

Report



Application of FARMSCOOPER tool in the Clun catchment – Summary report

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1 Introduction

ADAS have been contracted by the Shropshire Hills AONB Partnership, in a project funded by Natural England, to undertake a series of six farm visits in early 2015 to apply the FARMSCOPER tool in the Clun catchment. Farmers willing to participate have been identified through close discussions with the local NFU branch, and the project organisers are grateful to all participants for their time.

Background

High nutrient and sediment loads have been identified as major causes of degradation of the River Clun and its tributaries. The lower reaches of the River Clun have been designated as a European Special Area of Conservation (SAC) for the protection of a population of freshwater pearl mussels, which are threatened by the decline in water quality and condition of the habitat.

In the River Clun Nutrient Management Plan (October 2014), diffuse pollution from agriculture was identified as a key source with farm livestock estimated to be the largest sources of phosphate and arable land being the third largest source. 92-99% of the nitrogen is estimated to be from agricultural sources and agriculture is also considered to be the source of the majority of the silt carried into the Clun.

The Plan identified a range of potential measures to restore the river to a more favourable status, and actions to help reduce pollutants from agriculture are a key part of the plan. FARMSCOPER, a Defra-funded tool designed to determine the likely cost-effectiveness of farm scale mitigation implementation, was used to identify the priority measures for reduction of diffuse pollution from agriculture and to estimate the potential reduction in pollutants that could be achieved. The tool was applied to two broad farm types for the Clun catchment – upland grazing and lowland arable, and the top five mitigation measures were identified in turn for reduction of nitrate, phosphate and sediment for these two generalised farm types. The modelling exercise for the whole catchment indicated significant potential improvement in phosphate and sediment losses from applying the “top 5” measures, but limited scope for reduction in nitrogen levels.

FARMSCOPER was initially developed for the assessment of government policy on water quality. It was designed to operate at farm-scale in order to produce results that were auditable and understandable by users. The tool contains a number of assumptions based on typical practice (e.g. the National Farm Practice Survey) and reflects average management across a range of farms in a given area, rather than accurately representing a specific farm.

2 Objectives

2.1 Overall aim

This project aims to refine the approach applied at catchment scale (using the two broad farm types) by assessing the priority mitigation measures applicable to cropping and stocking systems at individual farm level, for a greater variety of farm types in the catchment. Six farms were visited across different locations, farm sizes and types in the catchment and with farmers who have voluntarily agreed to take part. The project however treats each farm individually and they are not intended as a sample from which generalisations regarding farming practices in the whole catchment can be drawn. The overall objective was to use FARMSCOPER to identify appropriate mitigation methods with which to progress the objectives of the Clun Nutrient Management Plan. These were compared to those identified from a survey of the farm when the farm infrastructure and fields were walked. This required information to be provided at individual farm level to raise awareness of the specific problems and encourage change in practices to reduce the risk of diffuse pollution.

2.2 Specific objectives for the farm visits

To identify the mitigation measures most applicable to a particular farm and discuss these with the farmer, including their practicality and costs.

To assess and discuss how appropriate the results of FARMSCOPER are for those farms, to identify the mitigation measures most applicable and to discuss the relevance of their implementation with the farmer, including their practicality and costs.

2.3 Reporting

The reports from individual farms have been made available to the AONB Partnership as commissioning body, to Natural England as the funder and to Environment Agency as the lead for the Nutrient Management Plan. They will not be made publicly available unless information is requested under the Freedom of Information Act or Environmental Information Regulations. This summary report with much more limited information about the participating farms will be published following consultation with the farmers. This focuses on overall lessons about measures relevant to the catchment and use of the FARMSCOPER model and not on the specific farms.

