Indicator 2: Uptake of mitigation methods

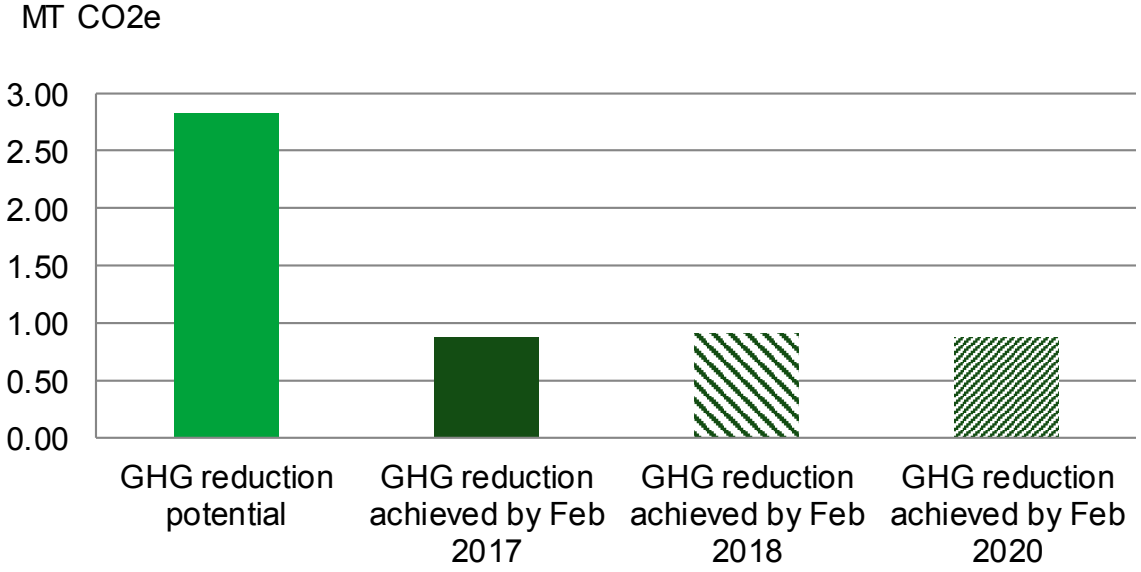
Rationale: there are a wide range of farm practices that can reduce greenhouse gas (GHG) emissions from agriculture. Monitoring the uptake of these mitigation methods, particularly those which have been assessed to be cost neutral or cost negative (i.e. which save money) provides an indicator of progress towards achieving the industry's ambition to reduce agricultural production emissions by 3 MtCO2e by 2020 compared to a 2007 baseline.

Indicator: overall progress is measured by the reductions delivered through the uptake of a range of mitigation methods. (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: increased uptake of these mitigation methods will be reflected by reduction in estimated GHG emissions.

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

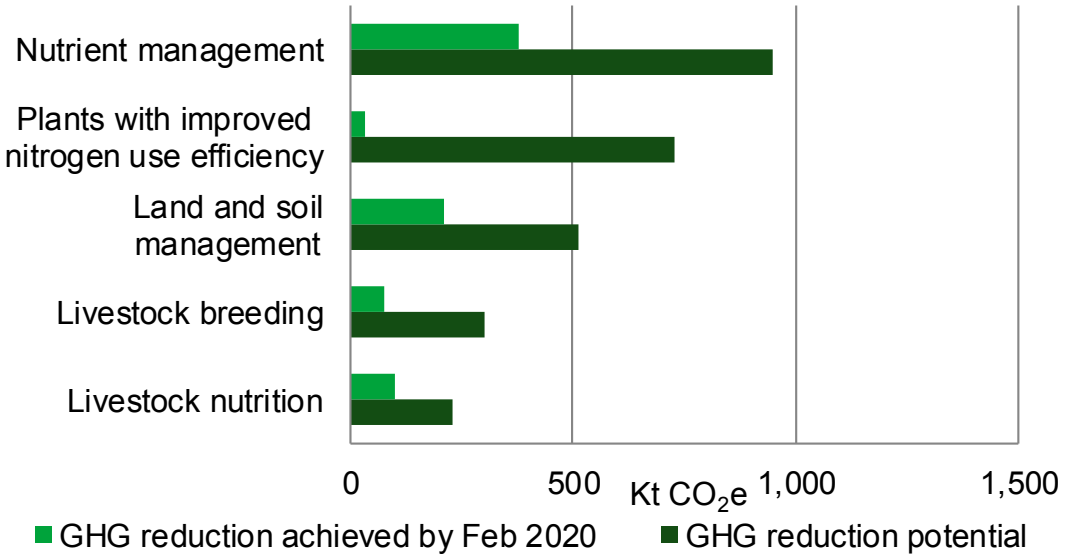
GHG reduction on uptake of key on-farm mitigation measures



