Strategic review of diffuse water pollution from agriculture

Initial appraisal of policy instruments to control water pollution from agriculture

Department for Environment, Food and Rural Affairs

June 2004
Strategic Review of Diffuse Water Pollution from Agriculture
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Section 1: Introduction

1.1 This paper presents an initial analysis of action to address diffuse water pollution from agriculture. It provides some of the background to the information presented in the consultation paper on “Developing Measures for Catchment Sensitive Farming”. This document has been published alongside the consultation document in order to obtain feedback on the analysis undertaken so far so that it can be developed and improved in parallel to the responses to the consultation paper.

1.2 Sections 2 to 6 look at the case for action to reduce water pollution. The evidence suggesting a need for action is discussed, and the initial assessment of the costs and benefits from of this action is presented. There is also consideration of the changes in water quality that are likely to result from policy actions already in place or planned, and assessment of the degree of improvement that may still be required once currently planned measures have been implemented.

1.3 Sections 7 and 8 present an initial qualitative analysis on the advantages and disadvantages of each of the broad approaches and individual measures.

1.4 We therefore welcome feedback on the analysis presented in this document in addition to the responses provided on the consultation paper. It is hoped that the feedback will enable us to develop our evidence base. That input will in turn help to develop a robust analysis for the Regulatory Impact Assessment.
Section 2: Economic Rationale For Intervention to reduce Water Pollution from Agriculture

2.1 This section outlines the economic case for government intervention to tackle Water Pollution from Agriculture, using the information currently available. The arguments for acting now to tackle the problem, which are examined in detail below, include:

- There are significant benefits from tackling Water Pollution from Agriculture. Current indicative estimates suggest that these could be worth in excess of £250m p.a.\(^1\) Illustrative estimates within the Water Framework Directive RIA suggest that the costs of the changes in existing farm systems needed to help deliver (strictly defined) good chemical and ecological water status in England and Wales may be in the region of £80-200m\(^2\) per year.

- Reducing water pollution from agriculture is a central aim of the Government’s Sustainable Farming and Food Strategy.

- Reducing water pollution from agriculture contributes to meeting Defra’s Public Service Agreement, of bringing nationally important wildlife sites into favourable condition, many of which are under intense pressure as a result of Water Pollution from Agriculture.

- The Water Framework Directive requires that action be taken to reduce water pollution from agriculture by 2012, with the overall aim of achieving Good Ecological Quality in waterbodies by 2015. Failure to do so will leave the UK open to infraction proceedings and fines. Acting now in a measured way will provide additional information, allowing the required action to be taken at overall lower cost. Failure to meet the terms of the directive could leave the UK open to fines of £25m-£50m per year for a single significant breach.

- Reducing Water Pollution from Agriculture is also relevant to meeting other directives such as the Bathing Water Directive, Freshwater Fish Directive, Shellfish Water Directive and Drinking Water Directive.

Water Pollution from Agriculture – the Rationale for Intervention

Public Goods and Externalities

2.2 Public goods exist where benefits are non-rival in consumption (i.e. an additional beneficiary or user does not reduce the good’s availability) and non-excludable (people cannot be prevented from benefiting from the good). Many components of agricultural systems have characteristics of public goods, including the existence of attractive landscapes, the provision of habitat for valuable species and for the

\(^1\) This estimate is taken from an Environment Agency (2002) study. It is acknowledged in the report that the estimates are broad and should be taken as indicative only, but also that they are likely to underestimate total costs.

maintenance of biodiversity. Non-cultivated land, including hedgerows and buffer strips, provides pollution control functions in addition to the aforementioned benefits – these can be thought of as a type of public good as they reduce the damage to water. However, farming also leads to negative externalities caused by emissions of nutrients and other pollutants to water. The market by itself does not provide farmers with incentives to increase the production of public goods or reduce negative externalities to the levels that would be socially optimal.