3 Method

The farms were visited in order to record the details of enterprises for FARMSCOPER and to inform decisions about the likely level of risk and extent of diffuse pollution. The farm details were recorded and keyed into FARMSCOPER during the farm visit in participation with each farmer. FARMSCOPER was then run to provide an estimate of both the current level of pollution and the potential pollution reductions and the likely costs associated with mitigation methods. In order to compare the theoretical recommendations with practical observation, a field inspection was carried out on the same day to assess issues such as slope, soil management and risk levels around farm tracks or feeding areas for example.

This field inspection also assessed existing levels of implementation of mitigation methods. The likely effectiveness of the selected methods were linked to the overall resource protection potential. Photographs were taken to show the condition of the farm and to record any relevant features.

Each farmer received a written report of the FARMSCOPER output and details from the farm walk with photographs of noted features, illustrating different levels of practice. A general description of each farm was included in the report together with an OS based farm map showing the farm area, local features and contours. Where relevant, text boxes were included to highlight specific issues.

The top five FARMSCOPER mitigation methods for nitrogen, phosphorus and sediment were highlighted along with their cost and whether they were already implemented on the farm. Additional details of recommended methods were included to provide further details when they may be put into practice.

The general characteristics of the six farms visited are set out below:

In all cases, soils are mainly medium to light sandy loams overlying stony sub soils with an annual rainfall of approximately 800mm. Whilst rainfall total is similar, there will be local variation in rainfall quantity, intensity and timing, and also local variation in soils according to slope, elevation, etc.

1. 63ha upland livestock farm, mostly permanent pasture with some arable (spring oats). Previously, potatoes have been grown, but this crop is now discontinued due to issues over soil erosion and the difficulty of access for large machinery. The land includes many slopes, but few watercourses. The farm is run extensively on a relatively low input system.
2. 160ha upland livestock farm. The land is all down to grass, being 145ha permanent pasture and 15ha rotational grass. The main enterprise is beef cattle, comprising 49 suckler cows and progeny, 48 yearlings and 49 calves. The land includes many slopes, but few watercourses. The farm is run extensively on a relatively low input system.
3. 174ha lowland arable and livestock farm. The arable crops occupy just over 50% of the land, with grass being predominantly permanent pasture, with some ley grass. Arable cropping includes winter wheat for milling, spring barley and winter oilseed rape. Much of the farm is relatively steeply sloping, especially to the north. There is a high level of soil management.
4. 168ha lowland mixed farm, comprising extensive permanent pasture that is grazed by cattle and sheep, plus 12 ha of temporary grass and some 67 ha of arable land. The cropping includes winter cereals (wheat, barley and oats), spring barley, maize, fodder beet, stubble turnips and forage rape. Some grassland is adjacent to river channels and riparian fencing and management has been carried out. However, there are no arable fields alongside the major watercourses.
5. 203ha lowland farm consisting of winter cereals with some stock. Cropping comprises winter wheat (milling), winter oats, winter barley (malting), winter oilseed rape and some permanent pasture under a stewardship agreement. Potatoes are generally grown on the farm, but not in the current season. There are few watercourses across the farm, but some frontage of the River Clun as permanent pasture which is fenced with drinking bays. The steepest slopes are also kept in permanent pasture. Numerous measures to prevent water erosion and minimise soil losses are routinely implemented.

6. 160ha upland livestock farm, mostly permanent pasture with some arable (spring oats). The land includes extensive slopes, but few watercourses. A number of steep uneven fields in permanent pasture drain directly into a tributary of the River Clun with springs evident. Some riparian fencing has been carried out.

4 Results

4.1 Mitigation methods suggested by FARMSCOPER

FARMSCOPER presents mitigation methods in order of efficacy and cost, with the ability to separate by pollutant. For the purposes of this study, the focus was on nitrogen, phosphorus and sediment. In order to make a fair comparison with the Nutrient Management Plan on any given farm, it was assumed that no mitigation was currently in place. This enabled the level of implementation already in place to be highlighted and the suitability of methods suggested by FARMSCOPER to be assessed.

For each pollutant - nitrogen, phosphorus and sediment, the FARMSCOPER top five methods were recorded. Whilst this gave a potential of 15 methods, many were common, particularly to phosphorus and sediment, so on one farm, the number of methods recommended was never 15.

