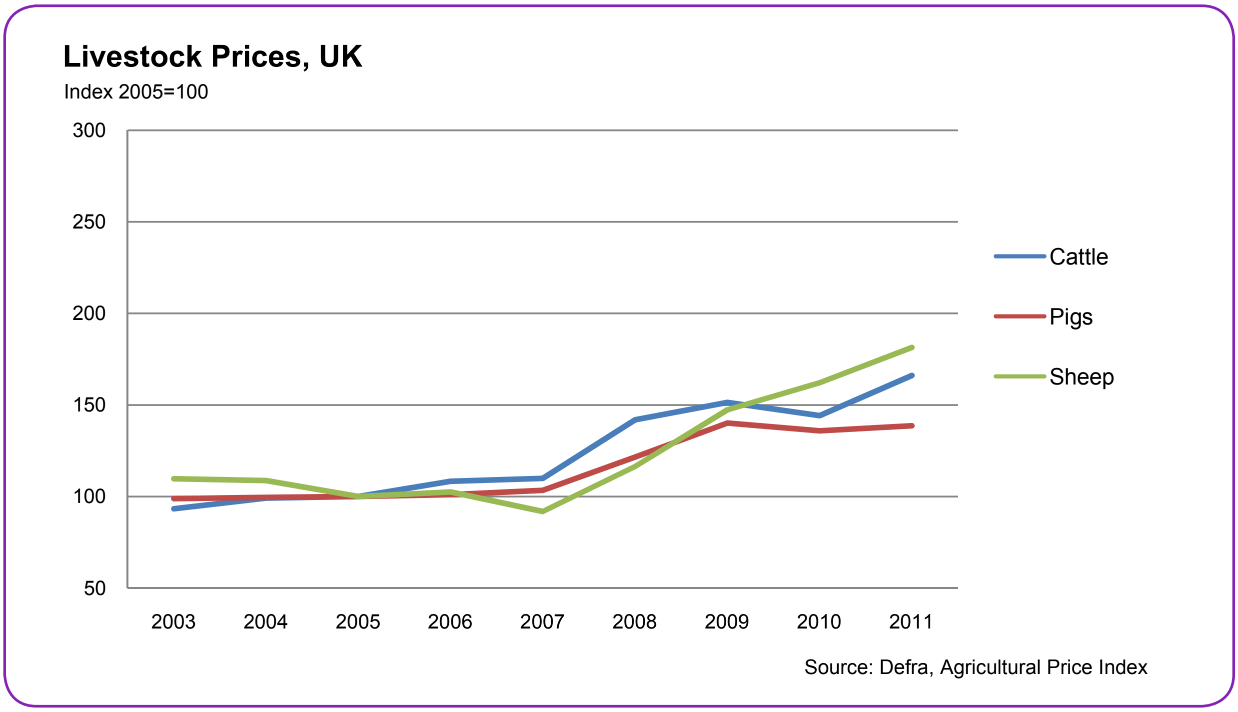
The information presented here is used within the agricultural accounts, and is derived from fuel values, and price information. This means that the headline measures over the long term are reliable. However it would be of value to have more detailed information on the actual volume of fuel, as well as information on the type of fuel (red diesel, LPG, natural gas, fuel oil, petrol, (and possibly coal on old horticultural units). It is not clear at present whether this information is available.

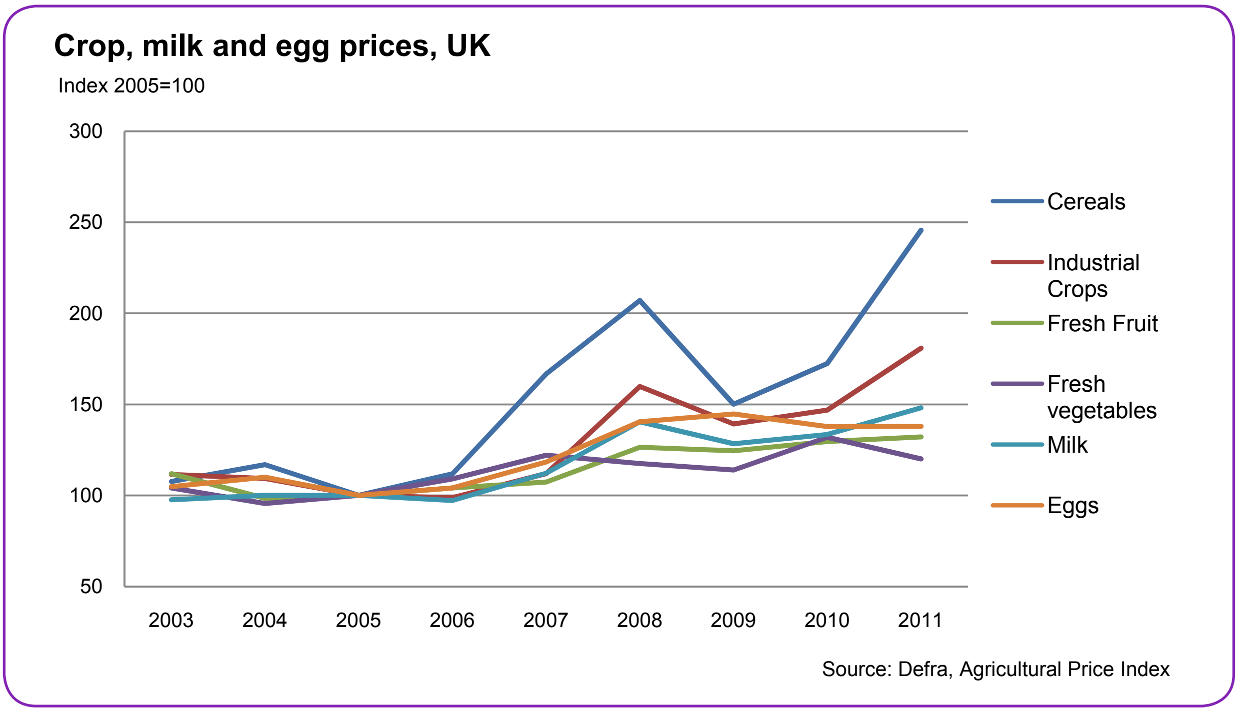
[30] Volume indices are calculated by taking a weighted average of volume relatives (volume relatives are the volume in year n / volume in year n-1) using the monetary values of components of the aggregated index as weights.

2.11 Contextual factors: prices of inputs and outputs

Output prices

Rationale
Prices of both inputs and outputs can influence management and business decisions taken by farmers which can in turn have an impact on greenhouse gas (GHG) emissions from the agricultural sector. For example, market prices may influence the use of mineral fertilisers and the age at which livestock are slaughtered.





2.11 Contextual factors: prices of inputs and outputs (continued)

Output prices (continued)

Trends
Livestock prices are influenced by both exchange rates and other factors such as disease outbreaks. After remaining relatively stable between 2003 and 2007 prices showed a sharp rise across cattle, sheep and pigs. Pig prices continued to increase until 2009 but have remained largely unchanged since then.

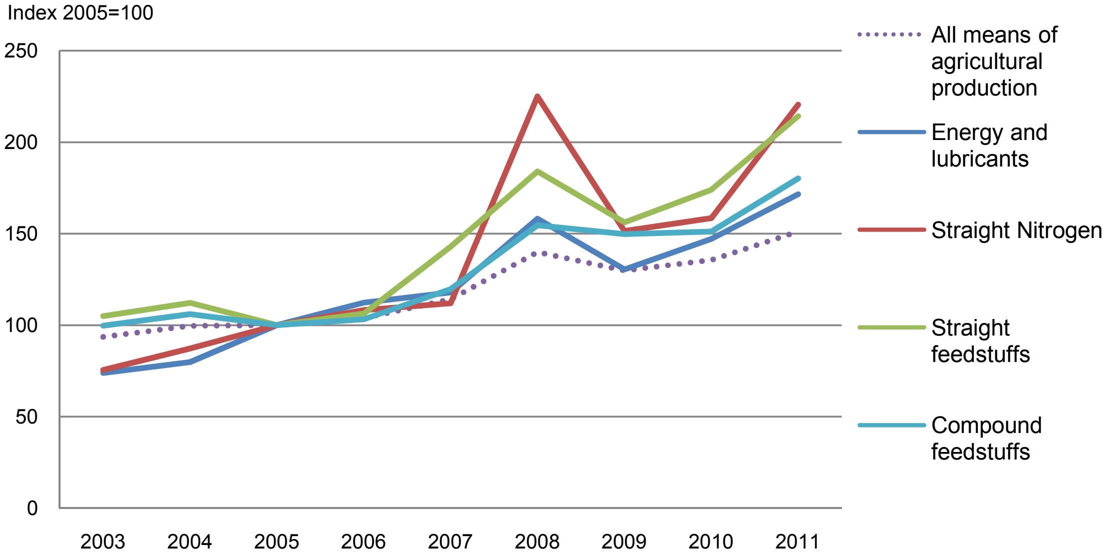
Cattle price increases in 2008 and 2009 were driven by lower supplies of prime cattle and strong domestic demand combined with increased export demand (due to the exchange rate). More recently an increase in demand and lack of supply led to increased prices, which continued through 2011 and into 2012.

Sheep Prices increased in 2008, supported by tight domestic supplies and a strong export market. In 2011, strong competition for British lamb continued to result in considerably higher prices which reached record levels. This was driven by reduced global supplies stemming from a shortage of New Zealand lamb.

Fluctuations in cereal prices have generally been a result of the UK (and global) supply and demand situation and currency movements. From 2006, cereal prices rose steeply peaking in 2008, this year also saw a high point in prices of industrial crops, fresh fruit, milk and eggs; only fresh vegetables were unaffected. 2009 brought a reduction in prices across all categories except eggs although 2010 and 2011 saw a recovery in cereal and industrial crop prices. For cereals the increase was driven by international grain prices coupled with lower than expected yields in the United States as a result of adverse weather conditions. Dry weather in Argentina and flooding across Eastern Australia at the end of 2010 also led to further increases in market prices.

Input prices

Purchase prices of agricultural production, UK



Source: Defra, Agricultural Price Index

Trends
The main sectors which purchase compound feed are cattle, pigs, poultry and sheep. Purchaser prices (the price paid by producers for agricultural inputs) for compound (and straight) feedingstuffs are influenced by changes in cereal prices, although farmers can mitigate some of the price increase seen here by substituting for different forms of animal feed.

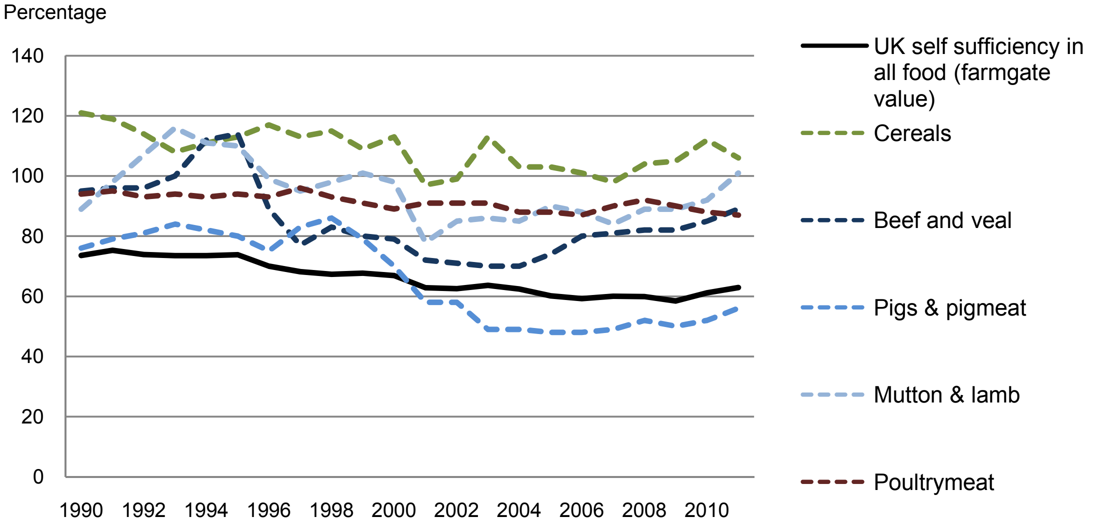
Prices of straight nitrogen also peaked sharply in 2008 resulting in slightly lower levels of usage of nitrogen fertilisers, as illustrated in Section 2.9.

2.12 Contextual factors: Trends in UKs ability to meet domestic demand and contribute to international markets

Rationale

All things being equal greenhouse gas (GHG) emissions associated with UK production would fall if UK production was displaced by produce from international competitors. Measures of UK production as a percentage of UK consumption are shown here to provide an indication of displacement and hence any 'carbon leakage'. These measures only provide an overview and do not capture the GHG emissions associated with food production. However, they do provide a useful high level summary.

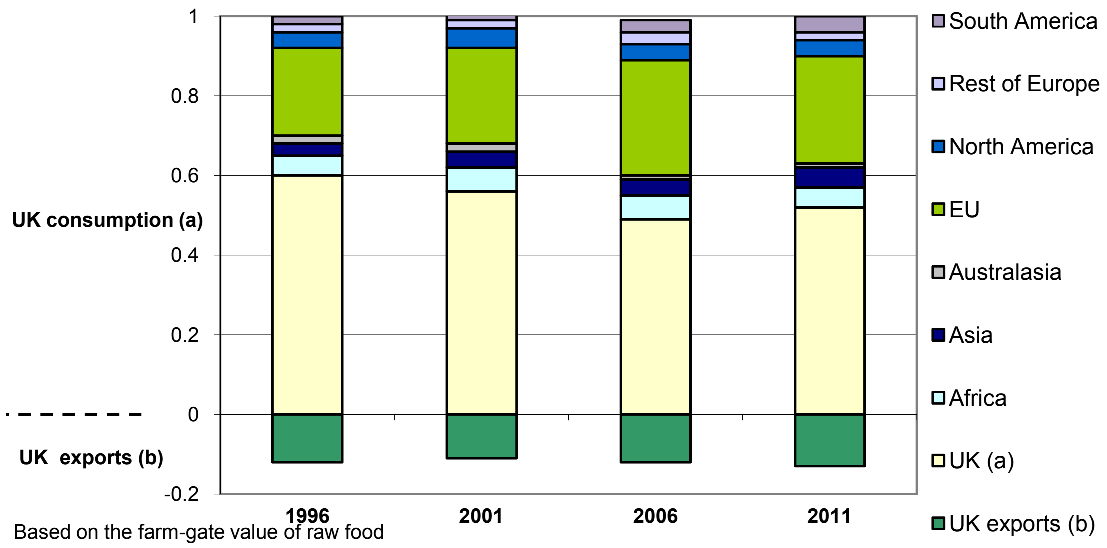
UK production to supply ratio ("self sufficiency") in food & key commodities



Note, measures of production to new supply ratio for commodities shown are volume based, whilst headline measure of production to supply ratio in all food is a value at the farm-gate measure.

Source: Defra, Agriculture in the UK

Origin of food consumed in the UK: 1996, 2001, 2006, 2011



Based on the farm-gate value of raw food

(a) Consumption of UK origin consists of UK domestic production minus UK exports

(b) UK exports are given as a percentage of total UK consumption.

2.12 Contextual factors: Trends in UKs ability to meet domestic demand and contribute to international market trends in food consumption
(continued)

Trends

UK consumption of agricultural products and carbon leakage: whilst production has fallen overall in the UK since 1990, which may result in lower total emissions, in the main domestic production (in particular meat) has been replaced with imports. Therefore, any reduction of emissions in the UK will have been at the expense of increases overseas. There is insufficient evidence to say with any certainty that this displacement will have been of a significantly different level of GHG intensity (that is, GHGs produced per tonne of grain, litre of milk or kilogramme of meat produced).

UK domestic demand and production of agricultural products

The impact of changes in domestic demand for agricultural products on price is limited as UK farmers are price takers within the wider international market

The theory of supply and demand would suggest that a fall in domestic demand might be expected to translate into a fall in price for agricultural products in the UK. However, the influences on food prices are subject to international factors (e.g. UK pig prices follow wider EU prices over time), and coupled with the fact that domestic demand is small relative to global demand, changes in UK demand would not be expected to have a significant impact on prices in an international market.

With any reduced demand domestically exports of agricultural products should rise

We would therefore expect change in domestic demand to impact on trade flows, rather than on prices. For example, given a rising global demand, but a falling domestic demand, UK producers would find international markets more attractive relative to domestic markets, even with the additional costs of exporting. Hence, exports should rise. Similarly, those countries currently exporting to the UK would, if prices started to fall as a consequence of falling demand, assess whether to continue exporting the same quantities to the UK or perhaps instead redirect exports to markets with a better price. This change in trade flows would 're-balance' supply and demand until the UK price was equal to international prices; UK imports would fall while exports would rise.

We can expect greater volatility for individual items than is seen at the all outputs level, and there will be some parts of the market where local supply/demand will have more of a bearing, but overall overseas trade flows will soon adjust to dampen down the impact of any price differential that emerges between the UK and the wider EU and international market as a consequence of changes to UK demand.

This adjustment through trade flows can be illustrated by looking at trends in UK production and consumption of pigmeat since the late 1990s. UK pigmeat production reduced by 37% between 1998 and 2010 while at the same time UK consumption rose by 5%. This imbalance between rising UK demand, and falling domestic production was not reflected in higher prices, rather UK prices over the period continued to follow the trends seen across the EU. But, UK imports rose by 64% and exports fell by 58% thus demonstrating how trade flows adjust to dampen down any differences in price that emerge.

Section 3 Farmer attitudes and uptake of on-farm mitigation measures

Background information

The following section provides key summary statistics on farmer attitudes and views – what farmers say, and uptake of a range of mitigation measures – what farmers do.

The farming industry, in England, and the UK more generally, comprises a large number of relatively small businesses. The characteristics of the many businesses and farmers are critical to the uptake of climate change mitigation measures. Understanding the attitudes of farmers can help highlight the barriers and motivations to action on greenhouse gases (GHGs).

