Office for Environmental Protection

Appraisal of agri-environment scheme actions for achieving agriculture water pollution targets

December 2024

ADAS

ADAS GENERAL NOTES

Project No.:	1022978
Title:	Appraisal of agri-environment scheme actions for achieving agriculture water pollution targets
Client:	Office for Environmental Protection
Date:	December 2024
Office:	Wolverhampton
Status:	Final
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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

This work has been undertaken in accordance with the quality management system of RSK ADAS Ltd.

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EXECUTIVE SUMMARY

The government has set targets to reduce the load of total nitrogen, total phosphorus, and sediment entering the water environment through agricultural diffuse pollution by at least 40% by 2038, relative to a 2018 baseline. Agri-environment schemes are intended to ensure agricultural land is managed in a way that protects and improves the environment, and thus they should contribute to the achievement of these diffuse pollution targets.

The objective of this project was to use the Farmscoper model to predict the changes in agricultural diffuse pollution (nitrate, phosphorus and sediment) resulting from current uptake of agri-environment schemes and from hypothetical scenarios of uptake of enhanced schemes. The schemes considered were Countryside Stewardship (CS), Environmental Stewardship (ES) and the Sustainable Farming Incentive (SFI).

Scheme agreement data obtained for use in the project showed there were currently 58,000 agreements for these different schemes in total, so a simple estimate was that the schemes cover 55% of the farms in England, given there are just over 100,000 commercial farms.

The scheme data listed the frequency with which the different actions available within them were implemented, and also the total area, length or count of those different actions (e.g. hectares of low input pasture, metres of grass buffer strip). This data was used to determine the implementation of the actions, expressed as a percentage of the area to which they were potentially applicable on the farms in scheme. These implementation values were then used as the percentage uptake values for those diffuse pollution control ('mitigation') measures in Farmscoper that corresponded to the various scheme actions. Farmscoper was used to predict pollutant losses with and without the uptake of the mitigation measures associated with the schemes, and thus by difference could estimate the potential impacts of the schemes on those pollutant losses. Additional scenarios of enhanced or extended uptake of schemes actions were also considered.

The results of the modelling suggest that current impacts of the schemes on the diffuse nitrate, phosphorus and sediment pollution occurring on the farms in scheme are reductions of between 1% and 7% for CS and 5% and 15% for SFI. Accounting for the fact that potentially only 55% of the farms in England are in scheme (and that more farms are in CS than SFI), then the overall national impacts of the schemes across all farmland are only reductions in the pollutant loads of between 3% and 6%. These figures suggest that agri-environment schemes will currently only contribute a limited proportion of the government's nitrate, phosphorus and sediment pollutant reduction targets of 40%. The future scenarios predicted national reductions in pollutant losses of up to 10%, but only when large (10%) reductions in fertiliser use and livestock numbers were included as part of the schemes. More detailed analysis showed that for some farm types under some environmental conditions, reductions in pollutant losses associated with these future scenarios could be over 20%. Agri-environment schemes could thus potentially make a larger contribution to the 40% reduction targets, particularly in some catchments, and if scheme coverage was expanded to more farms. However, the larger pollutant reductions associated with these future scenarios are mostly a result of the changes in land use (arable reversion to woodland) and reduced inputs to grassland, which would likely result in comparable reductions in farm productivity.

1 INTRODUCTION

The government's Environmental Improvement Plan from 2023 (EIP23) includes a range of government activities (such as regulations, voluntary agri-environment schemes (AES) and other rural grant schemes), that are designed to ensure agricultural land is managed in a way that protects and improves the environment. The plan refers to this as nature friendly farming. The Environmental Targets (Water) (England) Regulations 2023 (SI 2023 No. 93) has a primary target to reduce the load of total nitrogen, total phosphorus, and sediment entering the water environment through agricultural diffuse pollution by at least 40% by 2038, relative to a 2018 baseline.

The objective of this project is to assess the potential contribution of agri-environment schemes to achieving this 40% target. The AES within scope were those currently operational across England, i.e. Countryside Stewardship (CS), Environmental Stewardship (CS) and the more recent Sustainable Farming Incentive (SFI). The approach taken was to estimate the potential contribution of the schemes to achieving these targets, and how this may vary under different farming or environmental conditions, rather than undertake a detailed analysis of the scheme impact.

The project has used the Farmscoper model to determine the reductions in diffuse agricultural pollution (nitrate, phosphorus and sediment) due to CS and SFI, across a range of farm systems, to produce a national estimate and show the range in reductions under different situations. Current and potential future scenarios were modelled to show the contributions of certain components of the schemes to the pollutant reductions predicted and to investigate how expansion of the schemes could increase their impact.

The modelling has not considered other factors outside of the current schemes, such as climate change, technological advances or changes in the structure of the agricultural industry, that may contribute, or hinder, the achievement of the Environment Act 2021 targets.

2 METHODOLOGY

2.1 Modelling

Farmscoper (Gooday et al., 2014) was developed by ADAS in 2010 under Defra Project WQ0106(3), initially as a farm-scale decision support tool to predict the long term annual average losses of nine different pollutants from the farm to air or water, to quantify the effect of implementation of one or more mitigation measures on those pollutant losses and to estimate the cost of measure implementation. Subsequent iterations of the tool with Defra and Environment Agency funding have included wider pollutant coverage, a catchment scale application, and more explicit representation of the costs of mitigation. It is being extensively used by Defra group for national policy development in the field of planning and evaluating the environmental impact of farming activities. This use is driven by legally binding requirements on the UK to reduce greenhouse gas emissions (by 100% by 2050; Climate Change Act, 2008), ammonia emissions (under the National Emissions Ceilings Regulations 2018 and Gothenburg Protocol) and to meet standards for drinking water and good ecological status set by the Nitrates Directive (81/676/EEC) and the UK implementation of the Water Framework Directive (2000/60/EC).

Farmscoper v5 contains agricultural survey data (derived from the Defra June agriculture Survey (JAS) for 2019) for the whole of England at a range of catchment scales. The catchment scale application works by apportioning the total livestock and land use within an area between different farm types (e.g. lowland grazing farm, cereal farm), based upon the count of each farm type within the catchment and a weighting for the likelihood of a given crop or livestock being on each farm type. The tool then models the pollutant losses occurring on each farm system created for the different soil types and climate zones in Farmscoper, producing a national total given the total number of each farm type on each soil type and climate zone.

This project has used Farmscoper at England scale, which produces a set of 10 different farm systems, based on Robust Farm Types (RFT) used in government reporting[1]. The results shown in this report are the national totals and the values for the following specific farm and environment combinations:

1. Cereal farm, 900-1200 mm annual rainfall, very poorly draining soil
2. Cereal farm, 600-700 mm annual rainfall, free draining soil
3. Lowland grazing farm, 900-1200 mm annual rainfall, very poorly draining soil
4. Lowland grazing, 600-700 mm annual rainfall, free draining soil
5. Dairy farm, 900-1200 mm annual rainfall, very poorly draining soil
6. Dairy farm, 600-700 mm annual rainfall, free draining soil

These six were selected to show the results for three contrasting RFTs in differing environmental situations. Summary land use and livestock for these three farm systems are shown in Table 2-1. The cereal farm is mostly arable land and has limited livestock, the dairy and lowland grazing farms are mostly grassland with the dairy farm twice as intensively stocked as the lowland grazing.

Farmscoper contains a library of over 100 mitigation measures. Implementation of each measure is expressed as a percentage of the relevant land area of livestock type on a farm. Default implementation rates for each measure are included within Farmscoper to represent current practice. These default rates are based on national farm practice survey datasets, with implementation rates for some measures varying by soil type, farm type and whether or not a farm is inside a Nitrate Vulnerable Zone (NVZ). Different scenarios of mitigation measure implementation (see Section 2.3) have been assessed for all the farm, soil, climate combinations. National totals are shown assuming

[1] https://assets.publishing.service.gov.uk/media/641073c8e90e076cd09acda9/fbs-uk-farmclassification-2014-14mar23.pdf

all land is under a given scenario (i.e. all land is the agri-environment scheme) and also with only a proportion of the land under a given scenario (reflecting the actual proportion of land in scheme, see Section 2.2). The results shown for the specific farm types are always assuming the land is in scheme.

Although Farmscoper predicts multiple agricultural pollutant losses, the majority of the results shown in this report are for nitrate-N, total phosphorus and sediment (other pollutant data is included in the appendix). Most tables show the percentage reduction in the pollutant loss from a given baseline figure, specified by scenario.

Table 2-1 Key agricultural characteristics of the three farm types for which results are presented.

		Farm Type		
Property	Units	Cereal	Lowland Grazing	Dairy
Grassland	ha	20	32	98
Rough Grazing		-	2	2
Cereals		102	2	15
Other Arable		26	3	17
Woodland		6	2	3
Total Area		154	40	133
Cattle	Head	5	54	343
Sheep & Lambs		36	194	81
Livestock Density	kg N excreted ha^{-1}	4	104	228

2.2 Agri-environment Scheme Data

The summary data for April 2024 for Countryside Stewardship (CS), Environmental Stewardship (ES) and the Sustainable Farming Incentive (SFI) were obtained from the Defra website[2], with the SFI data separated for agreements in 2022 (SFI22) and agreements in 2023 (SFI23). This data contained the total number of agreements and data on the options (CS and ES), actions (SFI23) and standards (SFI22) implemented. The terms 'options' and 'actions' from CS, ES and SFI23 are comparable and refer to the individual management activities paid for by the scheme (e.g. riparian buffer strips, low input pasture), whereas the 'standards' in SFI22 could be implemented at different 'levels' and there were

[2] https://www.gov.uk/government/statistics/cs-es-and-sfi-option-uptake-data-2024

management activities prescribed for each standard and associated level. This report uses the term 'option' for both options and actions, SFI22 was not explicitly represented in the modelling (see below) and so the detail behind the standards and levels was not considered.

