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Policy mechanisms for the control of diffuse agricultural pollution, with particular reference to grant aid

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Policy mechanisms for the control of diffuse agricultural pollution, with particular reference to grant aid

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Background

1. The entry of excessive amounts of nutrients and silt into aquatic ecosystems via diffuse pollution poses severe ecological risks. Nutrient enrichment by nitrates and phosphates is widespread in English surface waters and heavy siltation has been observed in many rivers and lakes. Many sites designated for nature conservation are being affected. It has been estimated that agriculture is responsible for around 43% of phosphorus entering UK receiving waters. Agriculture is also a major contributor to silt loads, via soil erosion.

2. A range of major environmental drivers require that action is taken to control the effect of agriculture on aquatic ecosystems.

- The EU Habitats Directive – achievement of favourable conservation status for Special Areas of Conservation, reporting in 2004, 2010 and 2014.
- The UK government's public service targets for sustainable development, including key 'quality of life' indicators (particularly the achievement of favourable condition on 95% of Sites of Special Scientific Interest by 2010, and 91% of rivers meeting RQOs by 2005).
- The UK Biodiversity Action Plans for key species and habitats - reverse decline and restore populations and extent, mainly by 2010.
- The EU Water Framework Directive - good ecological status for freshwaters by 2015.

Unless positive steps are taken now to support the farming industry make the necessary adjustments to management regimes, the pressure for widespread regulatory action at farm level will increase within the near future. In addition, without preventative action soon, the severity of diffuse nutrient pollution from farms, particularly in relation to phosphorus, is likely to increase significantly.

3. A range of practical measures can be used to reduce diffuse pollution loads of nutrients and silt derived from farmland. A number of policy mechanisms can potentially be used to implement these measures, from advice, awareness programmes, grant aid and quality assurance schemes to taxes/levies, conditions on payment and regulation. At present, none of these policy mechanisms is contributing effectively to an overall solution to diffuse agricultural pollution.

4. Management measures and policy mechanisms aimed at controlling diffuse agricultural sources can be applied at different spatial scales: on all farmland, on all high risk land, within priority catchments or within high risk areas of priority catchments. The cost and effectiveness of different management measures vary as does the cost of applying different policy levers. The ability to audit and monitor environmental effectiveness is a very important and consequently highly controversial issue. These factors often predispose measures to application through certain policy levers and at certain spatial scales.

Objectives

5. The objectives of this study are to:

    1. assess at different spatial scales the potential of key policy mechanisms in implementing the range of practical management measures that might be used to control diffuse agricultural sources of nutrients and silt;

    2. critically review the use of grant aid in the UK and abroad to help control diffuse agricultural loads, including the funding of advice, farm planning, capital items, land use change and land management practices;

    3. develop, on the basis of 1 and 2, practical proposals for new grant aid, indicating the likely costs and the supporting role that other policy mechanisms might play.

Methodology

6. The study has been carried out by IEEP and partners, Paul Withers from ADAS and Paul Silcock and colleagues from GFA-RACE, over the period September 2001 to March 2002. It was undertaken in a number of distinct stages, as follows.

    *Stage 1: A*nalysis of various practical management measures for the control of diffuse pollution on different types of farms in different geographical areas, drawing upon the most up-to-date technical understanding of the issues and processes involved (led by Paul Withers).

    Stage 2: Economic modelling to explore the on-farm costs of potential management measures on a range of characteristic farm types and catchment situations (undertaken by GFA-RACE, led by Paul Silcock).

    Stage 3: Literature review and expert-interview research by IEEP to examine and evaluate a wide range of diffuse pollution policy mechanisms past, present and prospective in the UK and elsewhere. This identified and evaluated interesting approaches in France, Ireland, Finland, the Netherlands and the USA, as well as a range of innovative 'local area initiatives' in England, including Hampshire Landcare, the Tone Valley project, Somerset, and a variety of projects in the Wye and Lugg valleys in Herefordshire.

    Stage 4: Evaluation of applicability and likely effectiveness of future approaches in England. This included further expert interviews in the UK and abroad as well as a one-day discussion of issues and barriers to uptake with farmers, held in Cirencester in November. This was followed by a more detailed examination of some of these issues through a visit to the Tone project in Somerset, in January.

    Stage 5: Identification of suitable policy packages for development and piloting in Phase II of this project, and production of outline costings for the grant schemes involved.

Key findings

Practical management measures

7. There is a wide range of management measures effective at controlling diffuse pollution and deemed potentially suitable for use country-wide, wherever local conditions warrant it. These include:

- measures to reduce input levels eg reduction of N and P in livestock diets, reduction of N and P applications to avoid surplus application (most importantly, taking nutrients in manure into account);
- measures to achieve greater precision in fertiliser applications, eg placed starter fertiliser in crop production, careful attention to timing and rates;
- measures to reduce leaching from manures, eg incorporation of manure through ploughing; manure composting to degrade its toxicity, injection of slurry, avoiding spreading when ground is waterlogged or frozen, etc, ensuring adequate storage capacity to avoid having to spread when conditions are not ideal;
- a range of measures to reduce or help prevent soil erosion from cropped land, from in-field cultivation techniques suited to soil type, to winter cover, to the provision of off-field buffer strips, silt traps in drains and other mechanical barriers to soil movement;
- measures to prevent erosion and poaching by livestock along sensitive watercourses, such as bankside fencing.

8. In some parts of the country, either on high-risk land or in particular priority catchments, more fundamental management changes may be required to prevent diffuse pollution. These might include, for example, taking certain fields out of high risk crops like maize and potatoes, or ceasing cultivation altogether and establishing permanent cover. On livestock farms with serious N and/or P surpluses, reductions in stocking densities might be required.

9. In all situations, applying the optimal mix of management measures requires planning and the willingness to adapt existing farm systems. In general, different farms and different locations will respond most effectively to a different mix of changes in practice, and there may be a number of potentially appropriate options in each situation, enabling a farmer to select those which best suit his or her own economic and agronomic needs.

10. In overview:

- Measures to control N generally need to be applied over very broad areas, whilst those needed to control P and silt are most likely to require change in specific ‘high-risk’ situations on farms, and in particular, where soil erosion is a significant issue;
- Effective attempts to control N, P and silt diffuse pollution are likely to require combinations or packages of measures both at the farm and at the catchment scale.

Economic modelling of management measures

11. Six model farm types were selected for economic modelling, as follows:

I. Dairy, south west, priority catchment
II. Dairy, south west, non-priority catchment
III. Arable and pigs, south, priority catchment
IV. Arable, East Anglia, non-priority catchment
V. Mixed farm, west, priority catchment
VI. Hill farm, north, priority catchment.

12. The modelling used a computer template to show 'on farm' financial impacts based on best available agricultural cost data and expert analysis. The detailed results are presented in tables in Annexes to the report. Main overall findings of the modelling were as follows.

- The practices with the biggest financial impact on gross margins are reduction of stocking rates for livestock farming or a change in crop type for crop farms. A relatively large number of favoured measures are, however, cost neutral or beneficial, such as optimum application of N and P.
- In all the model farm situations, the importance of whole farm planning and management to the effective delivery of practical management measures is highlighted. While planning does not represent a conventionally costed element in farm gross margin assessment, it takes time and skill both to establish and to maintain effective plans.
- Management measures should build on existing practice by establishing and raising standards at farm level - this will generally lead to the lowest cost implications.
- Care should be taken to ensure that the agronomic disadvantages of actions do not outweigh their environmental benefits, but these must be assessed on an individual farm basis because they will vary significantly between farm types and situations.

Lessons from UK experience

13. Research findings and UK experience highlight a need for several key improvements to policy mechanisms to address diffuse pollution:

- more active farmer involvement and ownership of policy initiatives to increase participation and uptake of beneficial measures;
- increased use of farm management planning including the use of available software packages by farmers to improve their accuracy of nutrient management;
- advisory services and information improvement – including better/simpler publications, consolidation and communication of new research findings, increased use of ICT and more emphasis upon knowledge transfer, as well as more co-ordinated advice on-farm.

14. UK experience also highlights improved communication with farmers as a key starting point. There is a need to convince farmers of the severity of the diffuse pollution problem (both generally and in their immediate local area), of their

responsibility, and of the potential economic benefits of participation in initiatives to reduce diffuse pollution. This is probably best achieved through a combination of detailed advice and local demonstration, as well as the availability of flexible and locally tailored grant aid and the potential threat of regulatory action if the problem continues or becomes exacerbated.

Experience from EU and USA

15. Other countries have used policy approaches covering the full spectrum from obligatory requirements to entirely voluntary initiatives, in an effort to reduce diffuse pollution from agriculture. Several lessons can be learned from the experience of these approaches which are of direct relevance to a UK framework. The following points were highlighted.

- Effective information, advice and local flexibility in the choice of mitigation strategy at farm level are all important parts of an effective policy approach.
- The level of compulsion must be proportional to the severity of the pollution problem. Over-regulation can lead to farmer scepticism and unnecessarily high administration costs, whereas if there are no regulatory 'limits' upon individual actions it can be very difficult to initiate a process of farm management change.
- Farmers in many different situations have shown significant capacity to adopt a relatively sophisticated approach to mineral and soil conservation planning, whether prompted by regulation or encouraged simply by voluntary initiatives. In either case, significant investment in information dissemination and advisory support is necessary to achieve a good level of management change.

Towards a policy framework for England

16. The findings from stages 1 - 3 were consolidated with opinions expressed at the farmers' meeting to guide the development of a policy framework for England.

17. A consideration of farmer attitudes and thus likely participation is crucial to any attempt at designing a policy framework for the control of diffuse pollution. There are many factors that may prevent farmers from participating/complying with policies or initiatives. Many barriers to uptake were highlighted in the research material and during discussions with the farming community. The most significant barriers included:

- lack of awareness (of the diffuse pollution problem and their role in it);
- scepticism (of existence of the problem and their responsibility);
- lack of willingness to participate in new initiatives which offer no immediate gains;
- limited current ability in nutrient management;
- perceived ineffectiveness or yield loss risks of suggested management measures (eg limiting P on high value crops).

18. When barriers to uptake are evaluated in conjunction with the lessons learned from the analysis in stages 1-3 of this study, the following points emerge.

- In view of the nature of the problem, a dual focus approach seems required including some widespread actions that would generate minor changes across the country, with more fundamental action in priority areas.
- There is evidence from other countries that largely voluntary, farmer-owned advisory and planning approaches can achieve significant change in farm practices, wherever this can bring economic as well as environmental benefits or wherever it is linked to the possibility of future regulations. A new approach in England could build on this.
- A relatively high profile 'carrot and stick' approach will be necessary to raise overall standards and tackle specific problems at a catchment scale, in priority areas.
- Effort should be made to minimise the bureaucratic load from the policy framework and the net cost of implementation to the farmer.
- Both the costs of planning and management time, and the need for capital investment, should be taken into account when determining appropriate grant aid packages.
- Any messages from initiatives must be integrated into day to day farm planning.
- The literature for policy initiative(s) must be concise and accessible.
- Participation and compliance are likely to be increased by using locally based and tailored packages with local, well respected facilitators, where necessary.

Grant-aid packages to address diffuse pollution

19. This study suggests the use of a two-level approach. The proposed package includes a '**Basic Plan**' for implementation country-wide (eg as part of a new broad and shallow agri-environment scheme) and a more detailed '**Plan Plus**' for implementation in priority and 'high-risk' areas. The 'Plan Plus' model draws on emerging French experience with Fertimieux and CTE schemes, as well as current local initiatives in England.

20. The **Basic Plan** would offer support for every farmer to prepare a basic nutrient and soil conservation plan combining nutrient budgets, soil testing and a farm map, and within that, identifying and incorporating 'low budget management options' from a standard list. The plan would be prepared by the farmer but prior training would be given. This plan would then have to be approved by a qualified advisor. Once approved, the farmer would be required to stick to the plan for five years. Payment would consist of an up-front payment in year one and subsequent annual payments per hectare. The estimated national cost of introducing such a measure is between £13.5 and £28 million per year, over a four-year period (if 50% notional grant rate is offered – the figures for 100% notional grant would be £27-£56 million respectively), to achieve 80% uptake across the whole country. The basic plan might also link to a simple suite of payments (or indeed a minimum number of options in return for a slightly higher standard payment/notional grant rate) for a small number of more costly measures that may be needed on a widespread basis. Ideally, all these payments

would be part of a more comprehensive 'broad and shallow' agri-environment scheme.

21. The supporting guidance for preparing the basic plan would include a simple checklist to enable each farmer to identify if they are in a high-risk, priority area and so potentially eligible for funding to participate in the '**Plan Plus**' package. This is the more innovative approach, in a UK context. 'Plan Plus' would only be available to groups of farmers (perhaps a minimum of five per local area), working in partnership with local agencies. The additional aid payments would enable the farmers to draw up more detailed farm management plans and employ a bespoke local advisor who would be able to, in agreement with local EA and other relevant partners, offer grant aid for more ambitious changes in farm management. The total costs of the 'Plan plus' initiative, if applied to around 40 priority catchment areas in England and phased in over 5 years, would be likely to amount to around £0.25million in the first year, rising to around £6 million by year 5, or from £50,000-£180,000 per catchment, per year. The annual budget for each initiative would grow as it develops, aiming to cover, on average, around 50 farms or c.6,000 ha, in five years. Beyond five years, annual costs should gradually decline as fewer new activities would be needed in each area, on each farm.

Policy context

22. These aid packages would be introduced within a broader policy framework which also involves regulatory mechanisms to discourage polluting activities, as well as an extended range of agri-environment measures targeting environmental benefits. The likely extension of Nitrate Vulnerable Zones across most of England in the near future will oblige all farmers to take limited action to control nutrient losses from farmland. They will be required to produce crude nutrient budgets for N, to ensure application in line with crop requirements. However, this process will fail to address over-application of P, leading to increased soil P loading. Thus 'Basic Plan' provides an incentive for farmers to go beyond the current regulatory minimum by giving them the tools to achieve better standards of nutrient management and by tackling P and silt, as well as N.

23. If introduced as part of a 'broad and shallow' agri-environment scheme which offered further payment(s) for simple, but more costly, management actions relevant to controlling diffuse pollution (e.g. establishment of field breaks), additional benefits would accrue. The package would also complement the broadened availability of existing farm capital grants for pollution control in NVZs (which should soon cover most of England), by helping farmers to identify where such investments would be needed on their farm.

24. The 'Plan Plus' package is designed to focus extra attention and resources now, to encourage best management practice going beyond the standards expected of the generality of farms, in areas where lower nutrient and silt loads are a particular priority for biodiversity and water quality. 'Plan Plus' involves a positive commitment by farmers to a learning and experimental process. At the local level, it may be possible to link such initiatives to other catchment management objectives, for example by working with highway authorities where there is soil erosion onto public roads. In general, the Environment Agency and English Nature should be encouraged

to make farmers aware of the likelihood of longer term regulation, if management practices do not change in the near future. In addition, it should be made possible in these areas for farmers to qualify for Countryside Stewardship (CS), to fund a proportion of the more costly land-use changes as part of their plans, so that the local 'Plan Plus' grants can be focused only on filling the gaps left by the CS menu. Finally, the Environment Agency could apply its work to produce detailed catchment appraisals (using outputs from the PSYCHIC project) in these areas, helping farmers to understand the issues and develop workable plans linked to more clearly defined expected environmental benefits.

25. Looking ahead towards 2015, it is possible to envisage 'Plan Plus' evolving over time to become more self-sustaining, as farmers become able to take action without specific, targeted financial help. In addition, for the Basic Plan package, while updating the plans every five years would continue to be desirable on all farms, the costs of updates is likely to decrease as farmers modify their systems and become more familiar with the process. Thus the total cost of both grant aid packages would be likely to fall, over time.

26. It has not been within the scope of this study to consider alternative means of financing the grant-aid packages developed. However, a number of novel alternatives exist, including:

- the use of economic instruments. In a parallel study to this, RPA consultants (in association with ADAS) have recommended a charging mechanism be applied to nutrient use in order to help change farmer behaviour and generate funding for remedial action. If that recommendation were pursued, this study suggests that such an option might contribute towards funding the basic plan package, in particular;
- contributions from existing flood defence budgets – both packages offer significant potential to benefit flood control, since soil conservation involves better water retention and reduced peak flows. In view of their value to Catchment Flood Management Plans, contributions from flood defence budgets could be justified.

Conclusions, and recommendations for Phase 2

27. The study has identified a new policy framework to address diffuse pollution by nutrients and silt from agriculture, in England, drawing on experience from a wide range of domestic and broader sources. Using the indicative figures from the farm modelling, we have produced outline costings for the framework. However, these, and the details of mechanisms and measures at catchment and farm level, require refinement through piloting in phase two of the study.

28. Further Work in this Area Should Involve:

1. development of the farmer-led whole farm plan format and guidance - paper and electronic – suitable for identifying diffuse pollution control measures at field level;
2. identification of priority catchments and other areas likely to require 'plan plus';

3. phase 2 pilot - development of selected existing local initiatives as pilot plan plus projects to determine the effectiveness of management measures, test their practicality and assess real financial impacts on a range of farms in each area;
4. phase 2 pilot - selection and examination of additional case study farms to assess the components, costs and potential benefits of the basic plan package;
5. further assessment of the options for integrating diffuse pollution control measures with existing and proposed future agri-environment scheme packages, including comparative costings. This should incorporate the experience of the phase 2 pilot.

1. Introduction

This report contains the findings of a study on the subject of policy mechanisms for the control of diffuse nutrient and silt pollution from agriculture. It has been carried out for English Nature and the Environment Agency in order to provide a clear framework for applying different management practices and policy levers to resolve the problem of diffuse agricultural pollution, with particular consideration of the use of grant aid. There is currently a range of practical management techniques recognised as capable of reducing diffuse pollution from agriculture, but few of these are routinely used by British farmers. Current and past policies have been limited in their effectiveness in tackling diffuse agricultural pollution and there is no fully satisfactory policy framework in place for doing so. This report forms phase one of a two phase study. Phase two will conduct pilot studies of the policy packages suggested in this report and provide final recommendations including a more detailed analysis of the cost implications.

This project aims to:

- assess at different spatial scales (eg in priority catchments and wider countryside), the potential of key policy mechanisms to implement the range of practical management measures that might be used to control or reduce diffuse agricultural sources of nutrients and silt;
- critically review the use of grant aid and other funded initiatives in the UK, Europe and the USA to help control diffuse agricultural loads, including the provision of advice and support of farm plans, capital items, land use change and the adoption of new and enhanced land management practices;
- develop a range of practical proposals for new funding mechanisms in England, indicating the likely costs and the supporting role that other policy mechanisms might play.

The report begins with an overview of the problem of diffuse pollution from agriculture and an exploration of the need for new measures to address it. This is followed by a description of the methodology used. The main body of the report comprises the identification of management measures at farm level, economic modelling of implementation costs, consideration of policy experience from the UK, Europe and the USA, and discussion of barriers to uptake among the farming community. In conclusion there is a summary of key findings and a set of practical proposals for a future policy framework for England, as well as recommendations for testing these in a second phase of the EN/EA study, later in 2002.

The study has been carried out over the period September 2001 to March 2002.

2. Background

2.1 Diffuse pollution in context

Pollution can be classified as either point-source or diffuse (non-point-source). Point-source pollution has, as the name suggests, a single point of entry into receiving waters, and may occur as a continuous discharge (ie an effluent) or a transient event (eg a spillage of chemicals). Diffuse, or non-point-source, pollution will originate from a larger area and is frequently associated with run-off generated by rainfall events.

Diffuse pollution is a scattered, discrete or dispersed input of small amounts of contaminants that are collectively significant and can result from farming practices such as the over-application of fertiliser, inappropriate cultivation of soils, overstocking or overgrazing of land and/or erosion of river banks. For the purposes of this report the definition of diffuse pollution provided by D'Arcy *et al* (2000) is followed (with consideration limited to pollution by nutrients and silt from agriculture):

> 'Pollution arising from land-based activities (urban and rural) that are dispersed across a catchment, or sub-catchment, and do not arise as a process effluent, municipal sewage effluent, or an effluent discharge from farm buildings.'

Sources of diffuse pollution can often be insignificant on an individual scale but collectively constitute a serious problem. Diffuse pollution can also involve substances that are perhaps not widely regarded as pollutants, since they enter receiving waters in limited amounts under natural conditions. Nutrients and soil particles are the prime example of this – these become pollutants when they enter aquatic systems in artificially elevated amounts that threaten to disrupt normal ecological processes.

The extent and severity of diffuse pollution is greatly influenced by climate, both positively and negatively. For example, run-off of pollutants from land is higher during periods of heavy rainfall, but higher groundwater levels resulting from increased rain can reduce the relative concentration of nitrates; similarly during dry periods run-off and leaching from agricultural land is reduced, but subsequent rain can cause a disproportionate increase in erosion and leaching. The current understanding of diffuse pollution is based on an assumption of a constant climate but any climate change experienced by the UK in the future could cause dramatic changes to the extent of certain diffuse pollution problems. For example, predicted increased storm frequency and rainfall levels may cause increased leaching and run-off from agricultural land into surrounding watercourses. This dynamic must be considered when forming policy proposals and sufficient flexibility must be incorporated into policy to deal with eventualities as and when they arise.

Point-source pollution has been the target of successful, progressive regulation for many years. Unlike diffuse pollution the single outflow nature of point-source pollution makes it amenable to precisely targeted ‘end-of-pipe’ technical solutions, although analyses nearer the source are increasingly undertaken to reduce the incidence of pollution. Point-source pollution is a more suitable subject for 'traditional' regulatory approaches, such as issuing permits with specified discharge limits. There have been a number of recent major initiatives to reduce point-source pollution, all connected to the water industry’s Asset Management Programme (AMP):

- the implementation of the EC Urban Waste Water Treatment Directive (1991), including the extension of sensitive area designations;
- nutrient removal at selected sewage treatment works affecting Sites of Special Scientific Interest (SSSIs);
- action required to meet bathing water standards set by the EC Bathing Waters Directive;
- action to achieve River Quality Objectives (RQOs).

Further success has been achieved with farmyard sources of pollution, not covered by the discharge consenting process but falling under the 1991 Silage, Slurry and Agricultural Fuel Oils Regulations (SSAFO). Action under SSAFO was promoted throughout England by a combination of advice and grant-aid assistance (investment in pollution control technology) to help farmers bring storage and handling facilities up to required standards.

In addition, the forthcoming implementation of the IPPC Directive in England and Wales, including its extension to installations not previously regulated under IPC, such as intensive pig and poultry units, should have beneficial effects.

Diffuse pollution tends to be less amenable to traditional technical or regulatory control as it occurs over a larger area and variable timescales and thus precise cause and effect linkages are difficult to substantiate at the level of individual businesses. Nevertheless, it is a serious ecological threat and is a concern that is rising up the agenda of policy makers across Europe. Without further action to tackle the problem in the short term, its severity and consequences for the environment will continue to grow.

Agriculture is the most significant source of diffuse pollution and so is the most important focus for any attempt to reduce levels of diffuse pollution. Some specific regulatory measures have been applied to diffuse pollution, such as the Nitrates Directive, but these have addressed only small components of the problem. There is a growing number of EU and UK statutory and non-statutory drivers that require action on diffuse agricultural pollution. Table 2.1 provides a summary of relevant drivers and their deadlines for action.

Table 2.1 Key Drivers for addressing diffuse agricultural pollution

Source	Activity	Deadlines
EU Habitats Directive	Report to EU on conservation status of habitats/species and SACs	2004, 2010, 2016
PSA targets	Bring 95% of SSSIs into favourable condition Achieve 50% improvement in RQO compliance cf 1997, ie 91% compliant	2010 2005
UK BAP	Restore wetland habitats	2005-2010
EU Water Framework Directive	1. Transpose into UK law (including necessary control measures) 2. Complete analysis of inputs/pressures 3. Implement monitoring programmes 4. Publish River Basin Management Plans 5. Establish programme of measures 6. Implement programme of measures 7. Achieve Good Ecological Quality (excluding derogations)	2003 2004 2006 2008/9 2009 2012 2016

PSA - Government Public Sector Agreement; RQO - River Quality Objective; BAP - Biodiversity Action Plan

2.2 Ecological problems associated with diffuse pollution

Artificially elevated loads of nutrients and silt can affect a wide variety of aquatic systems, including rivers, lakes, ditch systems, fens, wet grasslands and estuarine/coastal habitats. An excessive supply of nutrients interferes with the delicate balance between aquatic plant species, favouring a smaller number of vigorous species and creating reductions in species diversity. In freshwaters, submerged flowering plants are lost and systems become dominated by algae – this has knock-on consequences for a range of animal species, dependent on submerged plants for shelter, food and reproduction.

In freshwaters, phosphorus is the nutrient of greatest concern, since it is naturally in short supply relative to the other major plant nutrient, nitrogen. In coastal systems, nitrogen is more of a concern since it is generally in shortest supply. However, these are over-simplifications and in fact there are situations in freshwater where nitrogen is a particular concern (for instance, on fens and wet grasslands), and in coastal systems where phosphorus is likely to be the key management target (for example, in instances where blue-green algae need to be controlled – these algae fix their own nitrogen and so are independent of nitrate availability in the water).

In addition to carrying large loads of phosphorus, artificially elevated loads of fine particulates (silt) have a major physical effect on aquatic systems, increasing turbidity and smothering river and lake sediments. The small particles fill the interstices in coarse sediments and prevent proper aeration, which has major consequences for certain plants and a range of animals with life stages that depend on sediments with low levels of silt. In rivers, salmonid fish are the most vulnerable to siltation (they bury their eggs in gravels), but a range of other fish, invertebrates and plants such as water-crowfoot species, are affected. In lakes, heavy loads of silt have been implicated in the decline of submerged plant communities, by creating an unstable and heavily anoxic rooting medium.

Many lakes and rivers in the UK are heavily enriched with both nitrogen and phosphorus, and associated wetlands fed by these waters are also at risk. Excessive siltation of river and lake sediments is a widespread concern in England, although there is much less systematic data on this issue.

Aquatic Sites of Special Scientific Interest (SSSIs) are under severe pressure from nutrient enrichment and siltation problems In a survey of 95 lake and other standing water SSSIs in England, Carvalho and Moss (1998) concluded that 80 of these were suffering from eutrophication. Classic SSSI rivers such as the Hampshire Avon and Herefordshire Wye are suffering from heavy loads of silt from agricultural land.

In addition to the national SSSI network, sites designated as Special Areas of Conservation (SACs) under the EU Habitats Directive (92/43/EEC) are under threat (most of these are also SSSIs). *Species* in the UK protected under the Directive and at risk from these problems include:

- atlantic salmon;
- freshwater pearl mussel;
- river, sea and brook lamprey;

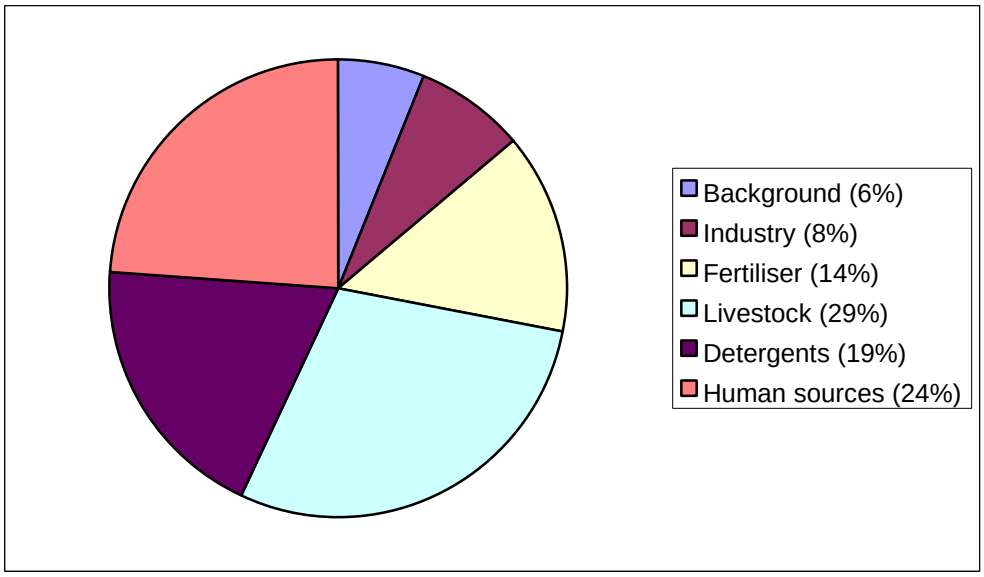
- allis and twaite shad;
- bullhead;
- spined loach; and
- floating water plantain.

Important habitats in the UK protected under the EC Habitats Directive and at risk from diffuse pollution include: water crowfoot (*Ranunculus)* communities in rivers; natural eutrophic lakes; hard oligo-mesotrophic waters; alkaline fens; and lagoons.

There are also many habitats and species listed under the UK Biodiversity Action Plan that are specifically at risk from nutrient enrichment and siltation. The most vulnerable include chalk rivers, mesotrophic lakes and species such as vendace.

2.3 Agricultural contributions to elevated nutrient and silt loads

A significant proportion of the nutrient and silt loads to UK receiving waters originates from agriculture. Agriculture is the largest single contributor of phosphorus to surface waters, accounting for 43% of phosphorus entering surface waters in the UK (see figure 2.1). Agriculture contributes even more to nitrogen pollution, accounting for 75% of nitrogen entering inland waterways in England and Wales. A large proportion of sediment entering surface waters also comes from agricultural land in the form of eroded soil.



Source: Morse et al, 1993

Figure 2.1 Sources of phosphorus entering surface waters in the UK

2.4 Geography of diffuse agricultural pollution

It is not possible to specify the exact severity or scale of the diffuse pollution problems from agriculturally-derived nutrients and silt across England as a whole because appropriate, comprehensive and up-to-date data of this kind is not available. However, there are some key points to bear in mind.

- The nature of receiving waters varies considerably across England:

    - upland waters are naturally nutrient-poor relative to lowland waters. Whilst most upland waters still have relatively low nutrient levels compared to lowland systems, small increases in nutrient supply over and above natural concentrations put these waters at severe ecological risk. Most lowland waters are heavily artificially enriched and would need major restoration to achieve a near-natural nutrient status.

    - upland rivers have higher energy and can transport larger quantities of silt than lowland rivers (in which fine sediment tends to be deposited). However, the majority of silt is deposited as rivers flows recede following rainfall. This puts all rivers at risk from enhanced loads of silt irrespective of their peak energy levels.

- Whilst ecological risks from nutrient and silt are widespread, the relative contribution and severity of the contribution from agriculture varies greatly from catchment to catchment, depending on land use (which is itself dependent on catchment characteristics and location) and the intensity of agricultural management. Thus there tend to be a certain number of catchments within which these problems lead to more severe consequences for water quality and biodiversity than in the rest of the countryside (hence the term 'priority catchments').
- Within any one catchment, action is generally needed across a large amount of farmland to control agricultural loads of nitrogen. Although minor changes in agricultural management are needed across a wide area to control phosphorus loads in general, more significant change is likely to be needed in particular 'hotspots' (hence 'high-risk areas').

2.5 The socio economic context

It is important to note that the past few years have been a period of relative crisis for the British agricultural community. The BSE and Foot and Mouth epidemics, combined with the damaging effects of the strength of UK Sterling against the Euro and other adverse market conditions, have caused the farming community considerable economic hardship and distress. Large numbers of people have left the farming industry and the future of farming in more vulnerable areas is increasingly uncertain. The impact of environmental legislation has been investigated by the Better Regulation Task Force (BRTF) who emphasised in their November 2000 report the need to minimise the regulatory burden on farmers.