Many farmers say that they are aware of climate change and agree that something needs to be done to reduce GHG emissions (i.e. mitigation). But there is a gap between this opinion and the level of farmer understanding of GHGs from agriculture, of the mitigation measures that could be adopted and indeed, between generalised concern and practical action taken on farm.

Ensuring a greater understanding of GHG emissions is likely to be an important driver for change for some farmers. A greater understanding of the issue may also lead to more innovative (and cost-effective) solutions for reducing agricultural GHGs.

While most practices to reduce GHG emissions could save farmers money (and many farmers are likely to be influenced to change their practices because it makes good business sense) there are several other barriers to uptake which are non-financial, or not directly financial;

- lack of information (in particular locally relevant demonstration)
- lack of trust in information source
- time availability
- lack of specialist skills to implement changes (Defra project FF0201)

The Integrated Advice pilot project mentioned in the introduction is intended to help understanding of how messages can best be conveyed to farmers on a wide range of subjects in order to instigate changes in farming practices.

Results from the Farming Futures Survey

A series of small sample telephone surveys were run by Farming Futures in March and September 2008, February 2009, in March 2010 and February 2011. Each survey had a sample size of around 400 farmers from England. The survey reports state that the samples are drawn from the NFU database and provide statistical reliability of 95% with a margin of error of +/-5% (based on approximately 55,000 NFU members).

The annual survey reports are given at:
http://www.farmingfutures.org.uk/annual-surveys

Confidence intervals

For details of confidence intervals for the Farm Practices Survey (FPS) please see the (v) Farmer attitudes and up take of on-farm mitigation measures: confidence intervals in the Appendix.

3.1 Farmer attitudes and views

Views about climate change.

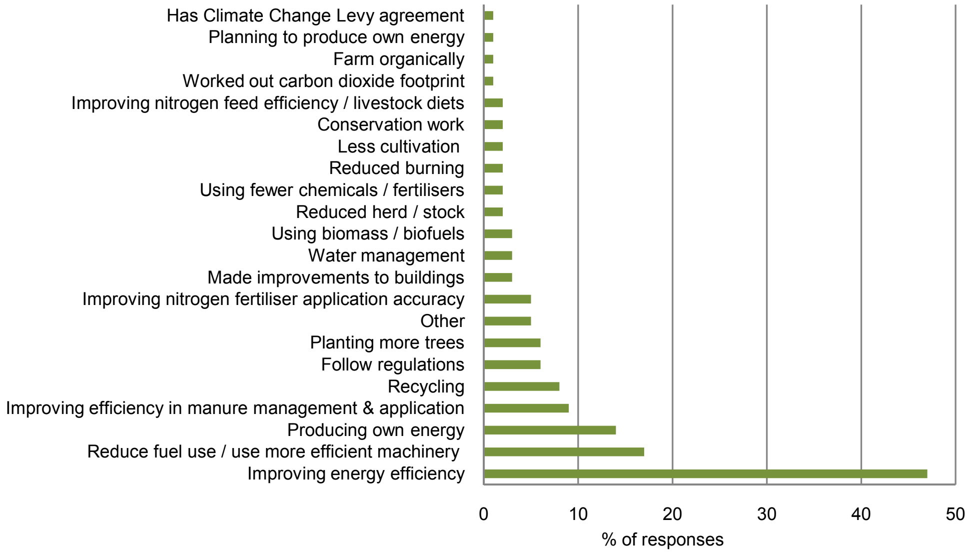
Results from the Farm Practices Survey (FPS) 2011 indicate that almost half of farmers thought that climate change would affect their business in the next 10 years. However, just 4% were currently seeking advice about this, little change on 2008. Almost 10% of farmers indicated that they were already making the most of opportunities associated with climate change by growing new crops, whilst 29% reported they were already taking action to adapt to threats of pests and disease associated with climate change.

What farmers say they do to reduce greenhouse gas emissions.

The 2011 Farming Futures Survey reported that 53% of farmers said that they were currently taking action to mitigate climate change or reduce GHG emissions – this compares to 55% in 2008 and 48% in both 2009 and 2010; these year-on-year changes do not represent a statistically significant change.

Some of the most common actions to reduce GHG emissions that farmers cited in 2011 were improving energy efficiency, reducing fuel use/using new vehicles or machinery, producing own energy, and improving efficiency in manure management and application[31].

What action are you taking to mitigate climage change / reduce greenhouse gas emissions?



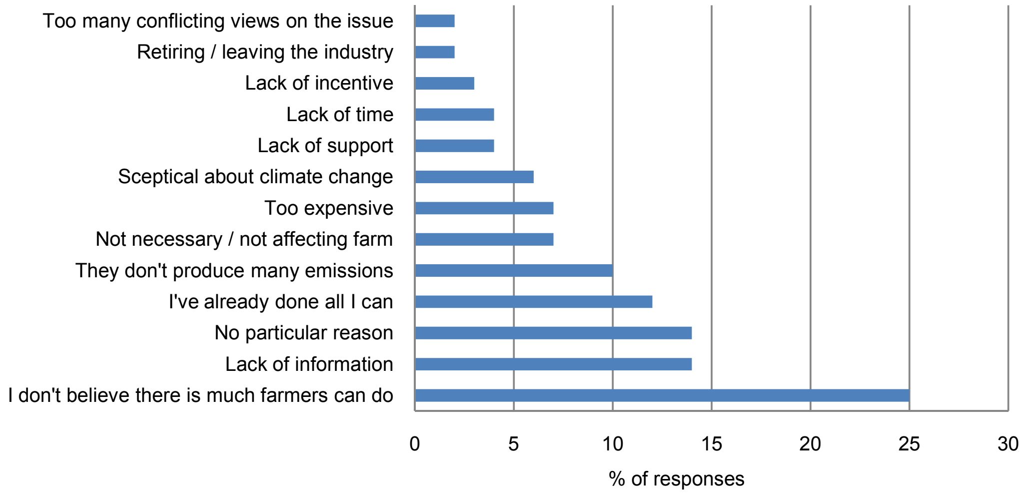
Source: Farming Futures:Climate Change Survey, Stage Five (February 2011)

[31] Responses are based on 212 respondents that are currently taking action.

What farmers say are the barriers to reducing emissions

In 2011, of those farmers currently not taking action to reduce GHG emissions 25% did not believe there was much farmers could do to mitigate climate change, this was unchanged from 2010. A further 14% said they did not know what they could do due to lack of information while 12% believed they had already done all they could to mitigate climate change[32].

What is stopping you in taking action to mitigate climage change / reduce greenhouse gas emsissions from your farm?



Source: Farming Futures:Climate Change Survey, Stage Five (February 2011)

34% of farmers indicated that they were interested in measuring their farm's carbon footprint compared to 31% in 2009, and 36% in 2010; these figures do not represent a statistically significant change.

These results suggest that, for some farmers, there is a gap in the understanding of GHGs from agriculture and of mitigation measures that they could adopt.

Motivations to make changes

Research shows[33] that certain types of farmers are likely to believe taking action is important i.e. the Custodian and Lifestyle Choice segments of the Defra farming segmentation framework – these make up around a third of farmers. Other segments within the farming community e.g. Modern Family Businesses and Challenged Enterprises recognise that adopting mitigation measures can be good for farming profitability by minimising costs – these two groups constitute around a half of farmers.

[32] Responses are based on 118 respondents that are not currently taking action.

[33] Understanding behaviours in a farming context: Bringing theoretical and applied evidence together from across Defra and highlighting http://www.defra.gov.uk/statistics/foodfarm/enviro/observatory/research-projects/published-research/

Market Segmentation in the Agriculture Sector: Climate Change (ADAS, 2010)

A series of questions on climate change were included in the FPS 2011. Analysing these in conjunction with the farmer segmentation codes provides an opportunity to assess the way that variations in attitudes and motivations of the farmer influences farm business decision-making. The breakdown of farms in each category is shown in Table 10. The Lifestyle Choice and Challenged enterprise categories contain similar proportions of farms to those seen in previous research[33] while the Custodians and Modern Family Business group contained a lower proportion of farms and the Pragmatist a higher proportion.

Table 10: Proportions of farms in the FPS by segmentation code

Farm segmenation group	2011 (%)	2012 (%)
1 Custodian	13	14
2 Lifestyle choice	5	4
3 Pragmatist	44	43
4 Modern family business	33	36
5 Challenged enterprise	6	4
All farmer types	**100**	**100**

Based on 3031 responses in 2011 and 1159 in 2012 Source: Farm Practices Survey

The following commentary and that included in section 3.2 Nutrient Management is an interpretation of the data using an understanding of the five farmer types (from other research insights[33]).

Do you think climate change will affect your farm in the next 10 years?

There is not a high level of variability between the responses (12% separating the 5 groups) but the highest response (Modern Family Business, 54%) and lowest response (Custodians, 42%) can be explained by a focus on anticipating risks as part of business planning by Modern Family Businesses whilst Custodians are more traditional and see environmental change as just another factor to adapt to.

Are you already / considering taking action to make the most of the following opportunities?

The segmentation approach is well-suited to exploring motivations and intentions and whilst there are not conclusive differences in terms of evidence of already taking action, the results for intentions re-enforce the underlying characteristics of the five segments. For example, Modern Family Businesses aspire to take advantage of all opportunities (higher than the average on all options) whereas those more constrained by time or money e.g. Challenged Enterprises, prefer to concentrate on the core business (lower than the average). Growing crops for energy and anaerobic digestion (AD) are interesting in that similar results are given i.e. Modern Family Businesses and Custodians above the average (opportunities for business and the environment). Additionally new ventures such as these are not so attractive to those ‘challenged’ (only 11% considering AD) due to time and possibly financial constraints and also those ‘lifestylers’ (only 9% considering AD) who are in agriculture for primarily non-agricultural reasons but where more novel approaches do not necessary fit in so neatly with the lifestyle (including less pressure to make money from new sources).

[33] Understanding behaviours in a farming context: Bringing theoretical and applied evidence together from across Defra and highlighting: http://www.defra.gov.uk/statistics/foodfarm/enviro/observatory/research-projects/published-research/

Market Segmentation in the Agriculture Sector: Climate Change (ADAS, 2010)

Are you taking / considering action to adapt to any of the following threats?

There are less clear-cut distinctions here (as more reactive than proactive) but some of the same patterns emerge. Modern Family Businesses consistently say they are taking most action (all above the average) but differently to the opportunities above, there are less strong responses which may imply a more positive outlook on action than evidence might suggest in reality. Of note is that environmental factors in terms of 'considering' are of concern most to the Custodians who recognise the importance of longer-term environmental sustainability i.e. soils (11%) and biodiversity (12%).

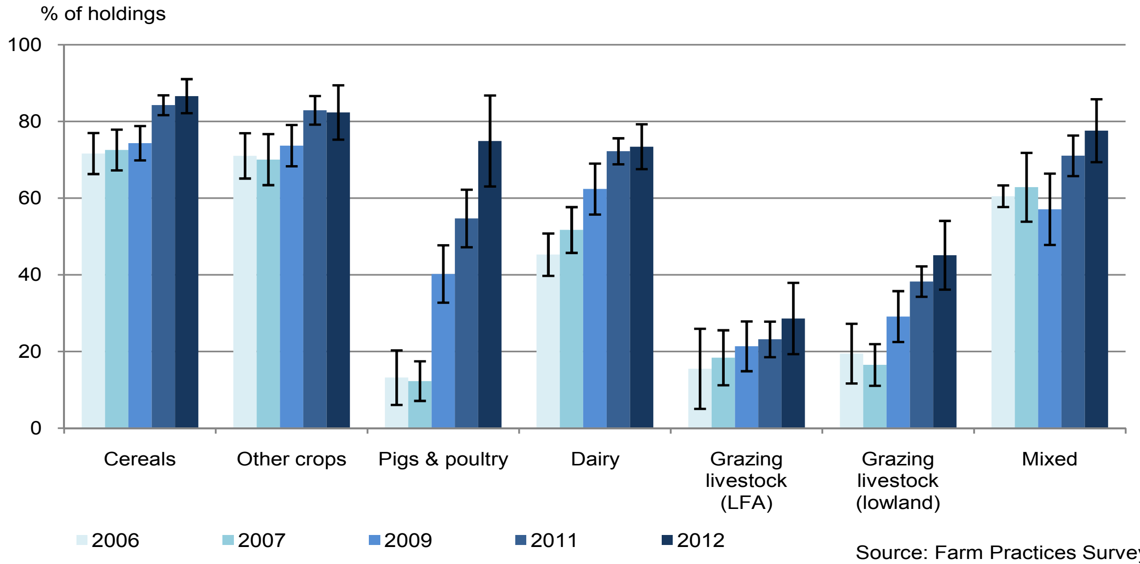
3.2 Uptake of on-farm mitigation measures

Statistics on a variety of mitigation measures are presented in the following section. These results are taken from the Defra FPS and the Defra British Survey of Fertiliser Practice (BSFP).

The FPS gathers information on a range of on-farm practices, this includes: nutrient management; anaerobic digestion; fertiliser spreaders; manure and slurry storage; farm health planning and biosecurity; grassland management; cattle and sheep feeding regimes and breeding practices.

Nutrient Management

Proportion of farms with a nutrient management plan, England



Source: Farm Practices Survey

Note: the ranges shown on the chart are 95% confidence intervals.

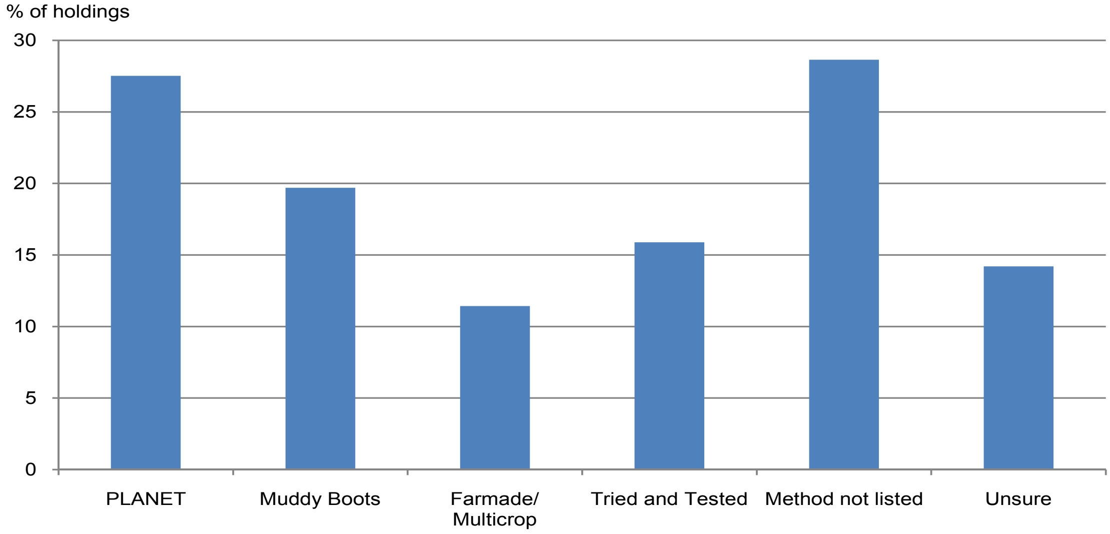
The proportion of farms with nutrient management plans has risen steadily from 46% in 2006 to 68% in 2012. The same trend is evident for individual farm types (shown in the previous chart). Uptake is greatest on cereal and cropping farms and lowest on grazing livestock farms, particularly those in the LFA. For those farmers without a plan about half indicated that they would be motivated to create one if they could be reassured that they would see a return for the work put in. However, 20% of those without a plan said that nothing would motivate them to create one.

Analysing the responses to the 2012 question "Have you completed a nutrient management plan for your farm?" in conjunction with the farmer segmentation codes described in Section 3.1 provides an opportunity to assess the way in which variations in attitudes and motivations of the farmer influence farm business decision-making in this area. Research shows that not all farmers will respond in the same way - both willingness and capacity to uptake will vary.

There is a variability between the segments in the uptake of nutrient management plans. The highest responses are for Challenged Enterprises (82%) where the business is focussed on the farms profitability and costs and for Modern Family Businesses (79%) where attention to detail and business planning is a key characteristic. The Modern Family Business group also review their plans more regularly with 81% updating annually and just 11% every three years or more. The Lifestyle Choice segment has the lowest proportion with a nutrient management plan (50%) which may reflect the characteristics of this group in terms of a higher number of ‘smallholders’ and ‘hobby farmers’ where nutrient management planning is not seen as so important and in some cases there is a more limited level of agricultural knowledge. Of the five segments only the Lifestyle Choice group has fewer farms with a nutrient management plan compared with 2011, although the small sample numbers for this group in 2012 make reliable comparisons difficult.

The segmentation approach is well-suited to exploring attitudes, motivations and intentions and whilst the samples sizes result in lower statistical confidence, some conclusions re-enforce the underlying characteristics of the five segments. For example, more than half of Modern Family Businesses (53%) have seen the financial benefit from having a nutrient management plan whereas more pressured businesses with less positive farmers in Challenged Enterprises have not seen the benefit (only 31% recorded any financial benefit). Judging environmental benefits was consistently difficult with around a third of farmers in all segments saying ‘don’t know’ but again a higher percentage of Modern Family Businesses (37%) saw environmental benefits (fitting with an underlying characteristic of the segment to see good environmental practice in line with good business practice) but only 14% of those Challenged Enterprises seeing environmental benefits. Attitudes and motivations for those farmers not having a nutrient management plan was also explored. The sample numbers were small for some groups and it was not possible to draw conclusive results but again capacity issues (time 39% and money 36%) and a low willingness to change (‘nothing’) were constraints on uptake for Challenged Enterprises (structural factors) but firm business outcomes were more important for Modern Family Businesses where those without a plan would need to see a return (61%).