Table 2-2 shows the number of agreements in each scheme, and the total and average number of instances of the different options implemented across the schemes. The data available also included the total amount (i.e. hectares, metres or units) of each option for the different schemes.

Table 2-2 Number of agreements by scheme, and the total number of options implemented. SFI22 data was for standards and levels rather than options and so is not shown.

Scheme	Agreements issued	Options implemented	Options per Agreement
Countryside Stewardship[1]	34,900	276,208	7.9
Environmental Stewardship	6,200	79,670	12.9
SFI23	13,900	90,200	6.5
SFI22	3,200	-	-

[1] Does not include capital-only agreements

This data included no information to determine if farms in scheme were different to farms not in scheme (e.g. larger in area), whether certain farm types were more likely to be in scheme, or whether certain options occurred more often on certain farm types. Therefore, it was assumed that all farm types were equally likely to be in scheme and options were equally likely to be on any farm type.

There are 102,000 farms in England according to the 2023 June Agricultural Survey, and thus a simple estimate based on this and Table 2-2 is that 34% of farms are in CS and 6% in ES, whilst 14% are in SFI23 and 3% in SFI22 (although it is possible for a farm to be in multiple schemes). When determining the national impacts of schemes, farm level results were weighted with those percentages to account for the proportion of farms in scheme.

Because of the similarity between CS and ES and between SFI22 and SFI23, the fact that CS and SFI23 were more common, and because this project was not intended to undertake a detailed assessment of scheme impacts, this project has only modelled CS and SFI23 in order to reduce the complexity of the modelling. When calculating the national impacts, the percentage of farms in CS and SFI23 were increased to reflect the farms in ES and SFI22 respectively. Thus 40% of farms were assumed to be in CS and 17% in SFI, 57% of farms in total. It is possible for a farm to be in more than one scheme (and thus less than 57% of farms would be in scheme), but this has not been considered in this work.

Calculation of mitigation measure implementation

Each option in the CS and SFI data was categorised by expert opinion as to whether or not it had an impact on the pollutants of interest in this project, and they were then ranked in order of the number of agreements on which the option occurred, allowing for those options not relevant or only occurring on a small number of farms to be excluded from further analysis. Roughly 40% and 30% of the total number of instances of CS and SFI options, respectively, were considered as relevant to water quality, so typically only 2-3 options per agreement.

Mitigation measure implementation in Farmscoper is expressed as a percentage of the applicable area for that measure. As no information was available to characterise the farms in scheme, implementation rates were derived using the average amount (i.e. ha or metre) of each option per farm in scheme and the average characteristics for a farm in England derived from the 2023 JAS. For some options, implementation rates could be determined by simply dividing the average area of an option by the national farm average data for the applicable area. For example, there was an average of 6.7 ha of 'IPM3 Companion crop on arable and horticultural land' per agreement in SFI. The average arable area per farm in England was 39.9 ha, so the implementation rate of this option would be 16.9%. For some within field options, it was necessary to account for the average area of a field occupied by such an option (e.g. 'AB8 Flower-rich margins and plots' was typically 1.3 ha) and the average area per agreement, allowing the number of fields per agreement to be determined, which could be expressed relative to an average number of fields per farm to produce a percentage. For other options, the average length of the option per agreement was converted into the number of fields per agreement given an average field size and making an assumption about the amount of the field covered by the option (e.g. a fence would be installed along one edge of a field).

The CS data included some options such as 'RP4 Livestock and machinery hardcore tracks' and 'RP5 Cross drains' that can be linked to Farmscoper measures impacting on water quality, but for which it is difficult to determine a percentage uptake rate as it is not possible to determine an appropriate denominator for use in the calculation (e.g. how much track was there in total on the farm, how many cross drains could be installed). Therefore, such measures were removed from the analysis.

To account for the potential contribution of the options that were removed from the analysis (such as tracks, cross drains and others that could impact on water quality but only occurred on a small percentage of farms), the calculated implementation rates were increased by a proportion equal to the total number of options excluded relative to the total number of options.

There are no mitigation measures in Farmscoper to represent changes in fertiliser use or livestock numbers, and these must be represented as explicit changes in the input data. For most of the scenarios described in the next subsection, it was assumed that the impacts of measures restricting fertiliser use and stocking densities on grassland (such as CS option 'GS2 Permanent grassland with very low inputs (outside SDAs)') were negligible as they are frequently utilised on fields where the restrictions were already met. However, an assessment of the maximum likely change associated with these options was determined.

The final calculated implementation rates for the Farmscoper measures representing CS and SFI are shown in Table 2-3 and Table 2-4 respectively. The assumption was made that the default mitigation measure implementation rates in Farmscoper did not include any contribution from CS or SFI, and thus the rates in those tables were added on to the default rates in Farmscoper. This is an over-estimation as some of the current measure implementation will be due to CS (SFI was not around when the default implementation rates in Farmscoper were created).

Because these implementation rates are averaged across all farms in scheme, there are more measures per farm (there are 11 items in Table 2-3, but Table 2-2 states there are only 8 options per farm), but at a lower implementation rate than would be found on those farms that actually implemented them.

Table 2-3 Implementation Rates for CS options

Option Name	Implementation (% of applicable area)
Winter bird food	13.0
Planting new hedges	5.3
4 m to 6 m buffer strip on cultivated land	57.0
Flower-rich margins and plots	13.7
Take small areas out of management	4.0
Fencing	15.7
Nectar flower mix	8.6
Hard bases for livestock drinkers	6.1
In-field grass strips	24.6
Basic overwinter stubble	2.3
Resurfacing of gateways	2.2

Table 2-4 Implementation Rates for SFI Options

Option Name	Implementation (% of applicable area)
Multi-species winter cover crops	84.7
Winter bird food on arable and horticultural land	23.0
Grassy field corners or blocks	1.2
4 m to 12 m grass buffer strip on arable and horticultural land	11.4
Flower-rich grass margins, blocks, or in-field strips	5.6
Take grassland field corners or blocks out of management	5.0
Pollen and nectar flower mix	7.0

Calculation of changes in fertiliser rate and livestock numbers

An estimate of the potential maximum likely change in fertiliser use and livestock numbers due to CS and SFI was made, so that one of the modelled scenarios could quantify the impact of this. This estimate was based on the scheme option data but using a constraint that the total change in fertiliser and livestock associated with these options could not be greater than recent changes in national fertiliser use and livestock numbers.

The total area of options restricting fertiliser inputs or grazing livestock on grassland equated to 750,000 ha across CS and SFI, with an average of 12.8 ha per CS agreement and 13.5 ha per SFI agreement. Thus, it was assumed that the change associated with the two schemes would likely be comparable and so a single effective change could be determined.

British Survey of Fertiliser Practice (BSFP) data for 2021[3] states that 54% of permanent grassland fields receive nitrogen fertiliser and that the average fertiliser rate to those fields is 78 kg N ha^{-1}. Assuming the limit to fertiliser application associated with the scheme options is 9 kg N ha^{-1} (the maximum allowed under CS option GS2), but that only 54% of fields are receiving above this, then that would have resulted in an overall reduction in fertiliser use of 28.1 kt of N (750,000 ha x 54% x (78 – 9)). Average fertiliser use to grassland across England is 200 kt, so this calculated change due to the schemes represents a 14% reduction. National rates of nitrogen fertiliser application to grassland have been decreasing for a long time, with the average rate dropping by around 10% from 2015 to 2021 (BSFP, 2022). Thus the calculated 14% reduction was assumed to be a reasonable maximum that could be associated with the scheme.

The RB209 fertiliser recommendation book suggests that to increase grassland production from 5-7 t dry matter ha^{-1} to 7-9 t ha^{-1} requires an additional 60 kg N ha^{-1} (so 30 kg N t^{-1}). Thus, the calculated 28m kg reduction in fertiliser use could result a reduction in grassland production of almost 1m tonnes.

[3] Most recent data available that exclude the impact of changes as a result of the war in Ukraine

Assuming that grass contains 11 MJ of metabolisable energy per kg, and that an adult beef cow requires 29,650 MJ per year (information from the ' Tried and Tested' Feed planning for cattle and sheep booklet[4]), then this would be enough grass to feed 350,000 beef cows. There are approximately 5 million cattle of all ages in England and also 15 million sheep and lambs[5], so the calculated change in livestock numbers due to schemes is likely to be a few percent of total grazing livestock productivity, which is not dissimilar to recent changes – total cattle numbers reduced by 5% from 2015 to 2021, sheep by 3%. The livestock numbers were converted to livestock units (using 0.6 for all cattle and 0.1 for sheep[6]), to allow a percentage change in overall grazing livestock to be calculated, which could then be applied to all cattle and sheep.

As the model was run assuming all land was in scheme, and the results then scaled back to account for the 43% of land not in scheme (derived from Table 2-2), it was necessary to inflate the calculated changes in livestock, so that the correct calculated change would still be represented when scaled back. Also, as the impacts of any actual change in land use and livestock due to the schemes would already be included within the JAS data, it was appropriate to increase the original figures such that they reverted to the current values after the calculated changes were applied. The changes were thus a 25% increase in fertiliser to grassland and a 7% increase in grazing livestock.

2.3 Scenarios

Farmscoper was used to model different scenarios of measure uptake, to quantify the impacts of compliance with regulations (Farming Rules for Water (FRfW; SI 2018 No. 151)) and of current and potential future uptake of agri-environment schemes. The scenarios are summarised in Table 2-5 and then described in more detail below. Scenarios 1 to 3 are essentially included for context and to provide a true baseline (scenario 3) against which to assess the impacts of the other scenarios. The implementation rates for the measures in scenarios 4-10 are shown in Table 2-3 and Table 2-4. These scenarios were modelled on all the farm, soil, climate combinations, with the results shown in the next section at both national scale and for a selection of farm, soil and climate combinations.