Bearing these factors in mind, any new policy package to combat diffuse pollution should avoid excessive red tape and bureaucracy and should not impose any unnecessary costs on farmers. Ideally the package should create a climate which can assist farmers in improving both the economic and environmental efficiency of their farms. This study has therefore been

designed to focus primarily on positive policy mechanisms to address diffuse pollution, involving different forms of grant aid and associated assistance (eg promotion, advice, technology transfer, etc).

At a more pragmatic level, there are new controls on the use of strictly positive measures to achieve policy goals, stemming from EU regulations concerning equal treatment in the agricultural sector, between Member States. Any ‘State Aid’ programme drawn up by individual Member States, including pilot programmes, must be planned in accordance with the European Commission’s guidelines on State Aids to the agricultural sector and must be approved in advance by the EU. These rules apply to any initiatives that offer direct payment to farmers as well as to some forms of advisory and extension support. The recommendations in this report are therefore designed to be compatible with EU State Aid rules.

3. Study methodology

The report presents a synthesis of four components which made up the overall study:

1. analysis of various practical farm management measures for the control of diffuse pollution on different types of farms in different geographical areas by Paul Withers of ADAS;
2. economic modelling by GFA-RACE to identify the on-farm costs of these various management measures, and farmer-tested analysis of aspects that might limit participation in any proposed schemes;
3. research by IEEP to evaluate policy mechanisms past, present and prospective in the UK, EU and USA as well as examination of a range of current local area initiatives in England;
4. a whole-team review of the findings of stages 1-3 and the subsequent development of a new policy package for England, including indicative costings, and a consideration of compatibility with the broader policy context, particularly including forthcoming regulatory and agri-environmental developments.

These different elements of enquiry have enabled the study to make a relatively broad exploration of the potential policy mechanisms that could be used, considering practices, financial and technical considerations and relevant policy experience and current developments.

Chapter 4 of the report explores the practical management techniques that can be successfully used to combat diffuse nutrient and silt pollution and looks at the management of nutrients, livestock, land and landscape.

Chapter 5 evaluates the economic implications of these measures in the context of six chosen farm-type models (two dairy, two arable, one mixed and one hill farm). Farm business management specialists from within GFA-RACE and the Royal Agricultural College analysed the actions likely to be taken and impacts likely to occur for each management measure by farm type. In general the costs were calculated ‘at the margin’, in the form of a partial budget and no allowance was taken for fundamental or structural changes which may take place over time in reality if a farm were committed to a package of (compulsory) measures. Costs are broken down into impacts on farm gross margin, operating (or fixed) costs and capital costs.

These two chapters give the report a strong consideration of farm-level implications and effectiveness upon which to build suggestions of change in farming practice and of the policy mechanisms most likely to effect these changes.

Chapters 6 and 7 explore existing experience with policies to address the diffuse pollution problem. Material and ideas have been gathered from the UK and abroad to illustrate and evaluate the range of different policy approaches that have been/are being used to tackle diffuse pollution, as follows:

- Literature has been gathered from official and unpublished sources in the UK, EU and USA.

- Interviews have been conducted with key contacts in DEFRA, EA, NFU, EN and other organisations active in this area of work.
- Telephone interviews have been conducted with individuals responsible for particular local area initiatives, including the Hampshire Landcare project and the Hereford Wye and Lugg project, and a field visit was made to the River Tone Catchment Project, Somerset, hosted by the Environment Agency, FWAG and the Somerset Wildlife Trust.

In addition, a half-day workshop took place in Cirencester to discuss the practicality of different management measures, the basic assumptions of the economic modelling and the barriers to uptake. This was attended by a range of farmers from different sectors and regions.

Finally, Chapter 8 of the report brings previous chapters together generating proposals for an integrated policy framework that aims to reduce loads of nutrients and silt from agriculture. The framework was put together in a meeting involving the entire research team, and refined following discussions and feedback from an expert seminar involving key policy officials and stakeholder organisations, in early February 2002.

The first part of the chapter includes a consideration of barriers to uptake and key messages from the various stages in the research, which highlight the strength of the case for new and positive policy measures. The second part involves the development of a package of positive mechanisms involving grant aid with supporting advice and information. Indicative costings for the package are derived from a combined analysis of farm level costs from the economic modelling work and strategic considerations of the most cost-effective implementation models, bearing in mind other relevant policy developments. The final part of the chapter sets this package in its broader policy context, within which important changes in the regulatory framework and in future agri-environment schemes in England offer further opportunities to help address diffuse pollution.

During the study, the team was able to identify the key areas needing further work in order to take the proposals forward. Chapter 9 concludes the report by offering a series of recommendations for the second phase of the study and other research projects.

4. Practical management measures for the control of diffuse pollution on farms

4.1 Introduction

Knowledge of the processes of particulate and nutrient transfer in run-off from agricultural land has increased considerably in recent years allowing some assessment of farming practices and landscape conditions causing potential problems. As stated in Chapter 2, the processes of nitrogen (N) and phosphorus (P) transfer within catchments differ fundamentally, particularly in relation to scale. In general, practices to control N need to be adopted widely over the catchment area, whilst those required to effectively control silt and P are often best adopted within specific contributing or 'high-risk' areas (Heathwaite *et al.*, 2000). In either case, losses appear to be driven by the amount of flow through the soil and landscape.

However, it is also recognised that more catchment-wide nutrient input controls may be required where the intensity of farming within the catchment is very high and poses a longer-term hazard to water quality. High-risk areas for sediment and P loss are the riparian zone due to its more consistent hydrological proximity, or further upslope if there is good water connectivity between the source and the point of final impact in the watercourse, for example via underdrainage schemes or along road culverts. The majority of P is transported in silt and clay ('silt'), although high dissolved fractions can occur in P-saturated soils or where manures are surface-applied, especially to grassland.

Uncertainty still exists over the precise impacts of diffuse sediment and nutrient loss and on the intensity of agricultural diffuse pollution required within the catchment system to cause significant eutrophication response. For example, excessive loads of P can be measured in run-off from an individual field due to poor management of manures, but only a few hundred metres downstream it has disappeared due to the effects of dilution from 'good' quality water. It is also unclear exactly where the pollutants which enter the waterbody originate because of the deposition of sediment and P along the hillslope/floodplain/river continuum before reaching the monitoring point, where effectiveness might be measured. This is not so much a problem for N.

Conceptually, mitigation options can be classed into those which reduce sources of sediment and nutrients (source management) and those which prevent their transport (transport management), and these may need to operate on a catchment-wide basis or be restricted to particular high risk areas (Sharpley and Rekolainen, 1997). However, implementation is under the control of the farmer and hence it is necessary to consider the principal practices operating in different types of farming systems (Mainstone and Schofield, 1996; Withers and Jarvis, 1998). These practices include nutrient management, livestock management and land/cultivation management, and combinations of these are best incorporated into an integrated whole farm plan, which is best modularised to enable regular updating and inclusion of other components. Landscape management introduces another tier where strategic use of the land encompasses more than one farm. For the purposes of sediment and nutrient loss, farming systems may be classified into upland, lowland livestock (dairy), lowland livestock (pigs and poultry), lowland arable and lowland mixed farming.

Effectiveness might be judged by improvement in trophic state, improvement in water chemistry or reduction in P load at a monitoring station, and needs to take account of antagonistic effects on other nutrients eg P on N. Mechanisms for the implementation of mitigation options can be classed into those which can be adopted voluntarily, those requiring coercion via economic instruments and those requiring regulation (Withers *et al.,* 2000). However, experience has shown that combinations of measures (suites or recipes) are most likely to be required at both the farm and catchment scale. In addition, the exact combination will vary from area to area, which may confound the identification of specific policy mechanisms for specific control measures. Conceptually the steps in decision making include:

1. what the land is best suited to, in order to reduce environmental impact whilst remaining profitable;
2. what levels of nutrient input are required to achieve the required production targets;
3. how best to manage those inputs to ensure minimal loss in surface and sub-surface run-off; and
4. what additional measures are required to minimise the risk of pollutants reaching the watercourse (ie run-off control).

Potential control measures, their effectiveness, cost, practical considerations and scale of implementation are summarised in table 4.1 below. Effectiveness and cost are broadly assessed here, prior to the presentation of more detailed economic modelling results in Chapter 5.

4.2 Evaluation of control options

4.2.1 Nutrient management

Control of input levels

Controls over the amounts of P applied in feeds and fertilisers will have little or no effect on P loss from soil in the short-term. This is because most agricultural soils are already well supplied with P from previous additions (see Withers *et al.,* 2001a), and therefore retain sufficient soil P buffering capacity to maintain background solution P concentrations. Similarly, the amounts of P in suspended sediment selectively detached from the soil during the erosion process are already ca. 500-fold greater than the amounts of P annually applied to crops. There is a more direct relationship between oversupply of N and N loss, so matching N inputs to meet requirements is an effective control option in the short-term (Withers and Lord, 2002).

Land with high nutrient surpluses does however encourage lower nutrient use efficiency and will eventually ‘leak’ nutrients depending on the buffering capacity of the soil. This introduces the concept of timescale over which surpluses can be tolerated without causing environmental damage. The timescale differs depending on the nutrient concerned: for N it is short because of the soil’s short-term buffering capacity whilst for P the timescale is long because of preferential retention of applied P in the soil. However, reducing nutrient surpluses still provides a safety net because it increases the timescale over which inputs can be buffered against loss.

Table 4.1 Matrix of practical management measures

Control Measure	Effectiveness	cost	practicality/ barriers to uptake	Country wide All land	Country wide high risk	Priority catchments All land	Priority catchments high risk
Nutrient Management							
1. Nutrient input levels							
Reduce dietary inputs	Low[1]	benefit	Feed compounders need persuading	X		X	
Reduce fertiliser inputs	Very low[1]	benefit	Potential yield reductions on marginal soils		X		X
Critical soil P levels - chronic - acute	 Very low[1] Low[1]	 low low	Requires resource and commodity analysis and good record keeping. Difficult to generalise over an entire catchment	X	 X	X	 X
Critical surplus loadings - chronic - acute	 Low[1] Medium	 low low	Requires resource and commodity analysis and good record keeping	X	 X	X	 X
2. Fertiliser and Manure Management							
Restrict application timing	Medium	very high	Requires expensive manure storage and/or improved weather forecasting		X		X
Placed starter fertiliser	Very low	low	Beneficial effect in reducing surpluses	X		X	
Slow-release fertilisers	Low	very low	Not suited to marginal soils		X		X
Incorporation of manures	High	very low	Requires arable crop in rotation because reseeding of grass not regular	X		X	
Injection of manures	Medium	medium	Costly machines with slower work rates and limits on application rates		X		X
Manure composting	Low	low	Needs to be large scale to be worthwhile	X		X	
Manure sharing schemes	Medium	medium?	Transport costs, running the scheme		X		X
Manure incineration	High	very high	Helps reduce surplus loading				
Manure nutrient recovery	Low	very high	Helps reduce surplus loading				
Nutrient immobilisation	Low	low	Effectiveness may be variable		X		X
No application zones	High	low	reduced crop yields possible in the longer term		X		X
Land Management							
1. Farm management							
Collect farmyard run-off	High	high	Building structures maybe required	X		X	
Ditch barriers/management	Medium	Medium	Effectiveness dependent on management skills		X		X
Farm track impoundments	Medium	Low	Silt requires emptying and recycling/disposal		X	X	
Move gateways/troughs	High	Low	Perceived nuisance task and dependent on water supply piping		X		X

Control Measure	Effectiveness	cost	practicality/ barriers to uptake	Country wide		Priority catchments	
				All land	high risk	All land	high risk
2. Crop management							
Avoidance of high risk crops	High	medium	Change in farming practice		X	X	
Early sowing of crops	High	low	Weather dependent		X	X	
Cover crops	High	low	Can be utilised over winter		X	X	
Grassing down	Very high	medium	Long-term measure		X		X
3. Soil management							
Contour ploughing	Medium	low	Not always effective		X	X	
Rough seedbeds	Medium	low	Only suitable for certain crops (eg wheat)		X	X	
Change tramline direction	High	low	Higher fuel costs, lower work rates		X	X	
Reduce cultivation passes	Medium	benefit	Not suited to some soils		X	X	
Minimal cultivation	Medium	benefit?	Not suited to some soils		X	X	
Novel cultivation practices	High?	Medium	Research required to commercialise		X		X
Green manuring	Low	low	Opportunity practice unless dedicated	X		X	
Livestock management							
Reduce stocking density	High	high	Fundamental change in farming practice requiring greater grassland management skills		X	X	
Restrict stock access	Very high	medium	Zero grazing required on restricted land		X		X
Landscape management							
Change farming system	High	high	Requires land capability assessment for the environment		X		X
Reinstate hedges	High	medium	Takes land out of production		X		X
Establish woodland	High	medium	Takes land out of production		X		X
Establish wetlands	Medium	medium	Takes land out of production		X		X
Regulate groundwater level	Medium	medium	Only applicable to certain areas		X		X
Riparian buffer zones	Medium	low	Requires in-field measures to be effective		X		X
Targeted buffer zones	High	low	Takes land out of production unless use alternative crop		X		X
Targeted impoundments	Medium	medium	Short-term solution which eventually act as a source		X		X
River bank stabilisation	High	high?	Permanent solution		X		X

[1]Effectiveness is considered low or very low only in the short-term. In the longer term, such measures are necessary to avoid the excessive accumulation of P in the soil and the resulting increase in background P loss.

In the longer-term, soil P levels will decline; and soil test P levels in P-rich soils will decline at a greater rate than those in low-P soils. Hence, restrictions on inputs imposed by critical thresholds for soils and/or surpluses are a long-term (e.g. 10 years) strategy to control *soluble* P losses in run-off only. Many decades of withholding P inputs would be needed to reduce particulate-P concentrations, which reflect a long history of inputs (Withers *et al.,* 2001a). Compound fertilisers containing no P may be more expensive than those with P.

In setting limits there are problems in using average critical soil, or surplus, values over an entire catchment because the relationships between surplus, soil P level and loss will vary within and between individual fields depending on the type of farming system, soil type, previous history and management. Hence setting of multiple critical thresholds to cater for high-risk areas is an attractive and probably necessary option. High-risk soils can be defined as those where there is a direct relationship between P surplus and loss.

Controls over N and P inputs in feeds will have a more immediate and significant effect on 'incidental' losses arising from fresh applications of manure to the soil surface, or during grazing. Research has shown reduced N and P excretion when animals are fed more precisely to meet their requirements, rather than the current practice of 'insurance' over-feeding. Improved diagnosis of requirements for both crops and livestock is a key to minimising inputs. This requires nutrient management planning and involves regular resource and commodity analysis to check N and P levels in manure and soils, as well as the maintenance of good records.

Fertiliser and manure management

Fertiliser and manure management is designed to reduce leaching losses of N and 'incidental' losses of N and P in surface run-off which arise when storm events follow fresh applications to the soil surface or during grazing (Haygarth and Jarvis, 1999). Incorporation of manure into the soil either by ploughing or injection is key here, since manures left on the soil surface represent a source of nutrient for some considerable period after application (Smith *et al.,* 2001; Withers *et al.,* 2001b). In reducing atmospheric N loss, incorporation also helps to utilise manure N more efficiently with less need to rely on fertiliser inputs. Cropping can be adjusted on many grassland farms to accommodate a ploughing cycle, for example by introducing maize or fodder beet to the rotation, although this introduces cultivation which may increase sediment loss without careful management. Injection is not suitable for all soils and work rates are often slower, so there will be more limited opportunity/acceptability for this option.

Restricting manure applications to 'safe windows' has been shown to be effective for reducing leaching losses of N, and is likely to be so for surface run-off losses of P during periods of high precipitation and/or when the soils are wet, typically in Autumn and Winter. Within existing Nitrate Vulnerable Zones, Action Plans specify that manures should not be spread between 1 September and 1 November (grassland) and 1 August to 1 November (arable land). However, this demands storage facilities which are very expensive in relation to the amounts of nutrient run-off saved by such restrictions (Unpublished ADAS data).

Placed 'starter' NP fertiliser has the potential to reduce inputs and vulnerability to surface losses, but requires modifications to drilling equipment. Similarly, manure additives can reduce NP solubility but their use is not strictly in accordance with the objective of the Water

Framework Directive of reducing losses at source since they will not encourage reduced applications. Sharing of manure nutrient loads between farms and sharing of the specialised equipment required for the improved management of manures is probably vital to successful nutrient planning within priority catchments. For example manure composting programmes with a saleable end-product/outlet probably require involvement by a critical mass of farmers to be economically viable.

4.2.2 Livestock management

High stocking rates generally lead to high levels of surplus nutrients resulting in increased soil test P, increased manure application rates with consequent increased risk of nutrient loss, for example in leaching and surface run-off, and increased risk of poaching damage with consequences for soil erosion. Reducing stocking rates has potentially significant financial implications for the farming system but also management challenges in being able to manage grass requirements accordingly. Restricting livestock access away from watercourses or high-risk areas is relatively straightforward but requires fencing costs and a switch to zero grazing techniques for managing the fenced areas. Interactions with habitat biodiversity at the water margin also need to be taken into account.

4.2.3 Land management

Farm management

Farm buildings, associated yardage areas and farm tracks are all potentially important sources of nutrients and/or silt. Although often considered separately as mini-point-sources, the run-off generated from these areas needs to be collected and controlled as part of management plans for diffuse nutrient control. The cost is generally low except where specific structures are required, for example where there is close proximity to a stream. Barrier ditch and reed-bed options are worth exploring for dirty water and entrapment of silt through improved ditch management can be effective. A strategy for silt recycling/disposal is required but this is perfectly manageable.

Crop management

Particle transfer in the run-off from fields includes processes of detachment, overland flow and sedimentation. The most effective strategy to combat the initial phase of detachment is the provision of ground cover. On arable land this can be achieved either through cover cropping on land which is used for spring-sown crops, or early drilling for winter-sown crops. The feasibility of early drilling is weather dependent and tends to be more practical for the larger farms where faster work rates can be achieved through the use of large machinery. For highly dispersive soils, a more permanent groundcover may be required in vulnerable areas, which may require a farm to adopt different management strategies (eg for grass).

Soil management

A number of low cost adaptations to cultivation systems (contour ploughing, minimum tillage, altering tramline direction, novel cultivation techniques) exist to help reduce the risk of surface run-off and the incidence of sheet and rill erosion from cropped land. A potential concern with sheet erosion is that the problem is not easily visible but this should be catered for by the use of on-farm risk assessment procedures. Key to the introduction of these soil-

conserving management systems is to demonstrate their agronomic and economic viability, but it invariably requires improved management skills. Again there is a possibility of sharing costly equipment between individual farms in priority catchments. Novel cultivation systems include ribbed rollers which leave irregular raised edges on the final cultivation pass which may help to reduce the incidence of run-off. If the farmer is willing to consider more long-term conservation practices such as incorporation of crop residues and green manuring, these can provide further opportunities for soil conservation.

4.2.4 Landscape management

Landscape management refers to the need to address some issues at catchment scale where implementation on single farms may not have the desired impact. In effect they are schemes which might be introduced in catchments of priority water bodies (eg sites designated under the Habitats Directive). Such schemes require information on land capability to support particular farming systems or high-risk crops. A land capability classification exists for production but there is a need to develop one for the environment which takes account of which practices might be best suited or safe on particular soils in particular areas and the standard of management required to maintain such safe practices.

A number of control measures that involve landscape-scale effects can be classified as sinks and their effectiveness in the longer term has been questioned. Certainly, the smaller impoundments have a limited lifespan; they can be very effective at trapping silt in the short-term but eventually become sources of P during storm events due to the effect of waterlogging on P release from sediments, especially as such impoundment's are often located next to the stream. Riparian buffers are unlikely to be effective without additional in-field control practices to control run-off and sediment yields. Uncertainty over long-term effectiveness is bound to affect uptake. Strategic placement of permanent land use (grassing of valley floors /woodland) will reduce farm profits.

4.3 Conclusions

- Management solutions to diffuse pollution problems are often site-specific and also require lasting compliance with *best* management practice (not simply 'good agricultural practice as currently broadly understood).
- In order to control diffuse pollution effectively, any farm management strategy will need to include varied combinations of management measures tailored to each farm or area.
- A successful pollution reduction plan relies heavily on accurate prediction. While there are many low cost management options that can be used, there can be important management costs involved in drawing up and operating effective nutrient and soil conservation plans and they generally demand high levels of skill and a willingness to experiment.
- The effectiveness of farm level plans may depend upon group involvement as the water quality improvements resulting from the efforts of one farmer can very easily be undermined by pollution from other farms in the area.

5. Economic modelling

5.1 Introduction

The purpose of this component of the project is to demonstrate the 'on farm' economic impact of a range of potential management designed to control diffuse agricultural pollution, based upon the discussion and evaluation in Chapter 4. All of the work has been desk-based relying on modelling impacts on a range of farm types.

A computer template has been devised to show 'on farm' financial impacts using the best available agricultural cost and other data and expert analysis. The results for different farm types are attached in Appendices 1 to 6.

5.2 Farm modelling

A number of farm types have been modelled covering different enterprises, geographic areas and priority / non-priority catchments. Following discussions with the project sponsors and among the project team, six farm types were selected for the economic modelling work including four within priority catchments and two outside priority catchments. It was assumed that all farm types would include some 'high risk land'.

The farm types selected were:

1. Dairy, south west, priority catchment
2. Dairy, south west, non priority catchment
3. Arable and pigs, south, priority catchment
4. Arable, East Anglia, non priority catchment
5. Mixed farm, west, priority catchment
6. Hill farm, north, priority catchment

5.2.1 Farm descriptions

For each farm type, the characteristics of the farm were developed and described in order to provide a realistic set of circumstances for testing the impact of the various management measures. These characteristics include area, tenure, enterprise types, crop types and areas, stock types and numbers, performance, stocking rate, forage, buildings/infrastructure, topography and soil type. In addition the nature of the 'high risk' land on each farm was described.

These characteristics were based partly on Regional Farm Business Survey and DEFRA census data (area, enterprise types, cropping and stocking patterns) and partly on available descriptions of identified priority catchments and other areas (from project team members and expert / local knowledge).

5.2.2 Management measures

Working from the farm types selected and the descriptions subsequently developed the project team shortlisted those management measures from Chapter 4 which might be appropriate to control diffuse pollution on each farm. The number and type of management measures varied from farm type to farm type, depending on the nature of the farming system

(eg arable, dairy, mixed etc) and the physical circumstances of the farm (eg catchment characteristics, topography etc). The project team attempted to ensure that as many as possible of the previously identified management measures were considered during the modelling process in order to inform the subsequent analysis.

Special consideration was given to which management measures would be applied to the same farm type, eg dairy or arable, but under priority and non-priority catchment conditions. This reflected in part the topography and other physical characteristics of the priority catchment areas and hence the high-risk circumstances which needed to be addressed. For example, cultivation practices, tramline direction and seedbed condition were all considered with the priority catchment arable farm but not with the East Anglian arable farm.

It is acknowledged implicitly that not all the management measures selected for a farm type would necessarily be applied in practice. In most cases there is a certain degree of overlap between the management measures selected (for example grass strips *and* hedge creation were modelled on the arable and pigs farm) whereas in practice one might view these as alternatives. However as many measures as possible were included to inform the financial impact assessment of the management measures in different farm situations.

For some measures, such as manure sharing across farms or manure composting programmes (again across a number of farms) it was not possible to use the simple modelling process adopted for the study to estimate costs. Collaborative approaches of this type are better considered at a more detailed case study level and/or piloted, in order to address real costs per farm. A summary of the management measures selected for each farm type modelled is shown in table 5.1.

5.2.3 Management measure / cost matrices

The management measure / cost matrix, presented for each farm type in Appendices 1-6, provides the substance of each farm model. Each matrix covers the following elements:

- Management measures (including reference number)
- Coverage (whole farm or high risk land)
- Action required to be taken ‘on farm’ as a result of each management measure.
- Description of the financial impact
- The cost or benefit arising, allocated under ‘gross margin’, ‘fixed/operating costs’, or ‘capital costs’ according to the nature of the management measure.
- Assumptions made relating to action required to be taken or costs incurred.

Following the selection of farm types and the relevant management measures, the other elements of the matrices have been developed using both expert analysis and up-to-date costings.

Table 5.1 Practical management measures as modelled

Management Measure	Dairy, Priority	Dairy, Non priority	Arable & pigs, Priority	Arable, Non priority	Mixed, Priority	Hill, N, Priority
Whole farm planning and management	√	√	√	√	√	√
Dietary P input limits	√		√			
Omit/reduce fertiliser N/P on soils	√		√	√		
Closed period for spreading manure	√	√			√	√
No manure on steep slopes	√	√				√
Incorporate manure on maize	√	√				
Move livestock feeders	√				√	√
Reduce/limit stocking rate	√		√		√	√
Restrict stock access to streams	√	√			√	√
Collect farmyard run-off	√	√			√	
Silt traps on farm tracks	√	√	√		√	
Improve drainage on livestock paths	√	√			√	
Re-site gateways	√	√	√			
Reduce ditch clearance	√					
Undersow cover crops	√	√	√	√	√	
Grass strips	√	√	√		√	
Stock rotation			√		√	√
Stock location			√			
Improve drainage on farm tracks			√			
Crop location			√	√	√	
Early sowing of winter crops			√	√	√	
Rough seedbeds			√		√	
Tramlines			√		√	
Cultivation practices			√		√	
Underdrain sediment traps					√	
Sedimentation pond					√	
Establish wetland					√	
Change land use					√	
Establish woodland strips						√
Establish hedges			√			

5.3 Analysis

Farm business management specialists from within GFA-RACE and the Royal Agricultural College analysed the actions likely to be taken and impacts likely to occur for each management measure by farm type. This analysis included further consideration of the farm layout /set-up (building on the preliminary farm description) in order to provide an indication of areas or lengths of boundaries likely to be affected. The existing management practices

were also considered in order to establish an accurate assessment of additional/alternative management and costs/benefits likely to arise.

Costs are based on various sources including:

- Farm Management Pocketbook (Nix, 2001).
- CAAV Standard Costings (2001).
- Regional Farm Business Surveys (Various).
- Farm Building Cost Guide (SAC, 2000).
- Direct feedback from specialists (eg the whole farm planning costs).

The costs for each management measure have been aggregated in order to demonstrate the overall financial impact on the farm being modelled. However unit costs are relatively easily extracted using the assumptions stated. These assumptions are set out in the financial impact column and in the footnotes (where further explanation is necessary).

Management measures make a financial impact in different ways. Sometimes the output or variable cost of a crop or stock enterprise is affected and this affects the *gross margin*. Sometimes there is an impact on *fixed costs or overheads* (labour, machinery etc). Finally there may be a requirement for one off investment and *capital costs* may arise. Management measures may give rise to costs in more than one category, for example woodland planting involves the capital cost of establishment, the overhead or operating cost of maintenance and in certain cases the gross margin cost of the enterprise replaced.

In general the costs have been calculated 'at the margin', in the form of a partial budget. No allowance has been taken for fundamental or structural changes which may take place over time in reality if a farm were committed to a package of (compulsory) measures.

5.4 Findings

The tables below provide a summary of the financial impacts of the proposed measures on each of the farms. These are broken down into impacts on farm gross margin, operating (or fixed) costs and capital costs. The first two of these, were they to be supported by grant-aid, would most appropriately be the subject of an ongoing annual payment, whereas the capital cost impacts would be best supported in the form of a capital grant.

The first table identifies the level of financial impact (zero, negligible – less than £500, significant - £500 to £2,499, or large – greater than £2,500). From the table it can be seen that many of the measures do not have any significant financial impact. However, the correct application of several of these requires the production and implementation of a whole farm plan which would in itself imply a cost. Thus it is this plan, proposed for all farm types, that will probably offer the best returns in terms of limiting the impacts of diffuse pollution. For any given financial input, by preparing the plan, a farmer can identify a broad range of low or no-cost management options that would be suitable on their farm. Indeed, as this plan may lead to cost savings for the business (in, for example, fertiliser inputs) it could be argued that the production and implementation of such a plan might be cost neutral overall. The degree to which the preparation of a farm plan should be supported by grant aid would need careful

consideration. Similar types of plans have been proposed as a basic requirement in farm assurance schemes (Baines *et al*, 2000).

The measure that has the greatest influence on gross margin is the reduction or limiting of stocking rates. On the dairy (priority catchment) and pig farms this represents quite a significant downsizing of those enterprises unless alternative income sources can be developed to compensate. The benefits and costs of comprehensively restructuring such farms could be explored further in Phase 2 of the project. In the short term there are other less costly measures which could be employed to limit the impact of stocking on diffuse pollution on these farms, for example better stock location and rotation.

On those farms with crops, significant changes to crop management would also lead to significant financial impacts. These are most notable when there is a requirement to change the crop being produced (eg from potatoes to wheat, or from milling wheat to feed wheat). Such changes would need to be considered on an individual basis to ensure that they provided the anticipated environmental benefits. Care should also be taken to ensure that the agronomic disadvantages do not outweigh the environmental benefits. If this is the case then it may be that the wrong tool is being used to tackle the pollution issue.

In the calculations shown there is an element of continual management (operating costs) for the maintenance of any capital items installed. For example, if silt traps are installed then these will need to be cleared at regular intervals. The more expensive capital items tend to be associated with the livestock farms; however, it may be that these provide the most benefit in preventing diffuse pollution. Again, benefits would need to be assessed on an individual farm basis, to justify the choice of measures to be made.

Table 5.2 summarises the total financial impact of the total mix of measures on each of the model farms and the average impact in terms of £/ha (further detail is provided in Table 5.3). This gives an indicative unit cost for a complete package of measures (NB some minor duplication of measures is involved, here).

Aside from the detailed costings, the general findings of the economic modelling work highlight the following points.

1. In all cases, whole farm planning and management are a crucial element in the delivery of practical management measures.

2. Management measures overlap in certain situations and therefore the planning and selection of suitable measures is essential, eg field edge grass strips and hedge planting are alternative measures for the control of soil loss in some situations.
3. Management measures should build on existing practice on the farm(s) concerned. Establishing and raising standards should be an important part of any package of measures.
4. The models help to indicate the appropriate basis of payment for the delivery of any future grant aid, from the assumptions and category of on-farm cost incurred. For example; payments could be made on the basis of some proportion of unit cost (£/ha, £m); percentage cost; or total cost.
5. Some management measures appear to be cost neutral or beneficial, eg limits on phosphate application on high-risk land where phosphate leaching is or may become a

problem. Nevertheless the benefits of these measures clearly need to be demonstrated in order to persuade farmers to adopt them.

6. Management measures requiring capital investment often entail additional operating costs, eg the installation of silt traps will mean that there will be additional costs to clear these out in the future. Both these cost elements could be legitimate items for grant-aid, in different situations.