Tools used to create a nutrient management plan, England



Source: Farm Practices Survey 2012

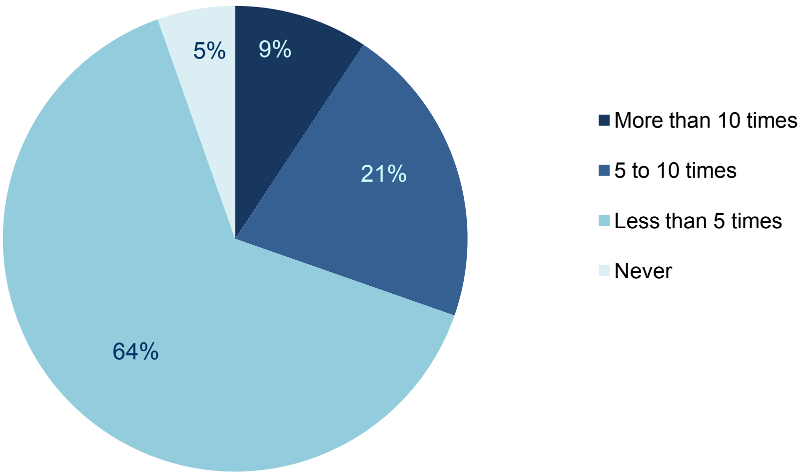
The previous chart shows that the most common tool for producing a nutrient management plan out of the four listed is 'PLANET,' and this was also the case in 2009 and 2011. Further analysis by farm type (Table 11) shows that 'PLANET' is a popular choice across most farm types.

Table 11: Proportion of farms with nutrient management plans created by each method

Farm type	PLANET	Muddy Boots	Farmade/ Multicrop	Industry plan - Tried and Tested	Method not listed	Unsure
Cereals	29%	22%	17%	13%	26%	13%
Other crops	30%	25%	21%	20%	28%	9%
Pigs & poultry	26%	6%	15%	22%	41%	10%
Dairy	28%	12%	5%	12%	33%	19%
Grazing livestock	19%	20%	34%	18%	36%	20%
Mixed	32%	26%	5%	20%	17%	10%
All farms	**28%**	**20%**	**11%**	**16%**	**29%**	**14%**

Source: Farm Practices Survey 2012

Frequency of referral to nutrient management plans in a year, England



Source: Farm Practices Survey 2012

The above chart for 2012, shows that almost all of those with a nutrient management plan (95%) refer to it at least once a year and 30% refer to it at least 5 times a year. The frequency of referral tends to be lower for grazing livestock farms than other farm types. About three quarters of farms update their nutrient management plan annually, a significant increase from 2009 when 65% of farmers reported that they updated their plans every year.

Manure management plans

The proportion of applicable farms with a manure management plan increased significantly between 2011 and 2012 from 67% to 76%. The greatest uptake is on dairy farms (90%) and lowest on grazing livestock farms (65%). Table 12 shows the source of nutrient recommendations for manure management plans; these show little variation between 2009 and 2012.

Table 12: Source of nutrient recommendations for manure management plans

	2009	2011	2012
Defra recommendations / manual (RB209[34]), CoGap[35]	92%	87%	90%
Other	12%	15%	13%

Source: Farm Practices Survey

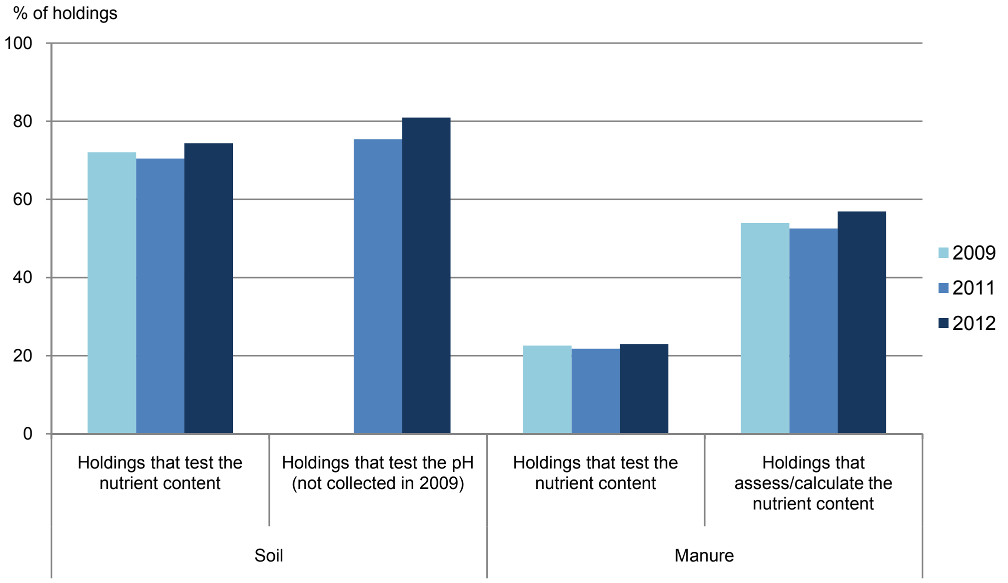
For details of the proportion of farms using each source of nutrient recommendations by farm type in 2012 please see (v) at the Appendix.

Nutrient testing of soil and manure

In 2012 the FPS reported that 74% of farms regularly test the nutrient content (indices) of the soil, this was not significantly different to 2009 or 2011. The FPS also indicated that 81% of farms regularly test the pH content of the soil, an increase from 75% in 2011. In addition 23% of farms reported that they tested the nutrient content of manure and 57% that they assessed or calculated the nutrient content of manure; these were again a similar level to 2009 and 2011. Grazing livestock farms were much less likely than other farm types to test their soils or manure.

For details of the proportion of farms testing soil and manure by farm type please see (v) at the Appendix.

Proportion of holdings who test soil and manure



Source: Farm Practices Survey

[34] http://www.defra.gov.uk/publications/files/rb209-fertiliser-manual-110412.pdf

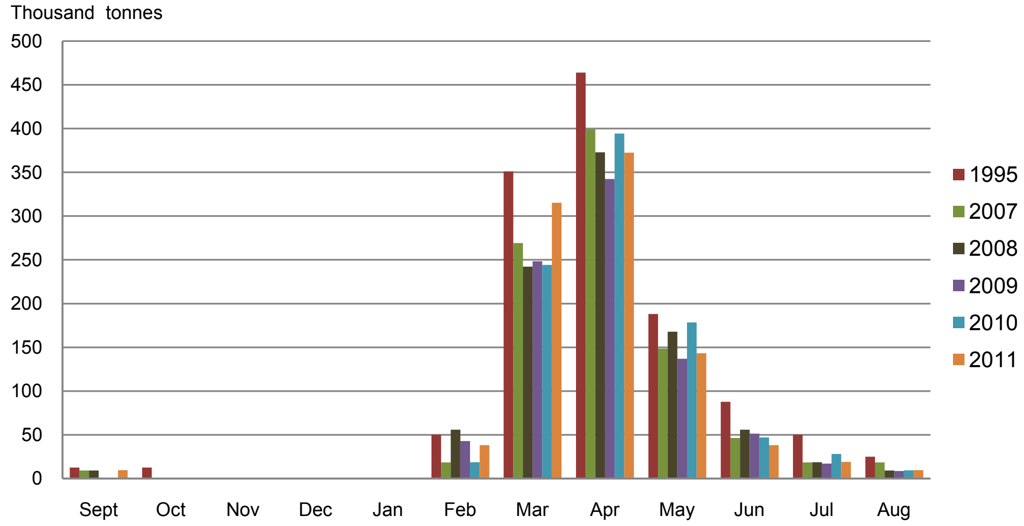
[35] http://archive.defra.gov.uk/foodfarm/landmanage/cogap/index.htm

Timing of fertiliser applications (source: British Survey of Fertiliser Practice)

The timing of fertiliser applications can have a bearing on the amount of nitrous oxide released. Avoiding spreading manufactured fertiliser when there is little or no crop uptake (for example between September and February) or when conditions are particularly wet can help minimise the risks.

The chart below shows results from the British Survey of Fertiliser Practice which indicate that the majority of nitrogen is applied in March and April, a trend which has remained relatively consistent over time.

Nutrient use by month of application: nitrogen (GB)



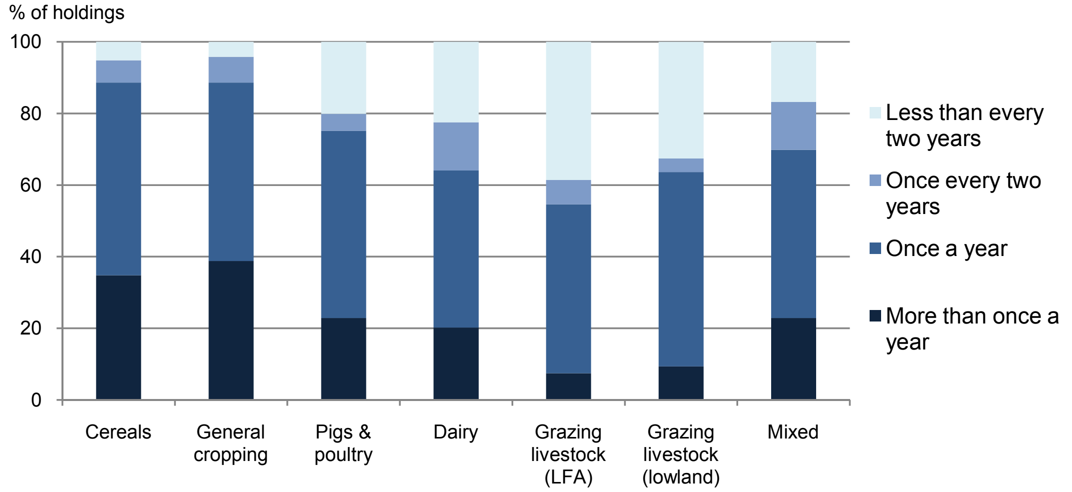
Source: Defra, British Survey of Fertiliser Practice

Fertiliser spreaders

Roughly half of all farmers give their fertiliser spreaders a general check more than once a year. A further 44% complete a general check once a year. These proportions are similar to those in 2011.

The chart below shows that majority of farmers across the different farm types check and calibrate the spread pattern of their fertiliser spreader at least once a year. However, the proportions are higher for cereals and general cropping farms than they are for livestock farms.

Frequency with which the spread patterns of fertiliser spreaders are checked and calibrated, England



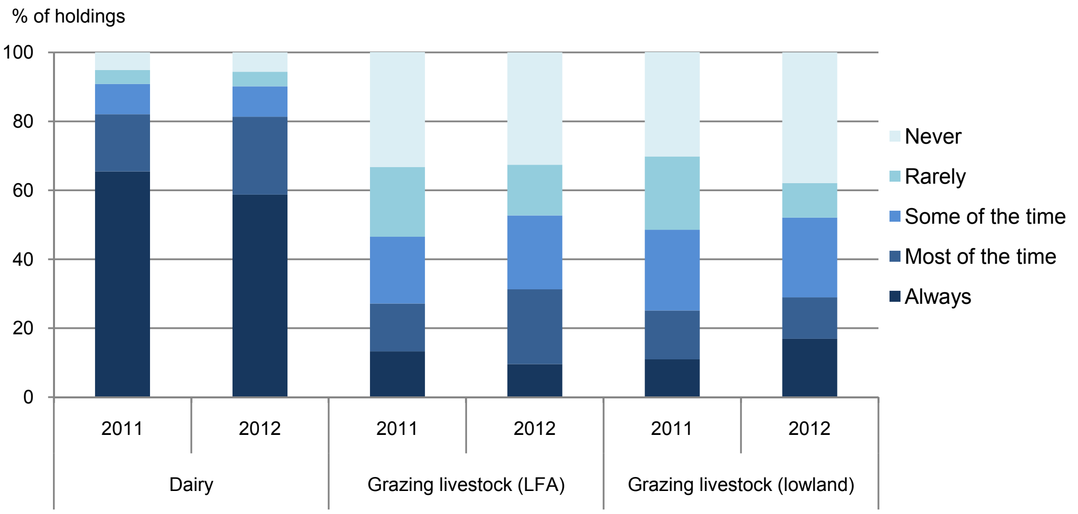
Source: Farm Practices Survey 2012

The FPS 2012 also showed that 55% of farmers checked and corrected the rate for the fertiliser type more than once a year. A further 34% checked and corrected the rate for the fertiliser type once a year. This is little changed from the results from 2011. Results are for holdings who apply fertiliser to crops or grassland.

Livestock: feeding regimes and breeding practices

The proportion of livestock farmers using a ration formulation programme or nutritional advice from an expert when planning feeding regimes (at least some of the time) is significantly higher for dairy farms (90% in 2012) than for grazing livestock farms (53% for LFA and 52% for lowland in 2012).

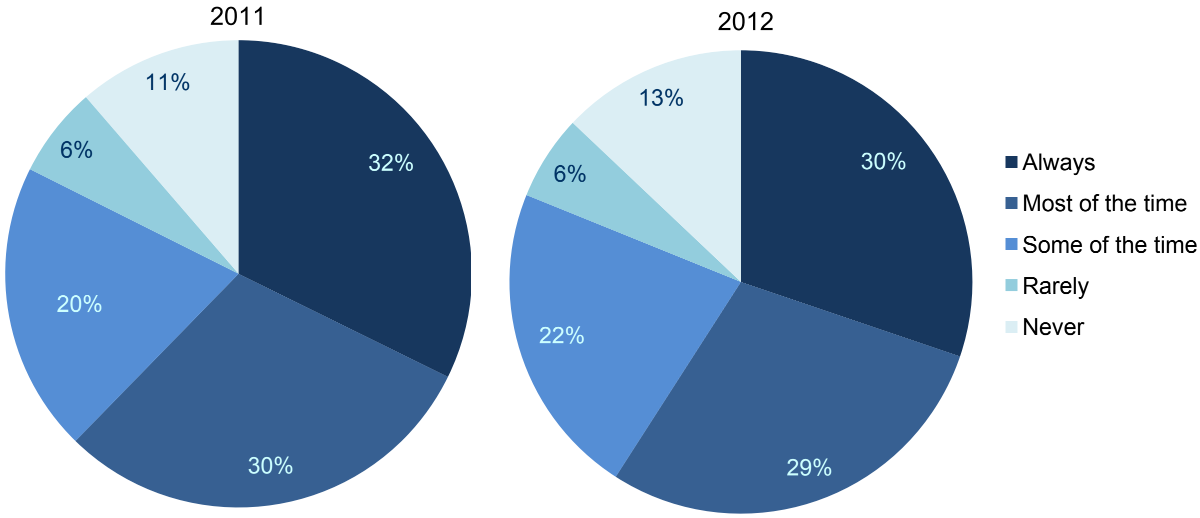
Frequency with which a ration formulation programme or nutritional advice from an expert is used when planning feeding regimes for livestock, England



Source: Farm Practices Survey

The 2011 and 2012 FPS indicate that almost a quarter of farmers with dairy cattle always use bulls with a high Profitable Lifetime Index (PLI) when breeding dairy cows. This rises to about 30% on farms where dairy is the main activity (shown in the chart below). Farm size is also a factor in uptake, 74% of "large" farms always use bulls with a high PLI at least some of the time compared to 44% of "small" farms.

Frequency with which farmers use bulls with a high Profitable Lifetime Index when breeding dairy cows, England

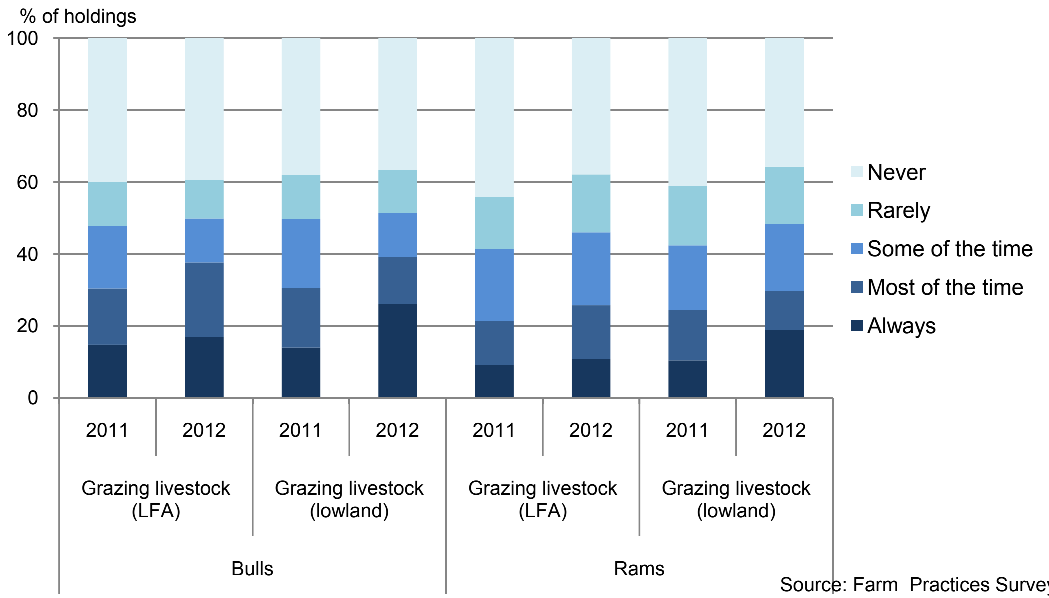


All figures are for dairy holdings only

Source: Farm Practices Survey

Overall in 2012, bulls and rams with high Estimated Breeding Values (EBV) were always used on 22% of farms breeding beef cattle and 16% of those breeding lambs. This shows no significant increase from the proportions in 2011. Focusing on only LFA and lowland grazing livestock farms, the percentages using bulls or rams with a high EBV are fairly similar, with around half doing this at least some of the time.