4 www.triedandtested.org.uk/media/43cbe5lc/feed-plan-cows-and-sheep.pdf

5 www.gov.uk/government/statistical-data-sets/structure-of-the-agricultural-industry-in-england-and-the-uk-at-june

6 www.gov.uk/government/publications/countryside-stewardship-mid-tier-and-wildlife-offers-manual-for-agreements-starting-on-1-january-2022/annex-6c-convert-livestock-numbers-into-livestock-units

Table 2-5 Summary of the modelled scenarios

ID	Short Name	Description
0	Naïve Baseline	No measure implementation
1	Current	Current uptake of measures, using default rates within Farmscoper
2	Compliance – Required	As per 1, but with 100% uptake of measures considered to be required by the Farming Rules for Water
3	Compliance – Reasonable	As per 2, but with a minimum of 20% uptake of measures considered to be 'reasonable precautions to prevent pollution' by the Farming Rules for Water
4a	CS Soil	As per 3, but with additional uptake of measures due to options from the 'soil' parts of the relevant scheme which are found on 5% of agreements or more
4b	SFI Soil	
5a	CS Top WQ	As per 3, but with additional uptake of measures resulting from the most common options relevant to water quality, excluding those changing fertiliser and livestock numbers such as 'low input pasture'
5b	SFI Top WQ	
6a	CS All WQ	As per 3, but with additional uptake of measures resulting from all options affecting water quality which are found on 5% of agreements or more, excluding those changing fertiliser and livestock numbers such as 'low input pasture'
6b	SFI All WQ	
7a	CS All WQ & LUC	As per 6, but with fertiliser and livestock numbers in the naïve baseline increased to represent the situation before scheme implementation of options such as 'low input pasture'
7b	SFI All WQ & LUC	
8a	CS Increased Uptake	As per 6, but with uptake of useful scheme measures raised to a minimum of 10%.
8b	SFI Increased Uptake	
9a	CS Additional Options	As per 8, but with an additional 10% uptake for each of 5 effective measures that could be considered within a future scheme.
9b	SFI Additional Options	
10a	CS Further LUC	As per 9, but an additional 10% reduction in livestock numbers and 10% of arable land converted to woodland.
10b	SFI Further LUC	

Scenario 1 – Current

Farmscoper contains a library of over 100 mitigation measures. There is a default implementation rate for each measure derived from national survey data such as the Defra Farm Practice Survey of the BSFP. The default rates vary by soil type and farm type.

Scenario 2 – Compliance – Required

Of the *c*.100 mitigation measures in Farmscoper, 9 of them correspond to requirements in the Farming Rules for Water and so implementation rates for these 9 are increased to 100%.

Scenario 3 – Compliance – Reasonable

The FRfW require land managers to take reasonable precautions to prevent pollution. There are 16 mitigation measures in Farmscoper that have been identified by the Environment Agency as ones that could be considered reasonable precautions. The implementation rate for these is set as a minimum of 20%, representing the fact that some farms would have to implement some of these measures. The minimum is used as the default rates may be higher for some measures on some farm / soil types.

Scenario 4 – Soil Options

Implementation rates were increased for mitigation measures corresponding to soil options with CS and SFI.

The following CS options were labelled as 'Soil and Water' and were in the top 15 most commonly implemented CS measures included in the modelling:

- 4 m to 6 m buffer strip on cultivated land
- In-field grass strips
- Resurfacing of gateways

There are only 3 SFI actions for soils, but one of these is producing a soil management plan (SAM1, which was excluded from the analysis as it has no direct impact) and one is a change in land use and so was excluded (SAM3 herbal leys). Thus, the only SFI option here was:

- Multi-species winter cover crops

Scenario 5 – Top Water Quality Options

Implementation rates were increased for mitigation measures corresponding to the most commonly selected options within CS and SFI according to the scheme agreement data obtained.

For CS, the most implemented options for water quality (excluding LUC options) were:

- Winter bird food
- Planting new hedges
- 4 m to 6 m buffer strip on cultivated land
- Flower-rich margins and plots
- Take small areas out of management

For SFI they were:

- Multi-species winter cover crops
- Winter bird food on arable and horticultural land

- Grassy field corners or blocks

Scenario 6 – All Water Quality Options

Implementation rates were increased for mitigation measures corresponding to all options within CS and SFI that were on more than 5% of agreements and impacted on water quality. The 5% value was chosen as an arbitrary cutoff to eliminate the large number of CS options with little implementation. These options are listed in Table 2-3 and Table 2-4 for CS and SFI.

Scenario 7 – All Water Quality Options including changes in fertiliser and livestock

In addition to the implementation of measures under scenario 6, the input livestock and fertiliser data were adjusted to account for options such as 'low input grazing', as described in Section 2.2

Scenario 8 – Increased uptake of options

The implementation rates for options identified by expert opinion as effective at reducing water pollution were increased to a minimum of 10%. This included options within the schemes that were initially excluded in the previous scenarios due to occurring on less than 5% of agreements.

The CS options increased to 10% implementation were:

- Planting new hedges
- Take small areas out of management
- Hard bases for livestock drinkers
- Basic overwinter stubble
- Riparian management strip
- Seasonal livestock removal on intensive grassland
- Winter cover crops
- Equipment to disrupt tramlines in arable areas
- Unharvested cereal headland
- Under sown cereal

The SFI options increased to 10% implementation were:

- Grassy field corners or blocks
- Flower-rich grass margins, blocks, or in-field strips
- Take grassland field corners or blocks out of management

Scenario 9 – Uptake of additional options

Additional options were added on to the scenario 8. These additional options were ones identified as useful for reducing water pollution, not currently included in CS or SFI as appropriate, did not correspond to measures considered reasonable precautions under scenario 3 and could potentially be suitable for including in an agri-environment scheme.

The measures were:

- Uncropped cultivated areas
- Adopt reduced cultivation systems

- Management of arable field corners
- Use slurry injection application techniques
- Allow grassland field drainage systems to deteriorate

Scenario 10 – Further changes in land use and livestock

Land use change added on to the definition of scenario 9. The changes were:

- 10% of arable land reverted to woodland
- 10% reduction in grazing livestock
- 10% reduction in nitrogen fertiliser to grassland

3 RESULTS AND DISCUSSION

Table 3-1 shows the annual average pollutant losses predicted by Farmscoper for the whole of England and for the specific farm, climate and soil types focussed on in this report – the losses are expressed as loads, in kg ha^{-1} of agricultural land. The national annual average nitrate loss from agricultural land is 23.3 kg ha^{-1}. The lowland grazing farm losses are lower than this, the cereal farms are comparable and the dairy farm losses higher, largely reflecting the intensity of management of the 3 systems, where the dairy farm has both a reasonable use of nitrogen fertiliser and significant amounts of livestock. There is limited variation between the environmental conditions shown (i.e. low rainfall on a freely draining soil versus high rainfall on a poorly draining soil), as the potential impact of the greater drainage occurring under the higher rainfall situation is largely offset as the model assumes there is greater denitrification in the wetter soil, reducing the amount of nitrate in the soil available to be leached in the first place. For phosphorus and sediment, there is much greater variation between the environmental conditions shown, as the '900-1200 mm Artificially Drained soil' situation has both greater drainage and drains to act as an efficient conduit for the transport of material. However, for the same environmental conditions, losses are still higher on the dairy farm and lower on the lowland grazing farm. Average national annual losses of sediment and phosphorus from agriculture are between the values calculated for the different environmental conditions, reflecting the range of environmental conditions found across England.

When reviewing the following tables of percentage pollutant reduction under different scenarios, the magnitude of the baseline loss for each farm and environment should be considered, as – for phosphorus and sediment – a smaller percentage reduction in the '900-1200 mm Artificially Drained soil' situation could have a bigger absolute reduction (in kg) than a bigger percentage reduction on the '600-700 mm free draining soil' situation.

Table 3-1 Annual average pollutant loads under Scenario 3 (the baseline against which subsequent scenarios are compared), nationally and for the specific farm, climate and soil type combinations focussed on in this report

Farm Type	Annual Rainfall (mm)	Soil Type	Pollutant Load (kg ha^{-1})		
			Nitrate	Phosphorus	Sediment
National	-	-	23.2	0.48	260
Cereal	900-1200	Artificially Drained	25.0	1.61	1,186
	600-700	Free Draining	25.3	0.47	168
Lowland Grazing	900-1200	Artificially Drained	12.9	1.21	456
	600-700	Free Draining	13.1	0.07	11
Dairy	900-1200	Artificially Drained	27.3	1.99	643
	600-700	Free Draining	33.6	0.13	13

Table 3-2 through to Table 3-7 show the percentage reduction in pollutant loads for the selected farm types (Cereal, Lowland Grazing, Dairy) under different soil and climate types. Table 3-8 shows the national results, assuming that all land in England is managed according to the scenario (i.e. the whole of England is in SFI, giving an effective results for all land 'in-scheme') whilst Table 3-9 shows the national results accounting for the area actually in the schemes. Table 3-10 shows some of the other outcomes predicted by Farmscoper, for a subset of the scenarios, accounting for the area in the schemes. The results in these tables are discussed below.

Scenarios 1-3 (non-scheme impacts)

Farmscoper includes an estimate of the current level of uptake of each of the mitigation measures in its measure library. The overall impact of this current uptake (scenario 1) is roughly a 10% reduction in the national agricultural pollutant loads for nitrate, phosphorus and sediment (Table 3-8). The impacts on nitrate for the select farm and environmental variables range between 7 and 10% (Table 3-2 through to Table 3-7). However, for phosphorus and sediment there is much greater variation, particularly between the environmental conditions – on the artificially drained soil, reductions are only 5-10%, whereas on the drier free draining soils, reductions are as high as 38% for phosphorus and 23% for sediment. This contrast is because on the free draining soil, surface runoff is the main pathway for transport of sediment and phosphorus, and it is easy to control or prevent surface runoff than it is other pathways.