**Information failure**

2.3 Although application of any fertiliser will inevitably cause some water pollution, in some cases part of the cause of Water Pollution from Agriculture is application of nutrients in excess of the crop requirements. Calculating these requirements is complex, given variable soil content, variable contribution from organic manures and varying demands of different crops. Moreover, nutrient loss from soil will depend on a variety of factors including the weather, topography, the type of crop, soil management and the timing of applications. Thus, it is possible that, given uncertainty as to the effect that reducing nutrient input would have on production and therefore revenues, and also the relatively small costs of fertilisers, some farmers apply nutrients in excess of crop requirements. The Survey of Fertiliser Practice shows that applications are generally in line with recommended levels, but that there is some over-application as a result of farmers not accounting for nutrient input from organic manures and from not using soil analysis to adjust applications downwards. There is also insufficient attention paid to the release of nutrients from soil organic matter over time. Evidence shows animal feeds may also contain nutrients in excess of animal requirements.

2.4 Lack of awareness of the problem may be an issue, since “farmers are in general unaware of the pathways pollutants take to water and therefore the effects a badly-maintained slurry store can have.” (NFU, pers. comm.) This is particularly likely to be the case for groundwater where the results of pollution are unseen – indeed farmers are often unaware that there is groundwater under their farms. It is possible therefore that if farmers were aware of their impacts on their own groundwater they would be more likely to limit those impacts. Withers et al. (2003)\(^3\) indicate that farmers are aware of the problem of runoff, but not of the extent to which it could be caused by poor soil management. Half of respondents either felt it unlikely that phosphorus, nitrogen and/or soil were being lost from their farms to nearby rivers, or didn’t know whether or not this was happening. This was felt to reflect either a lack of understanding of the issues of nutrient transfer to watercourses, or a reluctance to admit a problem.

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2.5 The Environment Agency's (2001) publication “Best Farming Practices: Profiting from a good environment” provides examples of improved farming practices that can both protect water, soil and habitats and save money on inputs and improve profitability. Examples include manure management and nutrient planning and integrated crop management, which it is calculated could save up to £40 per hectare. Thus it is likely that some measures that would reduce Water Pollution from Agriculture are either less costly than they currently appear or can even result in financial savings. However, current information is not sufficient to estimate the proportion of the required changes to practice that would fall into this category and opportunities will be business and site specific.

2.6 Another type of information failure is where farmers may fail to make investments that would both have positive net present value and would reduce organic waste, e.g. slurry stores, in part because they do not use the correct investment appraisal tool. The proportion of farmers using Net Present Value or internal rate of return is likely to be below 5%. Smaller farms are less likely to do consistent appraisal. This issue may well be relevant to decisions as to whether to invest in low or no cost measures. Calculations comparing the additional fertiliser value of slurry and manure with the costs of investment have shown that in fact this is unlikely to make a decisive difference. However, where costs and benefits are more closely related, the skills to carry out correct investment appraisal could increase the perceived desirability of an investment or change in practice. It is also possible that such investments are restricted by limited access to credit, particularly on farms that are struggling financially.. For those farmers in Nitrate Vulnerable Zones, the Farm Waste Grant Scheme currently offers up to 40% of eligible costs to improve manure and slurry storage facilities.

Missing markets

2.7 This point includes the fact that the environmental consequences of excess nutrient applications and inadequate slurry and manure management are external, and are therefore not factored into investment and farm practice decisions. Another issue is that in the absence of suitable insurance markets the risk of underapplication of nutrients is, at least at times, dealt with at relatively low cost by applying nutrients in excess of calculated requirements. This low cost does not include the external environmental and other costs. Therefore it may be that risks could be dealt with more effectively by with financial risk management tools – work is being done on this as part of the Government’s Sustainable Farming and Food Strategy.

2.8 An additional example of missing markets is where slurry and manure cannot be traded and are therefore disposed of by being spread on the land, even where this is not necessary in terms of the nutrient requirements of the land. A factor in this is that the cost of transporting and spreading manure onto neighbouring farms (or those further afield) outweighs the fertiliser value of dilute manures such as slurries. Moreover, internalising the external costs of nutrient over-application would increase the incentive to transport nutrients to land where they
can be used effectively by crops. Changes to the implementation of the Waste Directive will encourage trade of manure, as long as it does not involve quantities in excess of the requirements of the receiving land.

**Policy failure**

2.9 This is where current policy exacerbates a problem by providing an incentive to increase an activity which causes e.g. an environmental externality. In this case, historically the provision of production subsidies have maximised output and increased intensification. This has been achieved through large increases in inorganic nutrient inputs, greatly increased soil cultivation activity with heavy machinery, and higher livestock densities, all of which have led to increased pollution risk.