By February 2020, approximately 0.9 Mt CO2 equivalent reduction in GHG emissions had been achieved from the uptake of the key mitigation methods. In terms of moving to the desired outcome this no change on the 2018 level[1] and compares to an estimated maximum technical potential[2] reduction of 2.8 Mt CO2e were all of these methods to be fully implemented on relevant farms.

The headline indicator has been sub-divided into five activity groups each containing related, relevant mitigation methods. Progress for each of these groups is shown in the chart below.

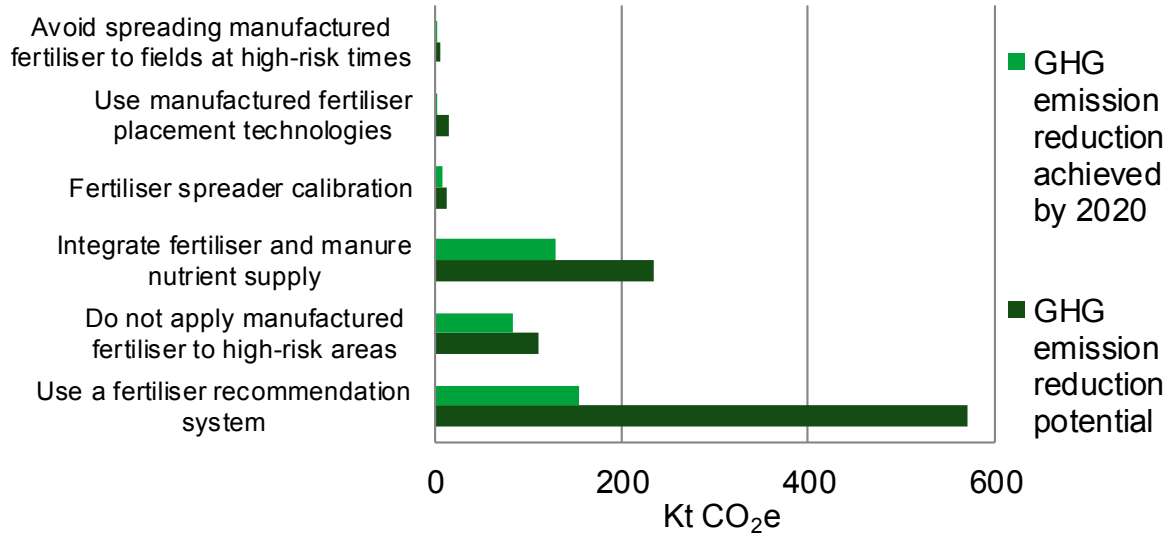
GHG reduction based on the uptake of key on-farm mitigation methods by activity grouping



Nutrient management

Good nutrient management can bring a number of important benefits: minimising GHG emissions, reducing the incidence of diffuse water pollution, and helping farmers save money through optimising productivity. This group of 6 mitigation methods collectively provides the greatest potential reduction in emissions (0.9 Mt CO2e) on relevant farm types. By 2020, uptake of nutrient management mitigation methods has been assessed to have delivered an estimated GHG reduction of 0.4 Mt CO2e, around 40% of the maximum technical potential reduction.

Potential and achieved GHG emission reduction: nutrient management mitigation methods



The uptake of each mitigation method has been assessed using relevant survey data. In some cases where relevant data are not available (i.e. Do not apply manufactured fertiliser to high-risk areas), the default Farmscoper uptake has been

assumed, based on an assessment of uptake by ADAS. This default implementation rate is a pre-determined level of adoption set within the model[3]. 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.