Raising the current levels of uptake to achieve a minimum of 80% compliance with the required aspects of the FR4W (scenario 2) has limited impact nationally for nitrate (1.3%), is more important for phosphorus (4.6%), but has no impact on sediment as the rules are targeting manure and fertiliser use. Highest impacts (up to 9% for both nitrate and phosphorus) are found on the livestock farms (as there is more manure) and particularly on the artificially drained soils (where pollutant loss shortly after manure application is more significant and thus there is more potential for mitigation).

The FR4W also require landowners to take reasonable precautions to prevent pollution, particularly soil erosion. The estimate of the impact of these reasonable precautions (scenario 3) is a less than 1% reduction in loads nationally (Table 3-8), although they would be more effective locally on those farms where the precautions would be needed. There was limited variation predicted by farm type, but values were greater on the wet artificially drained soil.

Scenarios 4-7 (current scheme impacts)

The first part of the analysis of CS and SFI looked at those options that were explicitly labelled as 'soil' options ('Soil and Water' in CS, 'SAM' in SFI). The CS options had very little impact on nitrate losses, but were more effective against both phosphorus and sediment losses – 3% and 6% nationally respectively. The highest percentage reductions were found on the cereal farm on the free draining soil, as the modelled measures were primarily reducing surface runoff on arable land (i.e. buffer strips). The only modelled soil option for SFI was winter cover crops, but due to the effectiveness of this measure, national impacts (assuming all of England was in scheme) were 5% for nitrate, 9% for phosphorus and 14% for sediment. Impacts were greater on wetter artificially drained soils (up to 21% for sediment on the dairy farm), but this is partly a function of the model set-up limiting the potential for uptake of cover crops on free draining soils rather than the measure actually being less effective on these soils.

Accounting for the percentage of farms in England in CS and SFI and those not in scheme, the overall national impacts are predicted to be 1% reductions for nitrate, 3% for phosphorus and 5% for sediment (Table 3-9).

The addition of the other measures impacting on water quality (scenario 6 and 7) had limited additional impact, around 0.5% extra for each pollutant for each scenario. This is because the highest measure implementation rates were for those measures included in scenario 4 (e.g. 57% for '4 m to 6 m buffer strip on cultivated land'; Table 2-3) whilst some of the additional measures had very low uptake rates, and for SFI, the most effective measure (cover crops) was part of in scenario 4.

Scenarios 4-6 have ignored the contribution of options that limit fertiliser use or restrict livestock numbers, as such actions are typically placed on fields that already meet the criteria. Scenario 7 attempts to quantify the impact of the maximum change in fertiliser use and livestock numbers that could have occurred. Impacts on the cereal farm (Table 3-2 and Table 3-3) are limited due to small proportion of grassland on this farm type. Impacts on the other two farm types are 6-8% reductions in nitrate and 2-5% in phosphorus, with no impact on sediment (as there was no land use change, and Farmscoper doesn't consider the potential impact of changes in stocking density on poaching and thus sediment loss).

Accounting for the percentage of farms in England not in scheme, inclusion of this fertiliser and livestock change results in a net national impact of the schemes of 3% for nitrate, 4% for phosphorus and 6% for sediment (Table 3-9).

Scenarios 8-10 (potential scheme impacts)

Some of the scheme options can be effective, but are limited in their impact due to their low uptake (e.g. 'basic over winter stubble' is only on 2.3% of appropriate land in scheme; Table 2-3). If uptake of these measures is increased to 10% of the applicable on-farm area (scenario 8), the impact of CS rises by between 0.5% (nitrate) and 1% (sediment), with limited variation between farms and environments.

Scenario 9 models the addition of a few extra measures, effective at reducing the pollutants of interest, but which are not currently in the schemes. Uptake of these measures was set to 10%. This results in an additional reduction in the pollutants of about 1% for both CS and SFI if applied nationally, although there is some variation between the farms and environments (but only to a maximum impact of 2.6%). Whilst this is not a very large impact, the reduction for nitrate is comparable to that achieved by scenarios 4-6 for CS.

Additional land use change was modelled in scenario 10. This has a national impact, additional to scenario 9 of almost 8% for nitrate and 6% for phosphorus and sediment. Sediment impacts are greatest on the cereal farm type (Table 3-2 and Table 3-3) as the 10% reversion of arable land to woodland has greater applicability. Nitrate and phosphorus impacts are similar across all farm types as the 10% reversion of arable land and 10% reductions in grassland inputs even out the differences between the farm types.

Accounting for the percentage of farms in England not currently in scheme, inclusion of these potential additional measures and land use change results in a net national impact of 6% for nitrate, 8% for phosphorus and 10% for sediment (Table 3-9).

Other outcomes of the scenarios

This report focusses on the impacts of agri-environment schemes on nitrate, phosphorus and sediment losses from agriculture, but Farmscoper predicts the impacts on a wider suite of pollutants and also considers the costs of implementation of the measures[7] – although it does not consider the costs of land use change or reductions in livestock as these are not represented as mitigation

[7] These are the costs to the farmer, and do not consider scheme administration costs or necessarily reflect scheme payment rates. Costs are using figures for 2021.

measures. Assigning monetary values[8] to the absolute reductions in nitrate, phosphorus, sediment, ammonia and GHGs predicted by Farmscoper and coming them together produces an aggregated environmental benefit, expressed in £.

Given the relative similarity in the results shown for the non-land use change scenarios 4-6 (for current scheme) and 8-9 (for potential scheme), Table 3-10 shows these extra outcomes only for scenarios 6 and 9.

Total costs to the farm of the measures represented are £90 million (scenario 6) and £159 million (scenario 9), although this equates to only £1,560 and £2,725 per scheme agreement and these costs would probably be offset by the scheme payments. For scenario 6, the net environmental benefit is greater than the costs, but not for scenario 9.

Given the modelling selected only those measures benefiting water quality, it is not surprising that the impacts on gaseous emissions are rather limited (a maximum of 0.7% for nitrous oxide). Reductions in faecal indicator organisms (FIO) and pesticide losses reach just over 1%, almost comparable to the reductions in nitrate. Implementation of the measures results in a small reduction in food production, but less than 1%.

Scenarios 7 and 10, which included changes in land use, fertiliser use and livestock, would have greater reductions in these other pollutants (results not shown) as they are actually controlling the source, rather than trying to reduce the mobilisation and delivery of the pollutants.

[8] These are contained within Farmscoper, but are values for 2021 from for the non-traded cost of carbon for GHG emissions, air quality damage costs for ammonia, and ENCA values for water pollutants.

Table 3-2 Percentage reductions in the annual average pollutant load, by scenario, for the Cereal farm type, 900-1200 mm annual rainfall, artificially drained soil. Reductions for scenarios 1-3 are relative to the naïve baseline, for scenarios 4-10 they are relative to scenario 3.

ID	Scenario Name	Pollutant Reduction (%)		
		Nitrate	Phosphorus	Sediment
1	Current	9.9	6.2	8.1
2	Compliance – Required	0.8	3.9	0.0
3	Compliance – Reasonable	0.3	0.5	0.5
4a	CS Soil	0.1	2.2	3.1
4b	SFI Soil	4.2	8.0	10.7
5a	CS Top WQ	0.8	3.0	4.0
5b	SFI Top WQ	4.5	8.2	11.0
6a	CS All WQ	1.0	3.4	4.3
6b	SFI All WQ	4.6	8.4	11.2
7a	CS All WQ & LUC	1.4	3.4	4.3
7b	SFI All WQ & LUC	5.1	8.5	11.2
8a	CS Increased Uptake	1.5	4.3	5.6
8b	SFI Increased Uptake	4.7	8.5	11.4
9a	CS Additional Options	2.7	5.6	6.7
9b	SFI Additional Options	5.7	9.5	12.4
10a	CS Further LUC	11.5	13.2	14.2
10b	SFI Further LUC	14.3	16.9	19.6

Table 3-3 Percentage reductions in the annual average pollutant load, by scenario, for the Cereal farm type, 600-700 mm annual rainfall, free draining soil. Reductions for scenarios 1-3 are relative to the naïve baseline, for scenarios 4-10 they are relative to scenario 3.

ID	Scenario Name	Pollutant Reduction (%)		
		Nitrate	Phosphorus	Sediment
1	Current	7.4	13.4	22.6
2	Compliance – Required	0.1	1.0	0.0
3	Compliance – Reasonable	0.5	0.0	0.1
4a	CS Soil	0.1	9.8	23.0
4b	SFI Soil	1.8	0.9	2.5
5a	CS Top WQ	0.7	12.0	27.4
5b	SFI Top WQ	2.2	2.1	5.1
6a	CS All WQ	1.0	13.1	29.1
6b	SFI All WQ	2.4	3.1	7.2
7a	CS All WQ & LUC	1.3	13.2	29.1
7b	SFI All WQ & LUC	2.7	3.2	7.2
8a	CS Increased Uptake	1.6	13.7	30.5
8b	SFI Increased Uptake	2.4	3.4	8.0
9a	CS Additional Options	1.9	15.4	33.0
9b	SFI Additional Options	2.7	3.9	8.1
10a	CS Further LUC	11.2	21.2	36.5
10b	SFI Further LUC	12.0	11.9	15.9

Table 3-4 Percentage reductions in the annual average pollutant load, by scenario, for the Lowland Grazing farm type, 900-1200 mm annual rainfall, artificially drained soil. Reductions for scenarios 1-3 are relative to the naïve baseline, for scenarios 4-10 they are relative to scenario 3.