2.10 CAP reform is likely to have a significant impact on this, although it is difficult to predict the environmental outcomes. The removal of production subsidies are likely to result in changes in production patterns, which are discussed further in Section 5. Cross compliance requirements will encourage environmental improvements, although this will depend on how they are specified and implemented. Defra is currently consulting on proposed and possible measures for implementation of cross compliance in England. The outcome of this consultation will be known by the late summer.

**External effects: The General Effects of Water Pollution from Agriculture**

2.11 The effects of water pollution include: the degradation of the ecological quality of the water, e.g. through loss of pollution sensitive species resulting in an system with low species diversity; the reduction in the economic value of water, e.g. the presence of pollutants can mean that the water is no longer a fit source for drinking water or shell-fisheries, or will require expensive treatment; that it is of reduced aesthetic value or no longer suitable for recreational use. Pollutants can also be directly toxic to living organisms, e.g. impacts of high Biochemical Oxygen Demand (BOD), dissolved ammonia, veterinary medicines etc.

2.12 The enrichment of water by excess nutrients, or eutrophication, can lead to the decline of species diversity by favouring species which are able to grow and compete in nutrient rich conditions. In freshwaters, for instance, systems become dominated by algae, resulting in the loss of submerged flowering plants with knock-on effects for a range of animal species which depend on the latter for food and as places of reproduction and protection. Algal blooms lead to further problems by reducing available oxygen resulting in fish kills, by releasing toxins which affect animal (including human) health, and by preventing the use of water for drinking and recreation. In freshwater, phosphates are considered to be the main nutrient driving eutrophication since, if their presence is limited, so is plant growth. In marine waters, nitrates mainly play this role. However, both nutrients can play a significant role in both freshwater and marine systems.

2.13 The presence of pesticides and veterinary medicines in aquatic ecosystems can result in environmental damage. For instance, considerable loss of biodiversity has been found in headwater streams.
as a result of the use of sheep dips and other insecticides. As effective pesticides, sheep dip chemicals are highly toxic to aquatic invertebrates, a food source for many species of fish normally found in upland and headwater streams.

2.14 Siltation and turbidity (reduced clarity of water) also affect submerged plants, with knock-on effects for other species dependent upon them, as well as animals such as salmonid fish, which require clear, unsilted stream beds for reproduction.

2.15 Organic pollution results from the contamination of water with biodegradable organic material, e.g. sewage and livestock faeces. Its decomposition by bacteria results in the rapid use of oxygen (measured as its BOD). Ammonia is also often produced. Solid material also increases water turbidity and reduces bed stability resulting in loss of species and dominance by pollution-tolerant species. Migratory fish are affected since they require well-oxygenated waters. Bathing and shellfish waters are monitored for the presence of faecal indicator organisms. The presence of high levels of indicator organisms, an indicator of pollution, can thus result in a failure of the bathing or shellfish water with consequent economic costs. Faeces can also contain pathogens such as E-coli O157 and Cryptosporidium. Drinking water must be treated to exacting standards to ensure it is safe, but at a cost.

2.16 The economic costs on the water industry are severe, stemming from the extensive and expensive treatment processes required to render abstracted water fit to drink. Problems arise in both groundwaters and surface waters as a result of contamination by nitrates, pesticides, algal toxins (arising from eutrophication), and microbial pathogens.

**Available information on the extent of the problem and the contribution of agriculture**

2.17 It is difficult to provide a detailed site-by-site assessment because the release of pollutants is affected by factors such as soil type, topology, land use, production intensity, and particular management regimes. Moreover the resulting damage depends on the sensitivity of the recipient aquatic habitats and the human uses to which the water is put. This section draws heavily on the DWPA (April 2003) Discussion Document and on the most recent evidence which can be found on the Defra website at [http://www.defra.gov.uk/corporate/consult/csf-spring04/index.htm](http://www.defra.gov.uk/corporate/consult/csf-spring04/index.htm).