Related survey data and current uptake: nutrient management mitigation methods

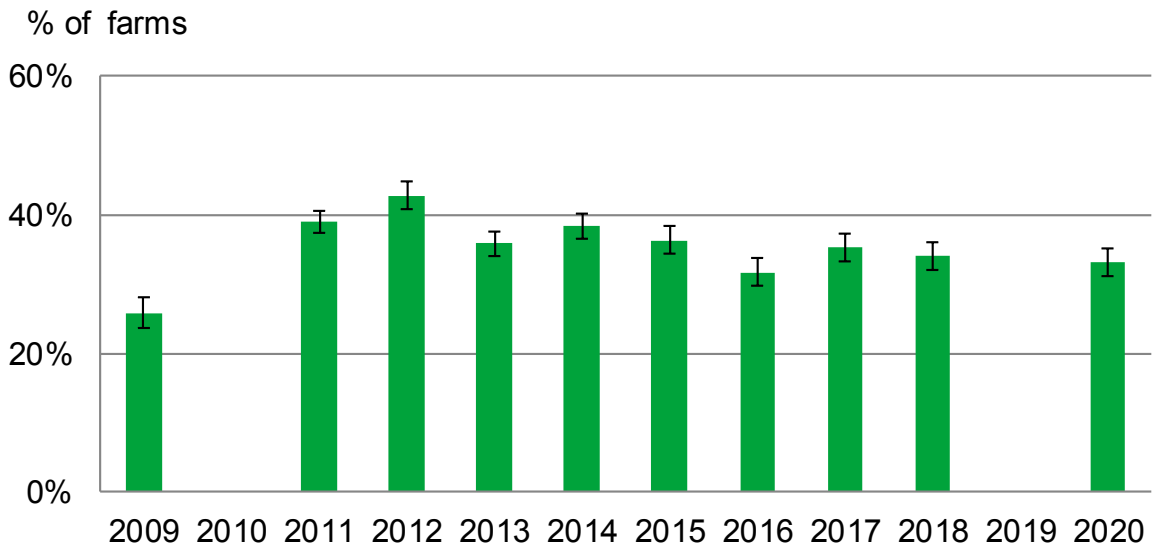
Mitigation method	Assessed by:	2018 uptake	2020 uptake
Use a fertiliser recommendation system	Proportion of all farms that have a nutrient management plan created using the following tools: PLANET, Muddy Boots, Farmade / Multicrop or Industry plan (e.g. Tried & Tested etc)	34%	33%
Do not apply manufactured fertiliser to high-risk areas (where there are direct flow paths to watercourses)	No suitable survey data.	(a)	(a)
Integrate fertiliser and manure nutrient supply	Nutrient management plans: uptake (% of farms with plan)	56%	57%
	Of which: Nutrient management plans: frequency of update (% of farms with a plan updated at least annually)	74%	73%
	Nutrient management plan: frequency of referral (% of farms with plan referring to it at least 5 times per year)	27%	29%
	Soil pH: frequency of testing (% of farms testing at least every 5 years)	68%	69%
	Soil nutrient content: frequency of testing (% of farms testing soil at least every 5 years)	64%	65%
	Manure management plans: uptake (% of farms with plan)	55%	57%
	Nutrient content of manure: testing by taking samples (% of farms testing samples by lab analysis and on farm testing)	12%	13%
	Nutrient content of manure: assess / calculate (% of farms that assess /calculate the nutrient content of manure)	25%	27%

(a) Farmscoper default uptake rate used 80% within NVZs and 50% outside NVZs.

Related survey data and current uptake: nutrient management mitigation methods (cont'd)

Mitigation method	Assessed by:	2018 uptake (unless stated)	2020 uptake (unless stated)
Fertiliser spreader calibration[4]	Fertiliser spreader: frequency of spread pattern checks using catch trays - at least once a year / at change of fertiliser type / factory set (% of farms with a spreader)	64% (BSFP 2017)	67% (BSFP 2019)
	Fertiliser spreader: check & correction of application rate (at least once a year on farms with at least one spreader)	na (see above measure)	na (see above measure)
Use manufactured fertiliser placement technologies	Use of precision farming technology (Variable Rate Application)	21%	20%
Avoid spreading manufactured fertiliser to fields at high-risk times	Use of nitrogen by month of application (% of nitrogen spread between March and September)	96% (BSFP 2017)	78% (BSFP 2019)

Proportion of all farms using either PLANET, Muddy Boots, Farmtrade/Multicrop or Industry plan to create nutrient management plan