Table 5.2 Average cost impacts*

	Gross margin		Operating costs		Capital costs	
	£	**£/ha**	**£**	**£/ha**	**£**	**£/ha**
Dairy – Priority Catchment	£6,788	£113	-£698	-£12	£8,620	£144
Dairy – non-priority catchment	£273	£5	£766	£13	£7,370	£132
Arable & Pig – priority	£20,935	£120	£3,099	£18	£23,665	£135
Stockless arable – non-priority	£6,656	£22	£5,140	£17	£2,240	£7
Mixed Farm – priority	£7,529	£43	£1,244	£7	£13,465	£77
Upland Farm – priority	£0	£0	£884	£2	£6,953	£17

**Total Gross Margin, Operating and Capital Costs for each farm*

Clearly the cost findings of the economic modelling work must be treated with caution. There are obvious limitations given the restricted range of farm types, the hypothetical nature of the farms and the extent of the assumptions necessary. Phase 2 of the project should enable a detailed investigation of the practicalities, financial impacts and non-financial impacts associated with the management measures to be carried out across a range of appropriate farm types.

Nevertheless, it is interesting to note that the average cost impacts per hectare (averaged out over the total holding area) for the farm models examined are well within the range of payment levels currently offered through agri-environment schemes in England.

The overall and unit costs derived from the modelling exercise have been used to inform the development of indicative costings for the grant aid packages outlined in Chapter 8.

Table 5.3 Detailed cost impacts

	Dairy Priority Catchment			Dairy non priority catchment			Arable & Pig Priority catchment			Stockless Arable Non-priority			Mixed Farm Priority catchment			Upland Farm Priority catchment		
	GM	OC	CC	GM	OC	CC	GM	OC	CC	GM	OC	CC	GM	OC	CC	GM	OC	CC
Farm Plan	X	[	[[	X	[	[[	X	[[	[[	X	[[	[[	X	[[	[[	X	[	[[
Dietary P Inputs	X	X	X	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-
Omit/reduce N/P on soils	([)	X	X	-	-	-	X	X	X	[[[	X	X		-	-	-	-	-
Restrict manure timing	X	[	X	X	[	X	-	-	-	-	-	-	X	[	X	X	X	X
No manure on steep slopes	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	X
Incorporate manure on maize	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Move livestock feeders	X	[	X	-	-	-	-	-	-	-	-	-	X	[	X	X	[	X
Reduce/limit Stocking Rate	[[[	([)	X	-	-	-	[[[	X	X	-	-	-	X	[	X	X	[	X
Restrict access to stream	X	X	[[	X	X	[[	-	-	-	-	-	-	X	X	[[	X	X	[[[
Collect farmyard run-off	X	[	?	X	[	?	-	-	-	-	-	-	X	[	?	-	-	-
Silt traps on farm tracks	X	[	[[	X	X	X	X	[	[[[	-	-	-	X	[	[[[	-	-	-
Well drained livestock paths	X	X	[[[	X	X	[[[	-	-	-	-	-	-	X	X	[[[	-	-	-
Re-site gateways	X	X	[[	X	X	[[	X	X	[[	-	-	-	-	-	-	-	-	-
Reduce ditch clearance	X	([)	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undersow cover crops	[	X	X	[	-	-	[	X	X	[	X	X	[	X	X	-	-	-
Grass Strips	X	X	X	X	X	X	[	[	[	-	-	-	[	[	[	-	-	-
Stock rotation	-	-	-	-	-	-	X	[[	X	-	-	-	X	X	X	X	X	X
Stock location	-	-	-	-	-	-	X	X	[	-	-	-	-	-	-	-	-	-
Well drained farm tracks	-	-	-	-	-	-	X	X	[[[	-	-	-	-	-	-	-	-	-
Crop location	-	-	-	-	-	-	X	X	X	X	X	X	[[[	X	X	-	-	-
Early sowing of winter crops	-	-	-	-	-	-	X	[[	X	X	[[[	X	X	X	X	-	-	-
Rough seedbeds	-	-	-	-	-	-	[[[	([])	X	-	-	-	[	([)	X	-	-	-
Tramlines	-	-	-	-	-	-	X	X	X	-	-	-	X	X	X	-	-	-
Cultivation practices	-	-	-	-	-	-	X	X	X	-	-	-	X	X	X	-	-	-
Underdrain sediment traps	-	-	-	-	-	-	-	-	-	-	-	-	X	[	[[[	-	-	-
Sedimentation pond	-	-	-	-	-	-	-	-	-	-	-	-	X	X	[	-	-	-
Establish Wetland	-	-	-	-	-	-	-	-	-	-	-	-	X	X	[	-	-	-
Change land-use	-	-	-	-	-	-	-	-	-	-	-	-	[[	X	X	-	-	-
Establish Woodland Strips	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	[	[[[

Summary of Impacts – X = no financial impact, [= <£500, [[= £500-£2,499, [[[= > £2,500, () = positive impact, - = not applicable

6. Experience of policies and initiatives in England

6.1 Introduction

For this part of the study, IEEP undertook a desk review of relevant literature including economic and other evaluations of past policies and initiatives. This was supplemented by interviews with experts and those running current initiatives.

In overview, past policies for controlling diffuse agricultural pollution by nutrients and silt include a mixture of measures implemented over varying timescales and to different effect. Examples of most kinds of policy approach have been evident.

6.1.1 Regulatory

- The Silage, Slurry and Agricultural Fuel Oil Regulations will have an effect upon diffuse pollution as well as point-source incidents on farms.
- Within Nitrate Vulnerable Zones (NVZs) diffuse pollution by nitrates from agricultural sources is targeted by a range of obligatory and non-compensated actions by farmers, including limits on N, nutrient budgeting, closed periods for spreading manure, designed to reduce N-leaching from farmland.

6.1.2 Grant aid

- The Nitrate Sensitive Areas scheme, designed to reduce N-leaching from farmland, operated as a pilot from 1988-92 and was then incorporated into the England agri-environment programme under EU Regulation 2078/92. However, in 1998 the scheme was closed to new applicants.
- Another agri-environmental scheme, the Habitat Scheme, which involved paying farmers to set aside land for up to 20 years for environmental purposes, included a so-called 'water fringe option'. The purpose of this option was to promote both biodiversity enhancement on the land concerned and also to help reduce certain kinds of diffuse pollution – notably siltation and eutrophication by soil sediments and phosphorus. The scheme was targeted to a small number of river catchments in England. In 1998, the scheme was reviewed and a decision made to incorporate it into the broader 'Countryside Stewardship' (CS) scheme, under which the original target areas now receive priority treatment, but are subject to the wider national CS framework of standard payments and management prescriptions.
- Under the two main agri-environmental schemes in current operation in England, neither CS nor Environmentally Sensitive Areas (ESAs) has a major focus upon resource protection among its objectives or targets. Nevertheless they are likely to be contributing to enhancement of water quality in a range of situations. Likewise, although the implementation of the Organic Farming Scheme is promoting organic conversion without any specific resource protection aims, where farms convert this may reduce diffuse pollution impacts upon nearby water-bodies.

- Within NVZs, farms are eligible for farm waste capital grants principally designed to reduce the risks of point-source pollution from livestock systems. These may also help to reduce diffuse pollution.

6.1.3 Advisory initiatives

- Nationally, a basic level of general advice on pollution control practice on farms is provided under the free conservation advice service operated by FWAG and ADAS on contract to DEFRA. However, the advisers working in this field tend not to have detailed understanding of water protection goals and risks – their main areas of expertise are more likely to be in biodiversity and landscape. In addition, more specific and targeted advice is offered in conjunction with the capital grants for pollution control measures in NVZs, again provided by ADAS through a contract with DEFRA.
- In fulfilling its regulatory role, the Environment Agency provides certain advice and information to farms, particularly those in high-risk areas where agricultural pollution is a significant problem. However, this tends to be reactive rather than proactive and does not cover all farms.
- In addition to the general national services, a number of local area advisory and promotional initiatives have been operating around the country, particularly in catchments where diffuse pollution is recognised as a particular problem requiring imaginative and collective solutions at farm level. Many of these initiatives are supported by a mix of domestic funding (most notably from agencies including the EA and English Nature) and EU funding, often under former Structural Fund programmes. As a result, most such initiatives are time-limited and many will be coming to an end in the near future as the former SF programmes are wound down.

6.1.4 Codes of good practice and other literature

- The Codes for the protection of water and soil include a range of advice and information which is specifically relevant to the control of diffuse pollution from agriculture. While some elements of the Water Code are Statutory – where they concern farmers' obligations under SSAFO and other related regulations – the bulk of advisory material in both codes is purely voluntary. Available evidence suggests there is a relatively low uptake of the detailed advice contained in the codes by farmers; not many have read them in depth and it is widely held that fewer still have acted upon them.

6.1.5 Cross compliance

The two cross compliance measures implemented in England target overgrazing in the uplands and the management of land set-aside compulsorily under the arable area payments scheme. Neither of these measures is designed to tackle diffuse pollution problems but it is possible that either might make some positive contribution indirectly.

6.1.6 Other

Recent studies have placed new emphasis upon the potential role of producer protocols and Quality Assurance schemes in encouraging enhanced environmental management standards on farms. A number of current schemes exist, including the major ‘red tractor’ scheme of Assured Farm Standards, but to date it incorporates relatively few environmental measures within its standards. This situation is likely to change in the near future as AFS is actively seeking proposals for environmental standards that it could take on board.

Table 6.1 summarises the findings from research literature and interviews about these various approaches. The findings are presented in more detail in Section 6.2.

Table 6.1 Summary of past, present and prospective policy instruments in the UK

Scheme	Type & status	Spatial application	Management measures	Successes	Problems	Other
NVZ	Regulatory Present scheme but due for significant extension	Priority catchments Currently covers 8% of England From Dec 2002 - >80% of England	Limits on organic and inorganic N application to crop requirements (requires crude N budgeting), with closed periods on vulnerable land. Improved slurry storage and farm records.	Thought to have led to improved awareness and lower N applications in NVZs	Need to combat farmer scepticism by evidence of effectiveness/need. Very little evaluation currently available. Could exacerbate P loading in some areas	
NSAs	Grant Aid Scheme operated 1990-98 then closed down	High-risk land in priority catchment areas (pre-dated designation of NVZs, applied to areas which were then mostly designated)	*Basic scheme* – continuation of arable cropping, reduced N input *Premium arable scheme* – conversion to grassland *Premium grassland* scheme – extensification, reduction in N input and closed period 1 Aug – 1 Feb	9.9% reduction in N application on NSA land '**90-91,** 18.9% reduction '**91-92.** '92-97: N reducing practices used on 25-75% NSA land depending on practice.'Should have contributed significantly to reducing nitrate concentrations in sources of public drinking water'.	Payments for basic scheme over- compensated farmers. Much higher uptake of basic scheme than premium scheme. Premium scheme payments not seen as attractive despite high levels (.£500/ha). Premium scheme would have given greatest benefits	Dairy farmers found it hardest to comply. Suggested improvements included requirement for whole farm entry, higher value crop options and more feedback for participants.
Water Fringe Area Option of the Habitat Scheme	Grant Aid Scheme operated 1993-98 then merged into CSS	High risk areas in priority catchments – 6 pilot areas defined, across England	General measures – no fertiliser or chemical application, tree/hedge maintenance and no changes to land drainage. Specific measures, different Options: *1* remove land from production *2* extensive grassland *3* raised water levels in ditches	Greatest environmental benefits came from removal of land from production. Cessation of fertiliser application led to a denser more diverse grass sword and less run-off. 'Probably' provided benefits to water quality' (Rossy MacLaren 1998)	Scattered distribution of uptake (especially arable-grassland conversion sites) minimised likely water quality improvements. Effectiveness of the scheme heavily dependent on geographic variables. Uptake levels low in some pilot areas	WF Areas still targeted under CSS but must deliver wider environmental goals. Suggested improvements: more geographically targeted management plans, more efforts to get greater (esp contiguous) uptake

Scheme	Type & status	Spatial application	Management measures	Successes	Problems	Other
Capital Grants Scheme (under NVZ)	Grant Aid Originally national, now only within NVZs, due for major expansion	Countrywide initially, then restricted to 8% of country Future coverage for all new NVZs in future (>80% of English farmland)	Capital grants to enable farms to adopt new technology or improve facilities to deal with storage and handling of farm wastes and other potentially polluting substances. Grant rate limited by EU rules to a maximum of 30% outside LFAs, 40% inside them.	Improved slurry storage. Significant initial take-up, judged to be an effective mechanism for preventing point source pollution.	Take-up has tailed off – may simply mean farmers have bought the equipment they need. Perhaps not promoted sufficiently and grants not generous enough. EA recommends adding further menu items to the range available	Better suited to tackle point-source pollution, not enough on its own to tackle diffuse pollution but can help (eg by increasing capacity of slurry stores to enable observance of longer closed periods).
ESAs and CSS	Grant Aid Current schemes involving annual and capital payments	Priority areas from a landscape /biodiversity or cultural heritage perspective – doesn't target resource protection. c.10% farmland	Payments for maintenance and enhancement of wildlife, landscape and historic features. Includes elements which can help protect water quality eg buffer strips, wetland creation, hedgerow restoration, ditch management, arable reversion	Waterside and other extensive management techniques could provide water quality benefits but these benefits have not been specifically monitored	Scattered distribution of CSS uptake areas reduces potential water quality benefits Few ESAs contain appropriate measures for DP. Relatively high admin costs (c25%), uptake of CSS restricted by budget	Generally attract marginal land/areas on farms, so current payment rates would be unattractive on most productive land. Thus targeting high-risk DP land could be very costly
NAAs	Advisory Initiative run as a pilot, 1990-92, then closed	Priority catchments for nitrates (predated NVZs and targeted similar areas)	Guidance on good practice given to farmers. Farm planning, extensification and reduced fertiliser application were encouraged.	Farmers were receptive to advice - 44-77% changed practices (depending on the practice). Many management practices cost very little or saved money	Level of uptake slightly lower than in pilot NSA incentive scheme and the changes in practice thus smaller.	At the time, the modest but clear achievements of this pilot were underplayed cf the NSA pilot 'success', but they are more relevant today
FWMP	Advisory Current initiative	Catchments in primarily livestock areas, targeted by EA action	Farmer and ADAS adviser draw up map and nutrient management plan to devise management routine to reduce pollution	Useful low-cost measure to promote good practice	Participating farms too scattered to have measurable impact on water quality Only covers waste, not fertilisers or soil	Many suggestions for improved advice and plans, eg integration and training of advisors and clearer written guidance
NVZ advice scheme	Advisory Current initiative	Priority catchments	Information dissemination - guidance booklet and farm visits from ADAS advisors	Farmers mainly felt the suggested practices 'should be done anyway'	Too scattered to have measurable effect	Suggest improved by increased integration with other advice

Scheme	Type & status	Spatial application	Management measures	Successes	Problems	Other
Local Area Init-iatives	Advisory Current initiatives	Targeted to priority catchments and high risk areas within these	Mainly involve local facilitators/advisers, farmer group involvement, experimentation and demonstration	Evidence of significant improvements in practice and nutrient levels in some (eg Tone), popular with farmers, cheap	Constrained by low resources and short-term horizons, would like flexible grants and stronger threat of regulation	Some of the most innovative England experience which should be built upon in future developments
Written infor-mation and ICT pack-ages	Voluntary, most current	General and more specific booklets, wide variety of simpler and more complex ICT packages	Codes of Practice set out best practice for water and soil conservation Booklets give further info on specific issues ICT packages promote farm planning and management	A valuable collection of information and practical tools for enhanced nutrient and silt conservation practices, if farmers can make effective use of them	Generally perceived as too time-consuming to read and/or implement, by majority of farmers, Some materials is lengthy, direct benefits to farmers aren't always clear	On their own, these can only achieve limited change. Require linkage to more immediate and direct incentives to act (positive or negative)
Cross comp-liance	Environ-mental Conditions, currently focused	Country-wide, DEFRA currently working on broader applications	Direct aid payments conditional on no-overgrazing (livestock aid) and environmental set aside management requirements (arable aids)	Not aimed at diffuse pollution but potentially useful tool in certain areas.	Generally seen as complex and bureaucratic to adminster and enforce (might be less so if future conditions simply linked to farm plans)	Not favoured for detailed DP management controls because of monitoring and enforcement difficulties
Set Aside	Regulatory but good compens-ation paid on all set-aside land	Country-wide, currently 10% of all eligible cropland	Removes arable land from production temporarily (1 or 5 years); farmers decide which land to enter, each year, can choose 'industrial set aside' instead – ie growing crops for non-food use	As shown in other schemes – removing land from production can be highly beneficial in controlling diffuse pollution, if suitably sited	Not targeted to where greatest need – benefits incidental, not long-term. May encourage more intensive use of other land. Not ideal for creating buffer strips: min. width 20m.	No monitoring to test the extent of benefits that this might be delivering for Diffuse Pollution.
Quality Assur-ance eg. LEAF, AFS	Voluntary but increas-ingly mandatory for major suppliers to multiple retailers	Potentially country-wide, biggest scheme (AFS) covers 60-80% of production by volume – lower proportion of farmland	Quality assurance specifying higher production standards which provides products of greater value and/or marketing potential. Currently includes relatively few environmental criteria	If environmental standards can be introduced to these schemes, it could help raise awareness of DP and encourage higher standards of management. Cheap to administer because industry policed	Environmental component yet to be achieved. Unclear if industry monitoring will be very strong on the environmental aspects of any label – safety and quality aspects are likely to dominate	Environmental criteria are to be drawn into AFS in near future – too early to prejudge their potential

6.2 Evaluation of past and present policies

This section gives a summary of the information gathered through the literature review and the series of expert interviews. The literature reviewed consists of new and recent publications exploring past and present UK schemes. The amount of empirical evaluation available is limited, but the literature reviewed does include in depth analyses of the Water Fringe Area option of the Habitats Directive (WFA), NSAs and advisory schemes. Expert views were obtained through interviews conducted with experts in the field of diffuse pollution policy, including representatives from, *inter alia*, DEFRA, the National Farmer's Union and the Environment Agency as well as organisers of local advisory initiatives. Interviewees were asked for their views on the various strengths and weaknesses of past and present schemes and to give suggestions for future policy.

6.2.1 Regulatory

Nitrate Vulnerable Zones (NVZs) under the Nitrate Directive

There are currently 66 designated NVZs in England, covering 8% of farmland. In these areas farmers are required to follow a programme of best management practice to reduce nutrient pollution. Farmers are issued with a management guide produced by DEFRA entitled *Guidelines for Farmers in NVZs*, with a support service provided by DEFRA's regional service centres. Farmers then receive a half-day visit from an ADAS advisor to check their compliance with the guidelines and are subsequently sent a tailored set of recommendations.

During 2001, however, the EU took the UK to court over failing adequately to implement the Nitrates Directive. In December 2001, as part of compliance with the ruling of this court case, DEFRA published a consultation paper entitled *How should England implement the 1991 Nitrates Directive?* outlining the two options for reducing nitrate pollution of waters from agriculture. The two options presented by the paper for implementation of the Directive are:

- Option 1: designation of all England as an NVZ and application of an Action Programme across the whole of England, which would provide a more level playing field for market competition between farmers;
- Option 2: designation of about 80% of England, focusing just on those areas draining into water with high nitrate concentrations and/or areas where the balance or aquatic organisms or water quality is, or may be affected (NVZs).

It is intended that the new action plan shall be the same as The Action Programme for England and Wales that came into force in 1998. The main requirements of this Action Programme are that farmers should:

- Limit inorganic nitrogen fertiliser application to crop requirements, after allowing fully for residues in the soil and from other sources.
- Limit organic manure applications to 210kg (reducing after four years to 170kg) of total nitrogen per hectare per year on arable fields and 250 kg per hectare on grassland (subject to EC approval).
- On sandy or shallow soils, ensure adequate slurry storage capacity to allow for annual closed periods (between 1 September and 1 November on grassland and 1 August to 1 November on arable land).

- Keep adequate farm records, including cropping, livestock numbers and the use of organic manures and nitrogen fertiliser.

Mixed opinions were presented by interviewees on the subject of NVZs. Representatives from government bodies were on the whole positive about them, partly because regulatory mechanisms are perceived as being effective and cost-efficient, whereas representatives from farming organisations were sceptical of the whole basis for the measures under the EU Nitrates Directive.

6.2.2 Grant Aid

Nitrate Sensitive Areas scheme (NSAs)

MAFF (1996) gives figures for the effectiveness of NSAs in terms of farmers compliance and fertiliser application. Nitrate reducing practices were actually carried out on 25% to 85% of land on farms entered into the NSA scheme (depending on the farm practice involved). The uptake by farmers of advised changes in management practice was as follows:

- 74% delayed application of first fertiliser and avoided winter application;
- 44% applied less than 120kg/ha of fertiliser in any one dressing;
- 75% sowed autumn rather than spring crops;
- 64% reduced application of manure;
- 55% grew cover crops; and
- 25% minimised grassland sowing.

Under NSAs 1990 to 1991 saw a 9.9% reduction of application of N (kg/ha/yr); 1991 to 1992 saw a 18.9% reduction. Changes were compatible with commercial agricultural systems. The measure most readily adopted was delaying cultivation after oilseed rape/legume cropping. The scheme has resulted in higher levels of knowledge about nitrate issues.

An evaluation of NSAs is provided by '*Nitrate* S*ensitive Areas Scheme Economic Evaluation*' (MAFF 1998). One of the most significant findings was that NSA payments over-compensated farmers for the changes in management practice that they introduced. The study also found that payments were not weighted appropriately and so caused a higher level of uptake of the less effective Basic Scheme than the Premium Scheme. The Premium Scheme involved conversion of arable land to grassland and/or a tightening of controls on management of existing grassland. The higher level of participation in the Basic Scheme was a major constraint upon NSA effectiveness.

The study explored economic and environmental impacts of the scheme.

- Participants experienced an average increase in income of £45/ha. a 1995 evaluation of the pilot NSA scheme recorded an average income increase of £55/ha. The changes in income on participating farms ranged from + £4,960 per farm to - £1,790.
- Participation led to a total reduction of 587 tonnes inorganic N fertiliser application.
- The scheme led to significant adoption of management practices designed to reduce leaching, such as the establishment of 2,300 ha winter crops.

- Participants did not generally enter the whole farm into the scheme, which reduced environmental benefits.
- Participation in the Basic Scheme was much greater than participation in the Premium Scheme. This also reduced the overall effectiveness of the scheme.
- The NSA scheme had **not** significantly altered farmers' attitudes towards the nitrate problem.
- Environmental benefit was often negated to varying extents by intensification of production on areas of individual farms that were not entered into the scheme.
- The report concludes 'the scheme should have contributed significantly to meeting the objectives of reducing nitrate concentrations in sources of public drinking water', but does not give specific data to reinforce this conclusion.

The paper suggested possible improvements to NSAs:

- Whole farm participation should be required, to avoid intensification on unentered land, and/or bonus payments offered to farmers who enter the whole farm.
- Payments should be reviewed in order to make the Premium Scheme more appealing and the Basic Scheme less appealing.
- New high value crop options should be promoted to farms within the scheme to help reduce the economic impact of participation.
- Participants should be given more feedback about the environmental results of the scheme.

The booklet *Solving the Nitrate Problem* (MAFF 1994) contains several papers exploring the nitrate issue, including an evaluation of the Pilot Nitrate Sensitive Areas Scheme, as it was in 1994. It concluded, *inter alia*:

- dairy farms producing cattle slurry found it the most difficult to comply with the scheme;
- loss of nitrates decreased where cover crops were planted as part of the Scheme;
- conversion to grass under the premium scheme resulted in a massive reduction in losses of nitrate from land.

Interviewees raised several positive aspects of NSAs, some believing they were abandoned before they had a chance to show positive results and prove their worth; in some cases real benefits may not have become evident for ten years or more. However the high cost of the scheme, the difficulty of demonstrating direct environmental benefit and its narrow environmental focus were recognised as problems.

Water Fringe Area (WFA) Option of the Habitat Scheme

An assessment of this option is given in *Water Fringe Areas Option of the Habitat Scheme 1994-1997* (Rossy MacLaren 1998). The study included an uptake assessment, vegetation monitoring, water quality assessment (desk study) and water vole monitoring. Results were reported against three performance indicators:

1. quality of bankside vegetation - showed no significant change under the WFA Option.

2. water quality - not assessed due to a lack of available information from the EA.
3. quality of vegetation in adjacent fields - showed positive results.

The report found that management of land under the WFA provided benefits to wildlife conservation value and 'probably' to water quality within most WFAs, with the majority of these benefits arising from the maintenance of, or conversion of arable areas to, extensive areas of grassland.

Other impacts documented in the report are summarised below.

- The management guidelines provide good opportunities for water quality improvements through reductions in agricultural inputs', These would be greatest in areas where farming had previously been intensive, especially where land is removed from arable production and diverse sward structure is allowed to develop.
- The scattered distribution of land that was converted from arable to grassland limited actual water quality improvements from reversion.
- Significant environmental benefits arose from cessation of fertiliser application to grassland and maintenance of extensive grazing, - this was the option that had the highest rate of uptake with the greatest area of land. .Improvements in water quality occur where poaching and overgrazing previously occurred near banksides and where there were regular applications of fertiliser next to watercourses.
- Effectiveness of the WFA is heavily dependent upon various factors arising from geographical location.

The study suggests that environmental benefit from WFA would have been increased if the Option required geographically targeted management plans and could achieve greater (preferably contiguous) uptake.

Capital Grants Scheme under NVZs

There was very little literature available evaluating the Capital Grants Scheme, it was however a topic of discussion during expert interviews. One interviewee reported that Farm and Conservation Grant Scheme (F&CGS) Capital Grants initially had a huge uptake, but that this tailed off as farmers had bought all the equipment they needed. Capital grants were considered best for technical solutions in the form of specific machinery/containers but diffuse pollution is not always amenable to such solutions. While there are a range of ways in which capital investments help to control diffuse pollution, such as covered slurry storage tanks, track improvement and gate relocation, significant reduction also requires widespread change in management practice over and above capital investment. Other problems raised by experts were that Capital Grants were not generous enough, did not cover sufficient items and/or were not promoted strongly enough to farmers.

Environmentally Sensitive Areas (ESAs) and Countryside Stewardship Scheme

As with the Capital Grant Scheme, there is little literature available evaluating ESAs and Countryside Stewardship Scheme (CS) roles in controlling diffuse pollution. ESAs and CS have no specific resource protection objectives and so any positive results for water quality would be coincidental, for example due to conversion of arable land to grass for biodiversity and landscape reasons. Changes in water quality and nutrient output as a result of CS

agreements have not yet been monitored. One interviewee felt that payment rates under CS would not be high enough to compensate for the losses incurred by farmers on removal of high-risk land from production in priority catchments and so would not attract uptake of management measures. CS includes riverside management measures that interviewees felt could help to reduce diffuse pollution, but it is difficult to monitor the diffuse pollution effects of CS because the participating areas are very spread out.

Targeting diffuse pollution through a new 'Broad and Shallow' Agri-environment Scheme

Interviewees believe that if some basic planning and management measures to reduce diffuse pollution were built into a new scheme of this kind it could significantly raise general standards of practice on farms and reduce diffuse pollution. This type of policy mechanism was regarded as potentially very useful for tackling diffuse pollution since this generally requires small changes in practice over large areas of farmland.

It is believed by some experts that the diffuse pollution problem is so widespread, and any control measures would need to be so widely implemented, that grant aid schemes would not have access to enough money to fund the necessary changes. It was also felt that while grant aid is a potentially useful tool it must be used in conjunction with other policy mechanisms in order to combat diffuse pollution fully. Experts felt that the effectiveness of grant aid would be increased by more flexibility so as to allow tailoring to individual farms.

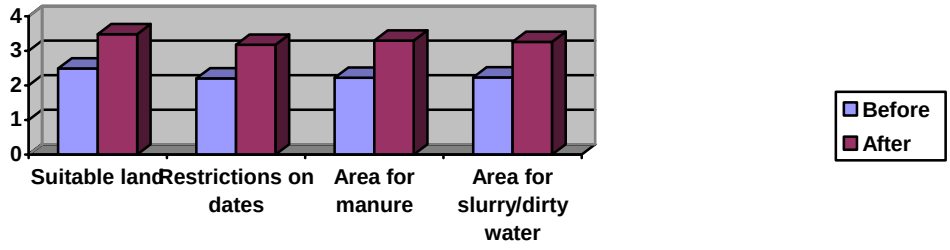
6.2.3 Advisory initiatives

Farm Waste Management Plan (FWMP) advice

ECOTEC (2001) looked specifically at FWMP and the advisory component of NVZs. The FWMP programme has offered targeted advice to encourage farms in high risk catchments to draw up and implement these plans, promoted in NVZ catchments by ADAS through straightforward and accessible leaflets and plans and drawn up in cooperation with the EA. The main findings of the report on the subject of FWMPs are summarised below.

Of the 1211 farmers surveyed:

- 359 had completed a plan (288 on own initiative, 194 for farm assurance, 134 on EA advice);
- 282 had considered completing a plan;
- 570 had not given the scheme any serious thought.
- a large proportion of farms completed a FWMP without using the free advice scheme.



1=poor, 2 = reasonable, 3 = good, 4 = excellent.
From ECOTEC 2001

Figure 6.1 Understanding of information in the FWMP before and after visit

A study was carried out by the EA into water quality improvements resulting from the FWMP areas, but as the monitoring points were far apart any change could not be attributed directly to the scheme.

The study conducted a number of stakeholder interviews, during which the following improvements to the scheme were suggested:

- Advisors should all be part of a national FWMP register of experts and receive training on nutrient management;
- guidance given in the FWMP booklet needs to be clearer eg on gradient of fields;
- move away from farm waste to nutrient planning and link to other initiatives;
- encourage use of Manure Nitrogen Evaluation Routine (MANNER) software programme (ADAS has found that when FWMPs were combined with MANNER they had much higher value to the farmer).

The researchers concluded that 'more focused campaigns aiming at getting 100% take up in a small area, rather than a lower take up over a larger area, would help maximise the environmental benefits'.

Experts interviewed believed that FWMPs form an important part of measures to control point-source pollution.

Advisory measures under NVZs

NVZs are essentially a regulatory mechanism, but in order to help farmers meet regulatory requirements they include an extensive advisory component. The advice given to farmers consists of written advice in the *Guidelines for Farmers in NVZs* booklet and a subsequent farm visit from an ADAS advisor.

ECOTEC (2001) reported the following findings from farmer surveys on NVZ advice.

- NVZ guidelines and MAFF regional service centres were important in recruiting farmers onto the NVZ advice programme.

- Many farmers had introduced few management changes following advice as they regarded management measures laid out in the legislation such as record keeping as 'good practice which should be done anyway by farmers.' However advice had increased their understanding of the NVZ.
- Livestock farms faced the biggest problems with storage and disposal of manure during closed periods. Without grants for storage facilities or free visits to help devise FWMP some participants adopted negative practices. One farmer commented that 'by following NVZ regulations in isolation, it is encouraging me to spread on fields not related to the protected groundwater, but which might have a greater impact on a nearby river'.
- Farmers perceived the NVZ designation process as inadequate (as it was often based on information that was eight or so years out of date) and the effectiveness of NVZs debatable. The credibility, as perceived by farmers, of the zones was also undermined by the slow impact of any changes on groundwater.
- Several farmers believed that taking advice should be compulsory to help raise awareness of regulations and support compliance.

The following suggestions for improvement in advisory services were made during stakeholder interviews.

- The need for integrated visits and training for EA inspectors, so they could monitor these aspects when on-farm, and point farmers in the direction of further advice.
- Improvements of MAFF datasets for NVZs and increased use of local advisors.
- Guidance booklets need to be clearer and more accessible, especially on issues such as field gradients and soil types.
- Good record keeping needs to be promoted, possibly supported with computer software.