2.18 Since 1990 there has been a steady improvement in water quality in England. 60% of rivers have concentrations of phosphorus greater than 0.1mg/l, compared to 67% in 1990. This improvement has been brought about by investment in sewerage treatment and by a steady reduction in the use of phosphate-containing detergents. However, rivers over a large proportion of England still show high, very high, or excessively high phosphorus levels. Even in rivers with relatively low phosphorus concentrations, significant enrichment is often apparent compared to the ecologically acceptable nutrient status. Agriculture is calculated to be responsible for 50% of phosphates found in water. No comprehensive
data are available at this stage for water quality of lakes in England and Wales, but in a study of 129 lakes, 69% had high levels of phosphorus\textsuperscript{4}.

2.19 As regards nitrogen, the proportion of nitrate leached from agricultural land has increased from 57% to 64% of total nitrates in water since 1983\textsuperscript{5}. This is linked to increased use of nitrogen-rich fertiliser, increased cultivation of crops such as oilseed rape that demand higher levels of nitrogen, intensification of livestock production, and the ploughing of established grasslands. 32% of rivers currently have high mean annual concentrations of nitrate (greater than 30mg/l). The Environment Agency has concluded that in Nitrate Vulnerable Zones, agricultural sources are responsible for the overwhelming majority of nitrate in rivers. Recent EA work shows that without alterations in farming practices, by the end of the 21\textsuperscript{st} century a significant proportion of water-bodies will contain more than 50mg/l of nitrates. This has serious implications for our drinking water supplies, as well as biodiversity in our rivers, lakes and seas.

2.20 In terms of siltation, the highest proportion of suspended solid loadings to rivers derive from diffuse sources – heavily dominated by agriculture in rural catchments. The chalk streams of the south and east of England, rivers in the south west of England and rivers along the Welsh Border have significant siltation problems. In southwest England excessive channel bank erosion is the most important contributor to siltation of gravel spawning areas in rivers, often caused by high livestock densities along riverbanks. Elevated loads of soil particles and nutrients entering many designated rivers generate high turbidity, clogged river gravels, and subsequent loss of plants and invertebrates and severe stress to fish.

2.21 For organic wastes, in 2000, 10.7% of river stretches in England and Wales failed to comply with their River Quality Objectives (an Environment Agency measure of the impact of pollution). Diffuse agricultural pollution was implicated in a third of these.

2.22 In terms of Conservation areas, English Nature has reviewed sites designated for nature conservation deemed to be most under threat from diffuse agricultural pollution, including SSSIs, SACs, SPAs and Ramsar sites. Of 102 SSSIs surveyed, 84% showed symptoms of being eutrophic\textsuperscript{6}. In addition to nutrient and soil particle pollution, organic pollution from farms remains a serious issue for many designated sites. Action on Water Pollution from Agriculture is required over this decade to achieve DEFRA’s PSA target of bringing 95% of SSSIs into favourable condition by 2010.

2.23 Networks of ditches running through wetlands, fens and grazing marsh have historically supported a diverse arrays of water plants and


associated invertebrates, and act as nursery grounds for fish. Many are now suffering heavily from nutrient enrichment either from intensive agricultural land management or agricultural and point sources further up the catchment. Ditches have lost flowering plants and become dominated by algae and duckweed.

2.24 For fens, bogs and wet grasslands, nitrogen is the nutrient that contributes most to eutrophication, although the role of phosphorus is still important. Sites at greatest risk are valley and basin mires, fens and bogs in very small catchments and focal points of agricultural drainage. Flitwick Moor in Bedfordshire, Blackfirs and Cranberry Bog in Staffordshire, sites on Dorset Heaths, Clarepool Moss in Shropshire and Moorthwaite and Newton Reigny Mosses in Cumbria are all exhibiting signs of damage; intensive agriculture is the main contributor of nutrients.

2.25 A range of maritime habitats are under stress from Water Pollution from Agriculture, particularly nitrogen enrichment. The Fleet, which is a coastal lagoon in Dorset, is showing signs of eutrophication, agriculture being the largest source of nitrogen. Many coastal areas and estuaries suffering from algal mats and other symptoms of eutrophication – again agriculture is the dominant nitrogen source.