Data unavailable for 2010 and 2019

Source: Farm Practices Survey

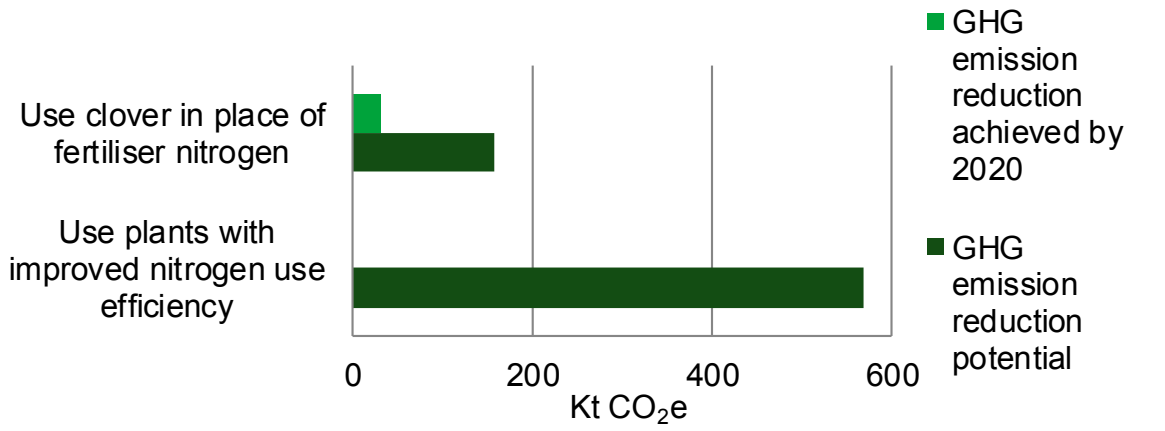
The overall uptake of nutrient management plans (NMPs) has increased from 46% of farms in 2006 to 57% in 2020. NMPs can be prepared using a variety of tools. In 2020, 33% of all farms had NMPs that were created using either PLANET, Muddy Boots, Farmade / Multicrop or an Industry plan (i.e. Tried & Tested). This compares to 34% in 2018 and 35% in 2017.

Plants with improved nitrogen use efficiency

This group of mitigation methods also offers a significant GHG emission reduction potential (0.7Mt CO_2e). Plants with improved nitrogen use efficiency (i.e. able to remove more mineral nitrogen from the soil) offer the greatest abatement potential within this group. Improving the nitrogen use efficiency of plants potentially offers reduced nitrogen fertiliser applications and improved nutritional characteristics of fodder.

Using clover within a grass sward reduces the need for manufactured nitrogen use and potentially reduces costs. It can be applied to most grassland systems but may entail a reduction in stocking rates where high rates of manufactured nitrogen fertiliser have previously been used.

Potential and achieved GHG emission reduction: plants with improved nitrogen use efficiency



Emission reduction calculated using FARMSCOPER

The 2020 assessment of emission reductions suggests that 31 Kt CO2e has been achieved (4% of the maximum technical potential reduction). Farm Practice Survey data suggests that 16% of farms with livestock currently sow more than 80% of their temporary grassland with a clover mix. However, there is no current source of survey data to monitor uptake of plants with improved nitrogen use efficiency. The 2020 assessment assumes no current uptake.

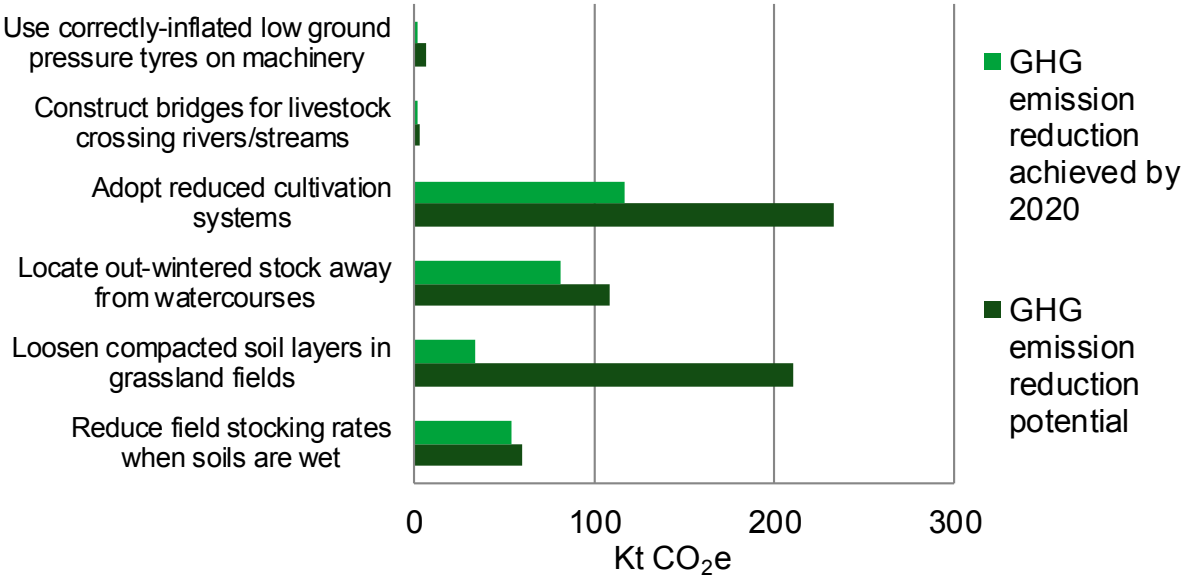
Mitigation method	Assessed by:	2018 uptake	2020 uptake
Use plants with improved nitrogen use efficiency	No suitable survey data.	(a)	(a)
Use clover in place of fertiliser nitrogen	Proportion of farms that have sown more than 80% of their temporary grassland with a clover mix	36%	16%