Nitrate Advisory Areas

The Nitrate Advisory Areas scheme (NAA) offered farmers advice on good agricultural practice. The purpose of the scheme was to determine whether or not farmers could make enough changes to their systems in order to have a significant impact on nitrate losses, without financial detriment to their business. All farms within each NAA were visited to discuss details of current management. Farmers were then sent a detailed set of field-by-field recommendations. A year later, farms were revisited to assess what changes had been made and any reasons for not following advice. This found the following:

- Prior to the initiative many farmers had been over-applying N because they were not allowing for N content of organic manures and ploughed out grass and many farmers had been over-applying fertiliser to potatoes.
- Farmers were receptive to advice even though there was no financial penalty or incentives. They complied with advice in 44 to 75% of the area involved (depending on management measure).
- As expected, changes achieved under this exclusively voluntary scheme were smaller than those achieved under the NSA grant scheme.

Assessment of techniques for persuading farmers to adopt nitrate-reducing practices

(MAFF, 1996) used a broad farm survey to assess:

- Codes of good agricultural practice
- Nitrate Advisory Areas (NAAs)
- Pilot Nitrate Sensitive Areas (Old NSAs)
- New Nitrate Sensitive Areas (New NSAs)
- Farm Waste Management Planning (FWMP)
- Minimal Impacts Dairy Schemes (MiDaS)

It explored the effectiveness of these measures in changing farmers' perceptions, raising awareness of issues and persuading farmers to change their management practices.

Knowledge levels were assessed by asking respondents to answer ten true or false questions on 'good agricultural practices'. Knowledge scores varied by scheme and ranged from an average of 70% for farmers participating in FWMP, to 86% for those who had partaken in the Old NSA scheme. Acceptance of the nitrate problem and adoption of pollution reducing management techniques depended to a large extent on farmers' perceived reliability of information sources. The report, while exploring techniques for disseminating information to farmers, stresses the importance of information exchange in attempts to control diffuse agricultural pollution. It is crucial for farmers to have a good understanding of technology and management techniques and to be able to calculate nutrient balances for themselves.

The report's main findings were as follows.

- 26% of farmers surveyed made use of consultant advice to conduct nutrient calculation but 25% did not even estimate nutrient levels.
- There was a relatively high level of awareness about nitrate leaching issues among farmers was observed but this was not necessarily accompanied by good practice.
- Overall Old and New NSA schemes (grant aid) have resulted in higher knowledge and information seeking levels, more positive attitudes and better agricultural practices among the farmers surveyed than purely advisory schemes.

Software

Over the past decade or so several IT packages have been developed by MAFF and other organisations to aid farmers in resource management and thus help to minimise diffuse pollution, mainly by nitrates. Those listed in MAFF, (1999) were:

- MANNER (Manure Nitrogen Evaluation Routine) developed in order to provide more detailed guidance on N availability and losses following application of manures and fertiliser;
- FERTIPLAN a computerised version of the MAFF Fertiliser Recommendations Booklet which allows estimation of manure production based on livestock numbers;

- WELL_N a fertiliser N recommendation system developed by Horticulture Research International, mainly used by horticulture consultants;
- SUNDIAL-RFS a dynamic fertiliser recommendation system made by the Institute of Arable Crops Research to follow changes in soil/crop system as they occur;
- NFERT based on a visualised model of grasslands system NCYCLE, estimates production and nitrogen loss pathways for grassland. Allows data to be tailor made to a system with specific production outputs of environmental specifications, primarily used by grassland farmers;
- MAGPIE a modelling system for assessment of nitrate pollution at national and catchment level from diffuse and point-sources.

More use of software packages was favoured by most interviewees. There were some doubts as to whether the majority of farmers would have the time, skill or inclination to use complicated computer programmes but the general consensus seemed to be that they would if the packages were kept simple. EMA (Environmental Management for Agriculture), a software package funded by MAFF (now DEFRA) and produced by the University of Herefordshire Agriculture and Environment Research Unit (AERU) was praised by some. However, this was unknown to other interviewees, including representatives from farming organisations.

There was a sense among experts interviewed that for advisory initiatives to be used to their full potential something of a sea change of opinion would have to happen within the farming community. There is a concern that farmers are not currently accustomed to keeping up to date with new knowledge and learning about new technology, which was seen by experts as one of the best ways to improve farmer efficiency and reduce pollution.

The level of farmer trust and involvement are seen by experts as being of great importance in taking up advice. In order for participation levels to improve farmers have to feel that they are involved in the process. Advice should therefore be tailored to the needs of individual farms and should be designed to give farmers a proactive role. Any individual farm plans should be drawn up in cooperation with farmers. The use of other farmers within advisory initiatives is as a very powerful tool as it boosts not only trust and interest but also a sense that farmer expertise and experience are being taken into account.

EMA is an award-winning software package that is designed to be user-friendly and is relatively cheap (thirty pounds). It is designed for use by farmers as well as advisors and contains three systems:

a technical system with -

- a range of databases;
- calculation programmes for fertilisers, pesticides and other chemicals.

an advisory system with -

- a library of all the Codes of Good Practice, legislation and practical information;
- assurance scheme information;
- a full index of information and industry contacts.

an evaluation system with

- an auditing programme for farm practices;
- a reporting programme for environmental performance;
- an emissions inventory.

Its distribution in 2000 was only 1600 copies, of which 42% went to farm advisors and only 32% went to farmers themselves.

Figure 6.2 Environmental Management for Agriculture (EMA)

Co-ordination of knowledge and advice was repeatedly stressed as an area desperately in need of improvement. There is concern that there is a significant amount of duplicate research and that different bodies are sometimes giving conflicting/overlapping advice in the field of diffuse pollution. Forty years ago, most on-farm advice was delivered by ADAS, now there are many different advisors visiting farms and there some frustration at the conflicting advice that is apparently being given. Several interviewees suggested that farm advice should be co-ordinated and delivered by one person with a broad range of knowledge rather than several different specialist advisors. This would increase not only farmer satisfaction and hopefully participation in pollution reducing schemes, but it would also increase cost-efficiency for the agents involved. Care would have to be taken, however, not to give too much information at any one time in order to prevent farmer overload.

6.2.4 Local advisory initiatives – recent experience

The Hampshire Landcare Project

Landcare is a pilot advisory initiative funded by the Environment Agency (EA) aiming to provide advice to farmers on better practice to reduce pollution from run-off from agricultural land. It is currently being run in the upper Hampshire Avon catchment. The Avon catchment covers roughly17,000 km^2 and the Landcare initiative covers roughly 950 km^2. There are approximately 350 farmers living in the Landcare area.

The first key step of the initiative was communication to farmers of the diffuse pollution problem and the role of agriculture in causing it. This very important as many of the farmers, particularly those further from watercourses, were very unaware of the impacts that they have.

Landcare has been mainly used demonstrations and farmer workshops. This format was used rather than one-to-one farm visits because they are more cost effective, but more importantly because farmers had expressed frustration that their own experience is not drawn upon in one-to-one visits and that the advice given in such visits is often impractical. Landcare is also liaising with other advisors with a view to providing more integrated advice to farmers as they also expressed frustration at receiving conflicting advice from different sources such as RSPB on wildlife, English Nature on habitats and the Environment Agency concerning water. Integration would also save time, money and other resources. Farmers have been complimentary about the advisory aspect of the Landcare project and are taking an -active role in it.

Landcare has explored other means of helping farmers to reduce run-off including a ‘toolkit’ guide to the various codes of good practice that have been produced. This was funded by English Nature and distributed to farmers. One code covered in the ‘toolkit’ was the Soil Code which a significant number of the farmers said they had never seen before (Bryson, 2001).

Landcare started with a broad partnership of key stakeholders including farmer interest groups, a fisheries interest group, Wessex Water and others. In hindsight EA believe this was too broad and has discouraged some farmers from participating and that future initiatives should have a stronger core farming partnership eg involving NFU and CLA.

Hereford Wye and Lugg initiative

There are currently three initiatives managed by English Nature in the Wye and Lugg catchment area in Herefordshire.

There is an agri-environment land management initiative, the Wildlife Enhancement Scheme (WES) along the River Lugg aimed at wildlife enhancement through reduction of soil and nutrient pollution. The main changes in management practice include the use of buffer strips of variable sizes (up to 20 metres in width) and use of fencing around watercourses. It is a £30,000 project covering about 8km of river. There is also a pilot project, run in conjunction with FWAG, using whole farm management plans as a means of encouraging farms to participate in the agri-environment measure.

Perhaps the most innovative initiative is a pilot advisory initiative, again run in conjunction with FWAG, which focuses on the development of whole farm nutrient budgets. The main aim of the project is to determine which management practices are most effective for reducing diffuse nutrient pollution. It also hopes to start to spread the message among farmers that it is possible to save money and reduce nutrient pollution at the same time. The project is primarily involved with setting up nutrient budgets at farm level and giving farmers advice on managing these budgets. It is a three-year project in its second year and currently has 18 participating farms.

The methodology for generating the whole farm nutrient budgets is based on a continental method for assessing nutrient input and output at a farm scale. It is a 'crude' methodology that allows nutrient budgets to be drawn up quickly and simply which indicates general trends. The system uses a set of indices and tables giving standard nutrient levels for certain crops or livestock eg 2000 tonnes of wheat or a certain number of cattle raised to a specific weight. Unlike 'Landcare', one to one advice is given by FWAG advisors on farm visits.

The pilot nutrient budget project has so far focused on P surpluses and has found that phosphorous surpluses on some farms are as much as 60-70%. The nutrient budgets calculated by EN for this study have shown that the trend for over-application of P is increasing. The P pollution problem is compounded by the use of poultry manure, as it is much higher in P than N so if a farmer calculates applications based on N levels it will result in over-application of P. Over application of P is a problem for all manures, but more specifically for poultry. Poultry manure and litter are so nutrient rich that it is difficult to spread them thinly enough to avoid exceeding nutrient levels.

The project aims to demonstrate what farmers could do to reduce their nutrient output. As there are only 18 farms in a large catchment area and nutrient budgets are only calculated at the farm level this initiative will not yet have a demonstrable effect on water quality. By the end of the three-year timespan EN hopes to identify what rate of adoption of beneficial management practices would be needed to improve on water quality.

River Tone Project, Somerset

The River Tone Catchment Project is a partnership project between FWAG (project co-ordinator), EA and the Somerset Wildlife Trust. It is a farmer-led project started in 1998 funded on a yearly basis by EA (£8,000) and Somerset County Council (£2,000) as well as receiving a small amount of funding from Landfill Tax. Some farms in the project area have

been able to receive funding under the Countryside Stewardship. It was initiated because it was evident that there were considerable problems with pollution by silt in the area but no significant research had been done into the problem or how to solve it. The project aims to find out what the problems are, where they are occurring and how to deal with them. The catchment area is home to roughly 300 farmers, but only 30 of these are thought to be a highly significant source of nutrient and silt pollution.

Measures under the scheme are essentially advisory but FWAG has made use of incentive payments, from the sources described above, and regulatory mechanisms, such as the threat of action from the Highways Authority for soil erosion onto roads. The first communication of the project to farmers in the local area was a mailshot of a simple leaflet giving farmers basic information about the project. This did not prompt significant feedback but acted as a precursor to contact by the field officer. In order to achieve a high level of participation and cooperation project organisers were careful to choose a field officer who was well known and liked among the farming community and so would get a good response and command sufficient respect and trust. The first field officer was a farmer from the local area, the second (replacement) is an agronomist who has worked in the local area for some time.

FWAG feel that the following lessons can be learned from the River Tone Project:

- one approach will not convince all farmers - some will cooperate with voluntary schemes, some respond to incentives and others will not change management practice unless confronted with regulation and/or penalties;
- even when awareness has been achieved it is still difficult to turn this into action;
- demonstrations have a crucial role in persuading farmers to change their management practices, but demonstrations in isolation are not enough, they must be accompanied by one-to-one advice carefully tailored to the area and individual farm needs;
- agronomic experts need to be involved in determining suitable farm plans;
- a range of suggested management practices is needed - a one size fits all approach will not work;
- true partnership with the local community is crucial to the success of such projects;
- co-ordination of knowledge between different authorities and organisations is essential, in the case of the Tone project an important example is the establishment of a joint database (by the County Council) to record any action taken by the different agencies involved;
- it is important to build a network of important local actors;
- communication must be carefully considered, the project found that one leaflet had a negative effect on farmer acceptance of the project as they felt that it was both patronising and confrontational about the issue of soil erosion;
- advice alone has already had important, measurable results in improving water quality. However the project partners believe that a locally-designed grant-aid package delivered alongside the advice would significantly increase results;
- there are limits to the effectiveness of standard national grant-aid packages (CS) – its contribution is helpful but not as much as the local advisory and follow-up work.

6.2.5 Codes of practice and other literature

Resources developed by MAFF/DEFRA over the past decade include:

- Booklets entitled *Managing Livestock Manures, Opportunities for Saving Money by Reducing Waste on Your Farm*, and *Codes of Good Practice for the Protection of Water, Air and Soil*. A database of the available N content from different manures was also compiled, which provided the basis for guidelines set out in the MAFF Fertiliser Recommendations booklet. DEFRA produced a series of three advice booklets for farmers in existing NVZs entitled *Guidelines for Farmers in NVZs, Manure Planning in NVZs* and *Farm Waste Grant Scheme*.
- A variety of research reports, eg *Solving the Nitrates Problem, Reducing Nitrate Loss to Water from Agriculture, Managing Livestock Manures, Farming, Fertilisers and the Nitrate Problem, Nutrient Budgets for Arable Farms* to support farmer workshops going on around the country (MAFF 1999).

Codes of Good Practice

Experts believe that Good Codes of Good Practice have been produced for Water and Soil which are very relevant to the control of diffuse pollution, but they need to be simplified so that they do not end up unread and put to one side. Interviewees report that farmers are generally negative about the Codes of Good Practice or are simply not familiar with them. As with all written information, they will only be used by those who have sufficient time and a good reason to read them.

6.2.6 Cross-compliance

Many experts believe cross-compliance to be an overly complex mechanism to apply to diffuse pollution control and felt that extended use of cross-compliance would just add to the bureaucratic burden on farmers and the government in this area. This analysis of the mechanism does depend on what cross-compliance is used for and how any specified management change is enforced (which is a problem for any regulatory approach). In relation to diffuse pollution one problem is that it would be difficult to enforce a whole farm plan through cross-compliance when only part of the holding is IACS registered.

6.2.7 Set-aside

Again although set-aside is not targeted at reducing diffuse pollution it is a potentially useful tool. A recent EFMA (European Fertiliser Manufacturers Association) report suggests it may be important in helping to reduce nutrient pollution. DEFRA has just launched a package on multi-annual set-aside areas to make them more conservation and environmentally friendly. Set-aside can be valuable for many other environmental objectives if positively managed.

6.2.8 Quality assurance

Assured Food Standards (AFS, the ‘Red Tractor’ label) is working with LEAF (Linking Environment and Farming) and others to raise environmental standards within its quality assurance programme. Such environmental criteria would raise product quality above the current legislative standards in relation to diffuse pollution risks. This is potentially a good way of getting farmers to adopt environmentally friendly practices as it would be industry

accredited, although there are concerns over the extent to which AFS can check compliance in a meaningful way. Also, although the Red Tractor scheme currently covers between 60-80% of production in the main sectors it covers a smaller percentage of farmers and misses out a lot of small farmers who cannot afford to meet the relevant criteria.

AFS is about to commission a gap analysis on AFS and environmental needs. As part of this work, there will be a stakeholder meeting to assess a set of common environmental standards that may be adopted by AFS in the near future.

6.3 Conclusions of UK experience with past and present policy

The majority of conclusions drawn by interviewees focused upon the need to improve farmer understanding through knowledge transfer, and increase active farmer participation in the management practice decision-making process. Specific suggestions included the following.

- Technology transfer should be encouraged and would be more successful if kept simple, compiled into accessible forms and alongside increased coordination of advice/advisors.
- Farmers should be more involved in decision making, giving advice and demonstrations to other farmers. Local facilitators and 'farmer ownership' would boost participation.
- Codes of Good Practice and other written information sources need simplification.
- Environmental criteria in farm assurance schemes should be a target, especially AFS.
- Agri-environment schemes could include measures to deal specifically with aspects of diffuse pollution, such as nutrient budgets, soil protection techniques and appropriate land use to limit run-off.
- There should be more promotion of integrated farming in NVZs.

Both experts and the literature support the creation of packages of policy mechanisms, eg using initial grant aid to meet extra costs incurred from the conversion of management practices, followed by simple regulation/standards which ensure that new practices are maintained, and supporting both with promotion and advice.

From the local area initiatives in particular, we draw the conclusions that:

- many issues of diffuse pollution require a significant promotional effort to farmers, if they are to be taken seriously;
- at local level, a mix of detailed technical advice and demonstration, flexible and locally-tailored grant aid, and the potential threat of action via a regulatory approach is probably the most effective combination of policy instruments to tackle issues in priority areas.

7. Experience of schemes in Europe and the USA

7.1 Introduction

Within the past two years, IEEP has undertaken two major studies of different countries' approaches to tackling diffuse pollution, including diffuse pollution from agriculture (Farmer et al, 2000, Baldock *et al*, in press). These studies examined policy approaches in a range of EU Member States as well as further afield, including the USA. This section of our report summarises the findings of these previous studies and examines some issues of relative effectiveness in policy implementation, in relation to these findings and based upon further discussion with experts in each of the countries concerned.

7.2 Overview of policy approaches

Among the EU Member States and the USA one finds a broad spectrum of policy approaches for tackling diffuse pollution by nutrients and silt from agriculture. These range from countries where the approach is very strong, comprehensive and regulatory, such as the Netherlands, to others where the emphasis is predominantly upon voluntary action, supported by a mixture of advice, co-ordination and promotion, and certain kinds of grant aid, as in France. The USA is an interesting example where a contrasting approach to property rights and agricultural policy measures has led to an emphasis upon economic instruments (tradeable permits) as well as widespread cross-compliance through the 'sodbuster' soil conservation programme.

In part, the differences between countries reflect the relative severity of pollution problems associated with agriculture. The Netherlands is a country with particularly intensive livestock production sectors for dairy, beef, pigs and poultry, and with the highest average stocking rate of all EU Member States, at 3.9 LU/ha. The entire Dutch territory was designated as a Nitrate Vulnerable Zone under the Nitrates Directive and farmers have been subject to fairly stringent controls on manure production and use for more than a decade. The Netherlands also produces more manure per hectare than any other country in Europe, at five times the EU average, and thus phosphorus pollution problems are also significant. By contrast, although there are particular regions in France with significant 'structural surpluses' of manure and other nutrient sources (most notably Brittany), across the country as a whole the issue of diffuse pollution is not seen as a major concern.

A rough indication of the relative significance of diffuse pollution among the Member States is given by their approach to implementing the Nitrates Directive. In this respect, Belgium, Denmark and Germany have taken a similar approach to the Netherlands by designating their entire territory as NVZs, while the designated areas in Sweden and Finland also cover a significant proportion of total agricultural land (which however is a minority of total land area). Relatively smaller proportions of land have been designated in most other EU countries but these often contain highly intensive agricultural systems – such as the intensive horticultural enterprises along the Mediterranean coastal strip in southern Spain. Here, high levels of chemical inputs combined with over-abstraction of water for irrigation are leading to severe problems of nutrient and other pollution in ground and surface waters.

However, this indicator of diffuse pollution problems is not entirely reliable, as there are some Member States – notably Ireland – who have yet to designate NVZs. Furthermore, this indicator ignores the phosphorus issue. In Ireland in particular, phosphate pollution from agriculture is the subject of a significant policy strategy, indicating its relative importance in this country.

It is also worth noting that in all countries, the importance of advisory and promotional support is highlighted, in tackling diffuse pollution effectively. This is the case whether advice is coupled to the application of regulations or incentive mechanisms, whether it is promoted on its own as an important policy initiative, or whether it is linked to market-driven developments including farm assurance standards and organic farming targets.

From Baldock *et al* 2000, the list below summarises the mix of approaches found in EU countries, by comparison with the current situation in England.

- The further development and implementation of Codes of Good Agricultural Practice.
- Greater application of mineral accounting systems and farm plans designed to regulate nutrient use.
- Some growth in the use of both mandatory and voluntary measures to control nutrient pollution, many of which are linked to the introduction of action programmes for nitrate vulnerable zones.
- Considerable growth in the use of agri-environment incentive schemes to promote a range of practices including organic conversion, lower input arable farming, buffer zones etc.
- The use of taxes and levies in a small number of Member States.

7.3 Selected examples of particular potential relevance to England

Bearing in mind the findings of the previous section on domestic experience with policies for diffuse pollution control, we have identified a number of examples of instruments and packages in different countries that have lessons to offer future policy development in England. These examples are as follows.

1. Approaches to mineral budgeting, planning, application limits and disposal of manure surpluses in the Dutch regulatory system;
2. the Irish experience with phosphates and the Rural Environmental Protection Scheme;
3. approaches to ensure best practice in the storage and application of manures to land in the Finnish General Agri-Environment Programme (GAEP);
4. advisory, self-help, incentive-based and promotional approaches pursued through the ‘fertimieux’ initiative and new integrated agri-environment and farm development measures – the CTEs - in France;
5. conservation planning through the sodbuster programme in the USA, as well as some local area experience with collective action and tradeable permits.

Each of these is now discussed in brief, highlighting aspects of particular relevance to the policy context and problems to be addressed in England. Table 7.1 summarises the results of this evaluation, while the subsequent text gives further details of each example.

Table 7.1 Summary of schemes in the EU and USA

Country	Scheme	Type	Scale	Management Measures	Strengths	Weaknesses	Other
Netherlands	MINAS	Regulatory	Farm-level country-wide (35% farms, 50% livestock farms). Coverage will increase in future	Limits per ha for surplus N and P – levies applied if limits exceeded. Limits are lowered over time Mineral accounting compulsory Levies charged on surplus manure	No direct monitoring: modelling suggests significant pollution reduction: from 15 – 80% depending on modelling method used Does not require extra paper work from farmers since accounts already 'standard practice' on these farms Cost of compliance relatively low to date	Significant administrative burden – Ministry now seeking alternative less rules-based approaches Levies not high enough, do not affect enough farmers to achieve results; many farmers do not pay	Introduced in 1998 – little data available. EFMA expects a significant reduction in use of fertiliser as a result of the scheme. From 2002 farmers producing excess manure have to secure contracts to transport it off farm or reduce cow numbers – unpopular
Ireland	National P Reduction Strategy	Strategic	Local authority level Country-wide	Authorities had to submit plans detailing how they intended to meet targets set out in the regulations	Addresses forestry and other sectors as well as agriculture – includes some direct restrictions		Expected to be addressed via byelaws (see next box)
	Local Authority Byelaws	Regulatory	Local authority level, most likely to implement: 16 plan to implement, 7 are still assesring need	County councils can introduce requirements for nutrient management plans on all farms. REPS plans will qualify.	Can cover all farms, not just those in REPS Considers pollution over larger area – eg water abstraction a long way downstream	Cannot prosecute on basis of no implementation Cost of preparing plan must be met by the farmer	Not yet implemented – likely to be established within next few years may encourage more farms into REPS
	REPS	Grant aid and training	Farm-level, Country-wide Currently agreements cover a third of total farmed area	Farmers must follow farm nutrient plans (drawn up by certified planner), attend compulsory training to help them meet scheme requirements	Popular with farmers (45,000 farms in) but new scheme less so (2000) than old ('93-99). Improved water quality and P status	Only includes farms that apply for participation Does not take distance impacts into account	Improvement in water quality first seen for 30 years. Agriculture responsible for c70% of nutrients entering waters
Finland	GAEP	Grant aid	Country wide (applies to 80—90% farmland)	Whole farm scheme 1environmental planning 2 fertiliser limits 3 plant protection rules 4 conservation headlands and buffer strips 5 maintenance of biodiversity and landscape Additional measures with additional payments (over 5-10 yrs)	Increased accuracy of fertiliser use, lower application rates shown. Modelling predicts significant N leaching reduction, reduced particulate P but increased dissolved P. Popular with farmers, cheap to run, high uptake means catchment scale effect	No demonstration projects or training facilities are included in the scheme – farmers have to pay to receive advice to help them prepare plans, etc	The scheme is generously funded and an important source of income support to farmers, so payments under the scheme merit farms taking external, paid advice when joining up.

Country	Scheme	Type	Scale	Management Measures	Strengths	Weaknesses	Other
France	CTE	Grant-aid and advice	Farm-level, country wide Covers 3% of agricultural land in France; regional variation in uptake Water quality objectives included in plans	A range from a 'menu of options' are selected at Departemental level in conjunction with local farmers 55% of contracts involve measures to reduce water pollution.	Large menu of options tailored to local needs Farmers obliged to implement environmental items to qualify for investment /diversification items Promoted in some areas through group schemes	Complex admin. Slow uptake due to learning curve requirement for local implementers Management plans may be intensive (2-5 days advice) High workload for local technicians	Too early to judge results RDP predicts that expenditure will be 4,300 million Euro between 2000-2006
	Ferti-Mieux	Advis-ory	Group action in local areas Priority catchments for N pollution 49 groups established, covering 1.9m ha	Nutrient management 'rational use' programme using local advice, group discussion and experiment to identify and apply better management practices. Label for groups who can demonstrate significant changes in farm practices – offers reduced regulatory costs, marketing potential.	Has reduced fertiliser use and area of soil left bare over winter. Real pollution reduction demonstrated in 2/3 project areas. Fairly cheap to run - £60,000 per area, from national and local partners funds and in-kind contributions	Focused on nitrates to date, just beginning to tackle phosphates, soils and pesticides.	Educational value: pioneering a new, more environmentally aware, partner orientated approach to agriculture. Emphasis on hearts and minds – farmer ownership, participation and design
USA	Conservation compliance	Cross compliance	High risk areas in priority catchments (highly erodible land) 10% of US cropland – all mapped under law	Production subsidies conditional on compliance with environmental criteria – in particular, all farmers with HEL have to have an approved soil conservation plan in place for this land.	Management measures generally low cost to farmers Data suggests large reductions in soil erosion as result of the scheme Non-market economic benefits $1400 million	Only deals with soil erosion, no particular focus on nutrients	Non-compliance very low (,5%), few cases prosecuted.

7.3.1 Netherlands

Due to the intensity of agricultural practice and particularly livestock production, the Netherlands has suffered some of the worst pollution levels in the EU. The most significant concern has been high nitrate and phosphate concentrations in fresh waters which have been held attributable to the vast quantities of manure produced from intensive livestock farming.

Manure and slurry is generally spread on fields and leaches into freshwater systems. Dutch soils are thought to be heavily contaminated with nitrate and some are saturated with phosphates. It has been recorded that on average, use of nitrogen on grassland was 679kg/N/ha in 1993. It is also estimated that agriculture's overall contribution to surface water pollution (from the application of organic and inorganic mineral inputs) amounts to 40% of total phosphate pollution and 56% of total nitrogen pollution (Smit 2000).

A family of measures to reduce water pollution include an increasingly strict manure policy, stringent mineral accounting systems and a 20% cut to the country's pig population; targets laid down in national action plans to reduce diffuse pollution, and commitments under the North Sea and Rhine Action Programme (MANMF). However, the Dutch Ministry predicts that EU freshwater quality targets under the Nitrates Directive will not be reached for at least two more years.

Manure policy

The Dutch use a range of regulatory and technical measures to reduce the over-application of livestock manure, inorganic fertilisers and in general to reduce nitrate and phosphate diffuse pollution. The first policy measures were introduced in 1986 and have been implemented in phases from 1987 to 1999. Farmers have been placed under increasing obligations to:

- limit manure production;
- reduce the use of fertilisers in order to prevent saturation of soils by nitrates and phosphates;
- replace (to a degree) inorganic fertilisers with manure application and balance application rates more closely to the absorption capacity of land.

To prevent increased manure production farms have quotas called 'manure production rights', some attached to the land, others not. The government aims to reduce 25% of country's total manure production in 1996 by 2002 by siphoning off these quotas. The total yield of this siphoning operation is estimated at 10 million kg of phosphate, and it will be funded from a dedicated government fund.

Farm level restrictions have also been set on the maximum amount of phosphate which can be applied in the form of manure. In 1995 these were set at 150kg/ha for grassland and 100kg/ha for arable land. In 2000 these were tightened to 85kg/ha for all land and from 2002 this will fall to 80kg/ha.

In addition, the law bans the spreading of manure and other organic wastes from 1 December – 28 February (unless manure is ploughed under soil within 24 hours of application). Farmers have to cover their manure heaps, silos and storage tanks. A minimum storage capacity of 6 months will be compulsory for all farmers by 2002. There are also severe restrictions on the

further expansion of the livestock population and a compulsory generic reduction of the pig population by 20%.

Perhaps the system of most interest to England is MINAS – a farm-level minerals accounting system, which sets limits per hectare for surplus nitrogen and phosphorus or so-called 'mineral loss standards'. If the standards are exceeded levies apply. The system covers both artificial and organic fertiliser sources and is compulsory for pig and poultry farmers, mixed cattle and pig farmers, intensive cattle farmers with a density of 2.5 LU or more per hectare, and arable farmers. In practice, this represents approximately 35% of all farms and 50% of all livestock farms.

These farms are required to keep mineral accounts and to adopt mineral accounting procedures. Accounts are inspected annually. Thus, each year farmers must work out the extent to which the mineral content in manure produced and inorganic fertiliser used on the farm exceeds the land's capacity to absorb it safely. Where 'significant excess' loading is calculated, manure must be taken off the holding to be used on farms elsewhere or to be stored and treated in regional waste plants. In 2003, new legislation will require livestock farmers who exceed their quotas to reduce cattle numbers in proportion to the amount of excess manure produced.

Limits: Surplus nitrogen in 1998 was not to exceed 300kg/ha on grassland and 175kg/ha on arable land. In 2000 these figures were both reduced by a further 25kg. In 2003 it is anticipated that surplus restrictions for nitrogen will be reduced to 100kg/ha on arable land and 175 kg/ha on grassland. For nitrate vulnerable zones (NVZs) the maximum nitrogen surplus will also be reduced to 50kg/ha. Maximum surplus phosphate limits in 1998 were 40kg/ha, in 2000 were reduced to 35kg/ha and in 2002 to 25kg/ha.

In 2002, the livestock density at which mineral accounting must be carried out on a farm lowered to 2.0 LU/ha. Farms with 1.5 to 2 LU/ha are encouraged to reduce their mineral losses voluntarily. However, the situation will be monitored and in 2005 a decision will be made as to whether minerals accounting should be introduced for this group as well.

The mineral accounting system was developed jointly by the agricultural union and government. It has the advantage of not requiring extra paperwork from farmers – in contrast to the UK, monitoring and calculating input and output values is an established feature of farm paperwork in the Netherlands. However, the administrative burden of the system is significant.

Farmers pay part of the cost of the system via a levy on surplus manure. For all excess nitrate and phosphate produced, farmers may be charged for its disposal. The mineral levy penalises excessive use of nitrates, but is more selective than a general tax on nitrate fertiliser and has a number of advantages in economic and environmental terms. Discussion with experts suggests that the levy has had a strong educational effect on farmers, leading to improved efficiency in nutrient applications. However, its administrative costs have been fairly high.

There are also operational problems with the levy. Currently, the surplus limits on nitrogen and phosphorus are estimated to enable as many as 90% of farms to avoid paying any levy, because arable farmers continue to provide a good outlet for excess manure production. Those farmers who are obliged to pay face payments of 2.5 guilders/kg/ha of phosphate and

1guilder/kg/ha of nitrogen, which is not a significant financial burden. However, many refuse to pay the levy - in 2000, only 14% paid up - and many court cases are outstanding.