Failure to satisfy environmental directives and water quality objectives

2.26 The Bathing Water Directive RIA notes that it is estimated that 12% of failures to meet “good standards” as set out by the directive are due to agriculture. The freshwater fish directive RIA estimates that agriculture is responsible for 5-10% of failures of the ammonium-N standard in non-designated waters. As mentioned above, in 2000 agricultural pollution was implicated in a third of failures of River water Quality Objectives.

2.27 In terms of substantiated pollution incidents, agriculture was responsible for 12.3% of Serious and Significant incidents in 2002 (Environment Agency). However, given that to be picked up these incidents must lead to an observable and traceable environmental effect, these agricultural incidents reflect primarily the point source contribution of agriculture. Agricultural point sources, although they can lead to significant environmental problems in certain places and at certain times, are likely to represent only a small proportion of the total nutrient exports from agriculture.

Economic Values of Water Pollution in the UK

2.28 Pretty et al (2000) estimate the damage costs from agriculture based on water treatment costs at £231m per year (nitrates: £16.4m, pesticides: £119.6m, phosphates: £52.3m, zoonoses: £22.5m). Pretty (2003) 

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7 Professor Louise Heathwaite – pers. comm..
estimates the total costs of freshwater eutrophication in England and Wales at between £75-114.3m (agriculture’s contribution being £32-49 million) and treatment costs at £54.8m.

2.29 EA (2002)\textsuperscript{10} estimated the costs of natural resource degradation and environmental pollution due to agriculture in the UK by estimating the total cost of the problem and agriculture’s contribution to each problem, and then assigning a proportionate cost as agriculture’s share of the damage cost. This methodology is acknowledged to be simplistic, so that the resulting estimates should be taken as indicative. However, it should also be noted that, given the range of impacts for which values have not been estimated, the EA report considers the reported estimates to be conservative.

**Damage costs from agriculture:**

<table>
<thead>
<tr>
<th>Damage Type</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eutrophication</td>
<td>£19m</td>
</tr>
<tr>
<td>Removing Pesticides from drinking water</td>
<td>£108m</td>
</tr>
<tr>
<td>Removing faecal pathogens from d. water</td>
<td>£20m</td>
</tr>
<tr>
<td>Faecal Indicator Organisms:</td>
<td>£69m</td>
</tr>
<tr>
<td>Costs to freshwater fisheries</td>
<td>£28m</td>
</tr>
<tr>
<td>Removing nitrate from drinking water</td>
<td>£13m</td>
</tr>
<tr>
<td>Total</td>
<td>£257m</td>
</tr>
</tbody>
</table>

2.30 The implication of this is that the potential benefits of tackling water pollution from agriculture can be estimated, on the basis of the Environment Agency study, to be in excess of £250m per year. However, it must be emphasised that given that certain aspects of the damage caused by water pollution are not included, this must be considered to be only a proportion of the total value of water pollution from agriculture. Issues that are not included in these values are:

- All non-use values, including damage to wildlife/ecosystems.
- Impacts of faecal pathogens other than in bathing waters.
- Eutrophication from nitrates, and the resulting costs to coastal fisheries, biodiversity and ecosystems, amenity and recreation
- Costs to water-using industries including agriculture
- Costs of organic pollution including BOD with resulting costs to biodiversity and ecosystems, amenity and recreation
- Costs of siltation of water from soil erosion

Section 3: Costs and Benefits of Action to Reduce Water Pollution from Agriculture

Overview

3.1 This section represents work in progress to evaluate the broad costs and benefits of tackling water pollution from agriculture in England. The approach chosen will form the basis for implementation activity within an action plan to reduce water pollution from agriculture. The analysis contained in this section includes:

- the benefits of reducing water pollution from agriculture
- the overall costs of meeting the action plan to reduce water pollution

Section 5 will go on to examine the “baseline” in terms of the likely contribution from planned or prospective initiatives that will help to reduce agricultural water pollution.

3.2 At this stage in the development of potential policy instruments, information on costs and benefits is highly incomplete and subject to a great deal of uncertainty. It is not yet possible to provide quantified assessments of all of the benefits, or definitive cost figures, or to identify which benefits will result from which costs. The approach we have taken is therefore to:

- compare estimates of overall costs to analyses of overall benefits;
- identify which costs are likely to be covered by baseline activity
- analyse the comparative cost-effectiveness of potential approaches in delivering the remaining required changes and their performance against certain criteria, including their use in conditions of uncertainty.

