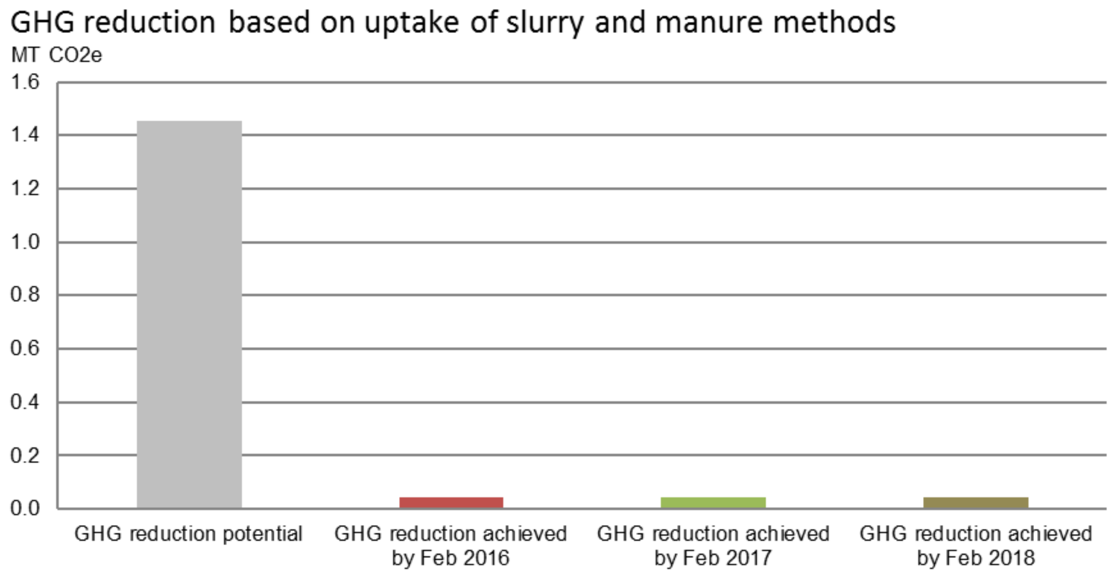
Indicator 9: Slurry and manure

Rationale: systems for the management of manure and slurry are relevant to the control of environmental risks to air and water including greenhouse gases (GHGs). Uptake of relevant mitigation methods provides an indicator of progress towards the industry's ambition to reduce agricultural production emissions by 3 $MtCO_2e$ by 2020 compared to a 2007 baseline.

Indicator: overall progress is measured by the GHG reductions delivered through the uptake of a range of mitigation methods relating to slurry and manure storage and handling. (*Note: indicators 2, 9 and 10 cover different mitigation methods. Indicator 2 covers general farm practices, indicator 9 covers slurry and manure management and indicator 10 covers organic fertiliser*).

Desired outcome: slurry and manure increasingly handled and stored in ways that can help minimise GHG emissions. This will be reflected by a reduction in estimated GHG emissions.

Current status	Long term: (last 10 years) …	Short term: (last 2 years) ≈



Estimates indicate that the maximum technical potential[1] GHG reduction from uptake of mitigation methods relating to slurry and manure is around 1.5 MT CO_2 equivalent[2] (e). Uptake of these mitigation methods by February 2018 suggests that the GHG reduction achieved has been around 0.05 MT CO_2e, which is a similar level to 2016 and 2017[3].

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[1] Maximum technical potential is the amount that could be saved if all mitigation potential was enacted regardless of cost.

[2] This assumes no prior implementation of methods.

[3] Estimates of achieved and potential mitigation for 2015 and 2016 have been produced using version 3 of the Farmscoper tool and may not be directly comparable with previous years which were produced using an earlier version of Farmscoper. See Indicator Methodology for more details.