As MINAS was introduced in the Netherlands in 1998 there aren't as yet any empirical data on the environmental effects of the scheme. Modelling studies on the possible effects have been undertaken however and a summary of these is presented in the table below. The European Fertiliser Manufacturers Association (EFMA) expects there to be a significant reduction in the use of fertiliser in the Netherlands between 1998/99 and 2008/9; more than 20% decrease in use of N, more than 30% decrease in use of P, but about 5% increase in use of K (ECOTEC, 2001).

Nieuwenhuize *et al* 1995 (cited in *ibid.* 2001) showed that 41% of Dutch dairy farmers can improve their profits by decreasing fertiliser application by 13% (on average), and almost all Dutch dairy farmers should be able to reduce feed input without financial loss. They thus judged it likely that compliance would be high as the cost of compliance is low.

Table 7.2 Results of modelling studies on the possible environmental effects of a system of levies on mineral surpluses

Study	Levy-free amount/ha	Levy/kg N (Dfl.)	Sector	Change in pollution
Berentsen and Giesen (1994)	200 kg N	4.00 (1.82 EUR)	dairy	-17 to –47% surplus
Baltussen (1992)	200 kgN/90 kg N	2.00 (0.91 EUR)	dairy/arable	-15 to –32% surplus
Oude Lansink and Peerlings (1996)	75 kg N	0.27 (0.12 EUR)	arable	-7.8 kg N/ha surplus
Fontein *et al.* (1992)	300 kg N	4.00 (1.82 EUR)	dairy/pigs	-40 to –80% emission
Polman and Thijssen	not applicable	1.00/2.00 (0.45/0.91 EUR)	pigs	-50 to –75% emissions

From ECOTEC 2001, p. 39.

Future developments

In a new development from 2002, farmers who produce too much livestock manure for their own land to absorb have to transport their surpluses off the farm by entering into contracts with arable farmers or manure processors. Those who cannot agree such contracts will have to reduce their livestock numbers. This change in policy has been heavily criticised by farmers because by setting a deadline of 1 January 2002 for agreement of these contracts, the government created a distorted market and potential manure purchasers held out for very high prices until the last minute, conscious of the deadline. Reports in *Agra Europe* indicated that prices began to fall in December but there remained much concern that not all contracts would be concluded by the deadline. In response, the Minister confirmed his intention to act swiftly to penalise all farms without contracts in place in early January.

As an alternative to the current administrative and regulatory burden due to these policies, the Dutch government is investigating the possible use of integrated environmental licences in future. Farmers whose environmental management is 'in order' would be granted such a licence, which would cover ammonia emissions, manure distribution, mineral accounts and

pesticide use. Manure and ammonia regulations would then be temporarily lifted. This system may soon be piloted in certain local areas, involving consultation with farmers, environmental organisations and water quality managers.

Summary of key points

- Simple mineral accounting systems are now established practice
- There is a strict regulatory framework
- There has been some evidence of farmer resistance to the levy on surpluses
- Schemes have imposed high costs on both sides and simpler approaches based upon whole-farm licences (like a whole farm standard) are now under active development.

7.3.2 Ireland

Agriculture is more important to the Irish economy than to any other present Member State. Irish agriculture and forestry occupy 70% of the land area; the contribution to national GDP, in terms of primary agriculture, is twice the EU average and accounts for 8.7% of total employment. Nevertheless agriculture's importance to the economy has declined in recent years, in line with all industrialised countries. Most of the country is given to livestock production (about 94% of total farmland), in particular, sheep grazing is widespread. Livestock density is also relatively high in many areas – the density of sheep grazing typically exceeds the carrying capacity of the land and, as a result, one of the most significant environmental problems in Ireland is overgrazing of sheep on commonage areas.

Ireland also has a history of declining water quality. Surface water quality in Ireland has been declining for decades (Lucey *et al*, 1999, Stapleton *et al*, 2000). Monitoring of river channels over the period 1971-1997 has shown a steady reduction in the length of unpolluted waters from 84% in 1971 to 51% in 1995-1997. Research over the last few decades has continued to identify eutrophication as a major threat to water quality in Ireland, with the primary cause likely to be excess phosphorus inputs. Of those waters which are slightly, moderately or seriously polluted agriculture is the 'suspected cause' for 47%, 46% and 25% of waters respectively. The most likely primary source of phosphate is diffuse pollution from agriculture, although Ireland also has problems with poor nutrient removal from waste-water treatment in many areas.

Irish regulation in relation to agricultural diffuse pollution has been significantly less comprehensive than many other northern Member States. Transposition of aspects of relevant EU legislation has been slow. For example, there remain no designated nitrate vulnerable zones and no nitrate reduction programme under the Nitrates Directive. However, as will be seen below, measures on nitrogen and phosphorus are being introduced.

Ireland has a national strategic phosphorus reduction programme, set out in 1997. The Strategy sets long-term phosphate reduction objectives and clear targets to improve river water quality, to be achieved over a ten year period. It also requires that local authorities halt declining water quality and ensure that levels of phosphate are reduced over the next ten years, through cuts in emissions from agriculture, forestry and other sectors. These requirements have become statutory with the advent of the 'Water Quality Standards for Phosphorus Regulations' 1998. Authorities had to submit plans on how to achieve these targets to the Irish Environmental Protection Agency by July 1999. As a result local

authorities are beginning to develop legal measures (see below) and the Environmental Protection Agency issued a discussion document on a national phosphorus balance for agriculture in 2001.

In addition, the 1997 Irish National Strategy for Sustainable Development also recognised the need for environmental and economic integration, particularly in the land based sectors, and made commitments to reduce application rates of fertilisers, to introduce nutrient management planning and reduce stocking densities in overgrazed areas. A major contribution to these commitments has been made through Ireland's agri-environment scheme, the Rural Environmental Protection Scheme (REPS).

REPS

The Rural Environment Protection Scheme (REPS), has expanded rapidly in recent years and 45,000 farms were enrolled by 1999, when REPS1 closed. This represented about a third of the farmed area of Ireland. Participants were generally small and medium-sized farms (average about 33 ha). One of the objectives applying to all REPS participants is to follow a farm nutrient plan, meeting certain specifications, on the whole area of the holding. The standards are not particularly stringent, for example, the permitted level of total nitrogen for grassland must not exceed 260kg/ha and the permitted level of nitrogen from animal and other wastes on the same area must not exceed 170kg/ha. Maximum permitted levels of phosphorus, as set down by the planner on soil test report forms, must be complied with. Furthermore, farmers must follow the scheme conditions relating to the collection, storage and disposal of animal manure and other wastes and must implement a fertiliser and manure programme based on soil analysis and crop requirements. Failure to comply with these measures will incur penalties ranging from 10% of the annual payment under REPS (for example if fertilisers are applied within 1.5 metres of a hedgerow) to 100% if the nitrogen limit is exceeded.

A nutrient management plan has to be prepared by a certified planner. Certification is undertaken by the Department for Agriculture. A number of private firms/individuals that are certified as well as government advisors. The farmer has to pay the full cost of the analysis and plan preparation. Thus the farmer must balance the benefits of the payments that would accrue by participation in REPS against the costs of participation. For the average farm (about 33 ha) the total cost of producing a REPS plan is about £6-700 - about £400 of which is the nutrient management plan. On average a farmer would expect to receive around £4,000 per year under REPS. Clearly, for many farmers there is a positive financial outcome. REPS planners also work on the enforcement of nutrient management plans.

The REPS plans are closely monitored. It is, of course, difficult to monitor day to day activities. However, it is thought that compliance is good. Inspections check farm accounts and a paper trail of supporting documents. Stocking levels are easier to check. Overall compliance is also cross-checked with aggregate fertiliser usage, etc, to ensure that the two tally. DAFRD is also able to compare results with the independent farm management survey which monitors 1,200 farms (400 of which are in REPS). This has very good data going back to before REPS was initiated and shows a decline in nutrient inputs.

For the first three years of REPS1 all farms were inspected. Currently 25% of farms are inspected each year. Initially inspections took place at the end of the farm year prior to REPS payments. Farmers knew this and there was concern about activities outside this period. As a

result inspections are now divorced from payment dates and are random throughout the year according to a confidential schedule. Penalties are imposed. About 10% of farmers have incurred some form of penalty according to REPS requirements and this may include compliance with their nutrient management plans.

In 2000 the REPS 2000 specifications were introduced. These retain the previous requirement for nutrient planning and the limits described above for nitrogen application. They also introduce limits for phosphorus. The limits are either those given in the general specifications or those advised by the planner following the production of a nutrient management plan - whichever is the lower. For grazing/silage/hay the general limits range from 0-29 kg/ha depending on the type of soil and the current phosphorus levels. For cereals the range is 0-45 and a wide range is applicable for other crop types, up to a maximum of 125 kg/ha for potatoes.

In 2001 the number of farms still in the REPS1 scheme was 21,700 and this is expected to decline to 4,600 in 2003 as contracts come up for renewal and farms switch to the new scheme. By November 2001 the number of applicants to REPS 2000 was 13,068. The target for REPS 2000 is for 70,000 farmers to join the scheme. However, a number of farmers who joined REPS1 have not applied for REPS 2000. As of spring 2002 only around half of the uptake target has been met and there has been speculation (Farmers Weekly 15-21 March 2002) that Ireland could underspend by EUR 2 billion (£1.3 billion) on REPS 2000. As a result the Irish Farmers' Association has called for the scheme to be simplified and the payment rates increased.

It is difficult within this context to judge the relative importance of education/advice and grant aid. The nutrient management plan process involves both and they are seen as 'two sides of the same coin'. Farmers are responsive to educational initiatives, with demonstration activities, meetings, etc. Educational initiatives may also be aimed at the wider community, bringing together different sectoral interests (eg within a catchment). This allows farmers to see their activities in context.

Effectiveness of REPS

Payments to farmers under REPS can only be made for action over and above good farming practice and legal requirements. In Ireland there has been little relevant legislation in this area. However, the potential for a number of counties to introduce bye-laws requiring nutrient management plans and for extension of nitrate vulnerable zone extension (see below) under the nitrates Directive will pose significant problems. Farmers currently receiving REPS payments for activities required by these laws, and thus regarded as 'good farming practice' would lose the payments. The implications are not yet known, but could be significant.

Nutrient management planning has been in place since REPS was introduced and there has been a significant reduction in fertiliser use. However, it is generally too soon to determine what the environmental impact has been. The latest data on water quality monitoring for 2001 has indicated an improvement in waters in the 'moderate pollution' class, which includes an important phosphorus concentration component. This is the first improvement for 30 years.

In order to assess impacts more clearly intensive catchment initiatives are being undertaken. Each involves an investment of £6-7 million over 3-4 years. The water courses are intensively monitored and there is a wide scale education programme for farmers. The

objective will be to determine what measures are effective and what levels of nutrient application cause responses in the water column.

Local authority action

Local authorities (counties) are empowered to adopt bye-laws under section 21A of the Water Pollution Act setting environmental protection requirements for farmers. Sixteen county councils propose introducing requirements for nutrient management planning and a further seven are assessing the need for it. The bye-laws are specific to the issues of concern to the county and are based on individual catchments (or sub-catchments). Where farmers are causing nutrient pollution problems, the bye-law can require farmers to prepare and implement a nutrient management plan. Where a farmer has prepared a nutrient management plan under REPS this will suffice. Failure to implement the nutrient management plan is not an offence *per se*, but pollution arising from non-implementation may lead to prosecution under the general provisions of the Water Pollution Act (this would be very difficult to prove, for diffuse pollution). It is this type of analysis and approach upon which implementation of the Water Framework Directive will be built. In an individual catchment, this may provide greater protection than nutrient management plans adopted under REPS because:

- all farms in a catchment would be covered, while REPS only includes those farms that apply for the scheme;
- REPS nutrient management plans may not fully take account of distance impacts (eg drinking water abstraction sources well down stream).

The Irish Environmental Protection Agency considers that bye-laws are generally 'stricter' than REPS. However, it is too early to judge their impact.

This activity is a new departure for local authorities and, therefore, they have begun a major training programme for staff in anticipation of the introduction of these measures. The Department of the Environment and Local Government has also issued detailed guidelines to local authorities on the preparation of nutrient management plans.

Depending on the influence of other factors, the requirements of local authorities might stimulate additional farmers to join REPS. The costs of preparing a nutrient management plan must be met by a farmer and, at least, under REPS they receive payments which should help to recoup these costs.

Future developments

The government is currently considering whether the whole territory of Ireland should be designated as an NVZ, Environment minister Noel Dempsey has proposed a nationally imposed limit of 210kg of organic nitrogen/ha/yr. Although not all surface or groundwater sources have nitrate problems, it is thought that complete designation may be administratively simpler and provide a clearer platform for communication with farmers. Noel Dempsey also recently voiced his opinion (22 February 2002) that all farms should be subject to compulsory ‘good farming’ rules to reduce pollution, on tha basis that making existing good practice guidelines mandatory would go most of the way to meeting the EU Waste and Nitrate Directives. There has been intense opposition to both these proposals,

especially from the Irish Dairy Farmer's Association ICMSA, who claim that setting a national limit for organic nitrogen application is 'probably illegal'.

Summary of key points

- The incentive based nutrient management plan REPS programme achieved good uptake at first (45,000 farms) but numbers have since declined (13,068 as of 2000).
- REPS has contributed to a significant reduction in fertiliser use and an improvement, for the first time in 30 years, in the quality of water in the 'moderate pollution' class.
- Intensive catchment monitoring initiatives are being undertaken under REPS, each costing around £6-7 million over 3-4 years.
- Byelaws can be adopted by local authorities, requiring all farmers in areas suffering from nutrient pollution to draw-up and follow nutrient management plans. This could boost REPS uptake.
- The Irish government is currently considering 100% NVZ designation.

7.3.3 Finland – the GAEP

Finland joined the EU in 1995 and instituted a major agri-environment programme at that time, designed to attract the majority of Finnish farmland. The Finnish agri-environment programme is the most ambitious scheme in the EU. The programme has been endowed with considerable resources due to the high environmental awareness in Finland and the need to compensate Finnish farmers for falling product prices after accession to the EU.

By 1998, this General Agri-Environment Programme (GAEP) had achieved an uptake of over 80% of all farms and a slightly higher percentage (around 90%) of Finnish farmland. Over the period 1995-2000, there has been monitoring of the impacts of the scheme on farm practices linked to predictive modelling work to examine the likely effects of these changes upon the environment. Control of diffuse pollution is an important objective of the GAEP and it is thus a central focus for such monitoring and modelling work.

The overall objectives of the agri-environment programme are to:

1 produce safe and high quality products; and

2. reinforce the maintenance of a viable countryside including the environment, landscape maintenance and protection of natural resources.

The agri-environment scheme is implemented throughout continental Finland with an estimated coverage of 1.6 million ha. It is a whole farm scheme. All farms have to commit themselves to a number of compulsory undertakings that vary depending on whether the farm is arable or livestock. These compulsory undertakings are set in the form of 'basic measures' which together are referred to as GAEPS, these include the following.

1. Environmental Planning and monitoring on the farm.
2. Limits on fertilisation levels for arable crops.
3. Plant Protection rules.
4. Conservation headlands and buffer strips.

5. Measures to maintain biodiversity and landscape.
6. Other basic measures specific to livestock farms.

Each farm must then select one additional measure from a list of options and this must be implemented for five years. These options include:

- more accurate fertilisation;
- plant cover in winter and reduced tillage;
- a reduction of ammonia emissions, improved animal welfare and treatment of dirty water from livestock farm buildings;
- more measures to increase biodiversity on farms; and
- more accurate measuring of soluble nitrogen and use of cover in weed prevention.

Further to this General Protection Scheme a Special Protection Scheme allows support for farmers for a period of 5-10 years if they wish to implement any of the following:

- establish and manage riparian zones;
- establish and manage wetlands and sedimentation ponds;
- adopt further methods for the treatment of runoff water;
- convert to organic production;
- limit arable farming in groundwater protection areas;
- conserve traditional biotopes;
- more measures to ensure efficient use of manure;
- special targeted measures to improve and manage the landscape or biodiversity;
- raise local breeds, cultivate local crops;
- take steps to reduce acidity in certain areas.

It is obligatory for all farmers enrolled in the scheme to meet the basic requirements of the GAEPS. The expected outputs for this programme in relation to diffuse pollution control include the following.

- Preparation of an individual farm cultivation plan on all farms.
- An increase in the accuracy of fertilisation use and therefore reduced nutrient load to surface waters and ground waters.
- Established headlands of at least one metre wide covered by perennial vegetation at the sides of all main ditches and buffer strips of three metres established by all streams and rivers.
- All nutrients in animal manure monitored and taken into account in fertilisation plans and practices. There are also special instructions on fertilisation practices, including limits on the amount and timing of manure spreading (eg no application on frozen ground, a closed period for spreading, minimum storage capacity of 6 months, etc).
- There are specific limits on levels of N and P that can be applied per hectare of arable land. These include 90N/15P for fodder crops, 20N/15P for autumn dressings on

winter wheat and 100N/0P for spring dressings, 60N/40P for potatoes, 180N/30P for silage and 90N/15P for grass leys (all figures are kg/ha/yr).

- The GAEP requires soil and manure mineral testing at least every 5 years and detailed cultivation and treatment records (dates, quantities, methods) must be kept on a field-by-field basis, each year.

Details of further outputs depend upon the uptake of the additional measures, such as those under the Special Protection Scheme. A special working group was set up for monitoring of agri-environment support measures and their effects, with representatives from agricultural and environmental administration, agricultural producers, rural advisory organisations, nature conservation organisations, as well as research. The group compiles annual reports on the implementation programme.

The implementation of the measures is monitored mainly through the integrated administration and control system (IACS), which provides annual summaries on the amounts of support paid and measures implemented. Implementation is also monitored through statistics on sales and use of fertilisers as well as the quality of the products.

Basic details of the agri-environment schemes and how to join and comply with them are provided to farmers free of charge from the government. However, no demonstration projects or training facilities are associated with the scheme. To be eligible for support, each farmer has to draw up a cultivation plan on an annual basis. Farmers can choose to pay to receive training or advice from the private sector, to help them do this. There is no in-built capacity to promote information transfer and skill sharing, within the scheme itself.

The environmental evaluation of GAEPs 1995-2000 estimated the likely impact of the recorded management changes made on a sample of farms dispersed around the four main agricultural regions in Finland. The changes included a significant fall in fertiliser use on GAEP farms. This was predicted to lead to a 4-15% reduction in leaching of N into water (varying according to the sample area), largely due to reduced applications of N-fertiliser and manure. The predicted effects upon phosphorus leaching were found to be variable. Particulate P-loss was reduced by 5-13%, mainly due to increased adoption of minimum tillage and an increased area of retained cereal stubble, on cropped land, in place of autumn ploughing. For dissolved P there were increased losses in some areas and no change in others, depending upon local conditions and farm type. This was mainly due to a reduced proportion of fallow land being retained in the IACS eligible rotation, which was not a focus for the GAEP but a result of broader CAP incentives. The increase in leaching was predicted to be less on dairy farms than on crop farms. These findings have been fed into the redesign and relaunch of the programme for 2000-2006.

Summary of key points

- This broad and shallow scheme has experienced very high levels of uptake
- The schemes have relied on farmer understanding and as a result, relatively low levels of public funded extension has meant quite low administrative overheads
- There are a wide range of ‘menu’ options targeting input reduction and better management

- The schemes are made up of basic and more ambitious tiers but uptake is heavily weighted towards the basic tiers
- Research predicts broad positive effects on water courses from reduced N and particulate-P losses in the short-term, while dissolved P losses were affected by changes outwith the scheme prescriptions. Levels of P application have also fallen but these will only have environmental benefits in the much longer term.

7.3.4 France – CTEs and Ferti-mieux

CTEs

In France's Rural Development Plan under the EU Rural Development Regulation 1257/1999, a wide range of agri-environmental measures target basic resource protection objectives. Most of these measures are specified in general terms in the national plan, but their pattern of implementation and their precise specification (including the calculation of aid rates) is determined at a more local level, through the Departmental agricultural administration and in consultation with other local interests. Most of these measures will be offered as part of the Contrats Territoriaux d'Exploitation (CTEs), which are France's principal local mechanism for delivering the RDP. CTEs are based around the concept of a multifunctional 'land management contract' with each business, to deliver a combination of economic and environmental benefits through a 5 year programme of grant aid, planning and advice. The menu options for CTEs are selected at Departemental level and individual agreements are approved by a Departemental committee (the CDOA) involving farming, local community and environmental representatives as well as the public administration.

In the national plan, a range of 'menu options' is available for Departements to select and apply. Many of these are presented as having 'water protection' and/or 'control of soil erosion' as their principal aim. These include:

- conversion of arable land to permanent extensive grassland or to temporary grass;
- introduction of new crops into rotations to reduce input use (eg cereals into a legume system, sunflowers into cereal systems, etc);
- planting green cover over winter;
- replacing spring crops with winter crops;
- prohibitions on cultivation before a certain date each autumn;
- prohibition on mechanical or chemical weeding between rows of permanent crops between August and February;
- restoration of hedges and hedgebanks, creation of beetle-banks and new hedges;
- creation of marshy areas as filters for water;
- buffer strips along watercourses;
- restoration of ditches, ditch-cleaning;
- restoration of traditional irrigation systems (terraces, small gravity-fed channels);
- stream and lake cleaning;
- adoption of integrated farming system practices;
- use of biological control;

- replacing chemical control with alternatives (mechanical, thermal, less polluting chemicals);
- use of precision farming techniques to reduce input use;
- composting of farm wastes;
- 20% reduction in nitrate use (or complete prohibition on all mineral fertilisers, in some areas);
- switch from inorganic to organic, slow-release fertilisers;
- farm waste analysis and planning;
- reducing area irrigated or adoption of more efficient irrigation systems;
- adoption of min-till systems;
- use of local breeds/varieties requiring less artificial inputs.

The French RDP predicts that expenditure on agri-environmental and environmental protection measures under the CTE programme will total over 4,300 million Euro between 2000 and 2006, which is around £2.6 billion, or over £400 million per year.

A recent report from the French Ministry of Agriculture (2001) gives summary statistics on the uptake of the CTE measures across France. In overview, take-up has been much slower than anticipated, probably not least because of the novelty of the approach for farmers and local administrators alike. Key figures are as follows.

As at 13 November 2001, 15,693 contracts had been signed, covering around 1.07 million hectares (3% of agricultural land in France), and a further 5,000 were approved and awaiting signature.

- Regional variations in uptake are significant – it has been highest in the Southwest of France and the Massif Central, both fairly marginal farming areas, and lowest in Brittany, which is a relatively intensive area.
- In the 12 Departements where the scheme has been most popular, it already covers 10% of all fulltime farms.
- About 62% of the land under CTEs is covered by environmental agreements.
- Payments per farm average 17.5 thousand pounds over five years, and agri-environmental payments average 72% of the total contract value, at around £3.6 thousand per year.
- About 27% of the investment aid to farms under CTEs (around £1,700 per farm, over the five year contract) is for improvements in environment, hygiene and animal welfare standards.
- Improving water quality is the most frequent environmental objective in the CTEs – at least 55% of all contracts include at least one action to improve water quality. Spatially, these actions tend to be concentrated in ‘vulnerable zones’ rather than in upland areas.
- As well as contracts with individual farms, the CTEs include 1200 collective group contracts, run by groups of farmers organised according to their farm type (2/3 of these projects) or according to their local area (1/3 of these projects).

The collective approach is of particular interest. Local area collective CTEs also involve local government and relevant professional organisations, whereas the ones organised by farm type (eg dairy, beef, etc) may not. The collective group undertakes an initial study to define CTE objectives and decide which menu items should be included in contracts with farmers. A project leader then ensures take up and follows progress with the contracts at farm level. 647 of the collective projects involve improved production methods, 425 enhanced land management, and 133 pursue both of these goals. They include many projects to improve water quality, among other things.

The advisory component of CTEs can be quite significant. For example, in the Departement of Drôme, in Southeast France, drawing up a single farm agreement involves an agri-environmental audit and the preparation of a farm business plan which usually takes between 2 and 5 days of specialist advisory time. The workload for local technicians may be another reason why uptake of the scheme has been slower than was anticipated at the national level.

Fertimieux

'Ferti-Mieux' is a national programme in France established to encourage farmers to adopt practices to reduce water pollution, principally by nitrates but currently expanding to include phosphate and soil sediment. This voluntary 'Rational Fertiliser Use Programme' for nitrogen was set up in 1991 as an innovative scheme to improve water quality in the French Regions. It advises both arable and livestock farmers on how to use fertiliser efficiently and in a manner appropriate to the particular area in which they farm. The aim of the scheme is to reduce the risk of diffuse pollution of water from agriculture through encouraging voluntary changes in farm practice, in order to reconcile the goals of nature conservation and financially viable agriculture.

The programme is based on voluntary mobilisation of local actors. In each local area, if local analysis of water quality indicates high levels of nutrients, farmers and their representatives can decide to create a local Ferti-Mieux initiative. To do this, a steering group of farmers, farm advisers, water companies, agricultural suppliers and co-ops, local government and officials from the relevant departments of the county administration (agriculture, environment) is established. Each local initiative seeks to modify the practices of individual farmers and advises them on action to take on the basis of local diagnosis. Farmers can join the initiative by taking action on their own farms, with guidance from the technical advisers employed by the steering group (usually, staff from the local Chambre d'Agriculture are seconded to do this work). Evaluations are undertaken every two years to assess the changes in agricultural practices that result from this advice, and to evaluate their impact upon the release of nitrates into the local environment. A Ferti-Mieux label is then awarded by a national steering committee, to all individual farmer participants in each area, on the basis of satisfactory results from these biennial evaluations.

Currently, there are 51 local Ferti-Mieux projects in 39 Departements of France, covering an area of 1.9 million hectares (6% of France's farmland area) and involving around 30,000 holdings (5% of the total for France). National funding for the initiative comes from ANDA, The National Association for Development in Agriculture, and totalled around 2m Francs (£200,000) in 1999. However, the average investment of human and financial resources in each local programme is much larger than the ANDA funding alone – this total per

programme was estimated at 580 thousand francs in 1999 (about £60,000) and includes contributions from different organisations at local level.

Results

The programme has been successful in reducing fertiliser use, in improving the management of animal manures and in developing the use of more targeted techniques for the fertilisation of crops according to their precise needs. It has also achieved a reduction in the area of soil left bare over winter, and landscape-scale reductions in the pollution risks associated with intensive agriculture.

By monitoring nitrate concentrations in selected, relevant water bodies the Ferti-Mieux project has been able to demonstrate in around 2/3 of project sites that pollution from fertilisers and animal husbandry has decreased since project initiation. However, not all projects can yet demonstrate such quantified results. Project evaluation to award the Ferti-Mieux label depends principally upon an 'original method' using standard indicators of changes in farm practice and agronomic expertise to predict the environmental results of changes. As well as general improvements in nutrient levels, the evaluations indicate that regular peaks in concentrations have been mitigated and progressively curbed.

ANDA stresses the educational and experimental value of the initiative in pioneering a new approach to agricultural development that is more environmentally aware, more partnership-oriented, and yet tailored to the situation on each farm. It encourages different stakeholders in each local area to discuss these issues together and enables farmers to gradually develop agronomic expertise, as well as delivering concrete improvements to water quality. For the farmers themselves, the Ferti-Mieux Label can facilitate their access to other pollution control capital grants, such as are offered by the water agencies, as well as offering them a potential marketing tool for promoting their products to the public.

Summary of key points

- These policy approaches incorporate local flexibility and place much emphasis upon farmer-led and farmer owned actions. For Fertimieux at least, this appears to have been a highly successful way to ensure active participation: it is too early to judge CTEs.
- uptake and expenditure are currently low across France as a whole but they can be locally significant.
- Fertimieux appears to have demonstrated clear environmental enhancement despite small budgets, although the relationship between its achievements and those of the Nitrates Directive and its application in France are not entirely clear.
- The mechanisms to encourage collaborative action in a local area and to encourage adherence via a 'label', as in Fertimieux, could be of particular interest.

7.3.5 USA – cross compliance, collective action and permit trading

Cross-compliance for soil conservation

In the United States soil erosion is a major concern over significant areas of the land under agricultural management, particularly in the mid West, North West and California. Soil borne sediments originating from farmland represent a substantial environmental cost and are one of the primary sources of phosphate pollution. Tens of millions of acres have been classified as highly erodible and the control of erosion is the chief environmental strand of US agricultural and agri-environmental policy. The main policy instruments used are:

- A form of environmental cross-compliance, known as 'conservation compliance'.
- A large-scale incentive programme for removing highly erodible land from production under contracts with farmers, generally of 10-15 years duration. This Conservation Reserve Program is effectively a form of medium term set-aside.
- A much smaller incentive programme, EQIP, the Environmental Quality Improvement Program, which provides farmers with assistance for selective practices controlling soil erosion and for other environmental objectives, including reduced nitrate leaching in some areas.
- A Wetland Reserve Program, designed to fund the removal of previously wet land from agricultural production and the restoration of functional wetlands. This is limited to just under one million acres for budgetary reasons.

Conservation compliance requires farmers who wish to continue to receive agricultural policy benefits aimed at supporting crop production to abide by certain environmental conditions. Programmes such as commodity price and income support, crop insurance (dropped 1996), disaster relief, CRP and farm loans are all inclusive of conservation compliance. Farmers who want to cultivate cropland that is classified as highly erodible must apply a system of conservation practices approved by the USDA. Farmers who convert designated wetlands to agricultural production also stand to lose agricultural policy benefits.

The conservation practices required vary according to local conditions and are intended to impose only low costs on producers. The main measures entail following conservation cropping sequences, conservation tillage and the use of crop residues. A 1997 USDA review of conservation compliance found that over 1674 different conservation systems had been approved (Classen *et al* 2001). In 1997 approved conservation systems were in operation on 95% of all land subject to compliance (Claasen *et al* 2001). Other approved measures include contouring, terracing, grass waterways and green cover on bare soil.

Monitoring and enforcement of these obligations over the very large areas involved is a challenge, but the number of farms which have lost support payments because of failure to implement their obligations is relatively low. Compliance costs for farmers generally do not appear high. Conservation practices for which the costs of continuation are low (eg conservation tillage) are more likely to be maintained over a long period of time.

By facilitating the removal of highly erodible land from production the CRP will contribute to significant reductions in soil erosion and diffuse nutrient pollution. Monitoring data suggests that large reductions in soil erosion have been achieved as a result of both conservation compliance and the CRP. Between 1982 and 1997 total erosion on US cropland

fell from 3.08 to 1.89 billion/tons per year; 642 million tons per year of this reduction was due to reductions in sheet and rill (water) erosion and the rest was due to reductions in wind erosion. The proportion of farmland with erosion rates of above eight tons per acre per year (TAY) has fallen markedly, with the biggest gains on the most highly erodible land where erosion rates are above 20 TAY (Heimlich *et al* 2000). Conservation compliance and the CRP are thought to have contributed significantly to this reduction in erosion and so to improvement in water quality.

Evaluation of the range of positive influences of the CRP and conservation compliance has been undertaken. Table 7.3 gives a summary of results from economic evaluations.