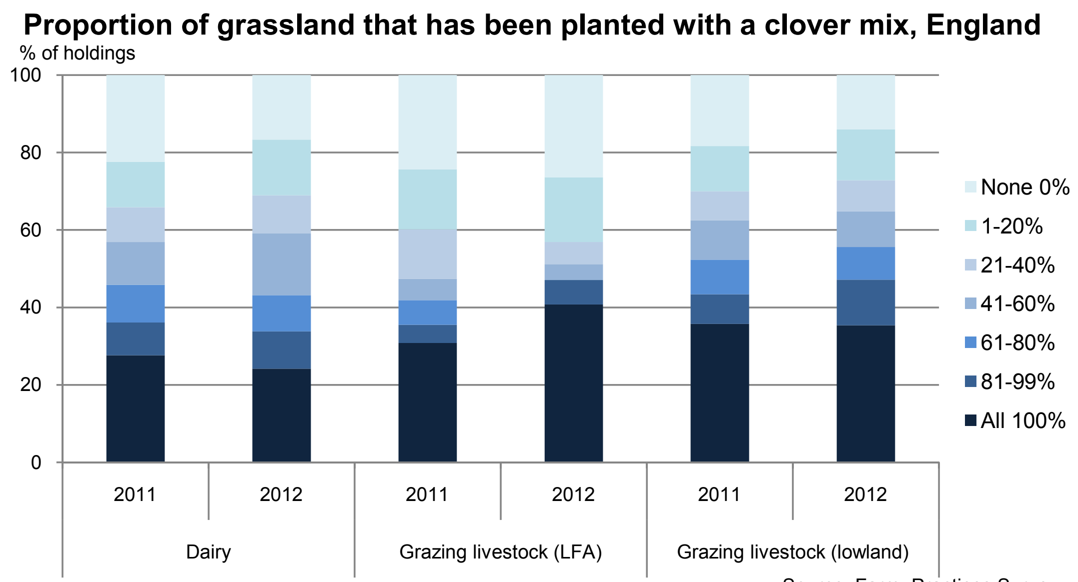
Frequency with which farmers use bulls or rams with a high Estimated Breeding Value when breeding beef cattle or lambs



Source: Farm Practices Survey

Grassland

Sowing a clover mix on temporary grassland has a variety of benefits, for example its nitrogen fixing properties (although not suitable for all soil types). The following chart shows that most livestock farmers across each of the three farm types shown plant some proportion of their temporary grassland with a clover mix. Overall, in 2012, 79% of livestock farms indicated that a proportion of their temporary grassland had been sown with a clover mix, little changed from 2011. High sugar grasses were sown on temporary grassland for 62% of livestock farms, again showing little change from 2011.



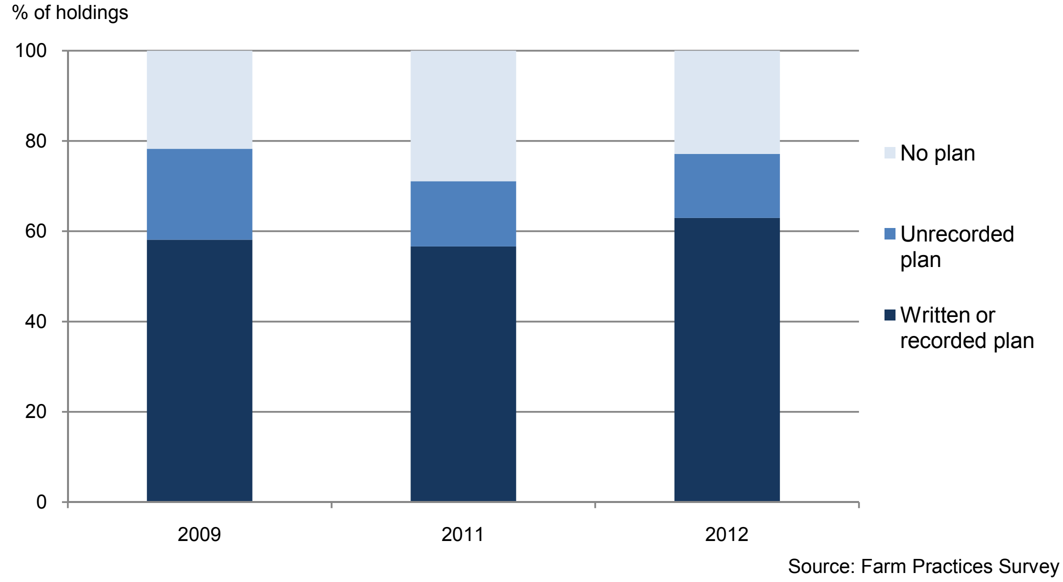
Source: Farm Practices Survey

Farm health planning

In 2012, 77% of livestock farms had a farm health plan. Whilst there has been little overall change since 2009, there has been a small increase in the proportion having a written (rather than unrecorded) plan. Dairy farms have the greatest uptake of farm health plans; in 2012 95% recorded having such a plan with almost all of these (94%) being written or recorded. The majority of (65%) farm health plans are created with the assistance of a vet or advisor increasing from 60% in 2009.

44% of those with farm health plans indicated that they "routinely" use their plans to inform disease management decisions whilst a further 36% used them "when possible". 20% of farms did not use their plans when making decisions relating to disease management, however of these 8% felt that they should.

Of those farms currently without a farm health plan 14% were planning to complete one with some assistance over the next 12 months. These were more likely to be larger farms.



Slurry separation and coverage of manure / slurry stores

Separating slurry greatly reduces storage space and can assist with the efficiency with which nitrogen is applied to land which has the potential to reduce emissions. Results from the FPS 2012 showed that of those livestock holdings with a slurry storage facilities, 8% had a separator and a further 7% were planning to get one in the future.

Of farms with facilities to store manure or slurry no more than a fifth of stores were covered. Table 13 shows a time series of the proportion of farms with covered manure and slurry stores by farm type and storage method. When taking into account the variability in the results, the proportion of covered stores has changed very little between

Table 13: Proportion of farms that have covered storage facilities for manure and / or slurry

	2010		2011		2012	
Type of store	**% of holdings**	**95% C.I.**	**% of holdings**	**95% C.I.**	**% of holdings**	**95% C.I.**
Solid manure stored in heaps on a solid base	7	± 1	6	± 1	7	± 3
Solid manure stored in temporary heaps in fields	#	#	1	± 0	0	± 0
Slurry in a tank	19	± 3	15	± 3	12	± 6
Slurry in a lagoon	2	± 1	1	± 1	0	± 0
Slurry in another type of store	14	± 3	12	± 6	19	± 20

Source: Farm Practices Survey

# Indicates that data has been suppressed to prevent disclosure of information about individual holdings.

Anaerobic Digestion

Anaerobic digestion is the process in which plant and animal material is converted into useful products by micro-organisms in the absence of air. The methane released can be used to provide heat and power. The remaining material is rich in nutrients and can be used as a fertiliser.

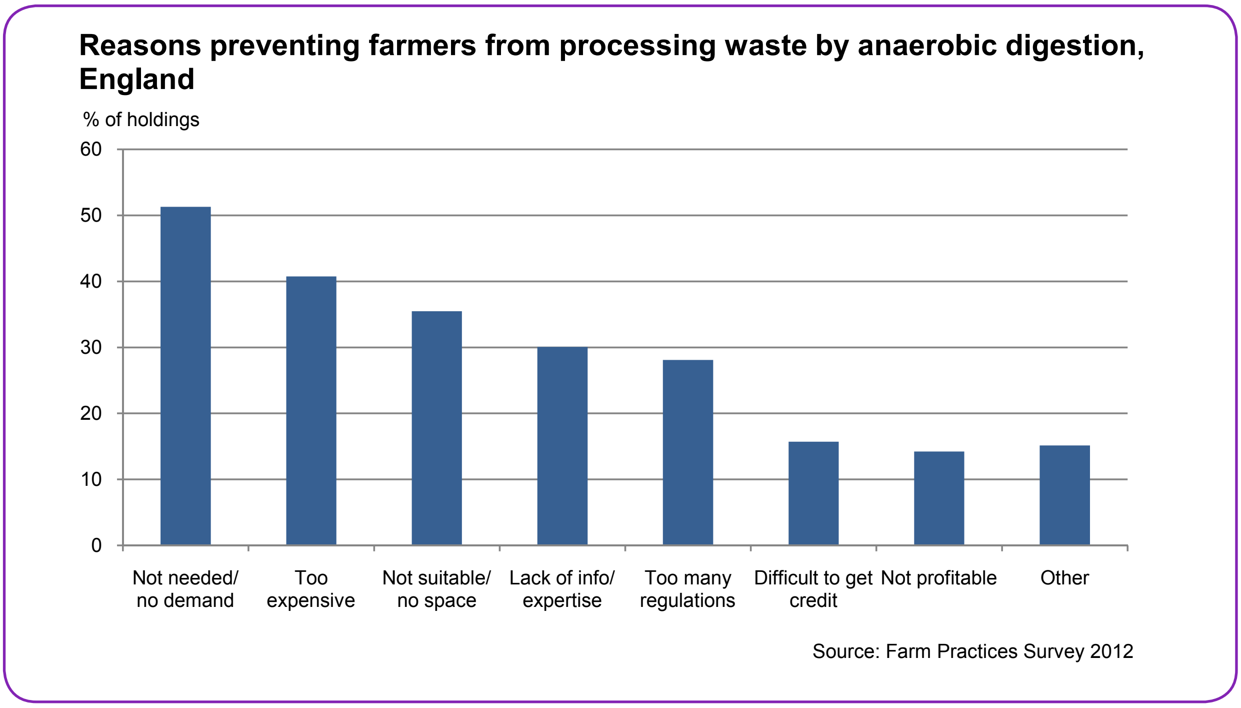
Survey data suggests a significant increase in awareness of anaerobic digestion between 2008 (57% of farmers) and 2011 (71% of farmers). Despite this, the number of farmers processing waste by anaerobic digestion has remained relatively small; the proportion processing slurries, crops or feedstocks has remained relatively constant since 2008 at around 1%, whilst the number planning to do so in the future has declined slightly from 7% in 2008 to 3% in 2012.

Table 14: Proportion of holdings already, or planning to, process slurries, feedstocks or crops by anaerobic digestion

	2008		2011		2012	
	% of holdings	95% C.I.	% of holdings	95% C.I.	% of holdings	95% C.I.
Already processing	1	± 0.8	1	± 0.5	1	± 0.8
Planning for the future	7	± 1.8	5	± 0.8	3	± 1.1
No plans to use AD	92	± 1.9	94	± 0.9	96	± 1.3

Source: Farm Practices Survey

The most common reason preventing farmers from processing waste by anaerobic digestion was a lack of demand. However, when looking at the results by farm size the majority of large farms said the process was simply too expensive.



3.3 Farmer attitudes and up take of on-farm mitigation measures: further developments

Farm Practices Survey

The 2012 FPS repeated most 2011 questions with some additions.   The following, although considered relevant mitigation measures, were deemed too complex for a short question on the FPS:

- Information on the calibration of manure and slurry spreaders.
- The frequency of removal of manure from housing.
- Use of band spreaders to apply slurries.

Farm Business Survey

As part of the 2010/11 Farm Business Survey information was gathered on farmers' aspirations and plans for the future towards the whole business and for individual enterprises, the strength of these intentions and the reasons. The results were published at the end of May 2012 and can be found at:
http://www.defra.gov.uk/statistics/foodfarm/farmmanage/fbs/publications/farmer-intentions-survey/

Also as part of the 2011/12 Farm Business Survey information was gathered on management practices including ones specifically relating to environmental aspects, such as existing and intended practices to mitigate greenhouse gas emissions. This data will be available towards the beginning of 2013.

Section 4 Emerging evidence

This section aims to capture evidence around mitigation as new research emerges. Some of this is subject to uncertainty and pending further research, where this is the case the text explains the position.

4.1 Potential impact of improved economic performance

There are considerable variations in economic performance between farms. Initial exploratory analysis using the 2007/08 Farm Business Survey data indicates that assuming the lowest performing quartile improve their performance to match the highest performing quartile, there are potential significant savings of greenhouse gas emissions. The table below provides further detail by sector. Note that beef and sheep and horticulture have not been considered for this analysis.

Table 15: Indicative aggregate GHG savings (for England) by improving performance

Sector	Improved fertiliser efficiency	Improved fuel efficiency	Improved feed efficiency	Improved breeding efficiency[36]
Combinable crops	Large	Moderate	n/a	n/a
Root crops	Small	Small	n/a	
Dairy	Moderate		Moderate	Large
Pigs			Moderate	
Broilers		Small	Moderate	
Layers			Small	

Source: Farm Business Survey

Small = 0.0001 to 0.01 mega tonnes CO_2e
Moderate = 0.01 to 0.1
Large = 0.1 to 0.5

[36]Improved breeding efficiency here relates to the number of breeding animals to produce the same amount of output.

Note that in preparing these estimates, the extremely broad approach has been used:

i) Assuming the lowest quartile improve their economic performance and hence efficiency of input use to the same level as the top quartile..

ii) In practice, of course, the lowest quartile might well account for less than 25% of aggregate production. However, there will also be savings in input use by the bottom quartile moving to the middle, and by some in the middle moving to the top.

iii) Apportioning all of the reduction in input usage at (i) to 25% of the aggregate volume of production. This is in order to estimate the amount of aggregate production that would be subject to reductions in input use if the lowest quartile (in terms of economic efficiency) raised their performance to the level of the top quartile.

iv) For simplicity, however, we have only modelled the impact of the 'bottom moving to the top'. Given the broad brush nature of the exercise, the estimation of the share of aggregate production was not refined as this implies spurious accuracy, given all the other approximations.

v) The methane saving for dairy cows was calculated by assuming an increase in average milk yields to those for the high performing quartile. This would result in a reduction in the number of cows required to maintain the same levels of milk production and would have a substantial effect on GHG emissions.

[36]Improved breeding efficiency here relates to the number of breeding animals to produce the same amount of output.

4.2 Associations between economic performance and greenhouse gas emissions

The approach described in section 4.1 has its limitations given the broad and simplistic basis of the analysis. In practice there are further subtleties which would need to be addressed to get a better understanding of the relationship between economic performance and emissions. Details of some of the research carried out using Farm Business Survey data, which took this approach a step further, can be found in Section 4 of the 2nd edition of Agricultural Statistics and Climate Change at:
http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-enviro-climate-climatechange-120203.pdf

The final report is given at:
http://archive.defra.gov.uk/evidence/economics/foodfarm/reports/documents/FBSEnergyModAnalysisReportV12.pdf

4.3 Emerging evidence: further developments

Update on Greenhouse Gas Platform

Defra and the Devolved Administration Governments are currently supporting the development of an improved Greenhouse Gas Inventory for direct methane (CH_4) and nitrous oxide (N_2O) emissions from agriculture through a five-year research programme called the Greenhouse Gas Platform. The Platform comprises three, closely-linked projects, which will improve the accuracy and resolution of our national reporting system. This will be achieved through the development of country-specific emission factors to reflect current and changing specific practices and production systems within agriculture. The outcomes will help to enable forecasting and monitoring of performance against the wider UK target emission reductions set by the UK Climate Change Act (2008).

The Greenhouse Gas Platform consists of the following three projects:

1. Data Management and Modelling: project AC0114 – bringing existing and newly-researched data together to create a new, more-disaggregated inventory model and a set of revised emission factors with an assessment of uncertainty.

2. Methane ResearCH$_4$ project: AC0115 – develops new CH_4 emission factors from the principal ruminant livestock species and breeds/genotypes (and manure from cattle sheep and pigs) under different farming systems and representative farm business structures.

3. Nitrous Oxide InveN$_2$Ory project: AC0116 – improved quantification of N_2O emissions from different nitrogen inputs as influenced by season, climate, crop, soil types and conditions, and land management under different farming systems and representative farm business structures.

Outputs from the three projects will by 2015 propose an improved UK agricultural GHG inventory in line with the Intergovernmental Panel on Climate Change (IPCC) 2006 Tier 2 /Tier 3 Guidelines, which will better reflect UK agricultural practices and systems. It will in due course upgrade the current inventory (predominantly at Tier 1 level using IPCC international default emission factors) delivered through Defra project AC0112 (Inventories of ammonia and greenhouse gases from UK agriculture) to DECC for inclusion in the multi-sectoral UK GHG Inventory (http://ghgi.decc.gov.uk/) submitted on 15 April each year to the United Nations Framework Convention on Climate Change (UNFCCC).

Considerable progress has been made across the Platform projects. A farm practice data collation and assessment exercise has been completed, a proposal for the structure and emission factor calculations for an improved inventory has been prepared and measurements of emissions have continued at sites representative of UK farming, to quantify N_2O emissions from soils under arable cropping and grassland and with various fertiliser and manure applications. Experimental work is also ongoing across the UK to determine methane emissions from dairy cattle, beef cattle, and sheep, using a range of ages, breed types, and diets, and to quantify methane emissions from manure management. Workshops have been held presenting updates on progress within the Platform to representatives of government and industry as well as engaging stakeholders on future possible farm practice surveys. Project partners have also represented the UK at Global Research Alliance (GRA) collaborative Research Group meetings. Members of the Platform team contributed to the Global ResearCH4 InveN$_2$Ory workshop at the University of Reading in October 2011 at which ninety delegates from 15 countries saw presentations on existing and developing technologies for measuring greenhouse gas emissions from diffuse agricultural sources. This was organised as part of the UK's commitment to the GRA and its activities. Updates on progress within each of the projects, in addition to newsletters and details of past/future events can be found on the Platform website at: www.ghgplatform.org.uk. More information on the Greenhouse Gas R&D Platform projects can also be obtained through contacting Toby Mottram the Platform Co-ordinator (toby.mottram@defra.gsi.gov.uk).