In most cases, the FARMSCOPER results were relatively similar since the less costly and more effective methods are likely to be at the top of the list, and soils and climate were similar. Nitrogen reducing methods can be different from phosphorus and sediment reducing methods since the latter two are closely linked.

From the six farms entered into FARMSCOPER, a total of 24 mitigation methods were recommended from once to a total of 13 times and this is shown in the table below.

Some measures are mutually exclusive e.g. establish cover crops in the autumn, leave overwinter stubbles, cultivate land for crops in spring rather than autumn, but the analysis looked at individual measures, so each was shown on its own merit. Theoretical Nutrient and Sediment losses calculated by FARMSCOPER were included.

The methods recommended ranged from those that saved money to others which were at a significant cost. However, FARMSCOPER calculated the worst case scenario and in practice, costs may not be so high. For example, in 'Use dry-cleaning techniques to remove solid waste from yards prior to cleaning' it is assumed to be used daily on outdoor feeding areas. In practice where it is recommended on any of the farms in the study, it would be appropriate to use it occasionally, due to the management practices of those farms, thereby reducing the costs significantly.

A further example would be 'Uncropped cultivated areas', the costs of which on one farm would have been over £10,000. Whilst this measure provides a buffer between cropped cultivated areas and watercourses, the economic result is a loss of crop, which would not be acceptable in this case. Further, on these soil types which tend to be unstable, there may be consequences for erosion.

Mitigation methods recommended by on-farm FARMSCOPER runs and their frequency

No of inclusions	FARMSCOPER method number	FARMSCOPER Mitigation Method	In NMP?
13	4	Establish cover crops in the autumn	
9	110	Uncropped cultivated areas	Yes
7	106	Plant areas of farm with wild bird seed/nectar flower mixtures	Yes
6	7	Adopt reduced cultivation systems	
	14	Establish riparian buffer strips	
5	6	Cultivate land for crops in spring rather than autumn	
	15	Loosen compacted soil layers in grassland fields	Yes
	113	Undersown spring cereals	
4	76	Fence off rivers and streams from livestock	Yes
	119	Use dry-cleaning techniques to remove solid waste from yards prior to cleaning	Yes
3	8	Cultivate compacted tillage soils	Yes
	13	Establish in-field grass buffer strips	Yes
	20	Use plants with improved nitrogen use efficiency	
	35	Reduce the length of the grazing day/grazing season	Yes
2	22	Use a fertiliser recommendation system	
	57	Minimise the volume of dirty water produced	Yes
	115	Leave over winter stubbles	
	120	Capture of dirty water in the dirty water store	Yes
1	37	Reduce field stocking rates when soils are wet	
	38	Move feeders at regular intervals	Yes
	78	Re-site gateways away from high-risk areas	Yes
	81	Establish and maintain artificial wetlands - steading runoff	Yes
	114	Management of grassland field corners	

In all cases, a number of the recommended mitigation methods were already implemented, whether consciously or not. This is because many of the FARMSCOPER mitigation methods are in fact 'best management practice' and likely to be taken up routinely by diligent farmers. Others are less obvious and may be implemented, but perhaps not in the most effective manner. An example of the former would be integrating organic and purchased fertiliser applications, which is increasingly routine practice. Of the latter, installation of field margins is increasingly common, but they may not be placed nor orientated or managed to best advantage.

The number of methods already implemented ranged from three to five. For some methods, they were implemented on one or two farms, but 'Cultivate land for crops in spring rather than autumn' was implemented on four farms.