ID	Scenario Name	Pollutant Reduction (%)		
		Nitrate	Phosphorus	Sediment
1	Current	7.8	6.2	5.7
2	Compliance – Required	4.8	5.0	0.0
3	Compliance – Reasonable	0.2	0.4	0.7
4a	CS Soil	0.0	0.4	1.1
4b	SFI Soil	3.0	6.5	14.5
5a	CS Top WQ	0.2	0.7	1.5
5b	SFI Top WQ	3.1	6.6	14.6
6a	CS All WQ	0.5	1.2	1.8
6b	SFI All WQ	3.1	6.7	14.7
7a	CS All WQ & LUC	8.1	3.6	1.8
7b	SFI All WQ & LUC	10.6	8.9	14.7
8a	CS Increased Uptake	0.7	1.6	2.5
8b	SFI Increased Uptake	3.2	6.8	14.8
9a	CS Additional Options	0.9	2.1	3.0
9b	SFI Additional Options	3.4	7.1	15.0
10a	CS Further LUC	10.0	6.6	5.0
10b	SFI Further LUC	12.2	11.2	16.0

Table 3-5 Percentage reductions in the annual average pollutant load, by scenario, for the Lowland Grazing farm type, 600-700 mm annual rainfall, free draining soil. Reductions for scenarios 1-3 are relative to the naïve baseline, for scenarios 4-10 they are relative to scenario 3.

ID	Scenario Name	Pollutant Reduction (%)		
		Nitrate	Phosphorus	Sediment
1	Current	7.7	29.3	22.8
2	Compliance – Required	0.3	1.7	0.0
3	Compliance – Reasonable	0.1	0.1	0.3
4a	CS Soil	0.0	0.7	4.0
4b	SFI Soil	1.2	0.4	2.6
5a	CS Top WQ	0.2	0.9	4.9
5b	SFI Top WQ	1.3	0.5	3.1
6a	CS All WQ	0.4	6.9	5.7
6b	SFI All WQ	1.3	0.6	3.6
7a	CS All WQ & LUC	6.2	10.3	5.7
7b	SFI All WQ & LUC	7.0	4.3	3.6
8a	CS Increased Uptake	0.7	7.5	7.2
8b	SFI Increased Uptake	1.4	0.7	3.8
9a	CS Additional Options	0.8	8.7	9.8
9b	SFI Additional Options	1.4	0.8	4.0
10a	CS Further LUC	8.5	13.0	8.3
10b	SFI Further LUC	9.1	6.9	5.3

Table 3-6 Percentage reductions in the annual average pollutant load, by scenario, for the Dairy farm type, 900-1200 mm annual rainfall, artificially drained soil. Reductions for scenarios 1-3 are relative to the naïve baseline, for scenarios 4-10 they are relative to scenario 3.

ID	Scenario Name	Pollutant Reduction (%)		
		Nitrate	Phosphorus	Sediment
1	Current	9.5	9.2	8.6
2	Compliance – Required	8.1	8.9	0.0
3	Compliance – Reasonable	0.2	0.4	0.7
4a	CS Soil	0.0	0.7	2.3
4b	SFI Soil	3.1	8.3	21.4
5a	CS Top WQ	0.2	1.0	3.0
5b	SFI Top WQ	3.2	8.4	21.5
6a	CS All WQ	0.5	1.7	3.4
6b	SFI All WQ	3.2	8.4	21.6
7a	CS All WQ & LUC	8.2	5.1	3.4
7b	SFI All WQ & LUC	10.7	11.6	21.6
8a	CS Increased Uptake	0.7	2.1	4.2
8b	SFI Increased Uptake	3.3	8.5	21.6
9a	CS Additional Options	1.2	3.6	4.8
9b	SFI Additional Options	3.7	9.8	21.9
10a	CS Further LUC	10.6	10.3	9.1
10b	SFI Further LUC	12.9	16.0	24.7

Table 3-7 Percentage reductions in the annual average pollutant load, by scenario, for the Dairy farm type, 600-700 mm annual rainfall, free draining soil. Reductions for scenarios 1-3 are relative to the naïve baseline, for scenarios 4-10 they are relative to scenario 3.

ID	Scenario Name	Pollutant Reduction (%)		
		Nitrate	Phosphorus	Sediment
1	Current	9.0	38.3	22.5
2	Compliance – Required	0.6	3.5	0.0
3	Compliance – Reasonable	0.1	0.1	0.4
4a	CS Soil	0.0	1.2	10.2
4b	SFI Soil	1.1	0.6	5.1
5a	CS Top WQ	0.2	1.5	12.1
5b	SFI Top WQ	1.2	0.7	6.0
6a	CS All WQ	0.4	9.5	13.4
6b	SFI All WQ	1.2	0.8	7.1
7a	CS All WQ & LUC	6.7	13.8	13.4
7b	SFI All WQ & LUC	7.4	5.5	7.1
8a	CS Increased Uptake	0.6	10.3	14.8
8b	SFI Increased Uptake	1.2	0.9	7.5
9a	CS Additional Options	0.7	11.6	17.2
9b	SFI Additional Options	1.2	1.3	7.7
10a	CS Further LUC	9.8	17.7	17.5
10b	SFI Further LUC	10.4	9.3	10.9

Table 3-8 Percentage reductions in the national annual average pollutant load, by scenario, assuming that all farms in England were under the management of that scenario. Reductions for scenarios 1-3 are relative to the naïve baseline, for scenarios 4-10 they are relative to scenario 3.

ID	Scenario Name	Pollutant Reduction (%)		
		Nitrate	Phosphorus	Sediment
1	Current	10.0	10.5	11.5
2	Compliance – Required	1.3	4.6	0.0
3	Compliance – Reasonable	0.4	0.4	0.6
4a	CS Soil	0.1	3.0	5.6
4b	SFI Soil	4.6	8.9	14.3
5a	CS Top WQ	0.5	3.7	6.8
5b	SFI Top WQ	4.8	9.1	14.8
6a	CS All WQ	0.7	4.6	7.4
6b	SFI All WQ	4.9	9.4	15.2
7a	CS All WQ & LUC	3.3	5.7	7.4
7b	SFI All WQ & LUC	7.3	10.4	15.2
8a	CS Increased Uptake	1.2	5.3	8.5
8b	SFI Increased Uptake	5.0	9.5	15.4
9a	CS Additional Options	1.7	6.1	9.2
9b	SFI Additional Options	5.4	10.3	16.2
10a	CS Further LUC	9.4	12.5	15.4
10b	SFI Further LUC	12.8	16.3	21.7

Table 3-9 Percentage reductions in the national annual average pollutant load, by scenario, accounting for the proportion of farms in CS and SFI. Reductions for scenarios 1-3 are relative to the naïve baseline, for scenarios 4-10 they are relative to scenario 3.

ID	Scenario Name	Pollutant Reduction (%)		
		Nitrate	Phosphorus	Sediment
1	Current	10.0	10.5	11.5
2	Compliance – Required	1.3	4.6	0.0
3	Compliance – Reasonable	0.4	0.4	0.6
4	Soil	0.8	2.7	4.7
5	Top WQ	1.0	3.0	5.2
6	All WQ	1.1	3.4	5.5
7	All WQ & LUC	2.6	4.0	5.5
8	Increased Uptake	1.3	3.7	6.0
9	Additional Options	1.6	4.2	6.4
10	Further LUC	5.9	7.8	9.8

Table 3-10 Annual national costs, monetised environmental benefit and percentage reductions in the average pollutant load, for scenarios 6 and 9, accounting for the proportion of farms in CS and SFI

		Scenario	
		6	9
Value (£ m)	Capital Cost	30.5	46.3
	Operational Cost	60.2	112.4
	Total Cost	90.6	158.7
	Environmental Benefit	81.6	108.9
Reduction (%)	Nitrate	1.1	1.6
	Phosphorus	3.4	4.2
	Sediment	5.5	6.4
	Ammonia	0.1	0.2
	Methane	0.0	0.0
	Nitrous Oxide	0.3	0.7
	Plant Protection Products	0.8	1.2
	FIOs	1.1	1.2
	Soil Carbon	-0.5	-0.6
	Energy Use	0.3	0.7
	Productivity	0.2	0.6

4 CONCLUSIONS

This project has used the Farmscoper model to estimate the potential reductions in diffuse agricultural pollution resulting from agri-environment schemes (Countryside Stewardship and Sustainable Farming Incentive), and how these schemes might help achieve the Environment Act targets of reducing nitrogen, phosphorus and sediment pollution from agriculture into the water environment by at least 40% by 2038.

Ignoring the contribution of land use change options (such as ‘low input pasture’), the predicted reductions in annual average agricultural losses of nitrate, phosphorus and sediment from land in a scheme range from 1% (CS impacts on nitrate) to 15% (SFI impacts on sediment). The land use change options were ignored as they are frequently used on land that already meets the scheme requirements (and so no change in management occurs to change the pollution losses). However, accounting for the maximum likely change in livestock numbers and fertiliser use resulting from such options reduces annual average losses of nitrate by a further 2-3% and phosphorus by 1%. Even including these, the reductions on the land in scheme are still substantially below the Environment Act targets.

The methodology applied in this work allowed for an assessment of how the reductions in nitrate, phosphorus and sediment could vary between farm type and under different environmental situations (low rainfall, freely draining soil and high rainfall, poorly draining soil). The results showed that reductions in annual average nitrate and phosphorus losses of over 10% could be achieved, but still only on those farms where reductions in livestock and fertiliser use were assumed to have occurred (i.e. not on arable farms). The Environment Act does include interim targets to achieve 10% reductions in nitrogen, phosphorus and sediment pollution from agriculture into the water environment by January 2028. The model outputs from this project suggest these interim target levels might be attainable, but only in grassland-dominated catchments and only if changes in management were made to meet the key scheme option requirements (i.e. reductions in fertiliser use or livestock numbers were made for measures such as low input permanent pasture, as modelled in scenario 7).

The scheme data used was for 58,000 agreements across CS, ES and SFI, which is approximately half (56%) the number of farms in England. Accounting for the number of farms in a scheme (assuming a farm was only in one scheme) and those not in scheme, the national level impacts of current uptake are reduced to just under a 6% reduction in sediment losses, 4% for phosphorus and 3% for nitrate.