(a) No data are available to measure uptake of this mitigation method.

Land and soil management

Land and soil management mitigation methods can help to preserve good soil structure preventing erosion and compaction, both of which can lead to GHG emissions. The mitigation methods in this activity group include using low ground-pressure tyre set-ups to reduce soil compaction, loosening compacted soil in grassland fields, adopting reduced cultivation systems and keeping livestock away from water courses. Together these have been estimated to have achieved GHG emission reductions of 210 Kt CO2e by 2020, 41% of the maximum technical potential reduction (513 Kt CO2 e).

Potential and achieved GHG emission reduction: land and soil management mitigation methods



Emission reduction calculated using FARMSCOPER

Data collected as part of the October 2012 Farm Practices Survey provided information on soils (removal of compaction and use of low ground pressure tyres). In spring 2010, around 40% of arable land had been cultivated using reduced or minimum cultivation systems (at least 30% of stubble/crop residue left on the surface) in the previous 12 months and a further 4% had been cultivated using zero tillage (direct seeding). The 2020 Farm Practices Survey indicated that 74% of all livestock farms took action to keep livestock out of watercourses (always or at least some of the time) and 91% reduced stocking rates when fields were excessively wet (either routinely or some of the time).

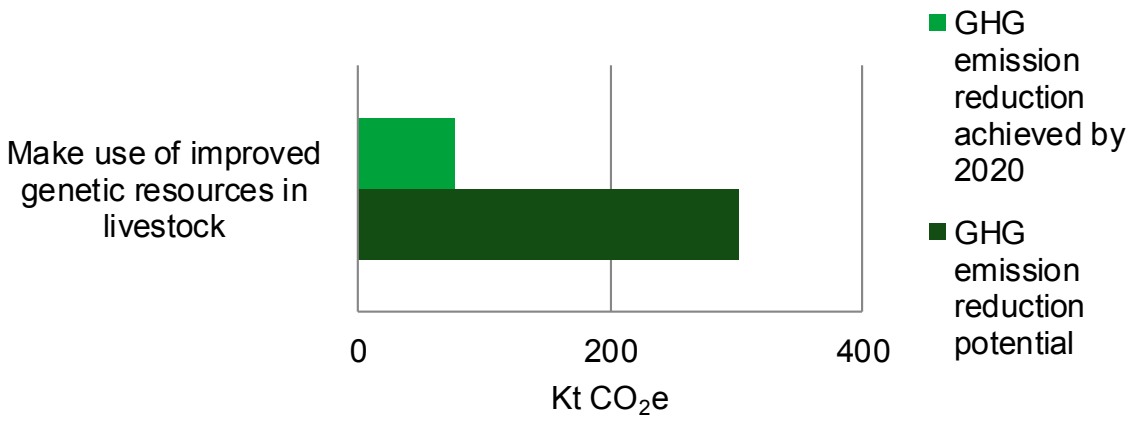
Mitigation methods	Assessed by:	Uptake (year shown)
Reduce field stocking rates when soils are wet	% of all livestock farms that reduce stocking rates when fields excessively wet (routinely / some of the time)	91% (FPS 2020)
Loosen compacted soil layers in grassland fields	% of farms removing compaction from grassland after harvest (in last 12 months)	9% (FPS 2012)
	% of farms removing compaction from grassland through turf lifting or spiking	14% (FPS 2012)
Construct bridges for livestock crossing rivers/streams	% of all livestock farms that keep livestock out of water courses (always / some of the time)	74% (FPS 2020)
Locate out-wintered stock away from watercourses		