Table 7.3 Economic evaluation of environmental performance of US programmes

Environmental performance measure	Programme	Nonmarket benefits ($million/year)
Soil erosion reduced	Conservation compliance	1,400
	CRP	694
	Includes -	
	Freshwater recreation	129
	Increase in soil productivity	145
	Reduction in costs of municipal water cleaning.	366
	Health impacts	50
Wildlife habitat improvement	CRP	704

From Claasen *et al* 2001 p. 18

Policies for the protection and the restoration of wetland, 'swampbuster' and WRP respectively, will also contribute to an improvement of water quality. Through the WRP, agriculture has become the largest source of wetland restoration. It is estimated that the WRP has been responsible for the restoration of 990,000 acres of wetland, at a rate of 110,000 acres/year, between three and four times the rate of wetland conversion to agricultural land. Estimates of the extent of wetland preserved by 'swampbuster' range from 1.5 to 13.2 million acres (Heimlich *et al* 1998 and Claasen *et al* 2000 cited in Claasen *et al* 2001). While there has been no direct assessment of water quality improvements resulting from these policies, wetlands have considerable beneficial effects on groundwater quality and so protection/increase of wetlands will help to reduce pollution. (ibid, 2001)

Collective action

There are several regional water quality programmes that involve partnership between governmental bodies, NGOs and local stakeholders. USDA supports several water quality projects under non-USDA programmes that involve a number of different partners. USDA gives increased technical and financial assistance to farmers in the upland areas of the EPA National Estuary Program, as well as to several multi-agency regional programmes that manage and protect water resources including the Chesapeake Bay Program, Great Lakes National Program, Gulf of Mexico Program and the Lake Champion Program. This support amounted to $6.1 million in 1998 (Anderson *et al* 2000).

The Great Lakes Program was established in 1978 to restore and protect the water quality of the area. Problems being addressed include toxic chemical contamination, nutrient pollution, sediment pollution and diminished wetlands. The partners include USDA, EPA, Fish and

Wildlife Service, Army Corps of Engineers, the eight Great Lake States and local advisory groups. USDA has targeted assistance to farmers through past and present programmes such as ACP (Agriculture Conservation Program), WQIP (Water Quality Improvement Plan) and EQIP. Progress has been made in reducing P loads from farms.

Another major cooperative programme is the Chesapeake Bay Program, a partnership of State and local bodies that has been directing restoration of the bay since 1983. Partners include Maryland, Pennsylvania, Virginia, Columbia District, the Chesapeake Bay Commission, EPA and local advisory groups. Reducing nutrient loads from agriculture has been a major goal. All participating States have initiated nutrient reduction programmes that have been successful in reducing agricultural run-off into the Bay tributaries.

EPA and other programmes

The US Environmental Protection Agency has established programmes concerning water quality. Section 319 of the 1977 Clean Water Act called for the control of non-point source pollution and established the Nonpoint Source Program. Because of the site-specific nature of non-point source pollution individual States are given primary responsibility for developing non-point source management programmes. The programmes developed by the individual states can include regulatory measures but are usually based on voluntary participation. EPA's role is to provide guidance, technical and (limited) financial support. In 1998, EPA provided over $537 million in grants to such projects, $191 million of which went to agriculture. (Anderson *et al* 2000)

Under the CWA the EPA also funded some regional programmes focusing on particular water bodies. The National Estuary Programme (NEP, Section 320) helps States to design and implement basin-wide management programmes to protect estuaries. It covers some schemes that address diffuse agricultural pollution, such as Delaware Inlet Bays.

The first federally mandated program requiring specific measures to deal with agricultural sources of diffuse pollution was the Coastal Zone Management Act Reauthorization Amendments (CZARA) of 1990. CZARA added non-point source water pollution requirements to the Coastal Zone Management Act and demanded that each of the 29 States and territories within the coastal zone management programme submit a programme to 'implement management measures for nonpoint source pollution to restore and protect coastal waters' (US EPA 1996). Each State's management plan must include a list of economically viable measures for controlling diffuse agricultural pollution. As under the EU Water Framework Directive, states are permitted to use voluntary incentive mechanisms at first but must enforce the management measures if these approaches fail.

The 1991 Comprehensive State Ground Water Protection Program (CSGWPP) coordinates all Federal, State, tribal and local programmes that address ground water quality. States are given a primary role in designing and implementing CSGWPP taking into account local needs and conditions. As of 1998 EPA had approved programmes in nine states (US EPA 1998 in Anderson *et al* 2000).

State level legislation

Much of the legislative activity for addressing agricultural water quality issues takes place at State level. All States provide education and financial assistance for implementing best

management practice. Technology standards are the most common mechanism employed by State water quality programmes and generally call for farmers to implement a unique conservation plan that contains recommended best management practices. The technology standards can be applied State-wide or can be targeted at certain areas. Enforcement of the standards is generally through citizen complaint. If a suitable plan has been adopted and is in force the producer does not have to pay fines or damages if a citizen files a complaint for damages and the producer may receive State assistance in order to rectify the complaint.

Florida is the only state to run a 'performance standard' water quality programme. The Florida Everglades are a very important wetland area that has suffered serious phosphorus pollution from agriculture. Dairy operations around Lake Okeechobee had been identified as a major source of this pollution. Under the water quality programme three regulatory mechanisms are applied to the Okeechobee basin, two of which are technology standard requirements, the third 'Works of the District Rule' is a performance standard regulation that imposes a maximum allowable phosphorus run-off standard on the dairies in the area. Such a an approach is possible in this area as an extensive system of drainage ditches enables the monitoring of phosphorus discharge from individual sources. Performance taxes are also being used in Florida under the Everglades Forever Act, which applies a uniform per acre tax on cropland. The tax starts at $24.89 per acre and will increase every four years to a maximum of $35.00 unless basin-wide phosphorus levels are reduced. This tax has a twofold effect by encouraging producers to adopt best management practice and to put pressure on recalcitrant neighbouring producers (Anderson *et al* 2000).

Another state-level regulation is the 1994 Kentucky Agriculture Water Quality Act. It is one of the few comprehensive water protection laws in the US and requires that all land users with ten or more acres develop and implement a plan based on the Statewide Water Quality Plan which lists 58 approved best management practices. Education, technical assistance and financial assistance are available for the development and implementation of the plans. If the watershed is still impaired after five years landowners found to be not implementing their best management practice plans can be subject to enforcement action and fines of up to $1000.

'Lessons learned'

The USDA are relatively advanced in their evaluation of water quality policies. There have been several analyses undertaken and many report papers contain a 'Lessons Learned' section, summarising the most important features for successful policy. The main conclusions from two such 'Lessons Learned' summaries are as follows.

- Cost-effectiveness is enhanced when programme activities are targeted to watersheds where agriculture is the primary source of water quality impairment, and to critical areas within watersheds.
- Voluntary programmes are likely to be most successful when farmers recognise that agriculture contributes to severe local or on-farm pollution problems such as ground water impairment.
- Voluntary programmes are likely to be successful when the programme's alternative practices generate higher long-term returns.
- Programmes with flexible financial assistance are more efficient than those with fixed rates and limited lists of supported practices.

- Project success is enhanced when education, technical assistance and financial assistance are offered in a coordinated fashion.
- Local research on the economic and physical performance of recommended practices can improve practice adoption.
- Interaction with non-USDA agencies and with organisations and local businesses within the watershed is important.
- More attention to water quality monitoring and project evaluation can help determine the cost-effectiveness of alternative practices and assist in the development of targeting strategies.
- Water quality programmes need a long-term focus.
- Voluntary programmes are enhanced if backed by firm but flexible regulations.

(Ribaudo 1997)

Table 7.4 Mechanisms used in State Water Quality Programmes 1998-1999

State	Fertiliser restrictions	Pesticide restrictions	Sediment restrictions	Nutrient mgt plan for farm waste	Comprehensive	Farm *A* System
Alabama						X
Alaska						
Arkansas						X
California		X		X	X	X
Colorado		X				X
Conneticut				X	X	X
Delaware						X
Florida	X					X
Georgia						X
Hawaii						X
Idaho						X
Illinois					X	X
Indiana						X
Iowa	X	X		X		X
Kansas			X		X	X
Kentucky				X	X	X
Louisiana						X
Maine				X	X	X
Maryland	X		X	X	X	
Massachusetts						X
Michigan						X
Minnesota				X		X
Mississipi				X		
Missouri					X	X
Montana		X	X		X	X
Nebraska	X		X	X		X
Nevada						X
New Hampshire						X
New Jersey						X
New Mexico						X
New York						X
North Carolina					X	X
North Dakota						X

State	Fertiliser restrictions	Pesticide restrictions	Sediment restrictions	Nutrient mgt plan for farm waste	Comprehensive	Farm *A* System
Ohio			X	X		X
Oklahoma				X		X
Oregon					X	XX
Pennsylvania			X	X		X
Rhode Island						
South Carolina					X	X
South Dakota					X	X
Tennesse				X		X
Texas						X
Utah						X
Vermont					X	XX
Virginia					X	XX
Washington				X	X	X
West Virginia				X		
Wisconsin	X	X		X	X	X
Wyoming				X		X

1 Mechanisms may apply only under certain conditions or in certain localities.

2 Comprehensive laws focus on meeting a water quality goal, regardless of the pollutant
From Anderson *et al* 2000, p.12.

Summary of key points

- The cross-compliance scheme (Conservation Compliance), based upon soil conservation plans, imposes low participation costs on farmers and has a large menu of management options which have shown a high level of uptake (95%) on land subject to compliance.
- CRP has been highly successful in removing highly-erodible land from production and significant estimates have been made of its financial (non-market) benefits.
- Soil erosion fell dramatically as a result of soil conservation policies.
- The Wetland Restoration Programme has seen large areas of wetland regenerated and so will have had a significant beneficial effect on water quality.
- Much state-level legislation exists to control nutrient and silt pollution.
- The USA is particularly strong in the field of local action, there are many partnership projects involving farmers, businesses, state authorities and local communities attempting to reduce nutrient and silt pollution.
- The USA is relatively advanced in its evaluation and consideration of the lessons learned from past policy experience. Many of these will be relevant to the UK.

7.4 Conclusions

This Chapter illustrates a number of points of direct relevance to the aims of this study.

- The basic approaches taken towards the control of diffuse pollution in different countries cover the full spectrum from obligatory requirements to entirely voluntary initiatives. However, their relative effectiveness is not obviously directly related to the

degree of compulsion involved. It is possible for entirely voluntary programmes to achieve significant positive effects, both with and without specific grant aid.

- The role of effective information, advice and local flexibility in the choice of mitigation methods are all highlighted as important – these should undoubtedly be features of any future framework for England.
- From a strategic perspective, it seems reasonable that the degree of compulsion involved in any mechanism must be clearly related to the severity of the diffuse pollution problem experienced in any area where it is to be applied. The experience from the Netherlands hints at the high administrative and compliance costs that can be incurred in cases where farmers do not accept the validity of the regulatory burden placed upon them (eg in the case of the manure levy).
- Under both a regulatory and a more voluntary approach, experience from other countries suggests a significant capacity for farmers to take on a relatively sophisticated approach to mineral and soil conservation planning, in order to address these kinds of issue. Uptake of these systems undoubtedly requires significant investment in information and advisory support.
- The potential benefits of a mix of policy tools –combining advice, incentives and some 'regulatory backstop' is clearly suggested by a number of the examples presented and discussed here. This echoes some of the findings of experience and local initiatives in the UK, as discussed in the previous section of this report.

8. Towards a policy framework for England

8.1 Barriers to uptake and other considerations

8.1.1 Introduction

The potential barriers to the uptake of various management measures (including non-financial impacts) were discussed at the Farmers' Meeting, following initial analysis. These potential barriers can be categorised as follows.

- Lack of **awareness** by farmers of the diffuse pollution problem in terms of its existence, nature, causes, solutions, financial impact, legislation, regulations etc.
- Farmer **scepticism** as to effectiveness and/or legitimacy of policy mechanisms and distrust of certain information sources.
- Lack of **willingness** to act by farmers. This clearly relates to awareness and perception above. The extent to which control of diffuse pollution is regarded as a priority by farmers. Is it significant enough or directly relevant to the farm business? Is it someone else's problem?
- The limited **ability** of farmers to plan, manage and implement certain management measures, without specialist training, advice or equipment.
- The **practicality** of various management measures in different circumstances.
- The **cost** of implementing different management measures across a range of farm types, particularly in this period of low profitability.
- The **effectiveness** of the suggested management measures in controlling diffuse agricultural pollution. Equally important is a clear demonstration of this effectiveness to farmers.
- Written information that is too long, complex or generally inacessible.
- Lastly, the **mechanism** or package for delivering different management measures needs to be considered carefully to ensure take-up.

Issues arising from analysis and the Farmers' Meeting include the following (in no particular order):

1. Whilst farmers are aware of point-source pollution (and the need to avoid or minimise this and the regulations in place) they are much less aware of diffuse pollution. This is likely to be a result of the point-source pollution policies and legislation that have been in place for many years together with the more obvious nature of the problems and ways of tackling them.

2. Farmers are generally more aware of soil related pollution problems and likely causes and solutions but much less aware of nutrient (ie nitrogen or phosphate) related pollution. This is likely to be a result of the visible nature of soil erosion and some aspects of siltation as opposed to the less obvious nutrient leaching or enrichment. For example, farmers mentioned that they were aware of their duties to minimise the amount of soil left on roads for safety reasons.

3. Farmers are unsure of the nature of the link between their farming practices and nutrient enrichment and siltation (ie there are surely other sources of pollution) and need clear evidence of this relationship and the effectiveness of the proposed management measures. The clear demonstration of the link between farming practices and diffuse pollution and the direct relevance of this to farmers will be necessary to overcome an unwillingness to act.

4. Farmers also need convincing about why they should be concerned about diffuse pollution ie environmental rationale, financial impacts (eg cost savings, resource protection) etc. Take up will be maximised where real cost savings or other benefits to the farm business can be demonstrated.

5. A high profile 'carrot and stick' approach to diffuse agricultural pollution will be necessary to raise overall standards and tackle specific problem areas.

6. The impact on land tenure patterns across the country must also be taken into account as this may affect the effectiveness of applied management measures eg much of the potato land by the River Wye is let on short term agreements to specialist growers.

7. Whole farm planning and management is critical to assess the nature of the problem and plan the solutions for each individual farm. In England, whilst farm waste management plans, field sampling of P,K and Mg and recording of inputs (via assurance schemes) are familiar and practised by an increasing number of farmers, the other elements of whole farm planning eg nutrient management planning, soil protection planning or FYM analysis, are very uncommon. There is a need to ensure farmers are given the right tools – advice, training, equipment etc – to at least manage and implement plans themselves if not produce or renew them. There is an understandable unwillingness by farmers to rely on consultants more than they have to, even if there is grant aid available. The possibility of bespoke IT packages to assist with planning was raised at the Farmers' Meeting.

8. It is considered essential by farmers that any whole farm planning for diffuse pollution control and any related grant aid scheme be integrated or incorporated with other whole farm schemes (eg relating to wildlife or similar) to minimise bureaucratic overload.

9. The amount of management time, apart from *implementation* costs and time, required by farmers should not be underestimated. This needs to be taken into account in determining policy packages. Where capital investment is required, subsequent operating costs likely to arise must also be taken into account.

10. The practicality and effectiveness of all proposed management measures must be field tested and demonstrated, to overcome reservations by farmers. The design of grant aid packages must take account of the standards and practices of farming carried out on different farm types, in particular those being targeted. For example, the amount of field sampling carried out on farms varies greatly between arable and stock farms. Furthermore whilst the Codes of Good Agricultural Practice for Air, Water and Soil may suggest good practice the extent to which they are *actually* followed probably varies considerably across the country.

In relation to particular management measures, from the farmers' meeting there appear to be clear distinctions between:

- options which are readily accepted by farmers as potential items on a grant aid menu that any of them might consider (eg buffer strips); and
- options which they consider essentially *unattractive* at first sight (often because they imply significant costs) and which therefore might only be adopted following more focused advice and negotiation (eg agreement not to spread manure over winter, agreement not to cultivate certain vulnerable fields).

Broadly speaking, the distinction between the two sets of options relates to what is regarded as acceptable change to existing practices, and what seems to require a re-think of the basic management strategy already in place on a farm. This has clear implications for the design of appropriate policy packages, in that the degree of change required on any particular farm could imply quite different approaches to achieving it.

8.2 Key points from the UK experience

1. Many past 'broad' or general initiatives have failed to change farmer behaviour because their messages have not been integrated with day to day farm management and business planning. Information provided (eg Codes of Practice) has been lengthy and complicated.

2. However, the SSAFO policy is seen as having been effective at tackling point-source hazards on farms, using a 3-pronged approach – regulations, advice and incentives delivered alongside one another. Without the regulations, it is doubtful how many farmers would have taken the advice or grants.

3. Experience suggests that locally based, local facilitators, and farmer ownership of policy packages will boost participation/uptake of new measures as well as having potential to 'change hearts and minds' in negotiating about the limits of acceptable change on farm.

4. Whatever the approach, there has to be some *direct benefit* to the farmer in terms of money saved, time saved, avoidance of prosecution, or increased income (short or longer term), in order to get them to change practices or adopt new approaches. Few have time or money to invest in new techniques simply out of interest or a desire for enhanced understanding. Labour on-farm is particularly short, at present, for many farmers.

5. In view of the nature of the problems, a dual focus approach seems required, to achieve widespread minor changes in management practice and targeted, more fundamental changes in farming systems.

6. It is difficult to use the current incentive payment schemes (CS, ESAs) as a mechanism for controlling general DP because you need such big coverage and so widespread uptake in order to be effective that it becomes very expensive.

7. A CS/ESA type of approach might work in the case of extreme pollution in small catchments but uptake might still not be enough (voluntary schemes always have the

potential to hold public funders to ransom if they have to get certain target areas in). However, packages (targeted advice, grants, information, promotion etc. all focused together and working with groups of farmers) – could potentially cover some of the drawbacks.

8. There is benefit in guiding all farmers towards using a model Whole Farm Plan with different elements and advice eg covering the separate diffuse pollution issues in modules, which they build up over time.

9. Some potentially more costly measures should be targeted to vulnerable areas eg to encourage things like conversion from arable to grassland or to promote collective composting of manure.

10. However, an appropriate 'broad and shallow' agri-environment scheme which is very easy to enter and cheap to administer might offer a vehicle for promoting more widespread, 'acceptable' measures to reduce diffuse pollution on all farms.

8.3 Key points from other countries

1. Some countries adopt a much more regulatory approach than has yet been applied in the UK. In this context, farmer uptake of a variety of management measures can be very high but the costs to the industry and to the administration are also significant. Minerals budgeting, blanket prohibitions on nutrient application times, rates and methods and minimum manure storage requirements are the most prominent ingredients.

2. Other countries tend to adopt a mix of voluntary and grant-based approaches. There is evidence that voluntary, farmer-owned advisory and planning approaches can achieve significant change in farm practices wherever this can bring economic as well as environmental advantages. Where economic costs are involved, without regulation, the cost-effectiveness of grant aid depends very much on the way in which it is 'sold' to farmers through an integrated package which meets their costs and is compatible with their business goals. However, such conditions can be met by both 'broad and shallow' approaches as well as more 'narrow and deep' ones.

8.4 The case for grant aid

This research has primarily been designed to examine the use of grant aid, in its broadest sense, to tackle diffuse pollution from farmland. Clearly, the case for addressing this issue through positive financial mechanisms has to be set in a broader context which includes clear consideration of other mechanisms, notably regulation, and the proper contribution that these should also make.

Much emphasis has been placed, at the strategic level, on the need to have policies which are broadly consistent with the Polluter Pays Principle (PPP), under which those who pollute should generally pay the costs of abatement. This approach is generally translated as implying the need to regulate or to charge, to reduce polluting activities. However, in the agricultural context, strict application of the PPP is often either practically difficult or politically undesirable, for the following reasons:

- Practically, it can be difficult to enforce a regulatory approach where polluters are fined or charged when pollution is seen to occur, since linking diffuse pollution effects to a particular farm or specific set of farm practices is not straightforward;
- Blanket prohibitions on input use or manure applications are recognised to be a very crude method of regulatory control which is likely to be justifiable only where nutrient loading is already at extreme levels (as is generally accepted to be the case in the Netherlands);
- More tailoring of limits to individual farm situations (eg attempting to enforce the dictum that farms should not apply more than the crop requirements, taking into account soil reserves and sources from both manure and artificial fertiliser) appears more environmentally appropriate but is practically difficult to achieve unless farms are already familiar with nutrient planning and budgeting processes, including good record keeping;
- Politically, there is strong resistance from the farming sector to the principle that it should absorb significant new regulatory costs without any compensation, because of the likely impact upon farm structures leading to loss of employment and social and cultural impacts upon rural areas. Recent policy statements have tended to agree with this view.

Nevertheless, we should bear in mind two important messages from the earlier sections of this report. These are:

- For many farms, it is likely that a range of low-cost management changes could bring about much improved performance in relation to diffuse pollution by nutrients and silt; but
- However, deciding which measures should be applied, where, and when, for each farm requires the development and use of more sophisticated farm planning than is yet widespread within England. To introduce this kind of planning would undoubtedly represent a significant, though front-loaded, investment of time and management skill on the part of most farmers across the country.

More generally, a mix of advice and grant aid has been shown to be a useful way to encourage farmers to pick up and learn new techniques and approaches, while new regulations are perhaps better suited to situations where it is clear to all parties what action must be taken, and why. While there remains genuine scientific uncertainty as to the best practical ways to reduce diffuse pollution on different farms in different situations, it will be difficult to introduce regulations that can be both efficient and effective.

We believe the case for grant aid is particularly strong in relation to encouraging farmers to adopt farm plans for controlling nutrients and silt, and learning how to put these into practice over a number of years. However, beyond that point, there appears to be a weaker case for supporting the adoption of the management measures, since many of these would not involve significant costs. An important exception is those measures used to control the transport of silt and silt associated phosphorus from a field to receiving water, thus it may be advisable to look for additional means to support these measures, at least within a transitional period, involving both capital and management costs.

8.5 Policy packages to address diffuse pollution

In order to begin to tackle the problems of diffuse pollution by agriculture from nutrients and soil sediment, it is vitally important to raise awareness among all farmers about these issues and their potential costs both to the farm business and to the wider environment. Only once the problems are recognised, identified at farm level and accepted by farmers themselves can they be acted upon.

In broad terms, this suggests a need for:

- good quality and appropriately focused advice and information,
- appropriate farm diagnostic tools, and
- some real incentive (financial and/or regulatory) for farmers to 'get involved' in taking action, especially in sensitive areas.

The expected broader application of the Nitrates Directive to at least 80% of England in the near future will certainly raise awareness of the issue of diffuse pollution by nitrates. It will require most farmers to calculate crude nitrogen budgets for their farms and their crops, since they must ensure that they apply no more than the crop requirement, taking into account other N-sources including manures and slurry. This will immediately make farmers consider the degree to which they are potentially applying 'surplus' nitrogen. Once a farmer has this information, he/she can ensure that more optimal N rates are used.

This development leaves important issues to be dealt with. In particular, given the usual balance between N and P in organic manures, adjusting inputs to match crop needs for N will lead to the application of surplus P. On soils where P-levels are generally low, this is unlikely to cause problems in the short term, but may cause long-term concern in some sensitive areas. However, where soils are already P-rich, the limiting of N will not eliminate the risk of background loss of P from soil to water. Thus for as long as this issue remains untackled through policy mechanisms, the severity of P-loading on farms and the risk of diffuse pollution from P is likely to increase.

The obligations introduced within new NVZs designated under the Nitrates Directive do not require soil testing, and will not oblige the farmer to identify particularly vulnerable areas or soils on the farm, from which leaching or erosion are most likely. To do this would entail drawing up some kind of field-by-field farm plan.

Thus it would appear extremely cost-effective to take this opportunity, when introducing an amended regulatory measure that requires compulsory N-budgeting on most farms, to introduce a broader, grant and advice package alongside the Regulations. This would enable all farms to prepare and follow a basic nutrient and soil management plan, which would deal with P and soil pollution issues at the same time as facilitating enhanced activity in relation to achieving the basic goals of the Nitrates Directive. A new, positive package of this kind would also be viewed as offering some support to the agricultural industry and its role in sustaining the rural environment, at a time of increased regulatory pressure from Europe.

Such a plan could be the primary resource protection element within a new 'broad and shallow' agri-environment scheme, intended to achieve a high level of uptake throughout England. It would enable all farms to prepare nutrient budgets including P as well as N,

integrate these with farm waste management plans, and map all areas of the farm that require special treatment when applying inputs or managing cropland in order to prevent serious soil and/or nutrient loss into watercourses.

8.5.1 Basic plan for all farm land

Outline

The essential character of a broad and shallow scheme requires that its 'menu items' be simple for farmers to apply for and implement, and simple to administer, such that scheme administration and related overheads can remain relatively low, by comparison with existing 'narrow and deep' schemes like Countryside Stewardship. Typically, broad and shallow schemes in other European countries achieve overheads of less than 15% of scheme costs - this is necessary to enable the scheme to achieve a very high level of uptake without requiring a large administrative bureaucracy to support it.

Thus it is desirable to design a basic plan that could either be prepared by a farmer on their own, or that would require only a relatively brief field check by an appropriately trained 'adviser'. We believe that this should be possible by drawing upon existing **best practice** as provided in four basic models:

- the Farm Waste Management Plan - which is already designed to be a self-assessment package;
- the US soil conservation plan as used in 'sodbuster' schemes across the States;
- the simple map and 'low budget options' approach within the FWAG 'Landwise' package, but adapted to focus on soils and nutrients rather than (or indeed, as well as) biodiversity and landscapes, as the principal plans currently do. A prototype of such a plan is currently being used in the Tone valley project;
- the risk assessment and decision-making tool to control diffuse loads of phosphorus and particulates from agricultural land currently being developed by an ADAS research consortium, for the EA, could help to inform the content of such a basic plan.

It should be a priority to provide the model in both hard copy and computer package forms.

Each farmer joining the scheme would agree to prepare a basic nutrient and soils plan using nutrient budgets, soil nutrient levels and a field by field map identifying higher risk areas where erosion control was needed and/or manure applications should be restricted. As part of the process, the farmer would identify from a standard list of 'low budget management options' for diffuse pollution control, those that should be applied to their situation and these would be specified as part of the basic plan. The plan and its components would probably then need to be approved by a suitably qualified source of advice, but whether this would require farm visits or simply checking at a 'surgery' or via a helpline run by people who have a good working knowledge of the local area is a matter needing further consideration and/or testing in the field.

For the purpose of the costing exercise undertaken below, it is assumed that this advice would be provided free of charge to the farmer. In the longer term, alternative strategies might prove possible. For example, this kind of checking might be achieved more cheaply in partnership

with those auditing a Farm Assurance Scheme, if those administering the scheme would agree to accept the plan as part of their 'environmental standard'.

Once approved, the farmer would be required to adhere to all the 'low budget' management requirements in their plan over the next 5 years. The plan would benefit from being reviewed and revised after 4-5 years, so the initial contract should probably be designed to run for 5 years and farmers could reapply beyond that point. The plan could be supported by payments over the five years which would have two components:

- an up-front payment in year one, of a standard amount per applicant, designed to enable them to invest their own time in preparing a plan and seeking its approval by an appropriate advisory source;
- an annual payment including an element paid per hectare, which would recognise the fact that plans for larger farms might take longer and cost more to prepare, and which would also represent an ongoing commitment by the farmer to implement and adhere to all the basic 'low budget options' for action, as written into the plan.

Suggested low budget management options for the basic plan

As indicated from the modelling work in Chapter 5, no or low cost measures could include:

- reducing N applications to no more than crop requirements (NVZs would require this);
- Optimising dietary P inputs in livestock feed;
- Omitting/reducing P application on high P soils (where soil testing would demonstrate that more P was not necessary);
- Restricting manure application timing on underdrained fields;
- No manure application on steep slopes (NB NVZ controls may require similar);
- No manure application within 6m of riparian zones;
- Reducing the frequency of ditch clearance;
- Changing tramline direction in high risk fields to work across the contours;
- adopting minimum tillage practices where the plan indicates this could be of benefit.

There are a number of other valuable measures which could represent a slightly higher cost per farm - although costs will vary depending upon current management practices - but which are also likely to be widely applicable to farms across England. These include:

- restricting stock access to streams;
- re-siting gateways;
- putting grass strips along field edges or track edges;
- introducing appropriately sited woodland strips;
- agreeing to alter the rotation so as to avoid maize or potatoes on the highest risk fields;
- undersowing cover crops, particularly when cropping higher risk fields;

- maintaining green cover on erosion-prone fields, over the winter months;
- establishing sedimentation ponds or other wetland areas;
- collecting farmyard run-off and clean water separately (NB in NVZs any necessary investment could be supported by a 40% capital grant).

To encourage uptake of these kinds of measure on farms, two options would be possible:

a. to make it a requirement of the basic plan that all farms should choose one or two of these options in addition to the low cost measures (as with the GAEP in Finland);
b. to offer specific payments for each measure in a menu, which might be part of a wider broad and shallow scheme menu also targeting basic biodiversity and landscape benefits.

In either case, some additional funding could be required. In option a this could simply mean a slightly higher standard annual payment rate across the farm. In option b it would entail specific rates for each activity. For this option in particular, careful thought would have to be given to the design of a menu that would still enable the scheme to be simple and cheap to administer. In both cases, enforcement costs would be likely to be increased, relative to the simpler 'low or no cost measures - only' option, because of the increased management requirement for each farm.

Indicative costings

Table 8.1 summarises the costs to a farmer of undertaking a Basic Plan, and suggests how these might be met by the two types of payment as indicated previously (lump sum in year one, annual payment for 5 years), if one were seeking to cover all such costs. However, these indicative costings are very much preliminary figures derived from the economic modelling work, it is not suggested that they are simply adopted as grant rates.

The costings based on the economic modelling (see Appendices 1 to 6) assume that whole farm plan production is carried out by farmers who develop plans for their own farms from the outset. Training and guidance would need to be provided to build farmer awareness, understanding and competency. The time input required from a farmer uses a suggested figure of £120 per day. This rate is based on the CAAV farm labour rate and enhanced to reflect farmer responsibility and value. It is recognised that there will be variations in farmers' perceptions of the value of their own time, not least dependent on their farm's profitability. However the rate chosen is considered to be reasonable given this variance and comparable situations.

The basis of payment shows costings for both small and large farms. Whilst there will be common elements for all farmers, for example familiarisation and basic training and demonstration, clearly the time required for assessing a farm and producing and implementing a plan will vary according to farm size (and farm type and complexity). Accordingly we have attempted to show the potential differences in farmer time required. When implementing a plan, some costs other than a farmer's own time will be incurred. Specifically, additional field soil testing and FYM testing may be required. Again there will be differences in these costs according to farm size (as well as farm type).

The Basic Plan payment structure comprises an initial capital payment for plan production and then an annual payment for plan implementation. The annual payment is split into a basic payment and an area supplement. This payment structure attempts to be simple whilst still reflecting real cost differences on the ground particularly in implementing plans across farms of varying farm sizes. We recognise however that there are other ways of structuring payments.