There are some mitigation measures in Farmscoper’s measure library that are not linked to current scheme options with significant uptake, but which are effective at reducing diffuse pollution and could be suitable for including in an agri-environment scheme[9]. For example, ‘reduced cultivation’ or ‘use slurry injection’ could reduce pollutant losses by up to 5% if applied nationally. Incorporation of a few such measures in the schemes, but with 10% uptake, was predicted to increase the reductions achieved on land in scheme by around 1%. This increase is comparable to some of the other reductions mentioned (e.g. the changes in livestock on phosphorus), but as it is only 1% it still leaves the total reductions short of the 40% target.

Including additional land use change (10% reversion of arable land to woodland, 10% reduction in livestock and fertiliser to grassland) had larger impacts on annual average nitrate and phosphorus reductions, increasing the totals on land in scheme to 10-20%. However, if there are still roughly only half the farms in the country in scheme then overall national impacts are only 6-10%.

EIP23 states that Government’s new farming schemes are expected to support 65-80% of landowners and farmers to adopt nature friendly farming on at least 10-15% of their land by 2030, and established

[9] Not all measures in Farmscoper are suitable, as some are more strategic/policy focussed or could not easily be defined in a scheme, such as ‘improve livestock through breeding’.

an aim for 70% of agricultural land and holdings to be covered by new farming schemes by 2028. Currently 56% of farms are in an agri-environment scheme, which is just below the lower end of this range. However, the results of this project indicate that even 100% of farms being in the current schemes would not be sufficient to achieve the Environment Act targets in isolation.

One issue with the Environment Act targets is that they are blanket 40% reductions in nitrate, phosphorus and sediment, which do not take account of the level of change required in any specific catchment to meet water quality thresholds - this will be greater than 40% for some pollutants in some catchments, but in other catchments no change will be required. Thus, from a purely water quality perspective, it would be better to focus activity in those catchments where change is required, especially as the Farmscoper modelling indicates that a 40% reductions are not achievable under current or slightly modified agri-environment schemes.

To achieve the target reductions of 40% in agricultural nitrate, phosphorus and sediment losses, it will be necessary to make further changes to farm management, most likely including a reduction in inputs (fertiliser, livestock) given the difficulty in reducing nitrate losses in particular. However, there is the potential for other factors, such as R&D, 'lifestyle' choices or other external factors to contribute to the required reductions, particularly given the target date is over a decade away. The Climate Change Act has set a target to reach net zero by 2050 which will require significant changes in the agricultural sector (which contributes ~10% of UK GHG emissions). These net zero-driven changes may help to achieve the Environment Act targets for water quality, through improved management of livestock and manure.

5 GLOSSARY

AES	Agri-environment scheme	Umbrella term for any scheme that provides funding to land managers to farm in a way that supports biodiversity, enhances the landscape, or improves the quality of water, air or soil.
BSFP	British Survey of Fertiliser Practice	Annual survey of fertiliser use on farm holdings across Great Britain.
CS	Countryside Stewardship	Defra run scheme that supports land management to protect, restore and enhance the environment or contribute to the mitigation of climate change.
EA21	Environment Act 2021	The UK framework for environmental protection, replacing EU rules on nature protection, water quality, clean air and other environmental protections.
EIP	Environmental Improvement Plan	The government's plan for how to achieve the Environment Plan goals, Environment Act targets and other commitments. The EIP is reviewed and updated every 5 years, with the most recent version in 2023.
ES	Environmental Stewardship	Defra run scheme that pays farmers to deliver simple actions that benefit the environment.
FRfW	Farming Rules for Water	Common term for the 'Reduction and Prevention of Agricultural Diffuse Pollution (England) Regulations 2018', which were introduced to reduce and prevent diffuse water pollution from agricultural sources.
JAS	June Agricultural Survey	Defra annual survey of cropping, livestock and labour on farms in England.
LUC	Land Use Change	In this project it refers to conversion of arable land to woodland or grassland and also includes reductions in fertiliser and livestock.
NVZ	Nitrate Vulnerable Zone	Areas designated at being at risk from agricultural nitrate pollution. They cover about 55% of land in England.

RFT	Robust Farm Type	Farm system classification used in Defra surveys, based on the enterprise within the farm that contributes the most in terms of financial output.
SFI	Sustainable Farming Incentive	Defra run scheme that pays farmers and land managers to take up or maintain sustainable farming and land management practices.
WQ	Water Quality	In this project WQ refers to nitrate, phosphorus and sediment pollution of waterbodies.

6 APPENDIX

The main body of this report focusses on Farmscoper's predictions for nitrate, phosphorus and sediment. This appendix contains the data for the other pollutants/outcomes predicted by Farmscoper for all of the scenarios in the report, both nationally and for the specific farm/environmental combinations considered.

For brevity in the tables, only the scenario IDs are listed – for scenario titles and more detailed descriptions please refer to the main report, Table 2-5 and Section 2.3.

For the national result tables, the Cost data predicted by Farmscoper are presented as totals, in £ million. For the farm result tables, cost data are presented as £ ha^{-1} as this allows a more meaningful comparison between the farm types. Costs are not presented for Scenarios 7 and 10, as Farmscoper does not quantify the costs associated with the land use change within these scenarios.

Table 6-1 Annual Implementation costs (£ ha^{-1}), environmental benefits (£ ha^{-1}) and percentage reductions in the annual average pollutant load / service provision, by scenario, for the Cereal farm type, 900-1200 mm annual rainfall, artificially drained soil.

	Cost (£m)				Reduction in pollutant / service (%)										
	Capital Cost	Operational Cost	Total Cost	Environ. Benefit	Nitrate	Phosphorus	Sediment	Ammonia	Methane	Nitrous Oxide	PPPs	FIOs	Soil Carbon	Energy Use	Productivity
1	8.2	16.8	25.1	96.5	9.9	6.2	8.1	11.3	-0.1	10.8	15.7	1.5	-0.7	5.4	3.8
2	0.0	14.0	14.0	11.8	0.8	3.9	0.0	2.3	0.0	0.6	0.0	0.1	0.0	2.5	1.9
3	0.0	3.3	3.3	3.7	0.3	0.5	0.5	0.0	0.0	0.0	0.1	0.0	-0.1	0.1	0.4
4a	0.1	3.0	3.1	18.7	0.1	2.2	3.1	0.0	0.0	0.0	0.9	0.0	-0.2	0.0	0.0
4b	0.0	6.8	6.8	66.6	4.2	8.0	10.7	0.0	0.0	0.6	0.5	0.0	-0.5	-0.3	0.0
5a	4.3	10.1	14.4	27.2	0.8	3.0	4.0	0.6	0.0	0.7	1.4	0.0	-0.3	0.6	0.7
5b	0.3	11.1	11.4	69.9	4.5	8.2	11.0	0.4	0.0	1.0	0.8	0.0	-0.6	0.1	0.4
6a	5.9	13.0	19.0	30.4	1.0	3.4	4.3	0.8	0.0	0.9	1.7	0.4	-0.4	0.7	1.0
6b	0.4	13.1	13.5	72.2	4.6	8.4	11.2	0.5	0.0	1.1	1.0	0.0	-0.6	0.2	0.6
7a	*	*	*	*	1.4	3.4	4.3	2.0	6.5	1.7	1.7	6.9	-0.4	1.6	1.2
7b	*	*	*	*	5.1	8.5	11.2	1.7	6.5	1.9	1.0	6.5	-0.6	1.1	0.8
8a	8.0	18.7	26.7	39.5	1.5	4.3	5.6	1.1	-0.1	1.2	2.8	0.4	-0.5	1.0	1.6
8b	0.4	14.8	15.2	73.2	4.7	8.5	11.4	0.6	0.0	1.2	1.1	0.0	-0.6	0.3	0.8
9a	8.0	23.9	32.0	50.9	2.6	5.4	6.5	1.8	-0.1	2.4	2.6	0.4	-0.6	2.1	2.5
9b	6.2	19.4	25.6	85.3	5.7	9.5	12.4	1.3	0.0	2.4	0.9	0.0	-0.7	1.4	1.6
10a	*	*	*	*	11.5	13.2	14.2	11.6	10.0	12.0	12.4	10.4	-4.0	11.8	12.3
10b	*	*	*	*	14.3	16.9	19.6	11.2	10.0	11.9	10.8	10.0	-4.1	11.1	11.4

* Costs not included for scenarios featuring land use change

Table 6-2 Annual Implementation costs (£ ha^{-1}), environmental benefits (£ ha^{-1}) and percentage reductions in the annual average pollutant load / service provision, by scenario, for the Cereal farm type, 600-700 mm annual rainfall, freely draining soil.