Digest of Ongoing Research Projects

A range of ongoing research projects are underway to support the R&D platform and efforts by the agricultural sector to reduce emissions. These cover livestock and forage improvement, crop improvement, more efficient use of fertilisers on crops and protein in animal diets and collation of evidence to encourage implementation of the industry GHG Action Plan. Evidence generated by these projects will feed into the inventory improvement programme. Details of the projects can be found in the Appendix at (vi).

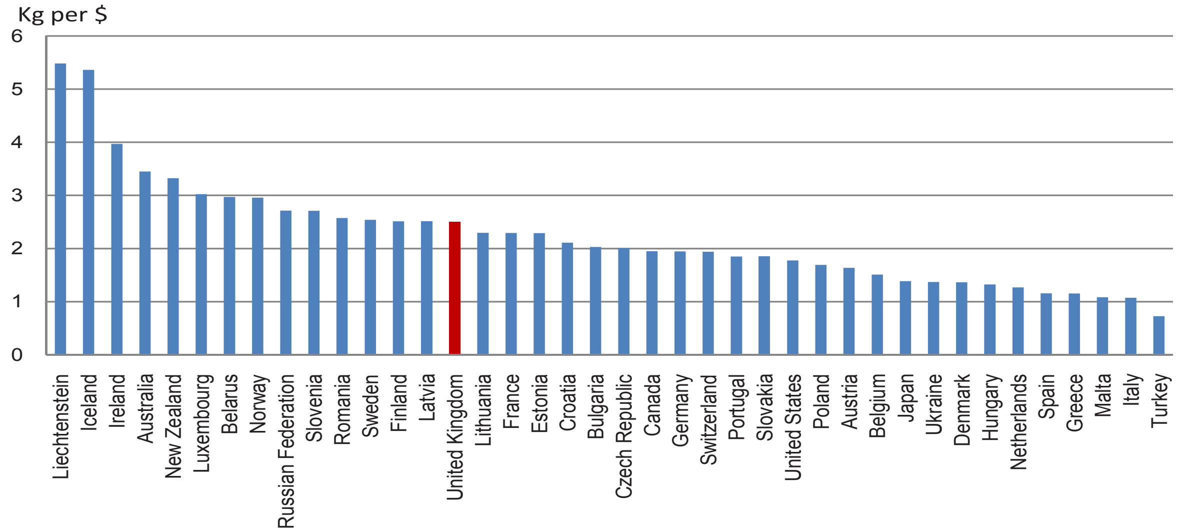
Section 5 International comparisons

This section endeavours to make meaningful international comparisons of both the productivity and greenhouse gas (GHG) intensity of agriculture. There are many challenges with making international comparisons due to lack of comparable data, and simply lack of data in some instances. In exploring international comparisons of GHG, two illustrative examples for cereals and milk are given. Here, where available, yields are considered alongside factors associated with risk of high GHG intensity.

5.1 International comparisons of GHG emissions per unit of agricultural production

Comparisons of GHG emissions from agriculture across countries are difficult, not only because of data availability but also due to the differing types of agriculture undertaken in each country. For example, the UK agricultural sector is very different to that found in Mediterranean countries. The chart below attempts to put the UNFCCC (Annex1)[37] countries on a common scale by assessing agricultural emissions on the basis of emissions per unit of output, although it is acknowledged that a relative assessment by agricultural sector (e.g. cattle, crops etc) would allow better comparisons between nations were the data readily available. The chart provides an indication of carbon efficiency in relation to agricultural output, expressed in financial (rather than biological or physical terms). It is likely that the Mediterranean countries are to the right of the graph because they produce high value crops with low emissions (e.g. olives and grapes etc) whereas the UK has a preponderance of grassland, has the largest population of sheep in Europe and a large population of suckler cows which produce methane and are produced largely at very low or negative profit margins even though they may be comparatively efficient in production terms.

Agricultural emissions in CO_2 equivalent per unit of gross agricultural production, 2009



Note: Gross agricultural production expressed in constant 2004-2006 prices
Sources: UNFCCC, FAO

[37] **Annex I** Parties to the United Nations Framework Convention on Climate Change (UNFCCC) include the industrialized countries that were members of the OECD (Organisation for Economic Co-operation and Development) in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States, and several Central and Eastern European States.

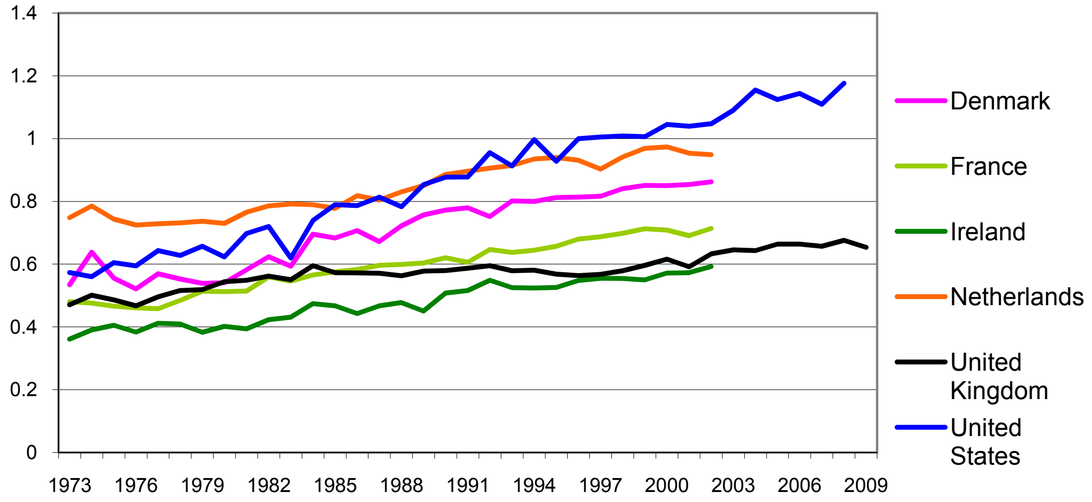
5.2 International comparisons of productivity

Total factor productivity provides a measure of the volume of output leaving the industry per unit of all inputs including fixed capital and labour. This measure is in part affected by factors outside farmers' control, such as weather events.

The chart below shows trends in total factor productivity for a selection of countries. This is a relatively simple comparison and it will be affected by random events outside of a farmers control such as weather. Additionally, it does not account for regional factors such as differing regulatory environments which may aid or limit productivity. A more sophisticated approach to assess the efficiency of UK agriculture, which also enables comparison with other EU countries, is published at:

http://archive.defra.gov.uk/evidence/economics/foodfarm/reports/documents/farmefficiency.pdf

Total factor productivity relative to the 1996 level for the US



Source: Productivity and International Competitiveness in the European UN and United States Agriculture, USDA Economic and Research Service , Defra

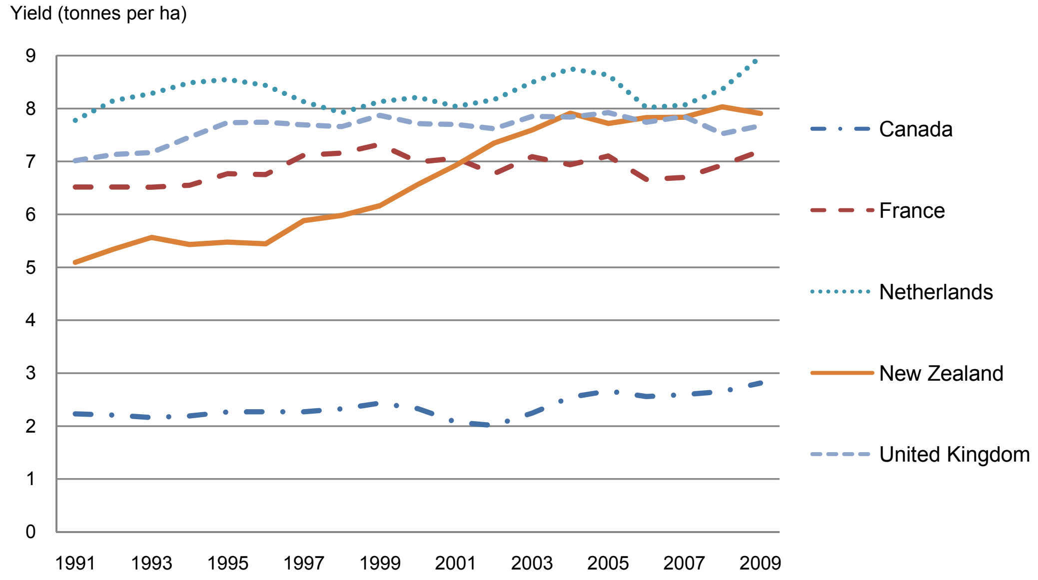
5.3 Yields and GHG risk factors: cereals

Wheat and barley are the main cereal crops produced in the UK. Other cereals which make significant contributions to world cereal production such as maize, sorghum and rice are not included here.

In 2010, the UK accounted for 2% of world production of wheat and 4% of barley (source: FAO).

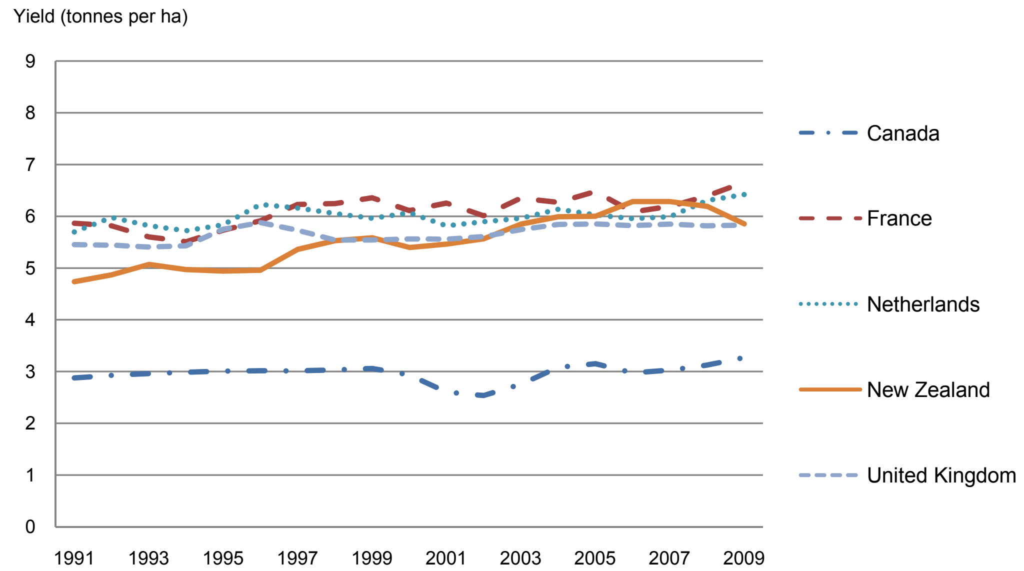
The following charts show trends in wheat and barley yields for a selection of countries over the last twenty years. UK wheat and barley yields have both risen by around 10% over this period.

Wheat yields (3 year moving average) 1990 to 2010



Source: FAO

Barley yields (3 year moving average) 1990 to 2010



Source: FAO

Figure 3 below shows international comparisons of cereal yield and soil nitrogen balance. The lower right quadrant represents the lowest risk to GHG emissions of having high yields and a low nitrogen balance.

The countries chosen for this analysis have some characteristics common to UK production (though clearly there will be significant differences).

Focussing on cereal yields has its limitations since nitrous oxide emissions are produced from sources other than cereals such as pastures and fodder crops etc. An approach which considers the efficiency of all nitrogen use (the percentage ratio of total nitrogen uptake by crops and forage to the total nitrogen available from fertiliser, livestock manure and other nitrogen inputs) and the balance is potentially enlightening in understanding risks of high GHG intensity. This comparison is given in the second figure.

In both the figures below, moving into the lower right hand quadrant would be expected to achieve a lower risk of GHG emissions.

Figure 3: Cereal yield and nitrogen balance, 2002 - 2004 average

Based on those countries with at least 60% of cereal production from wheat and barley and at least 25% of nitrogen output through harvested crops. The chart does have limitations as it does not take into account factors such as variation in climate.

	Cereal yield 2 to 5 tonnes per ha	Cereal yield above 5 to 10 tonnes per ha
Nitrogen balance 101 to 200 Kg per ha	Low yield, high N balance	High yield, high N balance Belgium, Denmark, Germany
Nitrogen balance 0 to 100 Kg per ha	Low yield, low N balance Canada, Finland, Spain, Sweden, Turkey	High yield, low N balance *Lowest risk of high GHG Intensity* France, UK

Sources OECD and FAO

Figure 4: Nitrogen efficiency and nitrogen balance, 2002 - 2004 average

Nitrogen efficiency is the percentage ratio of total nitrogen uptake by crops and forage to the total nitrogen available from fertiliser, livestock manure and other nitrogen inputs.

	Nitrogen efficiency 30% to 60%	Nitrogen efficiency 61% to 90%
Nitrogen balance 100 to 200 Kg per ha	Low N efficiency, high N balance South Korea, Japan, Germany, Belgium, Denmark, Netherlands	High N efficiency, high N balance
Nitrogen balance 0 to 100 Kg per ha	Low N efficiency, low N balance Canada, Portugal, USA, Spain, Australia, OECD, Switzerland Norway, Poland, Mexico, Sweden, Finland	High N efficiency, low N balance *Lowest risk of high GHG intensity* Hungary, New Zealand, Ireland, Italy, France, Turkey, Austria, UK, Greece

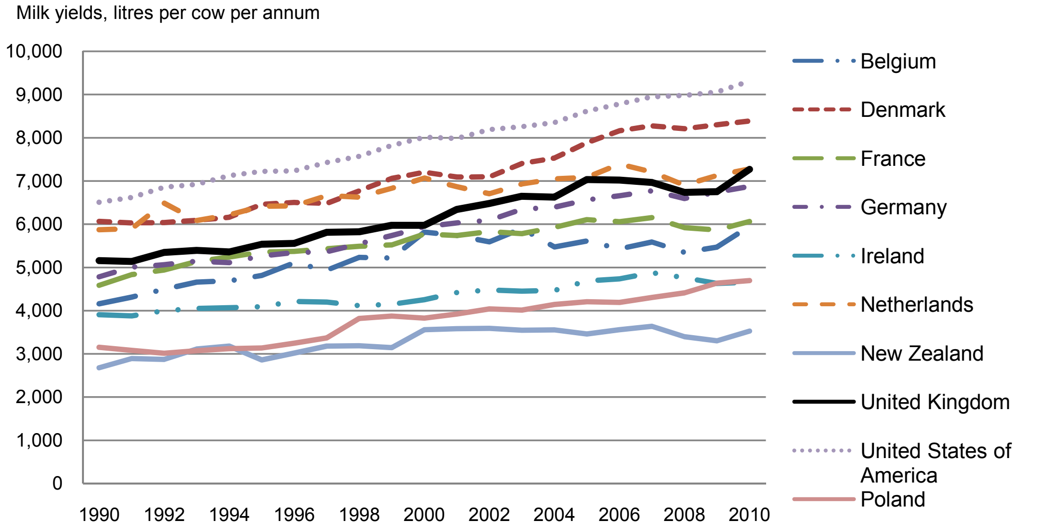
Source OECD and FAO

5.3 Yields and GHG risk factors: milk

The chart below provides some international comparison of milk yields. This says nothing about the intensity of GHG emissions. For the countries shown, yields will be positively correlated with the levels of input (there is limited information available to quantify this). For example:

- New Zealand and Ireland's dairy production systems may be defined as low-input/low-output (around 4 thousand litres per cow/ year). Feeding is based mainly on grazing.
- The USA's dairy production systems may be classified as high-input/high-output (around 8,400 litres per cow/year). Feeding is based mainly on grass/maize silage and compound feed.
- Germany's dairy production systems may be classified as high-input/high-output (around 7,100 litres per cow/year). Feeding is based mainly on grass/maize silage and compound feed.

Milk yields, 1990 to 2010

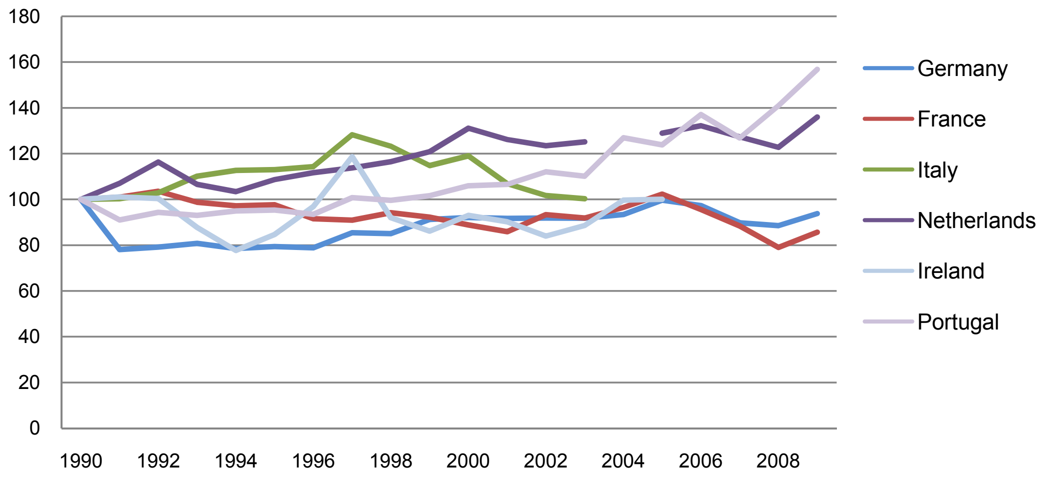


Source: FAO

The following chart shows a country level comparison of milk production to dairy cow compound feed production (it is not possible to include the UK on this chart as comparable data are not available across all the years). As explained in Section 2.4 the ratio of milk produced to compound feed production can be used as a proxy measure for the emissions intensity of the dairy sector.