Adopt reduced cultivation systems	% of arable land cultivated in the past 12 months using zero, reduced or minimum tillage (at least 30% of stubble, crop residue left on surface)	44% (FBS 2010)
Use correctly-inflated low ground pressure tyres on machinery	% of farms that have used low ground pressure set-ups in the last 12 months to reduce soil compaction	43% (FPS 2012)

Livestock Breeding

Breeding practices can play an important role in herd and flock productivity and efficiency, factors which can in turn influence GHG emissions. The mitigation method within this group relates to the use of improved genetic resources. Uptake has been assessed by the use of bulls and rams with a high Estimated Breeding Value (EBV) when breeding beef cattle and lambs and the use of bulls with a high Profitable Lifetime Index (PLI) when breeding dairy cows. By 2020, uptake of these mitigation methods has been assessed to have achieved an abatement of 77 Kt CO2e, 25% of maximum technical potential reduction of 302 Kt CO2e.

Potential and achieved GHG emission reduction: livestock breeding measures



Emission reduction calculated using FARMSCOPER

The use of rams and bulls with a high Estimated Breeding Value is further evaluated within indicator 5.

Mitigation method	Assessed by:	2018 uptake	2020 update
Make use of improved genetic resources in livestock	% of farms with dairy cows that use bulls with a high PLI (at least most of the time)	45%	44%
	% of farms with beef cows that use bulls with a high EBV when breeding beef cattle (at most most of the time)	37%	35%
	% of farms with lambs that use rams with a high EBV when breeding lambs (at least most of the time)	21%	19%

The SAC MACC 2 analysis[5] completed in 2010 includes additional livestock breeding mitigation methods which could provide an additional 1Mt CO2e of GHG emission reductions over and above that estimated by those currently included within Farmscoper.

However, the mitigation methods provided by the SAC MACC 2 analysis are not specific enough to be measurable using existing statistics, i.e. improving productivity / fertility in dairy herds. The livestock productivity indicators provide a high level insight of improvements in productivity across the livestock sectors.

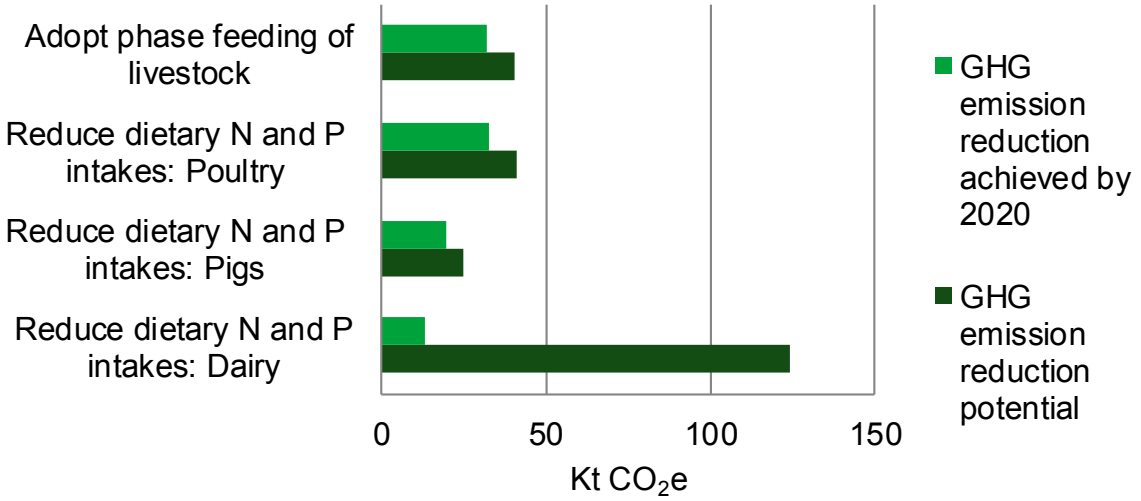
Livestock nutrition

Livestock feeding regimes also play an important role in productivity and efficiency, factors which can impact on GHG emissions. Mitigation methods relating to livestock nutrition have been assessed to have a maximum technical potential GHG reduction of 231 Kt CO2e.