	Cost (£m)				Reduction in pollutant / service (%)										
	Capital Cost	Operational Cost	Total Cost	Environ. Benefit	Nitrate	Phosphorus	Sediment	Ammonia	Methane	Nitrous Oxide	PPPs	FIOs	Soil Carbon	Energy Use	Productivity
1	8.1	55.8	63.9	34.5	7.4	13.4	22.6	12.6	-0.1	8.7	30.8	14.8	-0.1	3.2	7.6
2	0.0	9.3	9.3	6.9	0.1	1.0	0.0	1.6	0.0	0.2	0.0	0.0	0.0	2.0	1.6
3	0.0	-0.1	-0.1	0.6	0.5	0.0	0.1	0.0	0.0	0.1	0.0	0.2	0.0	0.1	0.1
4a	0.1	3.0	3.1	2.5	0.1	9.8	23.0	0.0	0.0	0.0	0.5	0.0	-0.1	0.0	0.0
4b	0.0	1.7	1.7	0.3	1.8	0.9	2.5	0.0	0.0	0.3	0.0	0.0	0.0	-0.3	0.0
5a	4.3	10.1	14.4	6.0	0.7	12.0	27.4	0.6	0.0	0.7	0.7	0.1	-0.3	0.5	0.6
5b	0.3	6.0	6.3	2.4	2.2	2.1	5.1	0.4	0.0	0.7	0.1	0.0	-0.1	0.0	0.4
6a	5.9	13.0	19.0	7.2	1.0	13.1	29.1	0.9	0.0	0.9	0.7	5.2	-0.3	0.7	1.0
6b	0.4	8.0	8.4	3.3	2.4	3.1	7.2	0.5	0.0	0.8	0.2	0.0	-0.1	0.1	0.5
7a	*	*	*	*	1.3	13.2	29.1	2.0	6.5	1.7	0.7	11.4	-0.3	1.6	1.2
7b	*	*	*	*	2.7	3.2	7.2	1.7	6.5	1.6	0.2	6.5	-0.1	1.0	0.7
8a	8.0	18.2	26.2	8.5	1.6	13.7	30.5	1.0	-0.1	1.1	1.1	5.5	-0.3	0.9	1.5
8b	0.4	9.7	10.1	3.7	2.4	3.4	8.0	0.6	0.0	0.9	0.2	0.0	-0.2	0.2	0.7
9a	8.0	24.4	32.4	12.0	1.8	14.2	30.7	1.7	-0.1	1.9	1.2	5.5	-0.3	1.6	2.2
9b	6.2	15.2	21.4	7.3	2.7	3.9	8.1	1.3	0.0	1.6	0.3	0.1	-0.2	0.9	1.3
10a	*	*	*	*	11.2	21.2	36.5	11.5	10.0	11.6	11.1	14.9	-3.9	11.3	12.0
10b	*	*	*	*	12.0	11.9	15.9	11.2	10.0	11.4	10.3	10.1	-3.7	10.7	11.2

* Costs not included for scenarios featuring land use change

Table 6-3 Annual Implementation costs (£ ha^{-1}), environmental benefits (£ ha^{-1}) and percentage reductions in the annual average pollutant load / service provision, by scenario, for the Lowland Grazing farm type, 900-1200 mm annual rainfall, artificially drained soil.

	Cost (£m)				Reduction in pollutant / service (%)										
	Capital Cost	Operational Cost	Total Cost	Environ. Benefit	Nitrate	Phosphorus	Sediment	Ammonia	Methane	Nitrous Oxide	PPPs	FIOs	Soil Carbon	Energy Use	Productivity
1	28.7	62.8	91.6	27.8	7.8	6.2	5.7	-2.5	-0.2	5.5	18.3	8.6	-0.4	2.6	-0.1
2	0.0	3.3	3.3	9.4	4.8	5.0	0.0	0.5	0.0	3.1	0.0	0.4	0.0	0.8	0.1
3	0.0	2.4	2.4	1.7	0.2	0.4	0.7	0.0	0.0	0.0	0.9	0.0	-0.1	0.0	0.1
4a	0.0	0.3	0.3	2.6	0.0	0.4	1.1	0.0	0.0	0.0	0.7	0.0	-0.7	0.0	0.0
4b	0.0	2.6	2.6	34.8	3.0	6.5	14.5	0.0	0.0	0.2	2.2	0.0	-0.2	-0.3	0.0
5a	3.9	8.7	12.6	4.4	0.2	0.7	1.5	0.1	0.0	0.1	1.2	0.0	-1.6	0.4	0.0
5b	0.2	6.1	6.4	35.4	3.1	6.6	14.6	0.0	0.0	0.3	2.5	0.0	-0.8	-0.1	0.0
6a	13.8	11.4	25.1	5.6	0.5	1.2	1.8	0.1	0.0	0.2	1.4	1.4	-1.9	0.5	0.1
6b	0.3	10.2	10.5	35.9	3.1	6.7	14.7	0.1	0.0	0.3	2.6	0.0	-1.0	0.0	0.0
7a	*	*	*	*	8.1	3.6	1.8	7.6	6.5	8.4	1.4	7.8	-1.9	11.4	6.4
7b	*	*	*	*	10.6	8.9	14.7	7.6	6.5	8.5	2.6	6.5	-1.0	10.9	6.3
8a	15.8	20.6	36.4	6.8	0.7	1.6	2.5	-0.5	-0.1	0.4	2.2	1.4	-2.0	0.5	0.1
8b	0.4	13.6	13.9	36.3	3.2	6.8	14.8	0.1	0.0	0.4	2.7	0.0	-1.3	0.1	0.0
9a	15.8	26.7	42.5	7.9	1.0	2.0	2.7	-0.3	-0.1	0.3	2.0	1.5	-2.1	0.7	0.1
9b	5.8	19.8	25.6	37.2	3.4	7.1	15.0	0.2	0.0	0.3	2.5	0.1	-1.3	0.3	0.0
10a	*	*	*	*	10.0	6.6	5.0	9.7	9.9	10.0	11.1	11.3	-2.5	8.8	10.1
10b	*	*	*	*	12.2	11.2	16.0	10.2	10.0	10.0	11.5	10.1	-1.6	8.4	10.0

* Costs not included for scenarios featuring land use change

Table 6-4 Annual Implementation costs (£ ha^{-1}), environmental benefits (£ ha^{-1}) and percentage reductions in the annual average pollutant load / service provision, by scenario, for the Lowland Grazing farm type, 600-700 mm annual rainfall, freely draining soil.

	Cost (£m)				Reduction in pollutant / service (%)										
	Capital Cost	Operational Cost	Total Cost	Environ. Benefit	Nitrate	Phosphorus	Sediment	Ammonia	Methane	Nitrous Oxide	PPPs	FIOs	Soil Carbon	Energy Use	Productivity
1	28.3	64.0	92.3	14.5	7.7	29.3	22.8	-2.1	-0.2	5.8	32.8	33.7	-0.2	2.4	0.6
2	0.0	5.8	5.8	4.6	0.3	1.7	0.0	0.2	0.0	2.3	0.0	0.1	0.0	0.6	0.1
3	0.0	0.4	0.4	0.1	0.1	0.1	0.3	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
4a	0.0	0.3	0.3	0.2	0.0	0.7	4.0	0.0	0.0	0.0	0.3	0.0	-0.7	0.0	0.0
4b	0.0	0.3	0.3	0.1	1.2	0.4	2.6	0.0	0.0	0.1	0.0	0.0	0.0	-0.3	0.0
5a	3.9	8.7	12.6	1.1	0.2	0.9	4.9	0.1	0.0	0.1	0.3	0.0	-1.6	0.4	0.0
5b	0.2	3.9	4.1	0.6	1.3	0.5	3.1	0.0	0.0	0.2	0.1	0.0	-0.6	-0.1	0.0
6a	13.8	11.0	24.8	1.7	0.4	6.9	5.7	0.1	0.0	0.2	0.4	10.8	-1.9	0.5	0.0
6b	0.3	7.9	8.2	0.8	1.3	0.6	3.6	0.1	0.0	0.2	0.1	0.0	-0.8	0.0	0.0
7a	*	*	*	*	6.2	10.3	5.7	7.6	6.5	8.2	0.4	16.6	-1.9	11.3	6.4
7b	*	*	*	*	7.0	4.3	3.6	7.6	6.5	8.2	0.1	6.5	-0.8	10.9	6.4
8a	15.8	20.2	36.0	1.3	0.7	7.5	7.2	-0.5	-0.1	0.4	0.5	11.0	-1.9	0.6	0.1
8b	0.4	11.3	11.7	1.0	1.4	0.7	3.8	0.1	0.0	0.2	0.1	0.0	-1.0	0.1	0.0
9a	15.8	20.8	36.7	1.7	0.7	7.6	7.2	-0.3	-0.1	0.4	0.6	11.0	-2.1	0.7	0.1
9b	5.8	12.0	17.9	1.3	1.4	0.8	4.0	0.2	0.0	0.3	0.2	0.1	-1.0	0.2	0.0
10a	*	*	*	*	8.5	13.0	8.3	9.7	9.9	10.0	9.6	19.9	-2.4	8.7	10.1
10b	*	*	*	*	9.1	6.9	5.3	10.2	10.0	9.9	9.2	10.0	-1.4	8.3	10.0

* Costs not included for scenarios featuring land use change

Table 6-5 Annual Implementation costs (£ ha^{-1}), environmental benefits (£ ha^{-1}) and percentage reductions in the annual average pollutant load / service provision, by scenario, for the Dairy farm type, 900-1200 mm annual rainfall, artificially drained soil.