3.3 The analysis contains a significant number of working assumptions that need to be tested and refined. Further work to improve our estimates of costs and benefits is being taken forward.

Attribution of Costs

3.4 The Action Plan is intended to help deliver the water quality aspects of a variety of existing and forthcoming European Directives, including the Water Framework Directive (WFD), and those on Habitats, Bathing Waters and Freshwater Fish. Most of the costs and benefits incurred as part of the action plan are therefore part of the costs and benefits of these Directives and should not be seen as additional to those in their respective regulatory impact assessments (RIAs).

3.5 The Action Plan will also help to deliver the water quality improvements required to achieve a small part of the PSA target of bringing 95% of SSSIs into favourable condition by 2010. It is not practicable to separate out the costs and benefits of delivering these improvements from the improvements in water quality required under EC Directives and in any case, these costs should again not be seen as additional to those required to deliver the SSSI PSA target.
3.6 Part of the aim of this project is to consider the options for reducing the potential regulatory impact of these Directives and targets.

Benefits of Reducing Water Pollution from Agriculture

Environmental benefits

3.7 Throughout this analysis, we will refer to the water quality target of the action plan as delivering “good chemical and ecological status” or “good water status”. Both of these phrases come from the Water Framework Directive, but are used in a wider sense and for the purposes of this paper should be taken to include all of the relevant targets the various drivers set out in paragraphs 3.4 and 3.5.

3.8 Reducing water pollution from agriculture will increase water quality, enhancing biodiversity, restoring fish habitats, and improving the aesthetic standards of water bodies, as well as reducing the cost of drinking water treatment.

3.9 Although we can only attribute values to a limited range of the damage caused by water pollution from agriculture, the costs of these impacts are likely to total in excess of £250m per year (see sections 2.28 to 2.30).

3.10 Even if it could be valued, the total cost of damage caused by water pollution from agriculture would still only give an indication of the possible magnitude of the benefits. This is because it may be possible to achieve good chemical and ecological status without reversing all of the environmental damage.

3.11 In addition to the water quality benefits, the changes required to reduce water pollution would also help to:

- improve soil structure and reduce soil loss
- reduce greenhouse gas emissions
- increase terrestrial biodiversity, and
- mitigate flooding risks
- It is difficult to assess the extent of these benefits and to attribute values to them and we have not yet attempted to do so.

Benefits to business

3.12 There are likely to be benefits to firms in the tourism and recreation industry if increased water quality leads to more visitors to water bodies, or an increase in the uptake of activities such as boating and angling. Many of these will be small businesses.

3.13 Reductions in eutrophication and faecal contaminants in estuaries and coastal waters will lead to benefits for the fish and shellfish industries respectively. Estuaries and coastal waters are important breeding areas for fish in the UK.
Overall Costs

3.14 Illustrative estimates within the Water Framework Directive RIA suggest that the costs of the changes in existing farm systems needed to help deliver (strictly defined) good chemical and ecological water status in England and Wales may be in the region of £80-200m$^{11}$ per year for the dairy, sheep and arable sectors. This is the range that we have used for the purposes of this paper to evaluate both the contribution of current and planned policies and the cost effectiveness of policy approaches.

3.15 It should be noted however that there are limitations to this figure and these are relevant to the assessment of overall costs. The analysis covers only dairy, arable and sheep farming and further work is needed to test the underlying assumptions.

3.16 Analysis of figures in a field assessment project sponsored by English Nature and the Environment Agency$^{12}$ suggests that the full costs may be in the top half of the range.

3.17 Both reports focus on the reduction of nutrient loss, which will also deliver reductions in soil loss (siltation) and water pollution by faecal pathogens, but (in contrast to the benefits figures) they do not include the costs of any changes aimed at reducing the emission of agricultural pesticides.

3.18 Significantly, although both analyses recognise that changes may be needed that go beyond adjustments to existing farm systems, neither contains any estimate of the additional costs involved. Additional changes could include moving to a less intensive farming system, or even changes in land use. The WFD RIA report considers it possible that around 10-15% of agricultural land might require changes to a different use (such as forestry). These changes could entail significant additional costs.