There is currently little data available to assess these methods. However, using the default ADAS estimates of uptake (see Indicator Methodology for more details) it is estimated that a 99 Kt CO2e reduction had been achieved by 2020.

The livestock productivity indicators also provide a high level insight into improvements in productivity across the livestock sectors.

Potential and achieved GHG emission reduction: livestock nutrition mitigation methods



Survey data do not currently map directly to these mitigation methods, although the 2020 Farm Practices Survey indicates that 35% of farmers with cattle or sheep used a ration formulation programme or nutritional advice from an expert either “always” or “most of the time” when planning the feeding regime of their livestock (little change on the 2018 level).

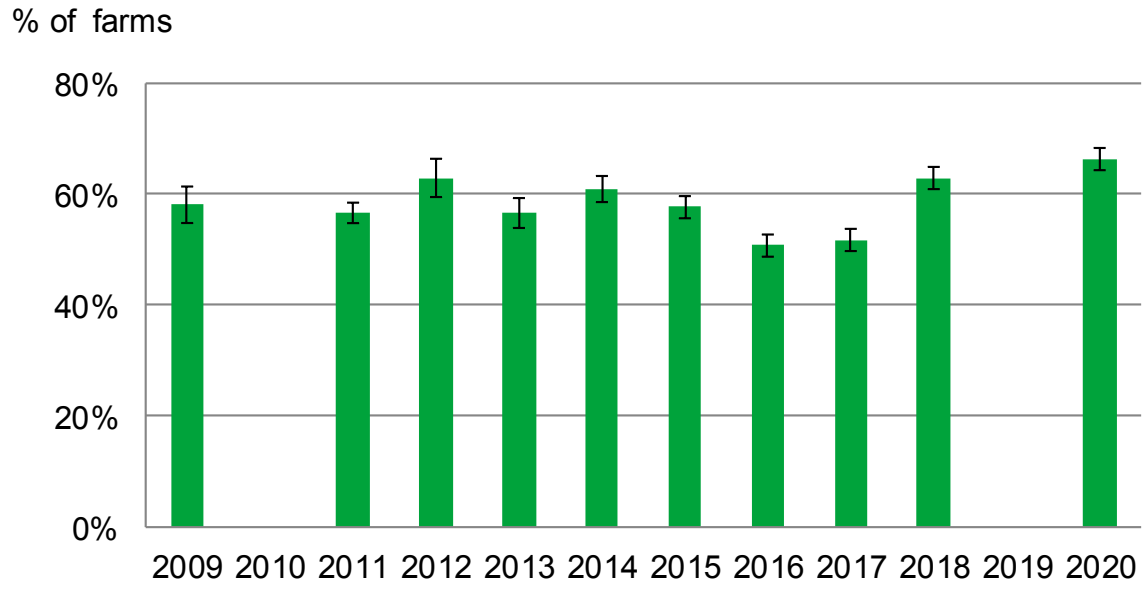
Mitigation methods	Assessed by:	2018 uptake	2020 uptake
Adopt phase feeding of livestock	% of farms with cattle or sheep using a ration formulation programme / nutritional advice (at least most of the time)	37%	35%
Reduce dietary N and P intakes: pigs and poultry			
Reduce dietary N and P intakes: dairy			

Estimates of GHG emission reductions are not available for all on-farm mitigation methods within the Farmscoper tool. The following mitigation methods have, therefore, been assessed on a qualitative basis only.

Farm Health Planning

Farm health planning can benefit livestock farmers by helping to prevent disease and as a result improve performance. In 2020, 75% of farms with livestock had a farm health plan; 66% of livestock farms had a written or recorded plan, an increase from the level in 2018. In 2020, 91% of plans were created with the help of a vet or other advisor. Around 61% reported routine use of their farm health plan to inform disease management decisions. 3% reported that they did not use the plan, a decrease from 2018. In 2020, 24% of farms routinely undertook staff training on animal health and welfare and disease management compared to 17% in 2018.