Frequency of prior implementation of recommended FARMSCOPER methods

Frequency	No.	Measure name	NMP top 5
4	6	Cultivate land for crops in spring rather than autumn	
2	4	Establish cover crops in the autumn	
2	7	Adopt reduced cultivation systems	
2	14	Establish riparian buffer strips	
2	35	Reduce the length of the grazing day/grazing season	
2	115	Leave over winter stubbles	
1	20	Use plants with improved nitrogen use efficiency	
1	22	Use a fertiliser recommendation system	
1	38	Move feeders at regular intervals	
1	76	Fence off rivers and streams from livestock	Yes
1	81	Establish and maintain artificial wetlands - steading runoff	Yes
1	106	Plant areas of farm with wild bird seed/nectar flower mixtures	Yes
1	119	Use dry-cleaning techniques to remove solid waste from yards prior to cleaning	Yes
1	120	Capture of dirty water in the dirty water store	Yes

Whilst the FARMSCOPER runs were carried out assuming no prior implementation of measures, it is interesting to see how this compares with reality, where 14 of the 24 recommended 'top five' methods are already in operation to some extent. There was some current implementation on the farms visited of measures recommended in the NMP (right hand column), but also of measures not featuring in the NMP as 'top five' measures. (Note that current implementation will also include some measures not ranked in the top five and therefore not appearing in lists in the NMP or through this project).

Other methods which were recommended were often not applicable for a number of reasons. The most common of these was because they were mutually exclusive e.g.

- Establish cover crops in the autumn
- Cultivate land for crops in spring rather than autumn
- Leave over winter stubbles

Others were expensive, such as ‘uncropped cultivated areas’ or not appropriate, for example, ‘re-site gateways away from high-risk areas’. This is often required where a row of fields share a track onto which their gateways open, or where a track follows through a series of gateways in line on a slope. This arrangement can create long unbroken pathways for run-off leading to significant losses. This was not found to be the case on any of the farms visited.

For others, uptake is unlikely unless management changes. Examples of these methods are ‘under sown spring cereals’, where in many cases, although a spring cereal may be grown, it was not due to be followed by rotational ley grass.

With regard to costs, some are negative value indicating a saving, for example, integration of organic manure and purchased fertiliser. There may be options in the new Countryside Stewardship which provide support for some methods, but they have not been announced at the time of writing.

As a result of the farm walks, some practices will be curtailed on some farms, for example power harrowing and leaving feeders in the same place for long periods.

The following measures identified by FARMSOPER as top five measures in the six visits were not highlighted in the Nutrient Management Plan as top five measures for the two broad farm types:

Ref	Measure name	N	P	Sediment
4	Establish cover crops in the autumn	Y	Y	Y
14	Establish riparian buffer strips		Y	Y
113	Undersown spring cereals	Y	Y	
7	Adopt reduced cultivation systems	Y	Y	Y
6	Cultivate land for crops in spring rather than autumn	Y	Y	
20	Use plants with improved nitrogen use efficiency	Y		
67	Manure spreader calibration	Y		
115	Leave overwinter stubbles	Y		
37	Reduce field stocking rates when soils are wet			Y
114	Management of grassland field corners	Y		
22	Use a fertiliser recommendation system	Y		

The model contains a large number of measures (currently well over 100), and these are quite specific so it is unsurprising that some ‘new’ measures are identified when working at the scale of the individual farm. Operating at this level of detail does enable a greater degree of accuracy of identifying the best measures to take, but takes time and money. The measures identified in the NMP do provide a sound basis for promoting good farming practices, and those identified in this report for the farm types may in addition provide a useful level of detail which may be applicable to other similar farms. Appendix 2 shows the breakdown and ranking of the top five measures identified for each farm visited.

The findings do illustrate, however, the differences between catchment scale and farm scale recommendations and the great range of factors that can influence diffuse pollution risk at the field level, hence the need for careful interpretation in both temporal and spatial issues.

From this work, it can be seen that even on a predominantly grazing farm, a small area of arable land can be the most significant part of the farm in terms of nutrient and sediment loss depending on the cropping pattern. Measures relating to arable activity were more commonly recommended by FARMSCOOPER than livestock related measures, especially for nitrate and to a lesser extent for sediment even in the case of only a small proportion of arable. The exception is Phosphate reduction measures which are quite focussed towards livestock operations, except on the farms with a real predominance of arable.