Ratio of milk production to dairy cow compound feed production per annum

Index 1990=100



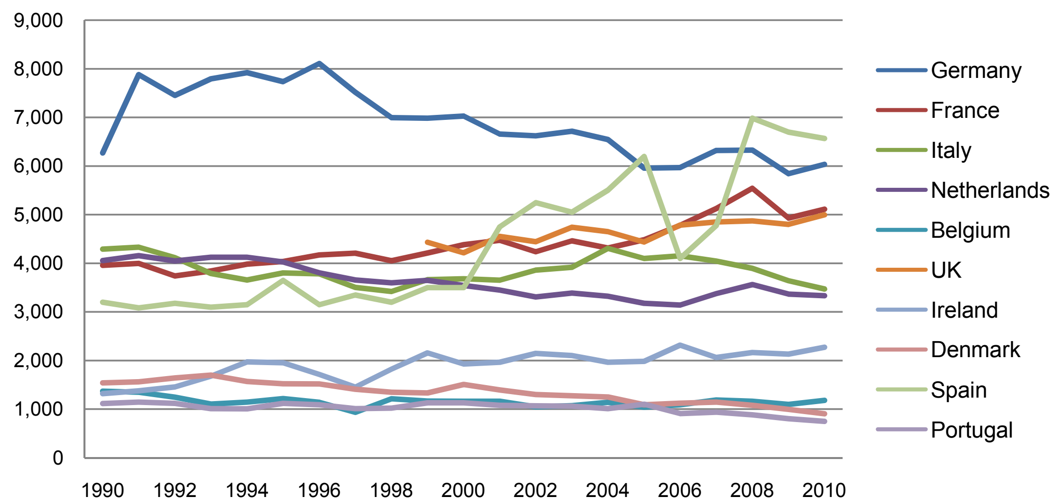
Source: FAO, European Feed Manufacturers Federation

5.4 Animal feed

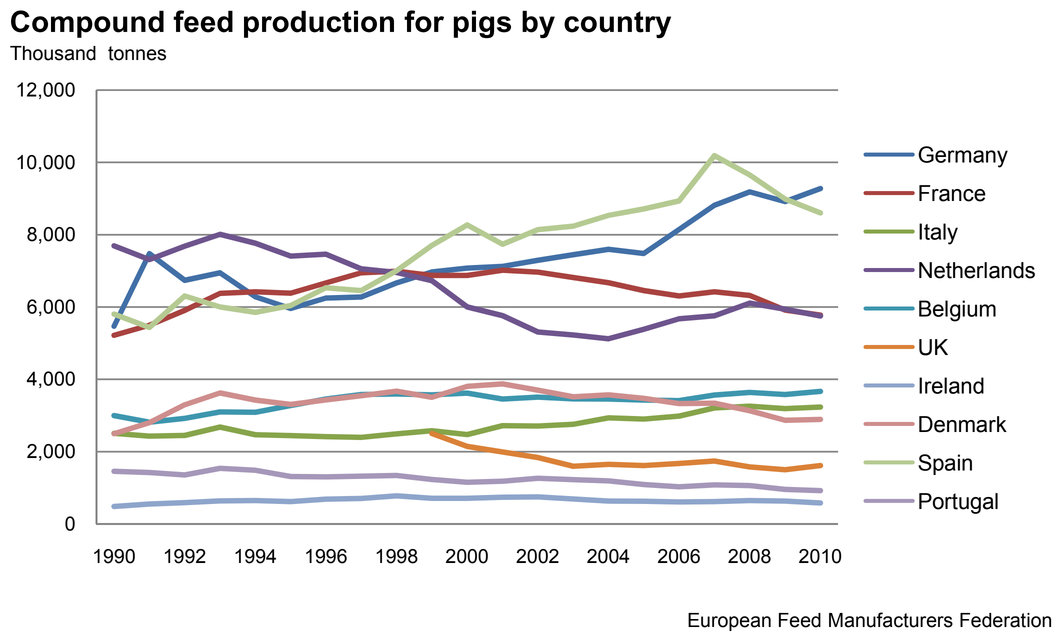
The following charts show compound feed production for a range of European Union countries to illustrate levels of inputs across different countries.

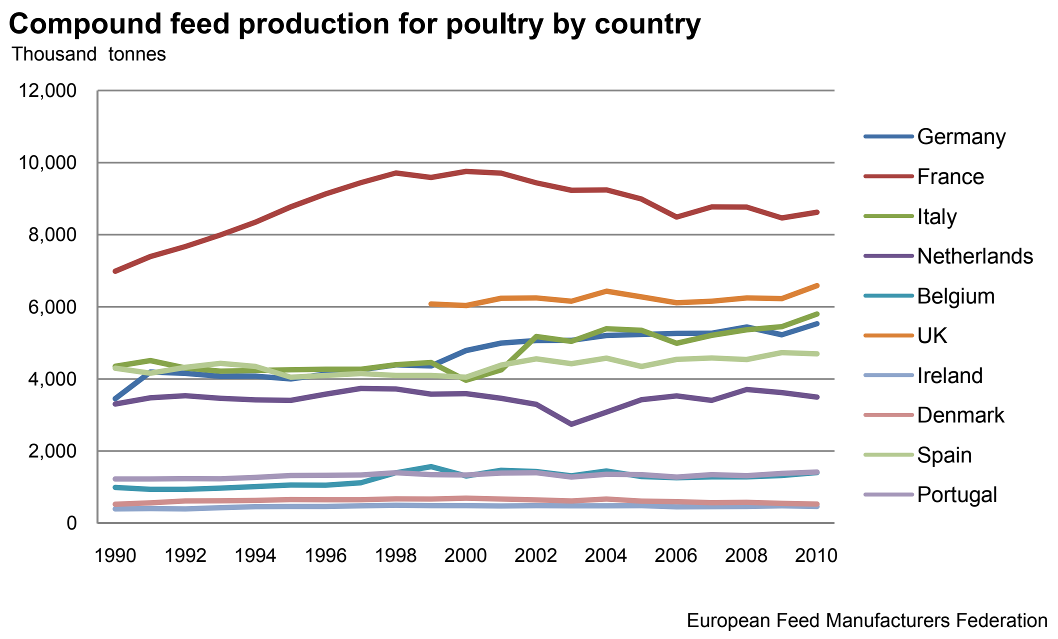
Compound feed production for cattle by country

Thousand tonnes



European Feed Manufacturers Federation


Compound feed production for pigs by country
Thousand tonnes
12,000
10,000
8,000
6,000
4,000
2,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Germany
France
Italy
Netherlands
Belgium
UK
Ireland
Denmark
Spain
Portugal
European Feed Manufacturers Federation


Compound feed production for poultry by country
Thousand tonnes
12,000
10,000
8,000
6,000
4,000
2,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Germany
France
Italy
Netherlands
Belgium
UK
Ireland
Denmark
Spain
Portugal
European Feed Manufacturers Federation

Appendix

(i) Methodology details for source data

Agricultural Price Index
http://www.defra.gov.uk/statistics/foodfarm/farmgate/agripriceindex/

AHDB auction market reports
http://www.eblex.org.uk/markets/

British Survey of Fertiliser Practice – section A2
http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-environ-fertiliserpractice-2011-120425.pdf

Cattle Tracing System - methodology section in the Cattle Book:
http://www.defra.gov.uk/statistics/foodfarm/landuselivestock/cattlebook/

Cereal Production Survey - page 9
http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-landuselivestock-june-statsrelease-uk-111222.pdf

Emissions data methodology - compilation and methodology at:
http://www.decc.gov.uk/en/content/cms/statistics/climate_stats/gg_emissions/intro/intro.aspx

Farm Business Survey - data collection and methodology:
http://www.defra.gov.uk/statistics/foodfarm/farmmanage/fbs/aboutfbs/datacollection/

Farming Futures Climate Change Survey - the 2011 survey was based on a sample of 400 farmers from England drawn from the NFU database offering statistical reliability of 95% with a margin of error of +/-5% (based on approximately 55,000 NFU members). Target sub-sample quotas were set at 40 farmers from each region of England and 40 from each farm type in order to ensure representation. Interviews were carried out by telephone and Computer Aided Telephone Input (CATI) between the 26th January and 16th February 2011. http://www.farmingfutures.org.uk/annual-surveys

Farm Practices Survey 2006 - page 7:
http://archive.defra.gov.uk/evidence/statistics/foodfarm/enviro/farmpractice/documents/fps06-final.pdf

Farm Practices Survey 2009 – page 3
http://archive.defra.gov.uk/evidence/statistics/foodfarm/enviro/farmpractice/documents/FPS2009.pdf

Farm Practices Survey 2010 - pages 2-3
http://archive.defra.gov.uk/evidence/statistics/foodfarm/enviro/farmpractice/documents/FPS2010.pdf

Farm Practices Survey 2011 - pages 3-4
http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-environ-fps-FPS2011-110801.pdf

Farm Practices Survey 2012 – pages 3-4
http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-environ-fps-statsrelease2012-120531.pdf

GB Animal feed statistics - “methodology” tab in GB retail production of animal feed stuffs dataset
http://www.defra.gov.uk/statistics/foodfarm/food/animalfeed/

Hatcheries Survey - “information” tab in UK Poultry meat production monthly dataset
http://www.defra.gov.uk/statistics/foodfarm/food/poultry/

Integrated Poultry Unit Survey - “methodology” tab in the Integrated poultry feed production dataset
http://www.defra.gov.uk/statistics/foodfarm/food/animalfeed/

June Agricultural Survey:
http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-landuselivestock-june-junemethodology-20120126.pdf

Market Segmentation in the Agriculture Sector: Climate Change (ADAS, 2010):
http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=17291&FromSearch=Y&Publisher=1&SearchText=market%20segmentation&SortString=ProjectCode&SortOrder=Asc&Paging=10

Milk production data are from surveys run by Defra, RERAD, DARDNI on the utilisation of milk by dairies. Information on the survey methodology are given at:
http://www.defra.gov.uk/statistics/foodfarm/food/milk/milk-utilisation/

National Soils Inventory:
http://www.landis.org.uk/data/nsi.cfm

Slaughterhouse Survey - section 6:
http://www.defra.gov.uk/statistics/foodfarm/food/slaughter/

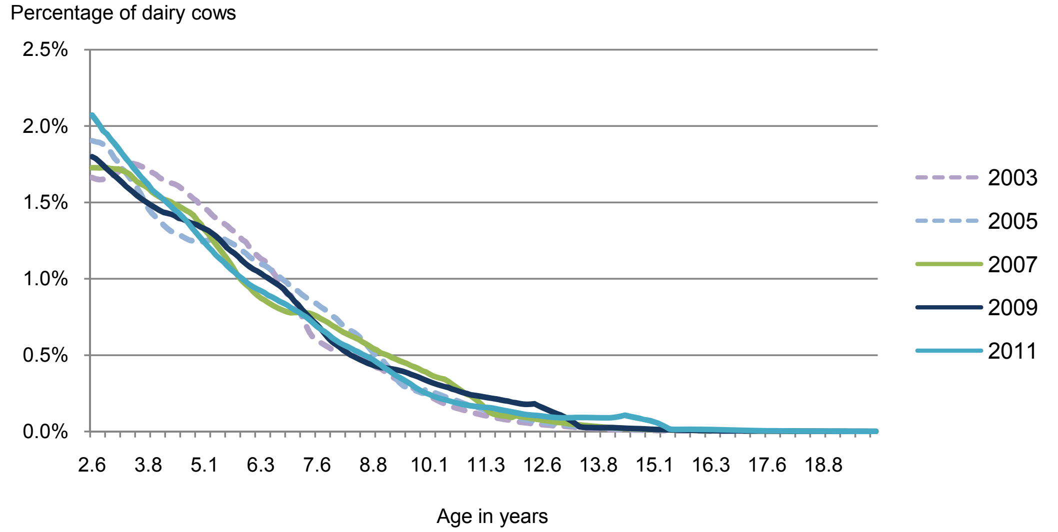
Soil Nutrient Balances
Information on the methodology for deriving Soil Nutrient Balances can be found at
http://www.defra.gov.uk/statistics/foodfarm/enviro/observatory/research-projects/published-research/soil-projects/
The ADAS report ‘Soil Nutrient Balances Draft Report June 2010’ explores uncertainty, see pg 46

The Countryside Survey:
http://www.countrysidesurvey.org.uk/about

Understanding behaviours in a farming context: Bringing theoretical and applied evidence together from across Defra and highlighting:
http://archive.defra.gov.uk/evidence/statistics/foodfarm/enviro/observatory/research/documents/ACEO%20Behaviours%20Discussion%20Paper%20(new%20links).pdf

(ii) Distribution of dairy cows by age in months

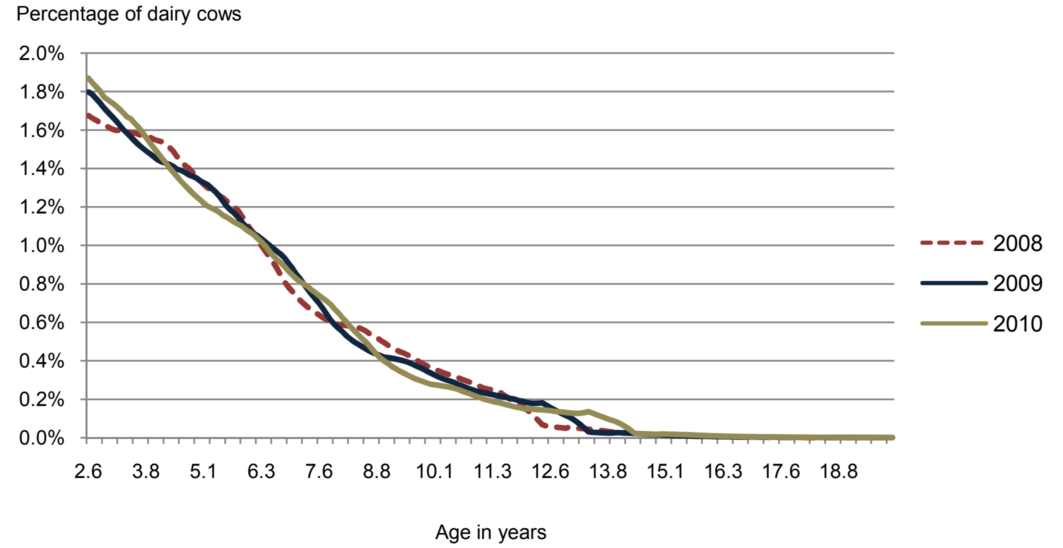
Distribution of dairy cattle by age in years, GB



The number of animals on which the percentage shown is based is an average of the number of animals in each month of the year

Source: RADAR, Cattle Tracing System

Distribution of dairy cattle by age in years, GB

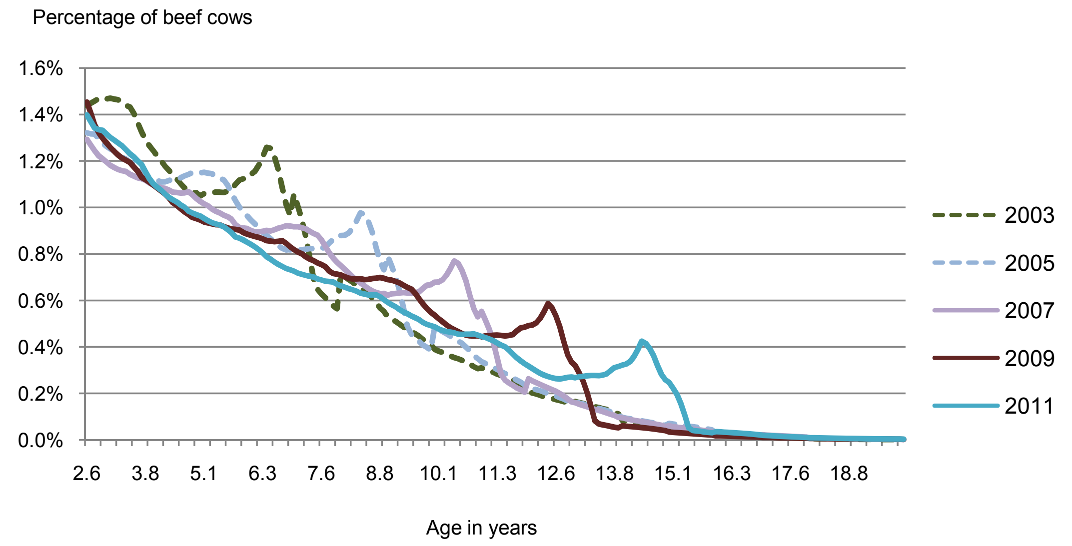


The number of animals on which the percentage shown is based is an average of the number of animals in each month of the year

Source: Defra RADAR, Cattle Tracing System

(iii) Distribution of beef cows by age in months

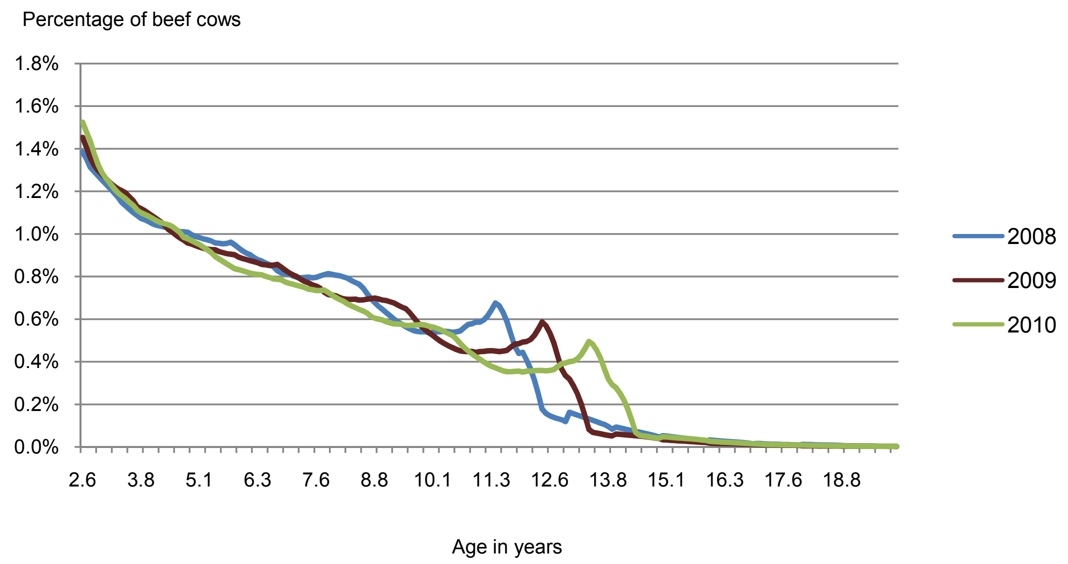
Distribution of beef cattle by age years, GB