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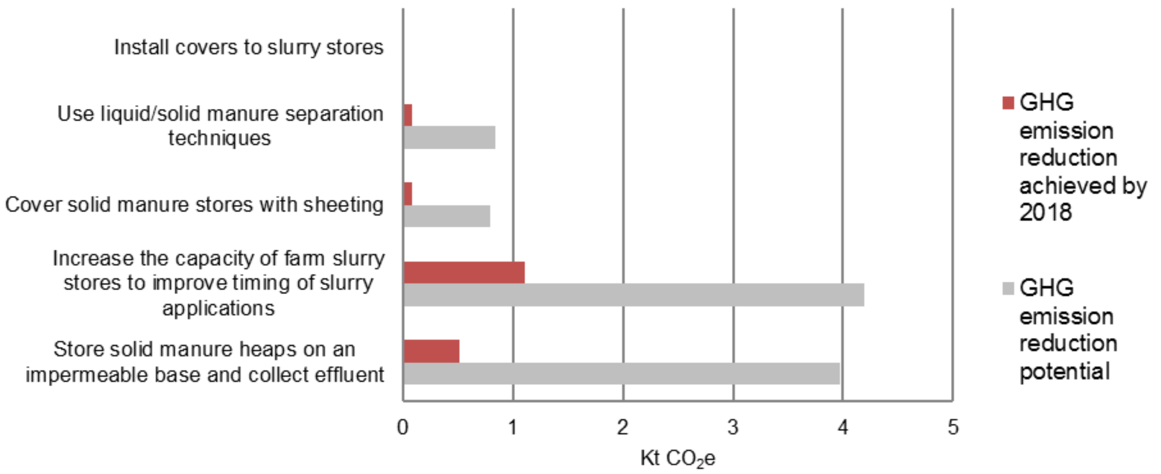
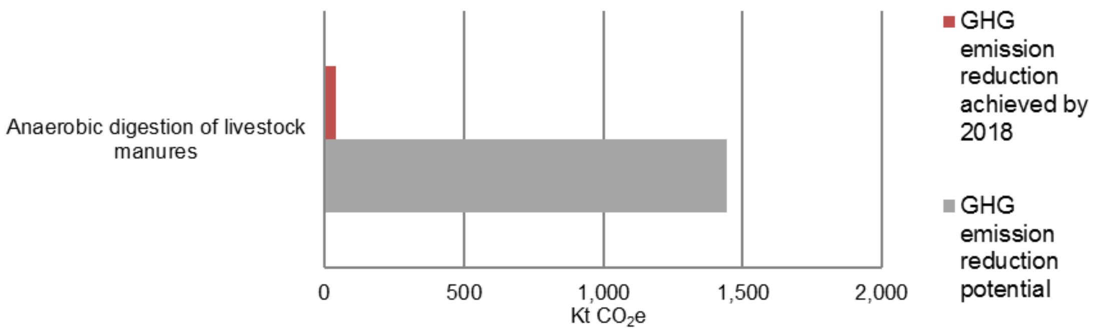
The use of slurries and manures for anaerobic digestion were assessed separately in previous years using data from The Review and Update of UK Marginal Abatement Cost Curves for Agriculture SAC MACC 2[4] as, at the time, the practice was not covered by the Farmscoper tool. However the Farmscoper 3 includes the anaerobic digestion of livestock manures. The headline indicator includes six mitigation methods relating to slurry and manure handling and storage. Progress for each of these is shown in the charts below.

Potential and achieved GHG emission reduction: slurry and manure mitigation methods



Emission reduction calculated using Farmscoper tool

GHG reduction based on uptake of anaerobic digestion of livestock manures and slurries



Emission reduction calculated using Farmscoper tool

The uptake of each mitigation method has been assessed using relevant survey data. In some cases where relevant data are not available (i.e. increase the capacity of farm slurry stores to improve timing of slurry applications) the default Farmscoper uptake rate has been assumed, based on an assessment of uptake by ADAS.