3.19 Finally, these costs only represent the costs of implementing changes on farms and not the costs of policy instruments. These are considered in the assessment of the cost-effectiveness of possible approaches below.

Comparison of Overall Costs and Benefits

3.20 We do not have complete estimates for either the benefits of reducing water pollution from agriculture, or the changes on farms required to deliver them. Nevertheless there is some value in comparing our current assessments of the costs and benefits as set out above.

3.21 The illustrative costs of the farm changes required to address nutrient, silt and faecal pathogen pollution are likely to be in the top half of the range £80m to £200m per year for the dairy, sheep and arable sectors, with additional costs for addressing pollution from pesticides and land use changes.

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3.22 The valued benefits are likely to be in excess of £250m per year, but this includes a damage cost of £108m per year for removing pesticides from drinking water. If we exclude pesticides from the total benefits to allow comparison with the costs figure, the valued benefits would be likely to be in excess of £140m per year. This does not however include either all the main benefits to environmental quality and aquatic biodiversity, or the ancillary benefits to air quality, climate change, terrestrial biodiversity and flood mitigation, which are likely to be considerable. Table 1 summarises these considerations.

<table>
<thead>
<tr>
<th></th>
<th>With Pesticides</th>
<th>Without Pesticides</th>
<th>Unvalued</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>Unknown</td>
<td>£80m - £200m</td>
<td>Land use changes</td>
</tr>
<tr>
<td>Benefits</td>
<td>£250m +</td>
<td>£140m +</td>
<td>Environmental Quality</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Aquatic biodiversity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ancillary benefits</td>
</tr>
</tbody>
</table>

Table 1: Summary of Annual Costs and Benefits

3.23 It seems likely that the unvalued benefits are of a greater magnitude than the unvalued costs. If this assumption is correct and the valued estimates are of the right order, it may be possible to say that the benefits of action are likely to be justified by the costs, and may significantly outweigh them. The costs of introducing and administering policy instruments would have a bearing on this, but we are unlikely to introduce instruments with such high associated costs that they would have a significant effect.
Section 4: Improving Farm Practice and Infrastructure

4.1 Defra has a significant research programme looking at the impacts of farm practices on emissions of potential pollutants - and possible approaches to mitigation. Details of current and completed research projects can be found on our website13.

4.2 Many of the improvements in farm practice that are likely to be required to deliver good water status in different parts of the country can be found in current Defra farm-practice guidance, or in publications such as the Environment Agency’s “Best Farm Practice: profiting from a good environment”.

4.3 In some cases however, solutions to specific pollution problems may involve action which goes beyond that suggested in existing guidance. As the Catchment-sensitive farming progresses, we will be publishing further information on the improvements in farm practice and infrastructure - and the land use changes - that are likely to be required to deliver good water status in different parts of the country.

4.4 Alongside the Catchment-sensitive farming consultation we are today publishing a paper produced for this project as part of Defra’s science programme called “Land use for achieving ‘good ecological status’ of waterbodies in England and Wales: a theoretical exploration for nitrogen and phosphorus called “Land Use-Scenarios for good ecological status” (Haygarth et al, 2003).

4.5 This technical paper addresses the significant question of to what extent nutrient emissions will need to be reduced to deliver good ecological status and how far this will need to be done through land use change.

4.6 Several key points are suggested by the data and conclusions within this paper and the previous work on which it builds:
   • it is likely that virtually all rivers in England have significant nutrient enrichment problems
   • there is a correlation between levels of inputs of potential pollutants and emissions to water
   • the reductions in levels of emissions of nitrogen and phosphorus required is likely to be in the range of 50-80%
   • in seeking to reduce agricultural water pollution, we will need to consider measures to address land use and inputs as well as land management and farm infrastructure

4.7 This work suggests that although diffuse pollution can be seen as a series of discrete local problems within different catchments, there appears to be a considerable shared problem of nutrient enrichment which may require significant action in virtually all catchments. To this extent agricultural water pollution could be characterised as a significant national problem with local variations. We are undertaking further research to explore these points further.