However, much depends on the individual management of enterprises and this is the key area of interpretation required for FARMSCOOPER output. Where for example, catch crops can reduce run-off risk until they are utilised. The level at which risk increases will depend on the catch crop and how it is utilised. For example, leafy crops such as forage rape can be utilised relatively quickly, meaning treading by stock is minimised. However, at the other end of the scale, fodder beet, which is a hard, deep rooted crop takes a lot of time to eat, increasing the treading by stock and the risk of run-off in the event of a high rainfall event, particularly on sloping fields. The method of grazing is also relevant where set stocking a field spreads out the stock, but strip grazing will focus activity on a small area. This is particularly important in this area of inherently unstable soils and often significant slopes.

The one farm with livestock only matched closely in terms of profile of measures recommended to the NMP's 'upland grazing' type farm. The NMP's 'lowland arable' type was matched closely for sediment measures by most of the farms visited, but less so for nitrate, with additional measures highlighting timing of operations being more prominent (seeking to avoid bare soils over winter).

4.2 Photographs illustrating measures and issues observed



The photograph left shows a fodder crop in the process of grazing. Although this field is relatively flat, the lack of cover is likely to be of particular risk. The type of crop varies and leafy crops are less likely to lead to damage. Using set stocking may help and alternative management approaches can be used.



The picture on the left shows a field cultivated and drilled across the slope with no signs of run-off and very good soil structure.



The picture on the left shows a field where maize has been harvested, leaving a moderately trafficked surface, vulnerable to run-off, although this particular field is relatively flat. It is difficult to leave either a cover crop or a rough surface after maize and the use of cultivated uncropped margins or installation of swales may be helpful.



There were some excellent examples of best management practice and the photograph left shows a riparian buffer zone with fencing (measure 14).

Other examples included gateways, drinking bays and cultivation across the slope.

5 Discussion of suggested measures

For the FARMSCOOPER data input, a number of the questions (such as those regarding soil type, the presence of watercourses, access of livestock to water, and drainage) are fairly broad based. On any particular farm, these points may have a major influence on losses. For example, a key factor is the number of watercourses. These factors influence FARMSCOOPER output, clearly leaving an area for interpretation on an individual farm. Such differences between modelled output and the conditions and management carried out on the ground are the basis of the field visit required by this project.

This requirement for interpretation with regard to an individual farm is important to ensure that efforts to reduce risk of pollution are focused in the right way on the right areas.

Examples of such interpretation are as follows.

Leave over winter stubbles. Spring cropping of cereals is routine, followed by leaving stubbles over winter. In the field, the stubble fields examined may have had significant growth of both stubble and other ground cover, with no signs of soil loss in any of the fields.

Cultivate land for crops in spring rather than autumn. This method has the same effect as far as FARMSCOOPER is concerned as leaving over winter stubbles and may be carried out by default.

Reduce the length of the grazing day/grazing season. This is a common output from FARMSCOOPER and stocking levels in the area are low. Sheep may be housed both to avoid damage to pasture and prior to lambing. This ensures that poaching is kept to a minimum producing only light treading of fields.

Plant areas of farm with wild bird seed / nectar flower mixtures. Part of the farm may be planted with cover for wild birds. Whilst FARMSCOOPER does not suggest further than planting, such areas are best created across a slope or at the bottom of a slope to act as a barrier to run-off, which may not be the case in reality.

Other measures suggested may include:

- Re-site gateways away from high risk areas.
- Establish uncropped cultivated areas.

Whilst many fields are on slopes, where watercourses are some distance away, the risk for diffuse pollution may be relatively low. This is especially so with low stocking rates and careful grassland management which means that gateways and areas around feeders or troughs suffer from minimal soil disturbance.