The number of animals on which the percentage shown is based is an average of the number of animals in each month of the year

Source: Defra, RADAR Cattle Tracing System

Distribution of beef cattle by age in years, GB

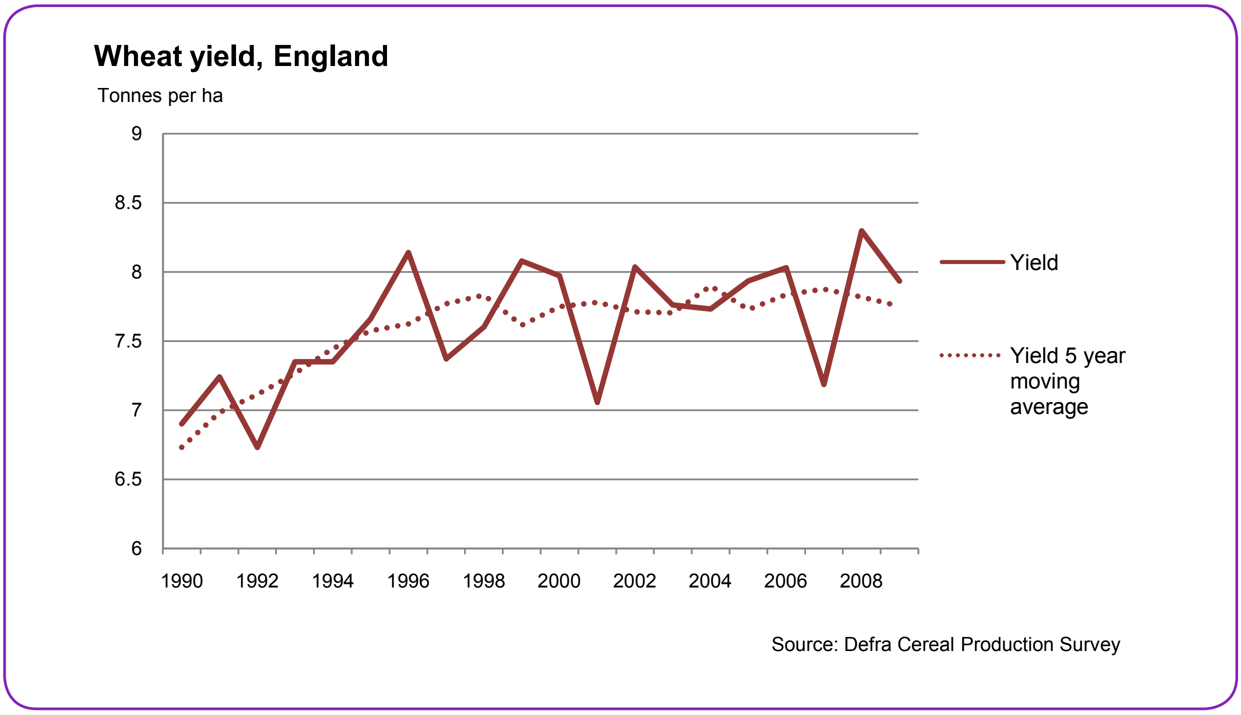


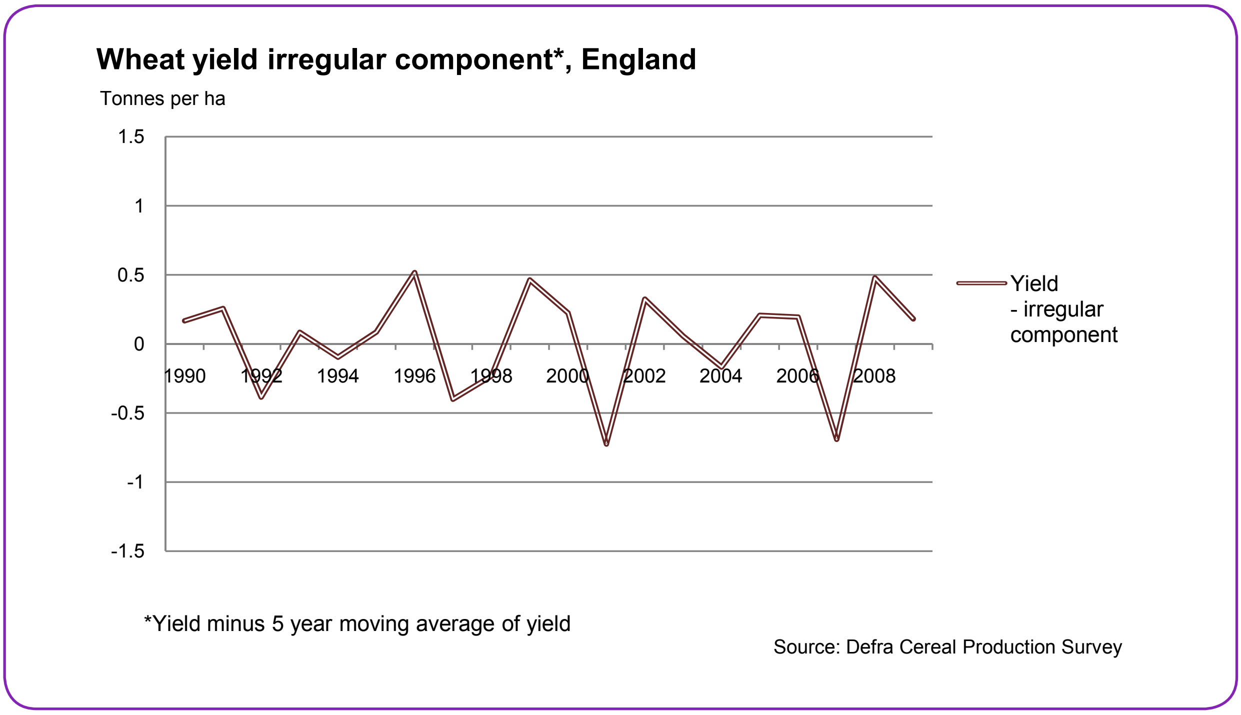
The number of animals on which the percentage shown is based is an average of the number of animals in each month of the year

Source: Defra, RADAR Cattle Tracing System

(iv) Wheat production per unit of manufactured N applied

The following charts illustrate the magnitude of the trend and irregular components of the time series given in Section 2.9. The charts show wheat only, similar charts for the other crops shown in Section 2.9 can be obtained by contacting alison.wray@defra.gsi.gov.uk

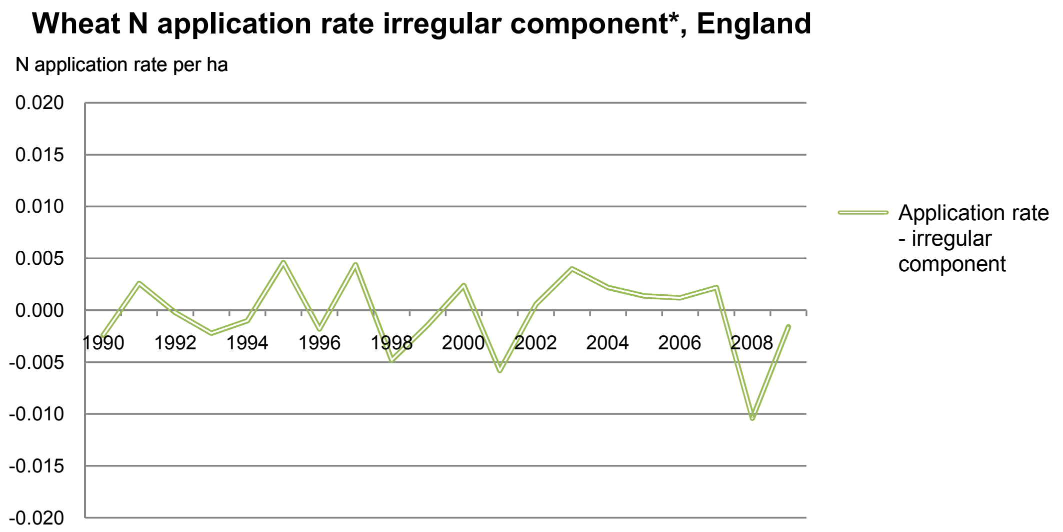




Appendix

(iv) Wheat production per unit of manufactured N applied (continued)

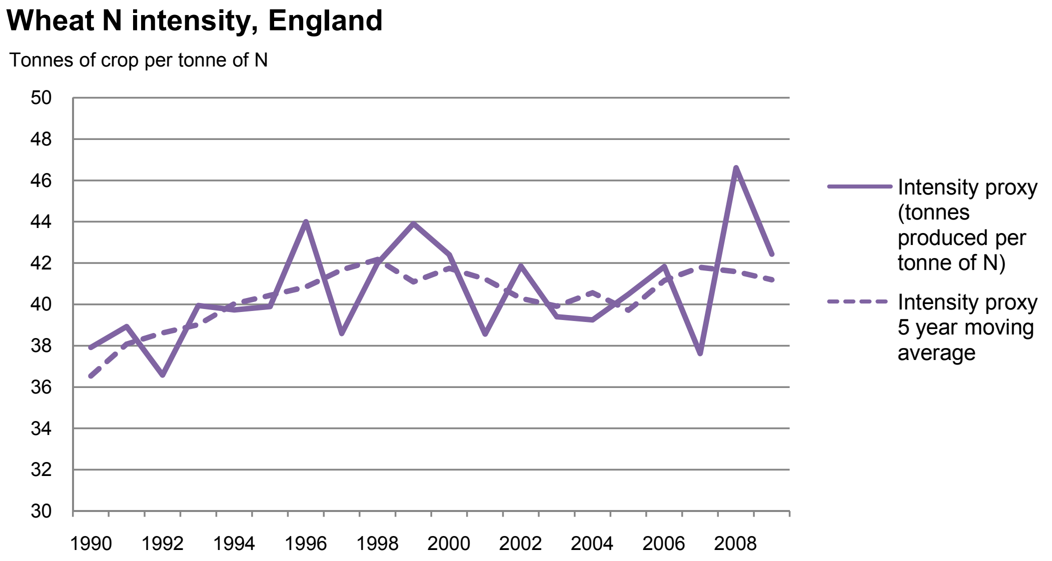
Source: British Survey of Fertiliser Practice



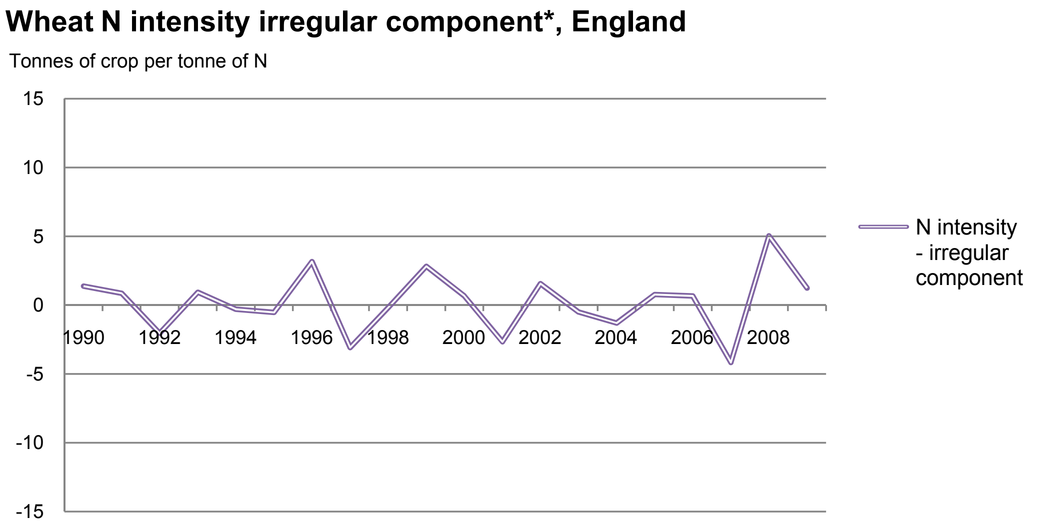
*N application rate minus 5 year moving average of N application rate

Source: British Survey of Fertiliser Practice

(iv) Wheat production per unit of manufactured N applied (continued)



Source: British Survey of Fertiliser Practice, Defra Cereal Production Survey



*N intensity minus 5 year moving average of N intensity

Source: British Survey of Fertiliser Practice, Defra Cereal Production Survey

(v) Farmer attitudes and uptake of on-farm mitigation measures: confidence intervals

Proportion of holdings with a nutrient management plan

	Percentage of holdings					95% confidence interval				
Farm type	2006	2007	2009	2011	2012	2006	2007	2009	2011	2012
Cereals	72	73	73	84	87	± 5	± 5	± 4	± 3	± 4
General cropping	71	70	71	83	82	± 6	± 7	± 5	± 4	± 7
Dairy	45	52	60	72	73	± 6	± 6	± 7	± 3	± 6
Grazing livestock (LFA)	15	18	18	23	29	± 10	± 7	± 6	± 5	± 9
Grazing livestock (lowland)	19	16	25	38	45	± 8	± 5	± 7	± 4	± 9

FPS 2012 results for all holdings that answered the queston in the farm type groups.
Number of responses used: 931

Tools used to create a nutrient management plan

	Percentage of holdings						95% confidence interval					
Farm type	PLANET	Muddy Boots	Farmade/ Multicrop	Tried and Tested	Other	Don't know	PLANET	Muddy Boots	Farmade/ Multicrop	Tried and Tested	Other	Don't know
Cereals	29	22	17	13	26	13	± 5	± 5	± 4	± 4	± 5	± 4
General cropping	30	25	21	20	28	9	± 9	± 8	± 7	± 8	± 8	± 6
Pigs & Poultry	26	6	15	22	41	10	± 18	± 9	± 14	± 17	± 20	± 10
Dairy	28	12	5	12	33	19	± 8	± 5	± 4	± 5	± 8	± 7
Grazing livestock (LFA)	0	22	4	21	54	20	± 0	± 17	± 8	± 17	± 20	± 16
Grazing livestock (lowland)	27	19	2	16	29	20	± 12	± 11	± 4	± 10	± 12	± 11
Mixed	32	26	5	20	17	10	± 11	± 10	± 4	± 9	± 8	± 7

Results are for holdings that have a nutrient management plan.
Number of records used: 791.

Frequency with which the nutrient management plan is updated

	Percentage of holdings			95% confidence interval		
Farm type	Every year	Every 2 years	Every 3 years of longer	Every year	Every 2 years	Every 3 years of longer
Cereals	82	9	9	± 5	± 4	± 4
Other crops	78	12	10	± 8	± 6	± 6
Pigs & poultry	83	13	4	± 15	± 14	± 9
Dairy	75	11	14	± 7	± 5	± 6
Grazing livestock (LFA)	42	16	42	± 20	± 15	± 20
Grazing livestock (lowland)	69	13	18	± 13	± 9	± 11
Mixed	77	7	16	± 10	± 5	± 8

Results are for holdings that have a nutrient management plan.
Number of records used: 792.

Frequency with which the nutrient management plan is referred to in a year

	Percentage of holdings				95% confidence interval			
Farm type	More than 10 times	5 to 10 times	Less than 5 times	Never	More than 10 times	5 to 10 times	Less than 5 times	Never
Cereals	10	25	62	4	± 3	± 5	± 6	± 2
Other crops	18	20	61	1	± 6	± 7	± 8	± 1
Pigs & poultry	9	19	72	0	± 12	± 16	± 18	± 0
Dairy	10	20	60	10	± 5	± 7	± 8	± 5
Grazing livestock (LFA)	0	4	70	26	± 0	± 8	± 19	± 18
Grazing livestock (Lowland)	6	17	73	3	± 6	± 10	± 12	± 5
Mixed	6	24	65	6	± 6	± 10	± 11	± 5

Results are for holdings that have a nutrient management plan.
Number of records used: 792.

Proportion of holdings with a manure management plan

Farm type	Percentage of holdings	95% confidence interval
Cereals	78	± 7
Other crops	82	± 9
Pigs & poultry	75	± 14
Dairy	90	± 4
Grazing livestock (LFA)	66	± 9
Grazing livestock (Lowland)	65	± 9
Mixed	81	± 8

For holdings that answered the question and for whom the question is applicable.
Number of records used: 847.

Proportion of holdings using each source of nutrient recommendations for the manure management

	Percentage of holdings		95% confidence interval	
Farm type	Defra recommendations/ manual	Other	Defra recommendations/ manual	Most of the time
Cereals	90	11	± 6	± 6
Other crops	93	9	± 6	± 7
Pigs & poultry	93	20	± 10	± 16
Dairy	92	9	± 4	± 4
Grazing livestock (LFA)	85	17	± 9	± 10
Grazing livestock (Lowland)	89	16	± 7	± 8
Mixed	91	11	± 6	± 7

Results are for holdings that indicated they have completed a manure management plan.
Number of records used: 660

Proportion of holdings testing nutrients of soil and manure

Farm type	Percentage of holdings				95% confidence interval			
	Regularly test nutrient content of soil	Regularly test the pH of soil	Test nutrient content of manure by taking samples	Assess/ calculate the nutrient content of manure	Regularly test nutrient content of soil	Regularly test the pH of soil	Test nutrient content of manure by taking samples	Assess/ calculate the nutrient content of manure
Cereals	96	96	33	73	± 3	± 2	± 7	± 7
Other crops	93	96	44	76	± 5	± 4	± 10	± 10
Pigs & poultry	76	79	44	63	± 13	± 13	± 16	± 15
Dairy	80	88	30	67	± 5	± 4	± 6	± 6
Grazing livestock (LFA)	32	47	7	29	± 9	± 10	± 5	± 9
Grazing livestock (Lowland)	53	64	10	43	± 8	± 8	± 5	± 9
Mixed	86	91	16	63	± 7	± 6	± 7	± 10

Results are for all holdings who answered the question and for whom the question is applicable.