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[4] "Review and update of UK marginal abatement cost curves for agriculture" http://www.theccc.org.uk/wp-content/uploads/2010/12/pr_supporting_research_SAC_agriculture.pdf

Indicator 9: Slurry and manure

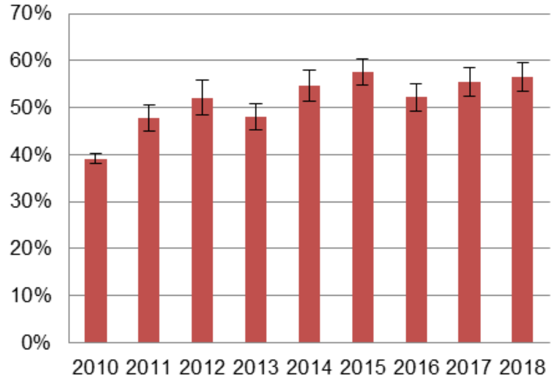
This default value is a pre-determined level of adoption set within the model[5]. For some of the mitigation methods data are currently available to make the short term assessment only; as data continues to be collected it will be possible to assess longer term trends.

Mitigation Method	Assessed by	Uptake by 2017	Uptake by 2018
Store solid manure heaps on an impermeable base and collect effluent	% of livestock farms with manure heaps on a solid base	56%	57%
Increase the capacity of farm slurry stores to improve timing of slurry applications	% of livestock farms with at least 5 months storage capacity	66%	66%
Cover solid manure stores with sheeting	% of livestock farms with covered solid manure storage	10%	9%
Use liquid/solid manure separation techniques	% of livestock farms that have a slurry separator (and facilities to store slurry)	8%	7%
Install covers to slurry stores	% of livestock farms with covered slurry stores[6]	13%	17%
Anaerobic digestion of livestock manures	% of farms using anaerobic digestion to process livestock manures and slurries	3%	3%

Store solid manure heaps on an impermeable base and collect effluent

Storing solid manure heaps on an impermeable base prevents seepage of nutrients which may then be lost to groundwater through leaching or runoff. In 2018, uptake of this method has been assessed to have achieved a reduction in GHG emissions of 0.5 KT CO_2e, approximately 13% of the maximum technical potential reduction. Current indications are that in 2018, 57% of farms with livestock store solid manure on solid base.

Proportion of livestock farms storing solid manure on a solid base



Source: Farm Practices Survey

[5] The default implementation rates are based largely on survey data, in particular Defra Farm Practices Survey, with a focus on data between 2006 and 2012. A simple scoring system was used to estimate the range of uptake; this reflects the uncertainty in mapping farm practice survey questions to specific mitigation methods.

[6] New storage categories were added to the 2015 Farm Practices survey. As a result data may not be directly comparable with previous years

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Increase the capacity of farm slurry stores to improve timing of slurry applications

On farms with limited storage capacity, expanding facilities can provide greater scope for the timing of application allowing spreading at lower risk times and when the crop can make best use of the nutrients. The Farmscoper tool suggests that increasing storage capacity for slurry on these farms could provide a maximum potential reduction in GHG emissions of 4 KT CO_2e. Using Farmscoper default uptake levels (see previous page and Indicator Methodology for more details) the estimated uptake of this practice achieved a reduction in GHGs of 1.1 KT CO_2e. Survey data do not currently map directly to this mitigation method, but responses to the Farm Practices Survey in 2018 indicate that 66% of livestock farms had at least 5 months storage capacity. In addition, 16% of those with stores intended to enlarge, upgrade or reconstruct their manure and slurry storage capacity, of these 89% plan to do so within the next 5 years.

Cover solid manure stores with sheeting

Covering solid manure heaps primarily prevents the loss of ammonia to the air. Although nitrous oxide emissions are likely to increase during storage, indirect emissions are likely to reduce through lower leachate losses. Increased uptake could lead to improved nitrogen use efficiency and a reduction in manufactured nitrogen fertiliser inputs. The Farmscoper tool indicates that covering solid manure stores can provide a maximum potential reduction in GHG emissions of 1 KT CO_2e while current uptake of these practices is achieving a reduction of around 0.1 KT CO_2e. In 2018, 9% of livestock farms that stored solid manure had covered storage, which was little change compared to 2017.