Uncropped cultivated areas provide a rough surface and the development of green cover with no inputs, reducing the likelihood of diffuse pollution. This measure was in the top five on several occasions, but its high cost due to the exclusion of potentially productive land is a major disadvantage.

In many cases, risk levels appeared to be generally very low, but inevitably, there were some areas that had suffered significant damage from trafficking or poaching. The folding of sheep on fodder crops, especially roots, was a factor identified from field visits which was not picked up by the FARMSCOOPER model, which does not take in information on grazing patterns to this level of detail.

The proportion of fields next to watercourses is a further area requiring interpretation and on some of the farms, watercourses were few, whilst on others they were many and significant.

One issue over which farmers have no control is damage to the roadside verges where roads are often narrow and the verges are raised. Large vehicles as well as two cars passing in opposite directions inevitably damage the verges in wet weather. In some locations, recreational off-road drivers are known to use certain tracks and damage was reported in a number of cases. Other studies relating to the catchment are looking in greater detail at sediment sources and pathways, this project focuses on agricultural aspects.

It is notable that measures associated with livestock and grazing tend to have a net cost, although there tend to be grants available for many of these, e.g. through the Catchment Sensitive Farming Initiative or projects working on fencing of riverbanks such as through the AONB Partnership.

By contrast, more of the arable related measures recommended offer a saving – e.g. reduced cultivation, fertiliser recommendation systems and plants with improved nitrogen use efficiency. Unsurprisingly, those measures offering a saving were some of the most likely to be currently implemented. The potential cost of measures taking land out of production is quite high, e.g. uncropped cultivation areas, wild bird seed/ nectar flower mixtures. However, careful location and design of such features may achieve the best gains for the least cost.

In a further example, the cost of 'Cultivate land for crops in spring rather than autumn' (measure 6) is high because FARMSCOPER assumes that this measure involves moving from a situation of winter cereals to spring on heavy land, i.e. the typical situation. This means a significant potential yield loss of around 25% as well as increased cultivation costs. However, on the farms in the project, the soils are medium and spring sowing is generally satisfactory, although spring crops are likely to yield less than winter. The outcome is a significant cost, but in practice, this will be far less than FARMSCOPER suggests.

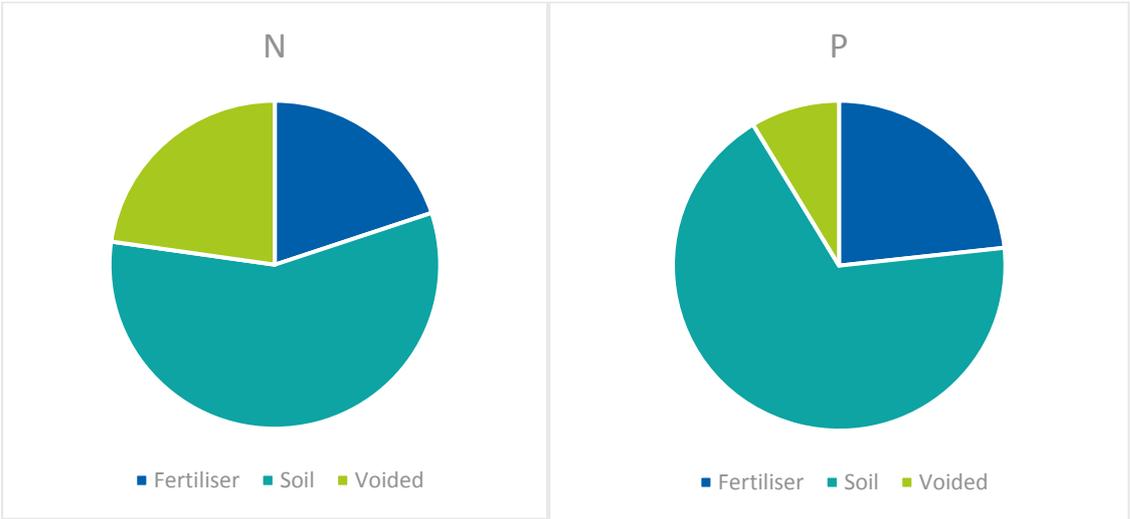
Appendix 1 Relative proportion of sources for nitrogen and phosphorus calculated by FARMSCOOPER

Concentrations were derived from the average drainage across each farm and the figures below are within the range of the six farms. These pollutant losses are in the absence of any mitigation implementation.