Table 8.1 Indicative costings for basic plan

Management Measure	Basis of Cost	Type of Payment and Scale of Cost Involved
Whole Farm Plan Production: Includes nutrient budget, nutrient management plan, and soil conservation plan.	Small Farm (100 ha): Familiarisation with the plan and written guidance- 1 day; Attending training & demonstration events – 1 day; Description of farm, carrying out budgeting & field by field planning - 2 days Total: 4 days farmer input @ £120/day = £480 Large Farm (300 ha) Familiarisation - 1 day; Training & demonstration - 1 day; Description, budgeting & planning - 3 days Total: 5 days farmer input @ £120/day = £600	Capital payment: £500
Whole Farm Plan Implementation: Includes annual review, additional record keeping and soil testing.	Small Farm (100 ha) Implementation / review – 1 day Additional record keeping – 1 day Sub-total: 2 days farmer input @£120/day = £240 Additional soil /FYM analysis (4 fields @ £20 each and 2 FYM @ £15 each samples) = £110 Total: £350 Large Farm (300 ha) Implementation / review – 2 day Additional record keeping – 1 day Sub-total: 3 days farmer input @£120/day = £360 Additional soil /FYM analysis (8 fields @ £20 each and 2 FYM @ £15 each samples) = £190 Total: £550	Annual payment (2 parts) Base payment per farm: £250/year Area Payment: £1/ha/year Note: base payment reflects fixed items of implementation cost.
No and low cost management measures	Through the planning process the farmer will identify and write into the plan those items from the guidance that are needed in their own situation.	No payment

To estimate the possible exchequer cost of basic plan as a package, a number of steps are then necessary. Table 8.2 indicates the potential gross cost of immediate and complete take up of the basic plan throughout England (a largely unrealistic scenario). Three levels of potential grant aid are examined: covering 100% of estimated farmer costs; 75%; and 50% respectively. The decision as to which of these rates should be used requires further consideration taking into account political and administrative practicalities, desired take-up rates (which we suggest should be very high – c.80% of all farms) and following the phase 2 field testing of the packages, including testing the option of requiring one or two more higher cost items as part of the deal.

As outlined in Chapter 2, it will need to be shown that the basis of the payment rates complies with the EC rules on State Aids, which generally require conformity with the approach taken in the Rural Development Regulation 1257/1999. In principle the indicative costings presented here comply with this regulation as they are based on income forgone (using gross margin partial budgets) plus the additional costs resulting from the management required (extra management time, operating costs and capital costs).

Table 8.2 Estimates of the national cost of basic plan for all farms in England*

	Capital payment £ mil	Annual base payments £ mil	Annual area payments £ mil	Total (first year payments) £ mil	Total (year 2+ payments) £ mil
100% payments	54.5	27.2	9.8	91.5	37
(75% payments)	40.9	20.4	7.4	68.6	27.8
(50% payments)	27.3	13.6	4.9	45.8	18.5

*Based on 108,900 holdings >5 ha in size, occupying 9,771,598 ha.

Table 8.3 then looks at the annual costs of the package assuming a more realistic pattern of take-up among farms in England, that is, phased in over a period of 4 years (ie around 20% of farms per year).

Table 8.3 Basic plan – possible budget profile

Year	100% (£ mil)	75% (£ mil)	50% (£ mil)
1	23.9	17.9	11.5
2	33.2	24.9	16.6
3	42.5	31.9	21.2
4	51.8	38.9	25.9

(assumes 80% of farms join up over a 4 year period, ie 20% per year)

In addition to the grants to farmers, the package would involve further implementing costs:

- in organising training for farmers in how to undertake the plans, and
- for advisers' time in checking batches of plans in each local area, via surgeries or some other suitable mechanism.

For these costs, we might assume the following:

- Training – 40 farmers per event, means 680 events per year.
- Costs for trainers' time = £1000 per event, which is £680,000 per year.

- Associated venue/refreshment/promotion costs = £1000 per event, which is £680,000 per year.
- Surgeries – 20 farmers per day, means 1400 days per year (equivalent to 7fte).
- Costs for advisers time = £700,000 per year.

Thus it appears that to fund the Basic Plan package would require a grant scheme costing from £11.5-26 million per year over four years, (based on 50% grant) to £24-52 million per year (based on 100% grant, both assuming 20% uptake per year), plus around £2 million for advice and training in those first 4 years. Subsequently, costs would decrease to around £18.5 million (50%) or £37 million (100%) annually for the remainder of the contracted period.

Without adding any of the higher cost management items to the basic plan requirement we suggest that a grant rate lower than 100% might still prove effective at attracting uptake, given the fact that this scheme, unlike the current agri-environment schemes, would offer funding to cover the time that farmers have to invest in learning about and planning the required management changes. On the other hand, a 100% notional grant rate might be justified if the basic package included a requirement to add one or two higher cost management items. The phase two piloting of the basic plan model might even indicate the need for a higher rate still than this, under those conditions.

8.5.2 'Plan Plus' for diffuse pollution in priority catchments and high-risk areas

Outline

As part of the basic plan, the farmer guidance for preparing a plan would be designed to give them a 'ready reckoner' way to identify whether they were farming in a particular area or situation corresponding to a 'pollution hotspot'. For example, this might be indicated by their relative proximity to special, sensitive sites and/or by general topographic, soil and geological features. In addition, agencies including EA and EN could help to promote awareness at local level, where these situations arise. If the 'reckoner' or local agency advice suggested that the farm was in such an area, it would be possible to apply for enhanced aids for planning, advisory support and a package of additional grant aid, through a 'Plan Plus' initiative. This would be a special approach designed to involve farmers in these areas in further and more innovative actions to tackle diffuse pollution effectively, going beyond a basic standard and promoting best practice in farm management.

Key features of 'Plan Plus'

- Because tackling diffuse pollution problems in such areas usually requires concerted action by groups of farms rather than individuals, a basic requirement of the 'Plan Plus' approach would be that only committed groups of farms (perhaps a minimum of 5 per local area) would be eligible to initiate the process by agreeing to work together. In addition, these farmers would have to establish a partnership with the EA and other relevant sources of expertise and advice, to advise the initiative as it developed.
- One component of the aid would enable the group to employ a bespoke adviser to promote and support the initiative, on a part-time basis. Ideally, this person should be a local farmer or agronomic adviser who is already well known in the area, who would be obliged to receive a short course of training in nutrient and soil pollution

issues and abatement strategies from the EA and other local expert sources, prior to starting work.

- Another component of the aid would be a more generous grant for plan preparation on each farm, reflecting the additional time and consultations that might be necessary in these higher priority areas (eg SSSIs or sites designated under the Habitats Directive).
- A third component of the 'Plan Plus' aid would be the ability for the bespoke adviser, working with the agreement of the wider farmer and agency partnership, to offer items of grant aid to achieve more dramatic changes in farm practice on particular farms, as necessary and appropriate. For example, the aid might include payments for agreeing not to grow potatoes on certain most vulnerable soils, or payments for wide buffer strips, or even payments to trial and then, if appropriate, adopt novel cultivation techniques designed to minimise P and soil losses. It would be important for the partnership to ensure that such aid was not used to compensate for clear examples of current unacceptable practice on particular farms.
- Ideally, the Plan Plus group would be allocated a fixed sum to use in this way which would be based on the area of the catchment covered by the group. They could then choose to spend the money on a variety of local payments. This could be based on a longer menu of options for which prescriptions would be defined at national level, similar to the model used for CTEs in France. Alternatively, it might be more cost-effective to design combined payments at local level, for instance enabling a much shorter menu of more standard payments across whole farms. These alternatives could be explored during the piloting of the approach in local areas, prior to launch of the scheme.
- 'Plan Plus' would also offer groups financial assistance to organise demonstration events and produce promotional information so that the core group could seek to involve more farmers in preparing and implementing plans and associated measures, as the scheme developed. This sum could be combined with the grant-aid facility into a 'single pot' per initiative, from which the balance of expenditure could be agreed via the broad farmer and agency partnership.
- A final option with the package could be to offer participating farms some kind of official recognition of the extra efforts being made by the group. For example, the EA might consider conferring approved status to successful Plan Plus groups which would ease their burden of regulatory inspections. If this were conferred via a recognisable 'label', it might also have potential local marketing value for certain suitable types of farm produce (as with the Fertimieux label in France). Alternatively, the approval could be linked into a broader environmental standard such as might be set under the various farm assurance schemes.

This model draws heavily upon emerging experience in France with the Fertimieux and CTE schemes, as well as from the successes of current local initiatives in England. It could not be launched effectively without the basic plan alongside it, because this would provide the initial stimulus for farmers to go a step further with the 'Plan Plus' approach. High risk and priority catchments would also benefit from additional efforts to promote the 'Plan Plus' model to farmers, by local agencies working in partnership together.

Suggested management measures

All farms entered into 'Plan Plus' will have to produce and implement a whole farm management plan. These plans will be drawn up to include a selection of measures from those presented for the Basic Plan package, as well as others from the longer list presented in Appendix 7 which would require additional funding from the local grant-aid package.

Indicative costings

Table 8.4 summarises the principal costs involved in each of the Plan Plus elements, excluding the costs of specific grant aid for management measures, which is dealt with separately below. Again, as with the Basic Plan package, these are extremely rough guides to the costs of implementation bearing in mind the extra advisory support element, the more detailed plans that would be needed on each farm, and the need to support demonstrations, trials and other promotional events and materials.

To estimate the necessary scale of the proposed 'lump sum' element in each Plan Plus area that would be necessary to fund specific management measures on participating farms, a number of additional calculations, incorporating further assumptions, had to be made. Again, it should be stressed that these figures are highly provisional and should be revised in the light of further pilot work in phase 2 of this research.

Considering the average net costs of management measures as calculated for the model farm types in priority catchments in Chapter 5, it is necessary to adjust these costs:

a. to remove any duplication of measures with similar functions, in each case;
b. to remove particular annual measures which could arguably be seen as payments which would either contravene the general principle that farmers should not receive compensation for current 'bad practice', or which due to their significant cost, would be unlikely to offer good value for the limited Plan Plus budget;
c. to remove the capital costs of planning, which is already covered in table 8.4.

This results in an adjusted estimate for average farm costs by type, as shown in Table 8.5. Using these adjusted net costs the following averaged estimates for the costs of implementation of Plan Plus have been produced:

- Annual cost: £2/ha - £50/ha depending on farm type
- Average annual cost per area: £27/ha, assuming the total areas covered will include varying mixes of farm types
- Average capital cost per farm: c£8,000, which could be spread over 5 years

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Table 8.4 Indicative costings for Plan Plus, excluding the Farm-Level Grant Aid for Management Measures

Management Measure	Basis of Cost	Payment Rate
Local Co-ordinator to obtain training, work with farmers to design/implement suitable plans, organise and promote demonstrations/trials.	Payment would be based on an agreed day rate and number of days for the implementation of a defined diffuse pollution control programme. Say, half time for one adviser per area:	£10-20,000/year per plan plus area.
Whole Farm Plan Production: Includes nutrient budget, detailed nutrient management plan and detailed soil conservation plan.	<u>Small Farm (100 ha):</u> Familiarisation - 1 day; Training & Demonstration (including farm visits by specialist advisers) – 2 days; Description, budgeting & planning - 3 days Total: 6 days farmer input @ £120/day = £720 <u>Large Farm (300 ha)</u> Familiarisation - 1 day; Training & Demonstration (including specialist adviser farm visits) – 2.5 days; Description, budgeting & planning - 4 days Total: 7.5 days farmer input @ £120/day = £900	Capital payment: £800 per farm *75% grant would imply £600/farm*
Whole Farm Plan Implementation: Includes annual review, additional record keeping and soil testing.	<u>Small Farm (100 ha)</u> Implementation / review – 2 days, additional record keeping – 1 day Sub-total: 3 days farmer input @£120/day = £360 Soil/FYM analysis (6 fields @ £20 each, 2 FYM @ £15 each samples) = £150 Total: £510 <u>Large Farm (300 ha)</u> Implementation / review – 3 days, additional record keeping – 1 day Sub-total: 4 days farmer input @£120/day = £480 Soil /FYM analysis (12 fields @ £20 each, 2 FYM @ £15 each samples) = £270 Total: £750	Annual payment: Base payment: £375/year Area Payment: £1.25/ha/year *75% grant implies £280/yr and 94p/ha/yr* Note: base payment reflects fixed items.
Demonstration, promotion and other activities	Say, five events per year, each costing around £500 to set up and promote, on average	£2,500/year

Table 8.5 Average net costs of Plan Plus by farm type

Farm type	Adjusted net costs		
	Annual cost		Capital cost
	£	£/ha	£/farm
Dairy – priority catchment	1,054[1]	18	7,700
Arable and pig – priority catchment	6,246[2]	36	(21,425[3]) c9,500
Mixed farm – priority catchment	8,773	50	8,825
Upland farm – priority catchment	884	2	6,033

1. Omit reduction in stocking rate and field management buffer zone (see Appendix 3)
2. Omit reduction in stocking rate (see Appendix 1)
3. The bulk of this cost (£16,000) is for upgrading a farm track for feed delivery. It is not envisaged that Plan Plus would have the resources to make this a cost-effective item to fund in full on most farms, and there would be clear economic gains from such an investment. Furthermore, a proportion of farms in these areas might already have good quality farm tracks. Thus we allow for a notional plan plus aid to be offered to cover around 25% of total farms' costs, on average.

We have assumed that each Plan Plus initiative might cover 80 farms in total in each area, managing 10,000 hectares of land, but that the likely take-up of management measures would be around 50 farms in five years. This would imply offering sufficient grant aid to cover an average area per initiative of around 6,000 hectares by the end of five years.

Annual cost items in the menu might run for a number of years, whereas capital costs would be discrete. Thus the costs of the package for each Plan Plus area would need to grow over its lifetime, roughly as follows.

Year 1 – assume 10 farms join up, annual management cost £33,000, capital costs £80,000 over 5 years, hence £16,000 per year.
Total costs: £49,000

Year 2 – assume 10 new farms enter: costs now total £98,000
Year 3 – same growth, costs total £147,000
Year 4 – ditto, costs total £196,000
Year 5 – ditto, costs total £245,000
Year 6 – first tranche have completed capital works, spend therefore £229,000
Year 7-10 – costs fall in stages to 165,000/year

So over a ten year period covering the full phasing in of the initiative, costs per area average £172,000. However, as with the management measures under the Basic Plan, many of those measures involved in Plan Plus plans would bring some potential agronomic and economic benefits to general farm operations. Thus it may be reasonable to offer less than 100% of costs, in determining appropriate grant rates. For the purposes of this very crude national budgeting exercise, we have assumed that the initiatives would offer grants which averaged around 60% of costs (in reality, these should be varied by measure to reflect the balance of public versus private benefit in each case). This would suggest that the grant-aid envelope for management measures in each area should be around £100,000/year, excluding the costs of preparing the farm plans, which are already covered in Table 8.4. However, the budget would need to be able to reflect the actual pattern of growth over time, as indicated above.

The total costs of each Plan Plus initiative then amount to an average annual sum of £127,000 in year one (assuming plans funded at 75% notional costs), climbing to £167,000 by year five

and falling to £137,000 beyond that point. (NB This ignores the necessary phasing of the management measures budget for each initiative, for ease of calculation). So, for the national budget, if 8 initiatives are started each year for the next 5 years, that implies a profile as shown in Table 8.6 below.

Table 8.6 Indicative national budget profile for Plan Plus

Year	Number of PP areas	Budget (£millions)
1	8	1.0
2	16	2.1
3	24	3.3
4	32	4.5
5	40	5.9
6 and 7, then beyond	40	6.0 for 2 yrs, falling to 5.5 by year 11

Thus the national costs of implementing the Plan Plus package over a total of 40 local high priority catchment areas in England could be expected to grow from a relatively low base in the first year, to peak at around £6 million per year by year 6. Clearly, the spending profile in relation to grant aid for management measures would indicate a rather more variable total spend over the period, but it has not been possible within the constraints of this study to model this more accurately. Ideally, it would probably be preferable to allocate Plan Plus lump sum grants to cover a five-year period for each initiative, thus obviating the need to track annual variability of this kind at national level. However, it should be noted that schemes which are funded under the EU's Rural Development Regulation 1257/1999, which currently includes the main agri-environment schemes in England, have to plan and track expenditure on an annual basis in order to claim the EU contribution to these measures.

8.6 The policy context

These aid packages would be introduced within a broader policy framework which also involves regulatory mechanisms to discourage polluting activities.

- As discussed in the preceding section, the likely extension of Nitrate Vulnerable Zones across most of England in the near future will oblige all farmers to take limited action to control nutrient losses from farmland. They will be required to produce crude nutrient budgets for N in order to ensure that they apply fertilisers in line with crop requirements. This process would tend to encourage them to over-apply P, leading to an increased level of P loading in soils. Thus the 'basic plan' package provides an incentive for farmers to go beyond the current regulatory minimum by giving them the tools to achieve better standards of nutrient management and by including P and silt, as well as N, in their revised management strategies.
- As set out in detail in table 2.1 earlier in this report, a number of key drivers will push the need to control diffuse pollution from agriculture higher up the political agenda, over the next decade. These imply that unless further steps are taken now, regulatory action at farm level would undoubtedly become necessary in future. In addition, without preventative action now, the severity of the diffuse nutrient pollution problem from farms, particularly in relation to phosphorus, is likely to increase significantly, implying that the costs of any such action will increase, the longer it is delayed. The policy package presented here is designed to focus extra attention and resources now, to encourage enhanced management practice going beyond the standards currently achieved on the generality of farms. Further, the more resource-intensive 'Plan Plus'

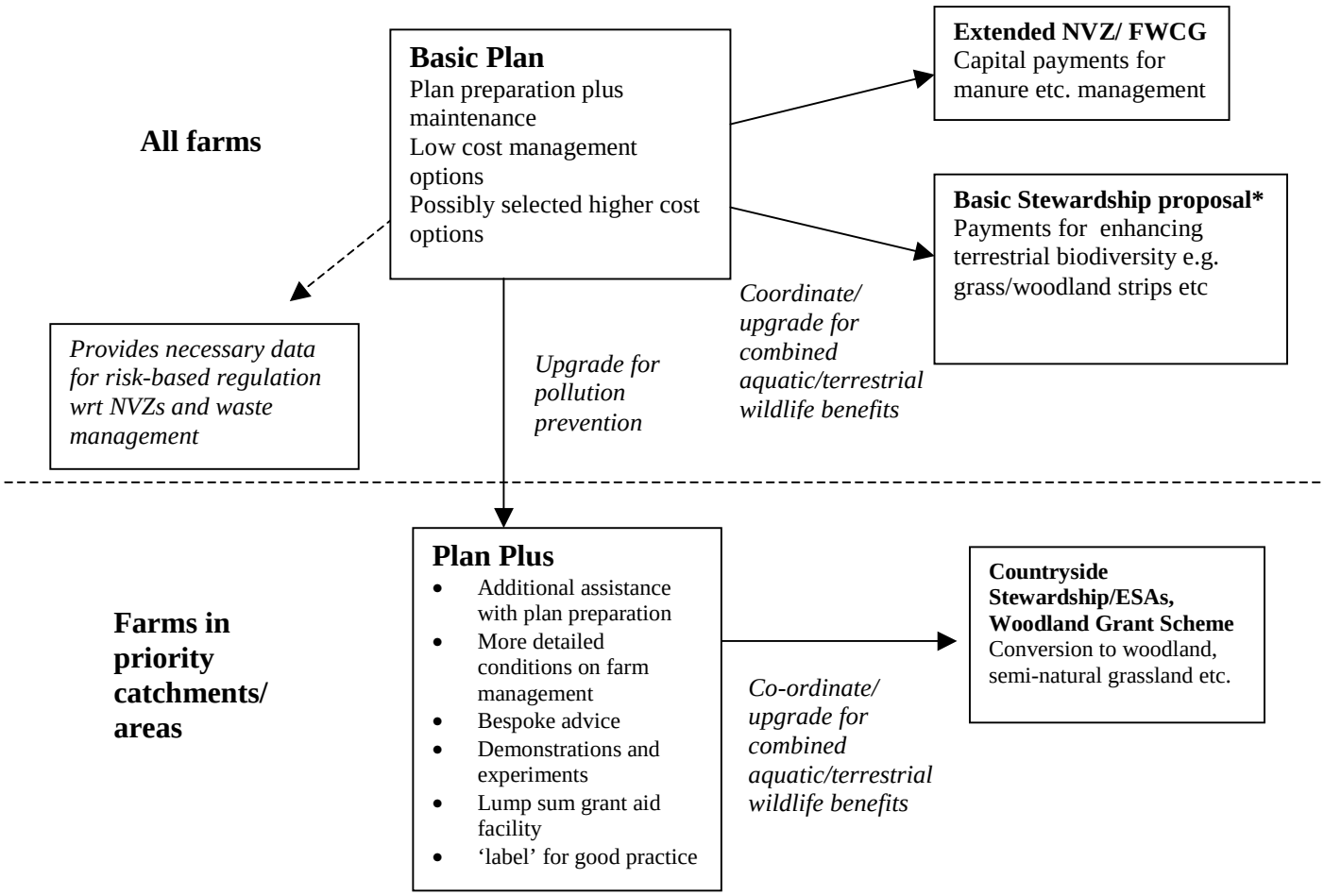
option would promote best practice and innovation, in areas where lower nutrient and silt loads are a particular priority for biodiversity and water quality.

- The 'Plan Plus' initiative involves a positive commitment by farmers to a learning and experimental process by which they can significantly raise standards of nutrient management and soil conservation practice on the farm. At the local level, it may well be possible to link such initiatives to regulatory incentives to get involved, for example by working with highway authorities where there is frequent soil erosion onto public roads. Where this is not possible, the Environment Agency and English Nature should be encouraged to make farmers aware of the likelihood of longer term regulatory action if management practices do not change in the near future.

The packages devised in this study should also be carefully co-ordinated with other existing and proposed grant aid, including agri-environment measures.

- If the basic plan is introduced alongside or as part of a broad and shallow agri-environment scheme (such as English Nature's Basic Stewardship proposal) which offered other payment(s) for simple, but more costly, management actions to promote broad environmental benefits on farms, farmers could use these payments to implement additional management measures, as discussed in section 8.5, option b. This would bring additional benefits to the low-budget options built into the basic plan and might be more cost-effective than attempting to fund such actions purely.on the basis of their resource protection functions.
- Both packages would complement the broadened availability of existing farm capital grants for pollution control in NVZs (which should soon cover most of England), by helping farmers to identify when such investments would be needed on their farm.
- There is clearly scope to look to tailor the use of the Plan Plus lump sum grant aid to *complement* the funds already potentially available through Countryside Stewardship and ESA schemes. Experience demonstrates that, although these schemes do not target diffuse pollution, they can usefully be promoted within target areas because agreements can be devised which pursue these goals alongside enhancements for landscapes, biodiversity, archaeology and amenity (the principal existing targets of the schemes). Therefore it should be possible in Plan Plus areas for a number of farmers to qualify for CS or ESA agreements which could fund some of the management changes identified within their farm plans, because these same changes would bring broader benefits. This suggests that the total cost of the Plan Plus initiative might be lower than estimated here because of reduced need for additional resources, over and above existing schemes.

Figure 8.1 gives a simple illustration of how the proposed policy packages in this report could relate to broader grant aid schemes/proposals.



* English Nature proposal for a broad and shallow agri-environment scheme aimed at reversing the national decline in farmland birds.

Figure 8.1 Possible relationships between Basic Plan/Plan Plus and other relevant schemes/activities

9. Conclusions, and recommendations for further work

9.1 Conclusions

This report has attempted to outline a positive and supportive policy-based approach to tackling diffuse pollution by nutrients and silt from agriculture. This is a problem which is likely to become increasingly important and increasingly severe, if no new policy action is taken to address it within the next few years.

Whilst the proposals outlined here involve a mix of mechanisms including forthcoming regulatory changes and a brief consideration of the potential use of economic instruments to raise funds for new measures, the emphasis of this study has been on achieving change through the use of grant-aid, in its broadest sense (ie including advice, training and events as well as payments to participating farms). This was the original instruction from the project sponsors. Irrespective of this instruction, the project team believes that from the evidence gathered in this report, it is apparent that grant-aid solutions of this kind are strongly favoured as the most cost-effective mechanism for tackling an issue of this nature in the short term, when set against the broader context of forthcoming regulatory change.

The total costs of the grant aid packages developed in this study are consistent with the kinds of scale of spending already considered for other environmental priorities, within existing agri-environment and capital grant schemes. For the country-wide 'basic plan', very rough figures would be from £13-27 million per year over four years, falling to £18m beyond that point for as long as the programme were continued. For the targeted 'Plan Plus', the figures would be correspondingly smaller, from £1-2.5 million over four years then falling to £1.1 million.

The extension of NVZs to either 80% or 100% of England, brought about by pressure from Europe, can be turned into an opportunity to tackle diffuse agricultural pollution issues in the round by building the necessary record-keeping into the basic plan package.

Looking ahead towards 2015, it is possible to envisage 'Plan Plus' evolving over time to become more self-sustaining, as farmers become more able to take action without specific, targeted financial help. In addition, for the basic plan package, while updating the basic plans every five years would continue to be desirable on all farms, the costs of updates is likely to decrease as farmers modify their systems and become more familiar with the process. Thus the total cost of both grant aid packages would be likely to fall, over time as the need and justification for financial support should diminish.

It has not been within the scope of this study to consider alternative means of financing the grant-aid packages developed. However, it would be possible to source these funds in a number of ways, including:

- through the use of economic instruments. In a parallel study to this on, RPA consultants (in association with ADAS) have recommended the application of a charging mechanism on nutrient use in order to help change farmer behaviour and generate funding for remedial action. If that recommendation is pursued this study

suggests that such an option might contribute towards funds, in particular, for the basic plan package;

- through contributions from existing flood defence budgets – both packages offer significant potential to benefit flood control, since soil conservation involves better water retention and reduced peak flows. In view of their value to Catchment Flood Management Plans, contributions from Flood Defence Budgets could be justified.

9.2 Recommendations for further work

This study has developed some initial ideas for grant aid packages. However, for these to be launched as fully-fledged new schemes, or elements within broader agri-environmental schemes, a phase of more detailed farm and area-level testing is essential. In conclusion, therefore, we highlight some essential further work on this issue, which includes the second 'piloting' phase of this study.

- Development of a whole farm plan format and guidance - paper and electronic versions – suitable for the implementation of diffuse pollution control measures.
- Identification of the priority catchment areas (location and extent, throughout England) likely to require the 'Plan plus' approach.
- Development of selected *existing local initiatives* as pilot projects for 'Plan Plus', to test out alternative approaches to delivering the lump-sum grant aid through a variety of management measures, test their practicality and assess real financial impacts.
- Selection and examination of the basic plan approach as applied on additional case study farms outside priority areas. Both the pilot projects and case studies will supplement the economic modelling work undertaken in Phase 1.
- Further assessment of the options for integrating both diffuse pollution control packages with existing and developing agri-environment schemes, including a comparative review of costings. This assessment should incorporate, and thus should follow, the experience of the pilot projects and the case study findings.

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Appendices

Controlling Diffuse Agricultural Pollution
Farm Model

Appendix 1. Dairy, south west, priority catchment

Farm Description

A 60 hectare (148 acre) in the Devon Redlands Natural Area on the River Exe under an FBT agreement. The farm is predominantly dairy with 80 average yielding friesian cows. Soils are predominantly clay, fields are small and characterised by steep slopes. Winter forage is from a mix of ensiled grass and maize. Cows cubicle housed with slurry-based muck system. The farm also has 60 followers plus 20 beef cattle giving a stocking rate of approximately 2.3 GLU/ha. High risk land comprises steeply sloping land, land adjoining watercourses, underdrained land and maize fields.

Ref	Description of Measure	Farm Coverage	Action to be taken	Financial Impact	Gross Margin	Fixed/ Operating Costs	Capital Costs
1.1	Whole farm planning and management • Nutrient Management Plan (including critical soil P levels) • Farm Waste Management Plan[1] • Soil analysis • FYM analysis • Nutrient recording	Whole Farm	• Instruct and work with adviser to produce whole farm plan • 1 in 4 year soil analysis of P, K, Mg; Annual FYM assessment • Record keeping of fertiliser and nutrient management	• Cost of plan (£800) • Farmer's input to initial plan (1 day @ £120/day) • Farmer's management time for ongoing implementation (1 day per annum @ £120/day) • [2]Cost of analysis (4 fields plus 2 FYM analysis per annum) and recommendation. Implementation of results should be cost neutral or positive • Additional record keeping over and above farm assurance scheme requirements (1 day per annum @ £120/day)	N/a	£120 £110 £120	£800 £120
1.2	Optimise Dietary P inputs	Whole Farm	Reduce feed input; Change Feed Type	As this is optimisation this should be cost neutral	N/a	N/a	N/a
1.3	Omit/reduce P on high P soils	High Risk Land	Reduce/change P fertiliser on steep slopes (beef enterprise – 7.5ha)	Change in fertiliser costs[3]	-£45	N/a	N/a
1.4	Restrict manure timing on underdrained fields	High Risk Land	No spreading in winter months on underdrained (forage) fields	Increase in contractor charge as spreading done at a busier time	N/a	£256[4]	N/a
1.5	No manure on steeper slopes and 6m riparian zone	High Risk Land	Unlikely to be application in these areas anyway	No financial impact	N/a	N/a	N/a
1.6	Incorporation of manure (on maize fields and fields due for reseeding)	High Risk Land		If manure/slurry application delayed to spring (1.4) no requirement for separate incorporation.	N/a	N/a	N/a
1.7	Move livestock feeders and troughs regularly	High Risk Land		Labour costs; should be done under COGAP; However, more movement due to high risk land. 2 days @ £70/day	N/a	£140	N/a

[1] Farm waste management plan may lead to requirement for additional waste storage. This possibility has not been costed for the example farm

[2] Soil analysis @ £20/field and FYM @ £15/per sample. These costs include collection analysis and recommendation

[33] British Survey of Fertiliser Practice (1998) shows P_2O_5 at 21kg/ha for grassland. Triple super phosphate at 47.5% P_2O_5 = £127.50/tonne, therefore omitting phosphate leads to saving of £6/ha

[4] Winter slurry output: 40 litres/day/head x 80 head x 180 days = 576,000 litres. Spreading at £4 per 4,500 litres = £512. Additional costs of spring spreading 50% of £512 = £256.