Proportion of holdings that check or calibrate the spread pattern of their fertiliser spreader/s by frequency of checks

Farm type	Percentage of holdings				95% confidence interval			
	More than once a year	Once a year	Once every two years	Less than every two years	More than once a year	Once a year	Once every two years	Less than every two years
Cereals	35	54	6	5	± 6	± 6	± 3	± 3
General cropping	39	50	7	4	± 9	± 10	± 6	± 4
Pigs & poultry	23	52	5	20	± 20	± 22	± 6	± 17
Dairy	20	44	13	22	± 6	± 8	± 5	± 6
Grazing livestock (LFA)	7	47	7	39	± 7	± 13	± 6	± 13
Grazing livestock (lowland)	9	54	4	33	± 7	± 12	± 4	± 11
Mixed	23	47	13	17	± 9	± 11	± 7	± 8

Results are for all holdings that have at least one fertiliser spreader

Number of records used: 822

Proportion of holdings using a ration formulation programme or nutritional advice from an expert when planning the feeding regime of their livestock by frequency of use

Farm type	Percentage of holdings					95% confidence interval				
	Always	Most of the time	Some of the time	Rarely	Never	Always	Most of the time	Some of the time	Rarely	Never
Dairy	59	23	9	4	6	± 7	± 6	± 4	± 3	± 3
Grazing livestock (LFA)	10	22	21	15	33	± 6	± 8	± 8	± 7	± 8
Grazing livestock (lowland)	17	12	23	10	38	± 6	± 5	± 7	± 5	± 8

Results are for holdings with cattle or sheep

Number of records used: 448.

Proportion of holdings using bulls with a high Profitable Lifetime Index (PLI) when breeding dairy cows by frequency of use

Farm type	Percentage of holdings: Always	Most of the time	Some of the time	Rarely	Never	95% confidence interval: Always	Most of the time	Some of the time	Rarely	Never
Dairy	30	29	22	6	13	± 6	± 6	± 6	± 3	± 5

Results are for holdings with dairy cattle

Number of records used: 207

Proportion of holdings using bulls with a high Estimated Breeding Value (EBV) when breeding beef cattle by frequency of use

Farm type	Percentage of holdings: Always	Most of the time	Some of the time	Rarely	Never	95% confidence interval: Always	Most of the time	Some of the time	Rarely	Never
Grazing livestock (LFA)	17	21	12	11	39	± 9	± 9	± 8	± 7	± 11
Grazing livestock (lowland)	26	13	12	12	37	± 9	± 7	± 7	± 7	± 10

Results are for grazing livestock farms only.

Number of records used: 162

Proportion of holdings using rams with a high Estimated Breeding Value (EBV) when breeding lambs by frequency of use

Farm type	Percentage of holdings: Always	Most of the time	Some of the time	Rarely	Never	95% confidence interval: Always	Most of the time	Some of the time	Rarely	Never
Grazing livestock (LFA)	11	15	20	16	38	± 7	± 8	± 9	± 8	± 10
Grazing livestock (lowland)	19	11	19	16	36	± 9	± 7	± 9	± 8	± 11

Results are for grazing livestock farms only.

Number of records used: 160

Proportion of holdings that have sown their temporary grassland with a clover mix by proportion of grassland

Farm type	Percentage of holdings							95% confidence interval						
	All 100%	81-99%	61-80%	41-60%	21-40%	1-20%	None	All 100%	81-99%	61-80%	41-60%	21-40%	1-20%	None
Dairy	24	10	9	16	10	14	17	± 7	± 5	± 5	± 6	± 5	± 6	± 6
Grazing livestock (LFA)	41	6	0	4	6	17	26	± 23	± 12	± 0	± 8	± 11	± 18	± 20
Grazing livestock (lowland)	35	12	8	9	8	13	14	± 12	± 8	± 7	± 7	± 7	± 8	± 9

Results are for holdings with livestock and temporary grassland

Number of records used: 226.

Proportion of holdings that have sown their temporary grassland with high sugar grasses by proportion of grassland

Farm type	Percentage of holdings							95% confidence interval						
	All 100%	81-99%	61-80%	41-60%	21-40%	1-20%	None	All 100%	81-99%	61-80%	41-60%	21-40%	1-20%	None
Dairy	17	13	11	17	11	12	19	± 6	± 6	± 5	± 6	± 5	± 5	± 6
Grazing livestock (LFA)	4	4	6	4	6	6	69	± 8	± 8	± 12	± 8	± 11	± 12	± 21
Grazing livestock (lowland)	22	5	6	9	8	6	43	± 10	± 6	± 6	± 7	± 7	± 6	± 12

Results are for holdings with livestock and temporary grassland

Number of records used: 226

(vi) Digest of ongoing research projects

On-going projects: livestock science and forage improvement

Project number	Project title	Start date	Aims	Defra weblink	Due to complete
AC0119	Feed management on livestock farms	Oct-11	To disseminate the results of research undertaken on feed management so that farmers can improve feed utilisation and conversion efficiency, thereby reducing GHG emissions and other environmental burdens. This will require a review and synthesise of the evidence base on livestock feed management best practice including significant recent Defra projects, with particular emphasis on ruminants. The main output of the work will be the publication by the research contractor(s) of detailed guidelines for feed management aimed at farmers and advisors.	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=17790#Description	30/04/2012
AC0120	LCA of endemic diseases on GHG emissions intensity	Oct-11	The objectives of this study are to model the impact of controlling selected endemic cattle diseases and conditions on cattle productivity in GB, agricultural performance and GHG emissions. Results are required at sub-sector (dairy, suckler beef and beef finisher) and for each of the Devolved Administrations of Great Britain (England, Wales and Scotland).	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=17791	30/09/2012

Project number	Project title	Start date	Aims	Defra weblink	Due to complete
AC0122	Increasing efficiency of dietary nitrogen use in dairy systems	Jun-12	Determine the scope for increasing efficiency of N use in dairy systems. Determine, in multi-lactation studies, the longer-term effects of reductions in dietary intake of protein on longevity, reproductive performance, health, welfare, milk output and milk composition of dairy cows. Determine the effects of reduced dietary intake of protein on excretion of N in faeces and urine, on N balance, and on efficiency of N use by dairy cows and growing cattle. Determine the extent to which dietary manipulation can influence the composition and total volume of excreta and the consequences of such changes on N excretion and on predicted emissions of greenhouse gases and NH3, and diffuse pollution from NO3. Assess the potential economic consequences of reductions in total dietary N intake.	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=17793	Mar-18

On-going projects: livestock science and forage improvement (continued)

Project number	Project title	Start date	Aims	Defra weblink	Due to complete
AC0123	Developing new ammonia emissions factors for livestock housing and manure management systems	Summer 2011	To measure ammonia emissions from novel animal housing and manure/slurry management systems to update the emissions factors implemented in the ammonia inventory. New legislation, industry action and changes in consumer preference have transformed livestock management practices and these must be reflected in national reporting. The project will proceed in two phases: A literature review and stakeholder consultation process to establish the requirements for new emissions factors (gap analysis) followed by a field campaign to establish new emissions factors where required.	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=17811&FromSearch=Y&Status=2&Publisher=1&SearchText=AC0123&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description	Mar-14
AC0124	Scoping project: Regional Validation of CH4 inventory	Summer 2011	This project will examine the scope for networks of sensors to produce regional scale inventory validation. The project will use the NAME model in the inverse model to attribute emissions of methane to source at high resolution. The work will allow an assessment of the necessary network to achieve cost effective validation of inventory estimates of methane emissions.	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=2&ProjectID=17816	Mar-13
LK0693	Assessing the environmental consequences of husbandry changes in UK poultry systems through a Life Cycle Analysis	Sep-09	Quantify the environmental consequences and resource use of system changes, including changes in breeding, feeding and husbandry, of different UK poultry systems through a Life Cycle Analysis framework. This will be addressed on the most significant poultry production systems in the UK, namely conventional, free range and organic for both egg-laying and meat-producing chickens.	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=2&ProjectID=16540#RelatedDocuments	31/08/2012

On-going projects: livestock science and forage improvement (continued)

Project number	Project title	Start date	Aims	Defra weblink	Due to complete
LK0694	Estimation of ruminant energy and degradability values of maize silage using Near Infrared Reflectante Spectroscopy (Maize Silage NIRS)	Nov-09	Develop reliable NIRS-based prediction equations of the energy content and degradability characteristics of maize silage for use by the UK farming industry. The equations produced can be quickly implemented by silage laboratories within the Forage Analytical Assurance Group.	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=16826	31/10/2011
LK0697	Environmental and Nutritional Benefits of Bioethanol Co-products (ENBBIO)	Oct-10	Quantify sources of variability in W-DDGS, identify opportunities to enhance their value, to consider innovative processes to reduce fibre content (for non-ruminants) and to quantify the contribution of the co-products to the overall GHG balance of UK crop, livestock and ethanol production.	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=17089	30/09/2013
LK0686	Genetic improvement of perennial ryegrass and red clover to increase nitrogen use efficiency and reduce N losses from pastures and silo	Apr-08	1. Develop new varieties of perennial ryegrass with NUE 10-15% higher than in current varieties. 2. Reduce N leaching losses from red clover by deployment of new varieties. 3. Develop new red clover varieties with a 15% enhancement in PPO activity and use a digestion study in steers to quantify the impact of differences in PPO activity on N losses to the environment. Expected benefits of this research include reduced N pollution of watercourses and a lower requirement for N fertilisers. The latter will lead to considerable financial savings for UK livestock farmers. There will also be production benefits from the reduction in protein degradation likely as a result of enhanced PPO activity. Note: Enzyme polyphenol oxidase (PPO) in red clover plays an important role in reducing protein degradation in the silo and hence cutting nitrogenous losses.	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=15739#RelatedDocuments	31/03/2013

On-going projects: livestock science and forage improvement (continued)

Project number	Project title	Start date	Aims	Defra weblink	Due to complete
LK0687	Genetic improvement of perennial ryegrass and white clover to increase the efficiency of nitrogen use in the rumen	Apr-08	1. Using marker assisted selection based approaches to develop a range of perennial ryegrass varieties with enhancement of WSC levels 8% beyond that seen in material currently available to farmers. 2. Developing and evaluating white clover varieties with 5-10% reduction in leaf protein content. 3. Carrying out an experiment with dairy cows to test combinations of WSC: protein dietary ratios at levels of WSC made possible by germplasm development in this programme. Expected benefits from the work include reduced emissions to air and water, and increased efficiency of nitrogen use for the production of meat and milk.	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=15740	31/03/2013
AC0209	Ruminant nutrition regimes to reduce methane and nitrogen emissions	Apr-07	Decrease methane and nitrogen emissions per animal and per unit output and evaluate the most promising of these within the context of intensive and extensive ruminant systems through: 1. Synthesis of existing knowledge of ruminant nutrition and husbandry to identify strategies. 2. Utilize recent advances in grass and legume breeding and evaluate the use of novel pastures 3. Use of novel dietary supplements identified in recent screening programs 4. To modify and utilize existing farm livestock, economic benefit and farmer uptake models to expand the interpretation of the data obtained to a whole systems context and to consider wider husbandry, environmental, and economic impacts of the strategies adopted. 5. Dissemination of results through stakeholders and networks.	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14952#Description	April 2011 (completed)

On-going projects: fertiliser use and crop improvement

Project number	Project title	Start date	Aims	Defra weblink	Due to complete
AC0213	Potential for nitrification inhibitors and fertiliser nitrogen application timing strategies to reduce direct and indirect nitrous oxide emissions from UK agriculture	Jan-10	Assess the potential for nitrification inhibitors (NIs) and fertiliser nitrogen (N) application timing to reduce greenhouse gas (GHG) emissions from UK agriculture.	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=16481&FromSearch=Y&Publisher=1&SearchText=AC0213&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description	31/03/2014
AC0314	Identification of important crop traits for adaptation to climate change	Apr-10	To test the hypothesis that traits for water or nutrient use efficiency identified at current CO2 levels are the same as those that are relevant under high CO2. Using wheat as an example of a cereal seed crop and Brassica oleracea as a leafy vegetable crop. A range of genotypes will be screened for growth, productivity and water use efficiency in glasshouses at ambient (~380 ppm) and elevated (550 ppm) CO2 and at different levels of irrigation and nutrition alone or in combination. A series of growth parameters, photosynthetic rates, compositional quality and yield will be monitored. From the results of these experiments it will be possible to devise crop improvement strategies for productive and robust genotypes	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=17247&FromSearch=Y&Status=2&Publisher=1&SearchText=AC0314&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description	30/04/2013
AC0111	Air quality measurements on cracking clay soils	Apr-08	To quantify air quality and green house gas emissions from heavy clay soils under drained and un-drained conditions.	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=15541&FromSearch=Y&Publisher=1&SearchText=AC0111&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description	31/03/2013
LK09128	Minimising nitrous oxide intensities of arable crop products (MIN NO)	Mar-09	Improve estimates of N2O emissions associated with production of UK arable crops. The project will develop emissions factors for a wide range of arable crops, and undertake lifecycle assessment to quantify the emission of UK arable products. The project will also consider the impact of legumes in rotations on GHG emissions.	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=16501&FromSearch=Y&Publisher=1&SearchText=LK09128&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description	30/06/2014

On-going projects: livestock science and forage improvement (continued)

Project number	Project title	Start date	Aims	Defra weblink	Due to complete
LK09134	Reducing GHG emissions, nitrate pollution and lost productivity by fully automating N fertiliser management	Oct-09	Develop and validate a comprehensive N management protocol, which will be automated as much as possible, using spatial data on crop history, remotely sensed crop information and weather data. The project will assess the benefits of precision farming techniques for arable systems.	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=16914&FromSearch=Y&Publisher=1&SearchText=LK09134&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description	30/09/2014

On-going projects: supporting the implementation of the GHG Action Plan

Project number	Project title	Start date	Aims	Defra weblink	Due to complete
AC0226	Quantifying, monitoring and minimising wider impacts of GHG mitigation measures	Dec-11	To assess the wider implication of the GHG action plan to ecosystem services. Whilst good evidence exists for GHG, ammonia and nitrate reductions, less is known about potential biodiversity, product quality, landscape value, rural social impacts etc. This project seeks to clarify some of these issues and improve the evidence base on win-wins and potential trade-offs.	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=17780	Mar-13
AC0227	Case studies of mitigation method implementation	Summer 2011	To assess the impacts of sets of multiple mitigation measures implemented on 15 case study farms in line with the Industry GHG Action Plan. A nitrogen balance approach will be used to quantify the change in N surplus before and after method implementation. Simple modelling approaches will be taken to examine the fate of the excess nitrogen (i.e. emissions to air and water). Economic impacts will be assessed through analysis of farm accounts. The project will also track farmer experience and perceptions throughout the process.	http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=17814&FromSearch=Y&Status=2&Publisher=1&SearchText=AC0227&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description	Mar-13

Glossary

BSE
Bovine spongiform encephalopathy is a fatal disease in cattle that causes degeneration in the brain and spinal cord. BSE is commonly known as ‘mad cow disease’.

Cattle Tracing System (CTS)
The CTS records births, deaths and all movements of cattle as well as breed types and gender.   It is mandatory for every bovine animal to have a passport and ear tag and for owners to report every movement via the CTS.

Carcase weights
The weight of the meat produced from an animal. Cold dressed carcase weights are recorded.

Clean pigs
Pigs bred purely for meat production.

Dairy herd and beef herd
Unless otherwise stated, the dairy herd refers to those breeding animals which produce milk, and the beef herd refers to those breeding animals which produce offspring for slaughter. The beef herd is also commonly referred to as the suckler herd.

Pig fattening herd
Pigs intended for meat production.

Feed conversion ratio (FCR)
A measure of an animal’s efficiency in converting feed mass into increased body mass expressed as feed per kg of liveweight; a low FCR is more efficient than a high FCR.

Finishing
Finishing is the feeding process used prior to slaughter for cattle or sheep intended for meat production.

Greenhouse gas intensity
Greenhouse gases produced per tonne of grain or litre of milk or kg of meat. This may also be referred to as GHG efficiency.

Total Factor Productivity (TFP)
Total factor productivity shows the volume of output leaving the industry per unit of all inputs including fixed capital and labour. It includes all businesses engaged in farming activities including specialist contractors.

Marketing pattern
The pattern of animals slaughtered per month over the course of a year.

Soil nitrogen balance
The soil nitrogen balance is a measure of the total loading of nitrogen on agricultural soils over the crop year.

Less favoured area (LFA)
Less favoured areas are land that is classified as difficult to farm due to limitations such as climate, location or features of the landscape (e.g. mountainous or hilly areas).

Over thirty month scheme (OTMS)
In March 1996 the EU imposed a worldwide ban on the export of bovine and bovine products from the UK due to BSE in UK cattle.   The Over Thirty Month (OTM) Rule prohibited beef from animals aged over thirty months from entering the food chain.   The Over Thirty Month Slaughter Scheme (OTMS) provided a disposal outlet for OTM cattle which could not be sold for the food chain. Cattle entering the scheme were slaughtered and destroyed with compensation paid to the farmer.