Pollutant	Load (kg)	Load (kg/ha)	Concentration (mg/l)	National Average Load (kg/ha)
Nitrate (NO ₃ -N)	6,000	30.00	7.00	27.6
Phosphorus (P)	125	0.50	0.10	0.54
Sediment	50,000	275.00	80.00	218

The baseline pollutant loads were both above and below the national average load depending on the farm type, management and location. Note that FARMSCOOPER makes a number of assumptions that may be different to a greater or lesser extent than the situation on a given farm.

The charts below indicate the sources of nitrogen and phosphorus pollution. In this case, most of the nitrate and phosphorus losses are from the soil supply and this would be the area to focus on in terms of method implemented to reduce losses, either by reducing the supply (e.g. lowering phosphorus soil status or not stimulating mineralisation through cultivation) or preventing movement of the supply (e.g. through use of cover crops). This is the case for this area and soil types in particular.



- Key:
- Fertiliser - Purchased artificial fertiliser
 - Soil - Losses of nutrients present in the soil
 - Voided - Losses from defecation when stock are grazing

Appendix 2 Summary of measures recommended by FARMSCOPER for the selected farm types

The top five measures (and their ranking) for each of the selected farm types are shown below for the three factors of nitrate, phosphate and sediment. 1 indicates that measure was ranked highest for potential benefit/mitigation for that farm. 1 to 5 indicates the order of the top five FARMSCOPER measures for that farm, for that factor.

	Upland grazing with some arable	Upland livestock only	Lowland mixed with some steep slopes	Lowland mixed with significant water-courses	Lowland arable with some stock	Upland livestock with some arable
NITRATE						
4	1		1	1	3	1
110	3		2	5	2	3
6	4		5	3		5
20			4		4	4
113	2			2		2
7			3		1	
115	5			4		
22					5	
67		3				
76		5				
119		2				
120		1				
114		4				
PHOSPHATE						
4	1		1	5	3	
120		2		1		2

		Upland grazing with some arable	Upland livestock only	Lowland mixed with some steep slopes	Lowland mixed with significant water-courses	Lowland arable with some stock	Upland livestock with some arable
119	Use dry-cleaning techniques to remove solid waste from yards prior to cleaning		3		3		3
76	Fence off rivers and streams from livestock		1		2		1
15	Loosen compacted soil layers in grassland fields	4	4				5
81	Establish and maintain artificial wetlands - steading runoff				4		4
35	Reduce the length of the grazing day/season	3	5				
110	Uncropped cultivated areas			2		2	
14	Establish riparian buffer strips			3		1	
7	Adopt reduced cultivation systems			4		4	
106	Plant areas of farm with wild bird seed/nectar flower mixtures	5				5	
6	Cultivate land for crops in spring rather than autumn			5			
113	Undersown spring cereals	2					

SEDIMENT

106	Plant areas of farm with wild bird seed/nectar flower mixtures	3		5	3	5	3
14	Establish riparian buffer strips			2	2	1	4
4	Establish cover crops in the autumn	1		1	1	3	
8	Cultivate compacted tillage soils	4			4		2
13	Establish in-field grass buffer strips	5			5		1
15	Loosen compacted soil layers in grassland fields		1				5
7	Adopt reduced cultivation systems			3		2	
110	Uncropped cultivated areas			4		4	
78	Re-site gateways away from high-risk areas		3				
38	Move feeders at regular intervals		5				
35	Reduce the length of the grazing day/season		2				
113	Undersown spring cereals	2					
37	Reduce field stocking rates when soils are wet		4				