Ref	Description of Measure	Farm Coverage	Action to be taken	Financial Impact	Gross Margin	Fixed/ Operating Costs	Capital Costs
1.8	Reduce stocking rates	Whole Farm	Stocking rate on Dairy reduced to 2 cows per ha	Change in Dairy GM and total dairy herd size plus associated release of quota and capital[5]	£6,560	-£1,524	N/a
1.9	Restrict stock access to stream area and 6m riparian zone	Whole Farm	Fence off areas	• Reduction in grazing area (marginal, therefore not costed) • Additional cost of fencing (600m @ £3/m)	N/a	N/a	£1,800
1.10	Collect farmyard run-off and clean water separately	Whole Farm	Separate roof water to storm drains; dirty water to storage (lagoon) then spread.	• Capital investment required • Operating costs of spreading dirty water (1 day @ £160)	N/a	£160	*
1.11	Collect farm track run-off and silt via traps	Whole Farm	Install traps on high risk farm tracks	• 500m of track affected; traps at 100m intervals (5 traps at £250 each) • Operating costs of clearing traps (1 day @ £70/day	N/a	£70	£1,250
1.12	Establish well drained livestock access paths	Whole Farm	Additional drainage on grazed land for dairy	Capital costs of installing drains (250m @ £15/m)	N/a	N/a	£3,750
1.13	Collect gateway run-off or re-site gateways	High Risk Land	Re-site high risk gateways (say 3), with appropriate drainage/traps	Cost of new gateways (£300 each)	N/a	N/a	£900
1.14	Reduce ditch clearance frequency	Whole Farm	Reduction of clearing by one third	Labour/contractor charge cost	N/a	-£150[6]	N/a
1.15	Undersow cover crops on maize fields	Whole Farm	Sow ryegrass and redclover mix at the same time as maize, this will act as a cover crop after harvest, and can then slot sow directly into it following year	Increase in forage VC[7]	£273	N/a	N/a
1.16	Establish riparian grass strips to trap sediment from high risk fields		Apart from maize, all grass fields anyway. Maize is not on high risk fields	None	N/a	N/a	N/a

[5] Gross margin/cow = £820; reduction in stocking density leads to a reduction in herd size of 10% (8 cows); 50,800 litres of quota (6,350 litres/cow) leased out at 3ppl

[*] Items marked will require varying levels of capital investment dependent on farm situation. These items maybe be more suited to a percentage based grant aid rather than one off capital grant

[6] Reduction in ditching time from 24hours per annum to 16 hours per annum. 8 hours @ £18.75/h = £150

[7] Grass seed costs @ £10/ha plus drilling cost @ £12.75/ha (Nix, 2001) over 12ha maize = £273

Controlling Diffuse Agricultural Pollution
Farm Model

Appendix 2. Dairy, south west, non priority catchment

Farm Description

60 hectare (148 acre) in Somerset under an FBT agreement. The farm is predominantly dairy with 80 high yielding friesian cows. Soils are predominantly clay and underdrained. Fields are small but the terrain flatter than the Devon farm. Winter forage is from a mix of ensiled grass and maize (5 ha). Cows cubicle housed with slurry based muck system. The farm also has 60 followers plus 20 beef cattle giving a stocking rate of approximately 2.3 GLU/ha. High risk land comprises land adjacent watercourses and wet areas, underdrained land and maize fields.

Ref	Description of Measure	Farm Coverage	Action to be taken	Financial Impact	Gross Margin	Fixed/ Operating Costs	Capital Costs
2.1	Whole farm planning and management • Nutrient Management Plan • Farm Waste Management Plan[8] • Soil analysis • FYM analysis • Nutrient recording	Whole Farm	• Instruct and work with adviser to produce whole farm plan • 1 in 4 year soil analysis of P, K, Mg; Annual FYM assessment • Record keeping of fertiliser and nutrient management	• Cost of plan (£800) • Farmer's input to initial plan (1 day @ £120/day) • Farmer's management time for ongoing implementation (1 days per annum @ £120/day) • [9]Cost of analysis (4 fields plus 2 FYM samples per annum) and recommendation. Implementation of results should be cost neutral or positive • Additional record keeping over and above farm assurance scheme requirements (1 day per annum @ £120/day)	N/a	£120 £110 £120	£800 £120
2.2	Restrict manure timing on underdrained fields	High Risk Land	No spreading in winter months on underdrained (forage) fields	Increase in contractor charge as spreading done at a busier time	N/a	£256[10]	N/a
2.3	No manure on steeper slopes and 6m riparian zone	High Risk Land	Unlikely to be application in these areas anyway		N/a	N/a	N/a
2.4	Incorporate of manure (on maize fields and fields due for reseeding)	High Risk Land		If Manure/slurry application delayed to spring (2.2) no requirement for separate incorporation	N/a	N/a	N/a
2.5	Restrict stock access to stream area and 6m riparian zone	High Risk Land	Fence off areas	• Reduction in grazing area (marginal, therefore not costed) • Additional cost of fencing (600m @ £3/m)	N/a	N/a	£1,800

[8] Farm waste management plan may lead to requirement for additional waste storage. This possibility has not been costed for the example farm

[9] Analysis cost based on £20/field for soil and £15/sample for FYM. Cost includes sampling, analysis and recommendation.

[10] Winter slurry output: 40 litres/day/head x 80 head x 180 days = 576,000 litres. Spreading at £4 per 4,500 litres = £512. Additional costs of spring spreading 50% of £512 = £256.

Ref	Description of Measure	Farm Coverage	Action to be taken	Financial Impact	Gross Margin	Fixed/ Operating Costs	Capital Costs
2.6	Collect farmyard run-off and clean water separately	Whole Farm	Separate roof water to storm drains; dirty water to storage (lagoon) then spread.	• Capital investment required • Operating costs of spreading dirty water (1 day @ £160)	N/a	£160	*
2.7	Collect farm track run-off and silt via traps	High Risk Land	Traps on high risk farm tracks	No high risk tracks as flatter land	N/a	N/a	N/a
2.8	Establish well drained livestock access paths	High Risk Land	Additional drainage on grazed land for dairy	Capital costs of installing drains (250m @ £15/m)	N/a	N/a	£3,750
2.9	Collect gateway run-off or re-site gateways	High Risk Land	Re-site high risk gateways (say 3), with appropriate drainage/traps	Cost of new gateways (£300 each)	N/a	N/a	£900
2.10	Undersow cover crops on maize fields	High Risk Land	Sow ryegrass and redclover mix at the same time as maize, this will act as a cover crop after harvest, and can then slot sow directly into it following year	Increase in forage VC[11]	£273	N/a	N/a
2.11	Establish riparian grass strips to trap sediment from high risk fields	High Risk Land	Apart from maize, all grass fields anyway. Maize is not on high risk fields	None	N/a	N/a	N/a

* Items marked will require varying levels of capital investment dependent on farm situation. These items maybe be more suited to a percentage based grant aid rather than one off capital grants

[11] Grass seed costs @ £10/ha plus drilling cost @ £12.75/ha (Nix, 2001) for 12ha maize = £273

Controlling Diffuse Agricultural Pollution
Farm Model

Appendix 3. Arable and pigs, south west, priority catchment

Farm Description
A 175 ha (432 acre) owner-occupied arable farm on chalky soils on the Hampshire Avon. The farm incorporates an outdoor pig unit which rotates around the arable land. The pig unit comprises 50 breeding sows on 15ha of land. The remaining area is wheat (96ha), barley (24 ha), OSR (24ha) and set-aside (16ha). Yields are generally slightly higher than the regional average. High risk land comprises sloping land, land adjacent watercourses and land in pig production.

Ref	Description of Measure	Farm Coverage	Action to be taken	Financial Impact	Gross Margin	Fixed/ Operating Costs	Capital Costs
3.1	Whole farm planning and management • Nutrient Management Plan • Soil conservation plan • Soil analysis • Nutrient recording	Whole Farm	• Instruct and work with adviser to produce whole farm plan • 1 in 4 year soil analysis of P, K, Mg; • SMN analysis annually on fields coming out of pigs • Record keeping of fertiliser and nutrient management	• Cost of plan (£2,000) • Farmer's input to initial plan (2 days @ £120/day) • Farmer's management time for ongoing implementation (2 days per annum @ £120/day) • [12]Cost of analysis (4 fields per annum plus SMN on 2 pig fields) and recommendation. Implementation of results should be cost neutral or positive • Additional record keeping over and above farm assurance scheme requirements (1 day per annum @ £120/day)	N/a	£240 £280 £120	£2,000 £240
3.2	Omit/restrict N&P inputs on pig fields	High Risk Land	As a result of 3.1 – optimisation of existing nutrients		N/a	N/a	N/a
3.3	Add phytase supplements to reduce feed P inputs to pigs	High Risk Land		Increase in feed costs but should be cost neutral due to benefits	N/a	N/a	N/a
3.4	Rotate outdoor pigs effectively to reduce nutrient build up in fields	High Risk Land	As a result of 3.1	• Fertiliser savings likely under 3.2 • Operating costs – increase in frequency of rotation	N/a	£1,450[13]	N/a
3.5	Locate pigs away from watercourses and other vulnerable areas	Whole Farm	Avoid steeper slopes and river banks (from 3.1)	• Infrastructure costs of alternative field for pig enterprise[14]	N/a	N/a	£500
3.6	Limits on stocking rates	Whole Farm	Reduction in pig stocking rate	➢ Reduction in stocking rate from 20 sows/ha to 15 sows/ha. ➢ Leads to a reduction in herd size	£17,775	N/a	N/a

[12] Sampling costs based on £20per sample for P, K, Mg and £100/sample for SMN testing. Prices include sample, analysis and recommendation

[13] Assume increase in frequency of movement of pig enterprise infrastructure from every two years to every year. Labour costs for farmer (£120/day) and farm worker (£70) x five days = £950; plus tractor and trailer @ £100/day = £500

[14] Assume alternative field does not have water supply, extension from source £500

Ref	Description of Measure	Farm Coverage	Action to be taken	Financial Impact	Gross Margin	Fixed/ Operating Costs	Capital Costs
				from 300 to 225 @ a Gross Margin of £237 per sow[15]			
3.7	Collect farm track run-off and silt via traps	Whole Farm	Install traps on high risk farm tracks	• 1,500m of track affected; traps at 100m intervals (15 traps at £250 each) • Operating costs of clearing traps (3 days @ £70/day	N/a	£210	£3,750
3.8	Establish well drained farm tracks for feed delivery to outdoor pigs	Whole Farm	Upgrade main route to pig enterprise	500m of farm track to be upgraded @ £33/m	N/a	N/a	£16,500
3.9	Move Gateways	High Risk Land	2 high risk gateways to be resited/upgraded	Capital Cost (£300 each)	N/a	N/a	£600
3.10	Avoid high risk crops in problem fields	High Risk Land	Assess crop rotation/management (from 3.1)	Zero/marginal management cost (see 3.12 for spring crop management measure)	N/a	N/a	N/a
3.11	Early sowing of crops to reduce erosion risk	Whole Farm	Assume wheat drilled late August to mid November – bring forward last third of that	Additional contractor costs for earlier drilling of 32ha of wheat that would have been drilled late October	N/a	£2,320[16]	N/a
3.12	Establish over-winter cover for spring sown crops	Whole Farm	Do not plough allow natural regeneration. Possible broadcast of tailings/screenings on 12 ha of spring barley	Cost of glyphosate spray plus additional pass[17]	£343.20	N/a	N/a
3.13	Grass down run-off zones	Whole Farm	Field margins sown with grass on high risk areas	• 500m of high risk field margin, headland. Cost of establishment (£15/100m) • Maintenance (£1.80/100m) • plus reduction in wheat area	£144	£9	£75
3.14	Leaving seedbeds rough for cereals	Whole Farm	Take out one pass of cultivation (power harrow)	For cereals - Increase in seed costs (5%) – to compensate for poorer establishment; increase in spray costs (10%) – additional and more expensive	£2673.12	-£1,530	N/a

[15] £237 per sow GM from MLC Pig Yearbook 2001 (actual data for 2000, including a combination of indoor and outdoor breeding units)

[16] 32ha of additional cultivations, plough £44/ha, power harrow £28.50/ha = £72.50/ha

17 Glyphosate @ £7/ha, application of glyphosate @ £7.6ha, plus additional pass @ £24/ha = £28.60/ha

Ref	Description of Measure	Farm Coverage	Action to be taken	Financial Impact	Gross Margin	Fixed/ Operating Costs	Capital Costs
				herbicides needed; reduction in yield 2%[18]			
3.15	Change tramline direction in high risk fields	High Risk Land		No financial impact	N/a	N/a	N/a
3.16	Cultivation practices & crop residue management	Whole Farm	Review novel cultivation practices at point of machinery renewal	Additional cost of equipment should be absorbed in operating cost savings – i.e. not grant driven	N/a	N/a	N/a
3.17[19][20]	Establish field management buffer zone to trap eroding sediment from pig fields	High Risk Land	If 3.5 does not cover this then required buffer strip on two pig fields	• 750m of field margin, headland. Cost of establishment (£15/100m) • Maintenance (£1.80/100m)	N/a	£13.50	£112.50
3.18	Reinstate hedges to buffer sediment transport in high risk fields	High Risk Land	50% of field margin from 3.17 and 3.13 has hedges re-instated	Hedging costs (625m @ £3/m)	N/a	N/a	£1,875

[18] leads to reduction in GM of £23.45/ha for wheat and £17.58/ha for barley; saving in spring tine pass of £12.75/ha

[19]

[20] Management measures 3.17 and 3.18 are alternatives to (not additional) 3.5, 3.13 and 3.17

Controlling Diffuse Agricultural Pollution
Farm Model

Appendix 4. Arable, East Anglia, non priority catchment

Farm Description

A 300ha (740 acre) stockless arable farm on chalky boulder clay. It is a family run tenanted from a large estate with little additional labour bought in. Crops yield around average for the region. The land is flat with large fields. The rotation includes winter wheat (195ha), winter barley (40ha), OSR (25ha), Spring Beans (10ha), Set-Aside (30ha). High risk land comprises any nitrate sensitive areas and any wet areas / waterside land.

Ref	Description of Measure	Farm Coverage	Action to be taken	Financial Impact	Gross Margin	Fixed/ Operating Costs	Capital Costs
4.1	Whole farm planning and management • Nutrient Management Plan • Soil conservation plan • Soil analysis • Nutrient recording	Whole Farm	• Instruct and work with adviser to produce whole farm plan • 1 in 4 year soil analysis of P, K, Mg; • Rec[21]ord keeping of fertiliser and nutrient management	• Cost of plan (£2,000) • Farmer's input to initial plan (2 days @ £120/day) • Farmer's management time for ongoing implementation (2 days per annum @ £120/day) • Cost of analysis (20 fields per annum)[22] and recommendation. Implementation of results should be cost neutral or positive • Additional record keeping over and above farm assurance scheme requirements (1 day per annum @ £120/day)	N/a	£240 £400 £120	£2,000 £240
4.2	Restrict N inputs in sensitive areas	High Risk Land	Reduce N fertiliser (87kg late application of urea plus 20% in reduction in main applications) on three high risk fields (60 ha total)	➢ No milling premium from these fields ➢ Reduction in yield performance from high milling to average feed[23]	£6370	N/a	N/a
4.3	Establish crops early to avoid leaching	Whole Farm	60ha of wheat cultivations brought forward	Contractor costs	N/a	£4,380[24]	N/a
4.4	Avoid High risk crops in problem fields	Whole Farm	Assess crop rotation plan	Marginal management cost (see 4.5 for spring crop management measures)	N/a	N/a	N/a
4.5	Establish overwinter cover for spring sown crops	High Risk Land	Do not plough allow natural regeneration (on spring beans). Possible broadcast of tailings/screenings	Cost of glyphosate spray plus additional pass[25]	£286	N/a	N/a

[21]

[22] Analysis based on £20 per field includes sampling, analysis and recommendation

[23] High performing milling at 8.6t/ha, average yielding feed at 8t/ha; milling @ £80/tonne, feed @ £70/tonne; Urea @ £122.50/tonne; Ammonium Nitrate @ £107.50/tonne = 34.5%N – reduction in N from 180kg/ha to 144kg/ha gives 104kg/ha change in Ammonium Nitrate. Therefore output reduced by £128/ha, costs reduced by £21.84/ha – change in GM £106.16/ha

[24] 60ha of additional cultivations, plough £44/ha, power harrow £28.50/ha = £72.50/ha

[25] Glyphosate @ £7/ha, application of glyphosate @ £7.6ha, plus additional pass @ £24/ha = £28.60/ha

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Appendix 5. Mixed farming, west, priority catchment

Farm Description

A family owned 175ha (432 acre) mixed farm on the River Wye with a wide range of soil types on undulating terrain. 30ha of the land is cropped with one third of this used for potatoes. The remainder of the arable land is under winter wheat and barley. The majority of the grass (130ha) is permanent pasture with the remainder (15ha) temporary grass. Livestock is made up of a suckler beef herd (100) and sheep (850). High risk land comprises land adjacent watercourses, sloping land, underdrained land and land in potatoes, vegetables and other spring crops.

Ref	Description of Measure	Farm Coverage	Action to be taken	Financial/Time Impact	Gross Margin	Fixed/ Operating Costs	Capital Costs
5.1	Whole farm planning and management • Nutrient Management Plan • Farm Waste Management Plan[26] • Soil conservation plan • Soil analysis • FYM analysis • Nutrient recording	Whole Farm	• Instruct and work with adviser to produce whole farm plan • 1 in 4 year soil analysis of P, K, Mg; Annual FYM assessment • Record keeping of fertiliser and nutrient management	• Cost of plan (£2,000) • Farmer's input to initial plan (2 days @ £120/day) • Farmer's management time for ongoing implementation (2 days per annum @ £120/day) • Cost of analysis (6 fields per annum) and recommendation.[27]Potato fields tested routinely every year as part of current management. Implementation of results should be cost neutral or positive • Additional record keeping over and above farm assurance scheme requirements (1 day per annum @ £120/day)	N/a	£240 £150 £120	£2,000 £240
5.2	Restrict manure application timing in underdrained fields	High Risk Land	No spreading in winter months; rates of application assessed under 5.1	Additional management of adjusted spreading times (1 day @ £120/day)[28]	N/a	£120	N/a
5.3	Rotate stock effectively to reduce build up of nutrient	Whole Farm	Stock management from 5.1	Good husbandry/agricultural practice	N/a	N/a	N/a
5.4	Restrict stock access to water courses and other vulnerable areas	Whole Farm	6m buffer strip/fencing on river bank	• Marginal reduction in grazing area (not costed) • Capital cost of fencing (650m x £3/m)[29]	N/a	N/a	£1,950
5.5	Limits on stocking rates	Whole Farm	Manage stock (sheep) on high risk land over winter. Additional field used for grazing over winter	Additional stock management time (checking stock, feeding etc..) – 4 days @ £70/day	N/a	£280	N/a
5.6	Move livestock feeders and troughs regularly	High Risk Land		Labour costs; should be done under COGAP; However, more movement due to high risk land. 2 days @ £70/day	N/a	£140	N/a

[26] Farm waste management plan may lead to requirement for additional waste storage. This possibility has not been costed for the example farm
[27] Cost of analysis based on £20 per soil sample. This includes collection of sample, analysis and consultant recommendation. FYM analysis at £30 per annum.
[28] It is assumed that additional FYM storage is on field heaps, however, in a priority catchment area it may not prove possible to find appropriate sites for heaps. In this case construction of a purpose built facility may be required. In this example these additional costs have not been accounted for.
[29] Assume that water for stock is provided through troughs and river is not primary source

Ref	Description of Measure	Farm Coverage	Action to be taken	Financial/Time Impact	Gross Margin	Fixed/ Operating Costs	Capital Costs
5.7	Collect farmyard run-off and clean water separately	Whole Farm	Separate roof water to storm drains; dirty water to storage (lagoon) then spread.	• Capital investment required • Operating costs of spreading dirty water (1 day @ £160)	N/a	£160	*
5.8	Collect farm track run-off and silt via traps	Whole Farm	Install traps on high risk farm tracks	• 1000m of track affected; traps at 100m intervals (10 traps at £250 each) • Operating costs of clearing traps (2 days @ £70/day	N/a	£140	£2,500
5.9	Establish well drained livestock access paths	Whole Farm	Additional drainage to be installed on fields where natural paths occur	Capital costs of installing drains (250m @ £15/m)	N/a	N/a	£3, 750
5.10	Install underdrain sediment traps	High Risk Land	Install traps on 30ha of cropped land	• Capital cost – 50 outfalls need sediment traps @ £50 each • Operating costs of clearing traps (2 days @ £70/day)	N/a	£140	£2,500
5.11	Avoid high risk crops (potatoes) in problem fields	High Risk Land	Reduction in land available for potatoes of 5ha	[30]Change in gross margin from potatoes to winter wheat	£5,325	N/a	N/a
5.12	Early sowing of crops to reduce erosion risk	Whole Farm		Enterprise size does not lead to same problems of larger arable farms. No financial impact	N/a	N/a	N/a
5.13	Establish winter cover for spring sown crops	High Risk Land	Do not plough allow natural regeneration. Possible broadcast of tailings/screenings on 10 ha of potatoes[31]	Cost of glyphosate spray plus additional pass[32]	£286	N/a	N/a
5.14	Grass down run-off concentration zones	Whole Farm	Field margins sown with grass on high risk areas	• 500m of high risk field margin (£15/100m). • Maintenance cost (£1.80/100m) • Cost of establishment plus reduction in wheat area	£144	£9	£75

* Items marked will require varying levels of capital investment dependent on farm situation. These items maybe be more suited to a percentage based grant aid rather than one off capital grants

[30] Gross margin for wheat £535/ha, Gross Margin for potatoes (maincrop) £1,600/ha; difference = £1,065/ha

[31] NB measure 5.11 reduces the area under potatoes to 5ha

[32] Glyphosate @ £7/ha, application of glyphosate @ £7.6ha, plus additional pass @ £24/ha = £28.60/ha

Ref	Description of Measure	Farm Coverage	Action to be taken	Financial/Time Impact	Gross Margin	Fixed/ Operating Costs	Capital Costs
5.15	Leaving seedbeds rough for cereals	Whole Farm	Take out one pass of cultivation (power harrow)	For cereals - Increase in seed costs (5%) – to compensate for poorer establishment; increase in spray costs (10%) – additional and more expensive herbicides needed; reduction in yield 2%[33]	£374	-£255	N/a
5.16	Change tramline direction in high risk fields	High Risk Land		No financial impact	N/a	N/a	N/a
5.17	Cultivation practices & crop residue management	Whole Farm	Review novel cultivation practices at point of machinery renewal	Additional cost of equipment should be absorbed in operating cost savings – i.e. not grant driven	N/a	N/a	N/a
5.18	Establish riparian buffer zone to trap eroding sediment from high risk fields	High Risk Land	Covered under 5.4, 5.11 and 5.14		N/a	N/a	N/a
5.19	Establish sedimentation pond to trap silt in run-off zones	High Risk Land	This would be alternative/complementary to 5.14	Capital cost of pond establishment	N/a	N/a	£300
5.20	Establish wetland to trap silt in natural wet hollows	High Risk Land	Alternative/complementary to 5.19	Capital cost of establishment – reduction in cropped area is marginal and in low/no yield area, therefore no gross margin adjustment	N/a	N/a	£150
5.25	Change land-use on problem fields which continually erode	High Risk Land	Arable reversion to grass on 5ha of cereals	Change in gross margin. £280/ha based on Countryside Stewardship Scheme's arable reversion tier	£1,400	N/a	N/a

[33] leads to reduction in GM of £23.45/ha for wheat and £17.58/ha for barley; less spring tine pass @ £12.75/ha

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Appendix 6. Hill farm, north, priority catchment

Farm Description

A family owned 420ha (1037acre) hill farm with 70ha in-bye land, 310 ha rough grazing and 40ha of summer grazing. The farm has 25 beef cattle and 790 breeding ewes with a lambing percentage of just under 100%. The farm is not performing particularly well, and would be considered as a 'low' performance in the FBS survey. High risk land comprises steeply sloping land and land adjacent watercourses.

Ref	Description of Measure	Farm Coverage[34]	Action to be taken	Financial Impact	Gross Margin	Fixed/ Operating Costs	Capital Costs
6.1	Whole farm planning and management • Nutrient Management Plan • Farm Waste Management Plan[35] • Soil analysis • FYM analysis • Nutrient recording	Whole Farm	• Instruct and work with adviser to produce whole farm plan • 1 in 4 year soil analysis of P, K, Mg; Annual FYM assessment • Record keeping of fertiliser and nutrient management	• Cost of plan (£800) • Farmer's input to initial plan (1 day @ £120/day) • Farmer's management time for ongoing implementation (1 day per annum @ £120/day) • Cost of analysis (4 fields per annum plus 2 x FYM analysis) and recommendation. Implementation of results should be cost neutral or positive[36] • Additional record keeping over and above farm assurance scheme requirements (1 day per annum @ £120/day)	N/a	£120 £110 £120	£800 £120
6.2	No manure on steeper slopes and 6m riparian zone	High Risk Land	Unlikely to be application in these areas anyway		N/a	N/a	N/a
6.3	Restrict manure timing and rates in sensitive areas	High Risk Land		Given small number of cattle manure spreading can be adjusted easily and there is likely to be no financial impact	N/a	N/a	N/a
6.4	Rotate stock effectively to reduce build up of nutrient	Whole Farm	Stock management from 6.1	Good husbandry/agricultural practice	N/a	N/a	N/a
6.5	Restrict stock access to water courses	Whole Farm	Buffer strip/fencing on river bank on in-bye land with breaks on shallow banks for drinking access	• Additional cost of fencing (750m x £4/m (sheep fence)) • additional cost of drinking areas (£100 x 2)	N/a	N/a	£3,200

[34]

[35] Farm waste management plan may lead to requirement for additional waste storage. This possibility has not been costed for the example farm

[36] Soil analysis @ £20/field and FYM @ £15/per sample. These costs include collection analysis and recommendation

Ref	Description of Measure	Farm Coverage[34]	Action to be taken	Financial Impact	Gross Margin	Fixed/ Operating Costs	Capital Costs
6.6	Reduce stocking density on fields adjacent to watercourses	High Risk Land	• Assume grazing stock numbers can be maintained by accomodating stock on land away from watercourses (given modest stocking rates). • This measure may complement 6.5 to protect watercourse.	Additional management cost as less stock kept on easily managed in-bye land (2 days @ £120/day)	N/a	£240	N/a
6.7	Move livestock feeders and troughs regularly	High Risk Land		Labour costs; should be done under COGAP; However, more movement due to high risk land. 2 days @ £70/day	N/a	£140	N/a
6.8	Establish woodland strips in strategic locations	Whole Farm	Identify areas where there is a risk of slope or bank erosion (could include upland stream/river banks) and plant woodland/copses	• Capital costs of establishment and fencing 1ha[37] • Annual maintenance[38]	N/a	£154	£2,833

[37] Broadleaf trees at 3m spacing = 1,100 trees @ £300/1000 = £333; Labour @ £900/ha; rabbit fencing 400m @ £4/m = £1,600
[38] Woodland maintenance: spot spray twice, 1100 trees @ £0.07 per tree per spray = £154

Appendix 7. Outline indicative farm-level costs for potential plan plus management measures

Annual Payments		
Reduce/limit stocking rate	Reduction in gross margin of certain enterprises Eg Dairy GM = £820 less quota leasing at 6350 l @3ppl = £630/cow Outdoor pigs GM = £237/sow	Dairy cows: £630/cow/year Outdoor pigs: £237/sow/year
Increase frequency of stock rotation (pigs)	Farmer (£120/day) and worker (£70/day) x 5 days = £950 Plus tractor and trailer (£100/day) x 5 days = £500	*£1450/year*
Move livestock feeders and troughs regularly	Extra labour costs on high risk land. 2 days @ £70/day.	*£140 / year*
Undersow cover crops	Additional variable costs: **Grass after / with maize** Grass seed@ £10/ha Drilling @ £12.75/ha Natural regeneration after cereals Glyphosate @£7/ha Application @ £7.60/ha Extra culivation pass @ £24/ha	£23 /ha/year £39/ha/year
Early sowing of winter crops	Cost of contractor to undertake early cultivations: Plough: £44/ha Power harrow: £28.50	£73/ha/year
Rough seedbeds	Cost of increase in seed costs (5%), increase in spray costs (10%) and reduction in yield (2%): WW: £23.45 /ha, WB: £17.58/ha Less saving of spring tine pass of £12.75/ha	Winter Wheat: £11/ha/year Winter Barley: £5/ha/year
Underdrain sediment traps	Cost of clearing traps:2 days at £70/day	*£140/year*
Crop type and location	Change from potatoes to cereals on high risk land based on gross margin differential Potatoes GM = £1600/ha, W Wheat GM = £535/ha	Potatoes to cereals: £1,065/ha/year
Change land use	Arable reversion to grassland In accordance with Countryside Stewardship Scheme	£280/ha/year
Collect farmyard run-off	Cost of periodic spreading of dirty water based on contractor for 1 day.	*£160/year*
Silt traps on farm tracks	Cost of clearance of silt traps. 2 days @ £70/day	*£140/year*

Grass strips	Reduction in gross margin of winter wheat = £28.80/100m/year Cost of maintenance (cut) = £1.80/100m/year For 6m wide field margins	£31/100m/year
Woodland strips	Cost of maintenance: Spot spray twice: 1100 trees at £0.07/tree/spray = £154/ha	£154/ha/year
Capital Payments		
Stock location	Costs of infrastructure (water supply) in alternative field for pig enterprise *Note: this item could be broken down into components of water supply ie pipe and trough.*	*£500*
Well drained livestock paths	Cost of installing drains	£15/m
Restrict access to streams	Cost of fencing	Cattle fence: £3/m Sheep fence: £4/m
Underdrain sediment traps	Cost of installing underdrain sediment traps	£50 each
Collect farmyard run-off	Cost of works to separate roof water to storm drains and dirty water to lagoon	% of cost
Well drained farm tracks	Cost of upgrading farm tracks to improve drainage	£33/m
Silt traps on farm tracks	Cost of installing silt traps	£250 each
Re-site gateways	Cost of re-siting high risk gateways	£300 each
Establish grass strips	Cost of establishment of 6 m wide field margins sown with grass	£15/100m
Establish hedges	Cost of establishing new hedges	£3/m
Establish woodland strips	Cost of establishing woodland: Trees: 1100 trees at £300/1000 = £333/ha Labour: £900/ha Rabbit fencing: £4/m Cost of maintenance:1100 trees @ £0.07/tree/spray = £154/ha	Trees and planting labour: £1233/ha Rabbit fencing: £4/m Maintenance: £154/ha/yr
Establish sedimentation pond	Cost of creating sedimentation pond	£300 each
Establish wetland	Cost of establishing wetland	£150 each

Notes to Appendix 7

1. Where unit costs are not easily derived for certain management measures ie those payment rates in the tables shown in italics, further analysis is required particularly through the proposed piloting. It might be found that these items could effectively be aggregated into a general payment on a £/hectare basis across a whole farm. However, such an aggregated payment would probably need to be varied according to the make-up of management measures adopted in each area, which might render it overly complex to administer.

2. Some of the items with high payment rates, for example the reduction in stocking rates or change in crop type, require particularly close consideration. The cost effectiveness of these measures needs to be fully explored in the context of longer term restructuring in priority catchment areas. These payment rates may require local adaptation and/or expanded to cover to other stock/crop enterprises.

3. The basis of payment and payment structure for the whole farm plan production and implementation are similar to those for the basic plan. However it is recognised that the time input required from a farmer in Plan Plus is likely to be greater, both in terms of training and demonstration (including on farm guidance by an external adviser) and also assessing the farm and producing and implementing a whole farm plan. It is also assumed that proportionately more field soil testing and FYM testing will be carried out to obtain a better baseline assessment of nutrients and more closely monitor changes and inputs.

4. The payment rates set out in the menu of management measures are derived directly from the modelling work carried out on the different farm types. The payment rates have been divided into annual payments and capital payments for ease of reference. Within each category the management measures have been placed in order as those relevant to livestock enterprises, arable enterprises, farm infrastructure and landscape.

5. Where possible unit costs are shown ie £/ha, £/m, £ each. However where unit costs are not able to be extracted from the modelling work, the annual payment rates are shown in italics.

6. The basis of payments varies according to management measure. Some are based on partial budgets using gross margin data, some are based on estimates of additional fixed or operating costs (including labour and contractor costs) and some are based on the estimated cost of capital items. Whilst the table shows a summary of the basis of payment for each measure, the details are set out in Appendices 1 to 6.

7. Some items have direct comparables within existing agri-environment or forestry schemes. Where possible we have shown estimated actual costs rather than adopt the appropriate payment rates from these schemes.