Use liquid/solid manure separation techniques

Separating the suspended solids from slurry allows the two manure streams to be handled separately. The solid fraction can be stored on a concrete pad or in a field heap, while the liquid fraction can be stored and transported/pumped to fields for land application. Such separation can reduce storage space and improve the efficiency with which nitrogen is applied to land and this has the potential to reduce emissions. Use of a slurry separator is estimated to have achieved a GHG reduction of 0.1 KT CO_2e compared to a maximum potential reduction of 1 KT CO2e. In 2018, survey data indicated that of those livestock holdings with slurry storage facilities, 7% had a separator; a similar proportion to that seen over the last 5 years for which data have been collected.

Install covers to slurry stores

Covering slurry stores primarily helps to reduce ammonia emissions. Increased uptake of this method could lead to improved nitrogen use efficiency and a reduction in manufactured nitrogen fertiliser inputs. Although this method does not have an associated GHG reduction potential, uptake has been included here as a contextual indicator due to the associated positive impacts from reduced ammonia emissions. In 2018, 17% of livestock farms with slurry storage had covered stores.

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Slurries used in anaerobic digestion

Estimates from the Farmscoper tool suggest that the use of slurries for anaerobic digestion (AD) has a GHG reduction potential outweighing that from improved storage of slurries and manures (see charts on page 2). Methane emissions from the storage of slurries and manures are reduced and the methane generated from livestock manures during AD can be used to produce heat and power to replace fossil fuel use. In addition, there is the potential to increase nitrogen use efficiency and reduce the required quantity of manufactured fertiliser if the digestate is subsequently spread to the land. However, significant start-up and running costs are barriers to uptake. The 2018 survey data indicated that around 3% of farms processed slurries for AD, a similar level to 2017 and 2016 but an increase on previous years (from 2008) when the level was around 1-2%.

Data sources

This indicator uses estimates of potential and achieved GHG emission reductions that have been calculated using the Farmscoper tool developed by ADAS for Defra[7].

The data feeding into the Farmscoper tool are drawn from a variety of sources including land use and livestock population data from the June Agricultural Survey. Data on uptake of slurry and manure handling and storage mitigation methods are from Defra's Farm Practices Survey.

Indicator methodology

The "maximum technical potential[8]" and "achieved" GHG emission reductions have been calculated by linking data (measuring the uptake of mitigation methods) to the Farmscoper decisions support tool.

The Farmscoper tool quantifies farm-level environmental impacts, including emissions of nitrous oxide and methane, for over 100 on-farm practices including many of those in the Mitigation Method User Guide originally developed as part of Defra project WQ0106[6]. The latest version of Farmscoper, developed under Defra project SCF0104[6], allows the assessment of multiple farms (derived from Agricultural Census data) so the tool can be applied to a national scale.

[7] The initial version of Farmscoper was developed by ADAS under Defra projects WQ0106 http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14421 and FF0204 http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=17635&FromSearch=Y&Publisher=1&SearchText=FF0204&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description . The current version (version 3) used in the analysis here has been further developed and expanded under Defra project SCF0104.: http://randd.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=18702

[8] Maximum technical potential is the amount that could be saved if all mitigation potential was enacted regardless of cost.

Indicator 9: Slurry and manure

Indicator methodology (continued)

Developments to this latest version mean the 2016, 2017 and 2018 estimates of achieved and potential mitigation may not be directly comparable with all previous years. However, estimates for 2015 have been rerun using version 3 of Farmscoper to allow some comparison.

Farmscoper allows the user to enter an estimate of present uptake of individual mitigation measures. Where possible uptake has been based on responses to the Farm Practices Survey[9]. Where no current survey data are available, Farmscoper's default levels of uptake have been used. The default implementation rates are largely based on survey information (with a focus on data between 2006 and 2012) and, in a few cases, expert opinion.

As the Farmscoper tool is not sensitive to small changes in uptake, where survey data are available, the following uptake ranges were used (see table below),

Uptake ranges and corresponding averages

Uptake range (%)	Average input into Farmscoper
0	0
1-5	3
6-15	10
16-25	20
26-35	30
36-45	40
46-55	50
56-65	60
66-75	70
76-85	80
86-95	90
96-99	97
100	100

The mitigation methods included in the indicator were chosen, as far as possible, to reflect stakeholder feedback, the farm practices to be targeted by the Industry's Action Plan[10] and to also acknowledge the indicators set out in the Committee on Climate Change's (CCC) 3rd progress report[11]. Mitigation methods that the Farmscoper tool identified as having no associated cost but a mitigation potential were also included where possible.