	Cost (£m)				Reduction in pollutant / service (%)										
	Capital Cost	Operational Cost	Total Cost	Environ. Benefit	Nitrate	Phosphorus	Sediment	Ammonia	Methane	Nitrous Oxide	PPPs	FIOs	Soil Carbon	Energy Use	Productivity
1	95.4	47.9	143.2	142.9	9.5	9.2	8.6	1.9	3.1	8.3	15.0	19.1	-0.5	2.5	-0.3
2	0.0	-16.2	-16.2	41.0	8.1	8.9	0.0	0.5	0.0	7.3	0.0	3.2	0.0	1.0	0.1
3	0.0	5.7	5.7	2.6	0.2	0.4	0.7	0.0	0.0	0.0	1.0	0.0	-0.1	0.0	0.1
4a	0.0	0.8	0.8	7.7	0.0	0.7	2.3	0.0	0.0	0.0	0.8	0.0	-0.7	0.0	0.0
4b	0.0	5.8	5.8	72.1	3.1	8.3	21.4	0.0	0.0	0.2	1.7	0.0	-0.5	-0.3	0.0
5a	4.2	9.5	13.7	11.9	0.2	1.0	3.0	0.0	0.0	0.1	1.4	0.0	-1.4	0.3	0.0
5b	0.3	9.7	10.0	73.6	3.2	8.4	21.5	0.0	0.0	0.3	2.1	0.0	-1.0	0.0	0.0
6a	13.0	12.7	25.7	14.7	0.5	1.7	3.4	0.0	0.0	0.3	1.7	4.6	-1.6	0.5	0.0
6b	0.3	13.6	13.9	74.5	3.2	8.4	21.6	0.0	0.0	0.3	2.2	0.0	-1.2	0.0	0.0
7a	*	*	*	*	8.2	5.1	3.4	7.1	6.5	8.4	1.7	10.9	-1.6	10.8	6.4
7b	*	*	*	*	10.7	11.6	21.6	7.0	6.5	8.5	2.2	6.5	-1.2	10.4	6.4
8a	15.2	30.0	45.2	12.4	0.7	2.1	4.2	-0.8	-0.2	0.4	2.7	4.9	-1.7	0.5	0.1
8b	0.4	16.9	17.3	75.1	3.3	8.5	21.6	0.0	0.0	0.4	2.3	0.0	-1.4	0.1	0.0
9a	15.2	38.4	53.7	16.7	1.2	3.5	4.5	-0.3	-0.2	0.3	2.5	5.4	-1.8	0.7	0.1
9b	6.2	25.3	31.5	79.0	3.7	9.8	21.9	0.5	0.0	0.3	2.2	0.6	-1.4	0.3	0.0
10a	*	*	*	*	10.6	10.3	9.1	9.7	9.8	10.1	12.1	14.9	-2.9	10.0	10.1
10b	*	*	*	*	12.9	16.0	24.7	10.5	10.0	10.1	11.8	10.5	-2.4	9.6	10.0

* Costs not included for scenarios featuring land use change

Table 6-6 Annual Implementation costs (£ ha^{-1}), environmental benefits (£ ha^{-1}) and percentage reductions in the annual average pollutant load / service provision, by scenario, for the Dairy farm type, 600-700 mm annual rainfall, freely draining soil.

	Cost (£m)				Reduction in pollutant / service (%)										
	Capital Cost	Operational Cost	Total Cost	Environ. Benefit	Nitrate	Phosphorus	Sediment	Ammonia	Methane	Nitrous Oxide	PPPs	FIOs	Soil Carbon	Energy Use	Productivity
1	95.9	49.0	145.0	115.5	9.0	38.3	22.5	2.2	3.1	9.2	30.1	45.2	-0.2	2.5	0.1
2	0.0	0.6	0.6	22.7	0.6	3.5	0.0	0.2	0.0	5.7	0.0	0.6	0.0	0.6	0.0
3	0.0	1.0	1.1	0.2	0.1	0.1	0.4	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
4a	0.0	0.8	0.8	0.7	0.0	1.2	10.2	0.0	0.0	0.0	0.5	0.0	-0.7	0.0	0.0
4b	0.0	0.7	0.7	0.1	1.1	0.6	5.1	0.0	0.0	0.1	0.0	0.0	0.0	-0.2	0.0
5a	4.2	9.5	13.7	2.9	0.2	1.5	12.1	0.0	0.0	0.1	0.6	0.0	-1.4	0.3	0.0
5b	0.3	4.6	4.9	1.4	1.2	0.7	6.0	0.0	0.0	0.2	0.1	0.0	-0.5	0.0	0.0
6a	13.0	11.9	25.0	4.4	0.4	9.5	13.4	0.0	0.0	0.3	0.7	17.0	-1.7	0.5	0.0
6b	0.3	8.5	8.8	2.0	1.2	0.8	7.1	0.0	0.0	0.2	0.2	0.0	-0.7	0.1	0.0
7a	*	*	*	*	6.7	13.8	13.4	7.0	6.5	8.2	0.7	22.4	-1.7	10.8	6.4
7b	*	*	*	*	7.4	5.5	7.1	7.0	6.5	8.2	0.2	6.5	-0.7	10.4	6.4
8a	15.2	29.1	44.4	-0.5	0.6	10.3	14.8	-0.8	-0.2	0.4	1.0	17.4	-1.7	0.5	0.1
8b	0.4	11.8	12.2	2.4	1.2	0.9	7.5	0.0	0.0	0.2	0.2	0.0	-0.9	0.1	0.0
9a	15.2	33.0	48.3	1.6	0.6	10.7	14.8	-0.3	-0.2	0.4	1.1	17.5	-1.8	0.6	0.1
9b	6.2	15.6	21.9	4.5	1.2	1.3	7.7	0.5	0.0	0.3	0.3	0.1	-0.9	0.2	0.0
10a	*	*	*	*	9.8	17.7	17.5	9.7	9.8	10.2	10.7	25.7	-2.9	9.9	10.1
10b	*	*	*	*	10.4	9.3	10.9	10.5	10.0	10.1	10.1	10.1	-2.0	9.6	10.0

* Costs not included for scenarios featuring land use change

Table 6-7 Annual Implementation costs (£m), environmental benefits (£m) and percentage reductions in the national annual average pollutant load / service provision, by scenario, assuming that all farms in England were under the management of that scenario.

	Cost (£m)				Reduction in pollutant / service (%)										
	Capital Cost	Operational Cost	Total Cost	Environ. Benefit	Nitrate	Phosphorus	Sediment	Ammonia	Methane	Nitrous Oxide	PPPs	FIOs	Soil Carbon	Energy Use	Productivity
1	194.3	288.1	482.4	531.0	10.0	10.5	11.5	6.2	1.4	8.3	21.0	12.3	-0.3	4.3	2.8
2	0.2	47.5	47.7	107.1	1.3	4.6	0.0	0.8	0.0	3.0	0.0	1.3	0.0	1.8	0.8
3	0.0	23.1	23.1	10.7	0.4	0.4	0.6	0.0	0.0	0.1	0.2	0.1	0.0	0.1	0.3
4a	0.4	15.5	15.9	67.1	0.1	3.0	5.6	0.0	0.0	0.0	1.0	0.1	-0.4	0.0	0.0
4b	0.0	38.9	38.9	184.9	4.6	8.9	14.3	0.0	0.0	0.5	0.5	0.1	-0.2	-0.4	0.0
5a	36.2	82.9	119.1	100.3	0.5	3.7	6.8	0.1	0.0	0.4	1.4	0.1	-0.9	0.5	0.3
5b	2.2	73.6	75.9	201.4	4.8	9.1	14.8	0.1	0.0	0.8	0.7	0.1	-0.4	-0.1	0.2
6a	74.9	108.2	183.1	114.6	0.7	4.6	7.4	0.2	0.0	0.5	1.6	2.7	-1.0	0.6	0.5
6b	3.0	99.3	102.3	210.5	4.9	9.4	15.2	0.1	0.0	0.8	0.9	0.1	-0.6	0.0	0.2
7a	*	*	*	*	3.3	5.7	7.4	4.5	6.3	4.5	1.6	8.8	-1.0	5.2	2.9
7b	*	*	*	*	7.3	10.4	15.2	4.4	6.3	4.9	0.9	6.3	-0.6	4.7	2.7
8a	93.2	175.4	268.5	129.5	1.2	5.3	8.5	-0.2	-0.1	0.7	2.6	2.9	-1.1	0.8	0.8
8b	3.3	121.4	124.6	215.3	5.0	9.5	15.4	0.1	0.0	0.9	0.9	0.1	-0.7	0.1	0.3
9a	93.2	214.1	307.3	165.2	1.7	6.1	9.2	0.2	-0.1	1.2	2.6	3.0	-1.2	1.5	1.2
9b	53.0	157.3	210.3	252.0	5.4	10.3	16.2	0.5	0.0	1.3	0.9	0.2	-0.7	0.8	0.6
10a	*	*	*	*	9.4	12.5	15.4	7.3	9.4	9.4	12.1	12.3	-3.3	10.5	8.0
10b	*	*	*	*	12.8	16.3	21.7	7.6	9.5	9.6	10.6	9.7	-2.8	9.9	7.5

* Costs not included for scenarios featuring land use change

Table 6-8 Annual Implementation costs (£m), environmental benefits (£m) and percentage reductions in the national annual average pollutant load / service provision, by scenario, accounting for the proportion of farms in CS and SFI.

	Cost (£m)				Reduction in pollutant / service (%)										
	Capital Cost	Operational Cost	Total Cost	Environ. Benefit	Nitrate	Phosphorus	Sediment	Ammonia	Methane	Nitrous Oxide	PPPs	FIOs	Soil Carbon	Energy Use	Productivity
1	194.3	288.1	482.4	531.0	10.0	10.5	11.5	6.2	1.4	8.3	21.0	12.3	-0.3	4.3	2.8
2	0.2	47.5	47.7	107.1	1.3	4.6	0.0	0.8	0.0	3.0	0.0	1.3	0.0	1.8	0.8
3	0.0	23.1	23.1	10.7	0.4	0.4	0.6	0.0	0.0	0.1	0.2	0.1	0.0	0.1	0.3
4	0.2	12.8	13.0	58.3	0.8	2.7	4.7	0.0	0.0	0.1	0.5	0.0	-0.2	-0.1	0.0
5	14.9	45.7	60.5	74.4	1.0	3.0	5.2	0.1	0.0	0.3	0.7	0.1	-0.4	0.2	0.1
6	30.5	60.2	90.6	81.6	1.1	3.4	5.5	0.1	0.0	0.3	0.8	1.1	-0.5	0.3	0.2
7	*	*	*	*	2.6	4.0	5.5	2.6	3.6	2.6	0.8	4.6	-0.5	2.9	1.6
8	37.8	90.8	128.6	88.4	1.3	3.7	6.0	0.0	0.0	0.4	1.2	1.2	-0.5	0.3	0.4
9	46.3	112.4	158.7	108.9	1.6	4.2	6.4	0.2	0.0	0.7	1.2	1.2	-0.6	0.7	0.6
10	*	*	*	*	5.9	7.8	9.8	4.2	5.4	5.4	6.6	6.6	-1.8	5.9	4.5

* Costs not included for scenarios featuring land use change