Proportion of livestock farms with a written or recorded farm health plan, England



Source: Farm Practice Survey

This indicator and others in the framework that focus on livestock are intended to be viewed within the context of animal welfare regulations and legislation. In order to examine the wider potential implications of GHG mitigation measures Defra has commissioned a research (project AC0226[6]) to consider the impacts of efficiency measures on a range of areas including animal health and welfare

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 this model are drawn from a variety of sources including land use and livestock population data from the June Agricultural Survey. The majority of the data relating to the uptake of the mitigation methods used within this indicator are from Defra's Farm Practices Survey and the British Survey of Fertiliser Practice. For a minority of mitigation methods there is no current survey information on uptake levels. In these cases default rates have been used from the model.

Indicator methodology

The measures of "maximum technical potential[8]" and "achieved" GHG emission reductions have been calculated by linking data (measuring the uptake of mitigation methods) to the Farmscoper decision 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. Developments to this latest version mean the 2016, 2017, 2018 and 2020 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 and the British Survey of Fertiliser Practice[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 average used within Farmscoper

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 measures included in this indicator have been 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]. Measures that the Farmscoper tool identified as having no associated cost but a mitigation potential are also included where possible.

There are instances where survey data for a range of mitigation measures are covered by a single measure in the Farmscoper tool. Where this is the case the abatement potential associated with the Farmscoper measure has been apportioned between the component practices, at present this has been done on an equal basis across measures.

Statistical Background

Farmscoper

The project reports covering the development of the Farmscoper tool, including methodological details, can be found on file WQ0106, FF0204 and SCF0104.

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 CO2e (assuming no prior uptake of any Farmscoper farm practices) compared to the national inventory estimate of 28.9 Mt CO2e. 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.

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 details can be found on the June survey website.

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 2020 the survey was sent to approximately 7,000 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. All results reflect only those holdings that exceed these thresholds. Sample sizes and response rates are shown on the following page.

Farm Practices Survey sample sizes and response rates

	2014	2015	2016	2017	2018	2019	2020
Sample size	6,000	6,000	6,000	6,000	6,000	6,000	7,000
Response rate	41%	44%	38%	39%	40%	38%	35%

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 and 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.

British Survey of Fertiliser Practice (BSFP)

The British Survey of Fertiliser Practice (BSFP) is a voluntary annual survey. Respondents are selected from the population of agricultural holdings compiled using the June Agricultural Survey. Holdings of less than 20 hectares are not included in the sample. While these smaller holdings account for a significant proportion of all holdings in terms of numbers, they cover a much smaller proportion of the total area of crops and grass. The target sample size is 1,500 farms which is designed to achieve a nationally representative sample. In 2019 responses were

received from 991 respondents from the main sample (66%); this was increased to 1,327 (88% of the target) by contacting 'reserves'. This is a smaller sample size than in previous years as following a statistical review which revealed limited impacted on standard errors associated with the major crops, the decision was taken to reduce it. The overall response rate from all those contacted was 48%. The survey year for 2019 corresponded to the 2019 season or harvest year.

BSFP data collection is undertaken mainly through face to face interviews with individual farmers. At data entry, any omitted responses, figures outside pre-agreed limits or other discrepancies are flagged for checking and followed up, often by contacting the survey respondent. Additionally, 10% of the interviews undertaken are subject to a call back by an independent reviewer to check responses as part of data quality assurance arrangements. The aggregated figures are checked for consistency and trend analysis against historic data and are subject to independent expert peer review.

The BSFP sample responses are raised to be representative of the national population by using the inverse of the achieved sampling fraction (i.e. the number of holdings in the population divided by the achieved sample size in each stratum) as the weight.

The validity of the derived weights are assessed by calculating a weighted crop area for the most extensively grown crops by this method and comparing this to the latest available crop area estimates from the June Agricultural Survey. Standard errors are calculated for key results (major crops) using standard survey statistical methodology.

The sampling variation/standard errors associated with the application rates reported for the main arable crops, all tillage and grass and further methodological details can be found on the fertiliser usage website.

The BSFP has National Statistics status. These are official statistics which have been assessed and comply with the National Statistics code of practice.

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[1] Estimates of achieved and potential mitigation for 2015, 2016 and 2017 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.

[2] Maximum technical potential is the amount that could be saved if all mitigation potential was enacted regardless of cost assuming no prior implementation of measures.

[3] 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.

[4] Data previously sourced from the Farm Practices Survey now taken from the British Survey of Fertiliser Practice.
[5] "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

[6] Quantifying, monitoring and minimising wider impacts of GHG mitigation measures – AC0226 http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=17780&FromSearch=Y&Publisher=1&SearchText=AC0226&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description
[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.

[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
[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%.**