[9] In order to gain a more refined picture of the level of uptake of mitigation measures, responses from these surveys have, wherever possible, been divided into those from farms within Nitrate Vulnerable Zones (NVZs) and those outside.

[10] http://www.nfuonline.com/Our-work/Environment/Climate-change/GHG-emissions---agriculture-s-action-plan/

[11] http://www.theccc.org.uk/reports/3rd-progress-report

Indicator 9: Slurry and manure

Statistical Background

Farmscoper

The project reports covering the development of the Farmscoper tool, including methodological details, can be found at:
http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14421

http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=17635&FromSearch=Y&Publisher=1&SearchText=FF0204&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description

http://randd.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=18702

Initial results from the Farmscoper "upscaling" tool[12] were validated against the national agricultural GHG inventory estimates. The Farmscoper estimate of total nitrous oxide and methane emissions from English agriculture for 2010 was 30.5 Mt CO_2e (assuming no prior uptake of any Farmscoper farm practices) compared to the national inventory estimate of 28.9 Mt CO_2e. This difference is well within the uncertainty bands[13] of the 2010 GHG Inventory Model, providing reassurance that the method gave a reasonable approximation of on farm emissions.

The project report covering the development of the Farmscoper tool, including methodological details, can be found at:
http://www.adas.co.uk/Home/Projects/FARMSCOPER/tabid/345/Default.aspx

The Farm Practices Survey (FPS)

The FPS is an annual, voluntary, postal survey conducted by Defra which collects information on a diverse range of topics relating to the impact of farming practices on the environment. Since 2011 the survey has focused on practices relating to GHG mitigation.

In 2018 the survey was sent to approximately 6,000 holdings in England. These holdings were targeted by farm type and size to ensure a representative sample. Thresholds are applied to ensure that very small holdings with little agricultural activity are not included in the survey. To be included in the sample, holdings had to have at least 50 cattle, 100 sheep, 100 pigs, 1,000 poultry or 20 hectares of arable crops or orchards.

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[12] Prior to 2016 (when FARMSCOPER3 became available), the indicator was updated using the FARMSCOPER model in conjunction with an "upscaling" tool developed by Defra analysts. This allowed farm-level results to be used in the production of national estimates of impacts.

[13] 95% confidence intervals (Source: National Inventory Report 2010) are N_2O (soils): **+249%, -93%**; N_2O & CH_4 (manure management): **+/-25%**;CH_4 (enteric fermentation): **+/-16%.**

Indicator 9: Slurry and manure

Statistical Background (continued)

All results reflect only those holdings that exceed these thresholds. Sample sizes and response rates are shown below.

Farm Practices Survey sample sizes and response rates

	2012	2013	2014	2015	2016	2017	2018
Sample size	3,000	5,500	6,000	6,000	6,000	6,000	6,000
Response rate	46%	37%	41%	44%	38%	39%	38%

Results are calculated using a standard methodology for stratified random surveys to produce national estimates. With this method, all of the data is weighted according to the inverse sampling fraction. Where reference is made to the type of farm in this document, this refers to the 'robust type', which is a standardised farm classification system. Farm sizes are based on the estimated labour requirements for the holding, rather than its land area.

Results from the FPS are designated National Statistics. These are official statistics which have been assessed and comply with the National Statistics code of practice.

The June Agricultural Survey

Defra's June Agricultural Survey is an annual postal survey collecting detailed information on arable and horticultural cropping activities, land usage, livestock populations and labour force figures. The survey is compulsory with samples sizes varying between 30,000 and 70,000 holdings each year, dependent on EU requirements. A full Census is carried out once every ten years with 2010 being the most recent.

Further methodological details can be found at:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/182206/defra-stats-foodfarm-landuselivestock-june-junemethodology-20120126.pdf

Results from the June Survey of Agriculture are designated National Statistics. These are official statistics which have been assessed and comply with the National Statistics code of practice.