13 http://www2.defra.gov.uk/research/project_data/projects.asp?SCOPE=0&M=PSA&V=EP%3A120A
Section 5: This research complements and will be considered alongside the ongoing work undertaken by English Nature and the Environment Agency, which is set out in the “Mapping the Problem” paper, also published alongside the consultation paper.
Baseline for Action to Reduce Water Pollution from Agriculture

5.1 A number of policy initiatives that are expected to come into effect over coming years will promote changes on farms that will help to reduce water pollution. As a result, the gap between current water quality, and good chemical and ecological status is likely to decrease.

5.2 As explained in Section 2, water pollution from agriculture is an externality, and farmers are unlikely to act to abate pollution unless they face regulation or are given incentives for doing so. However, it is possible that where the required changes are cost neutral, or low cost, farmers may undertake to reduce pollution, even when they do not benefit directly from these actions themselves. For example, the Learning Skills and Knowledge review should result in policies that improve land management skills. It could be assumed that, even given no further incentives or regulation, many farmers could use these improved skills to implement no-cost and some low-cost changes which will reduce some water pollution from agriculture.

5.3 By estimating how much relevant change prospective initiatives are likely to deliver and making some very general working assumptions about the proportion of farmers that are likely to undertake no- and low-cost measures in the absence of further incentives or regulation, a broad indication can be given of the cost of the necessary remaining action to be achieved through new policy measures. This analysis is expected to improve over time as the assumptions are tested and improved evidence becomes available. In addition work is ongoing in the Environment Agency to formulate a baseline scenario for agriculture for the WFD. Results of this analysis will be available in the summer 2004 and will contribute to the river basin characterisation work for the WFD.

5.4 CAP reform is likely to have a significant impact on water pollution from agriculture through decoupling and cross compliance. In addition, two schemes already planned that will contribute to reductions in water pollution are the Entry Level Agri-Environment Scheme and the Higher Level Scheme. Finally, the outcomes of the Learning Skills and Knowledge Review and the Whole Farm Approach will raise awareness of regulatory requirements, provide advice on good practice and help farmers to develop the skills required to follow good practice.

5.5 We could also expect improvements in the baseline to come about through other changes such as technological advances, but we do not intend to estimate the impact of these at this stage.

CAP Reform

5.6 The GFA-RACE/IEEP (2004) report commissioned by Defra examines the anticipated agricultural responses to the June 2003 CAP reform agreement, and the predicted impacts of those responses on water pollution. This will help indicate the size and nature of additional work needed to reduce agriculture’s contribution to water pollution. The findings of the report are summarised below.

Impacts on agriculture relevant to DWPA
This and the following section summarises the current understanding of the CAP reform agreement’s impact on agriculture and the economy (which in turn impacts on DWPA). The analysis draws on Defra’s Strategic Review of DWPA (2003)\(^\text{14}\) and other related documents. The main impacts relate to the influence of decoupling, which will make production more market orientated/sensitive.

There will be restructuring within the industry. This will lead to continued specialisation with production concentrated in the most productive regions (e.g. dairying in the SW). There will be an overall reduction in beef and lamb production, with outdoor pig production expanding potentially. Farms will merge, resulting in larger dairy herds with higher yields. Smaller dairy and stock farms will continue to exist though, through local sales and developing added value products. Hobby farms will increase due to land release from restructuring. Contractors and labour/machinery sharing will increase to reduce costs. Unprofitable/marginal land will be used for other purposes – e.g. amenity.

There will also be a number of changes in the pattern of cropping and stocking. For instance, arable areas will be used more for winter wheat with oil seed rape as the preferred break crop where profitable. Non-food crops in general will become relatively more attractive. Set-aside will be used at the minimum rate, including significant uptake of 5m/wider strips adjacent to watercourses in order to meet cross-compliance etc. There will be a reduction in overall dairy stock numbers, although we will witness an increase on individual dairy farms. More land will be used for agri-environment schemes, particularly arable - through Entry Level Schemes - and beef/sheep grazed grass land.

There will be impacts on farm management practices. For instance, fertiliser applications will be even more closely targeted to crop requirements and pesticides will be more closely targeted to minimise costs and environmental effects. Rotations will be simplified which could potentially lead to increased reliance on the chemical control of pests/diseases using older, cheaper and less selective chemicals, which may harm biodiversity. There will be more intensive dairy systems requiring high use of veterinary medicines, which may increase the risk of water contamination.

**Impacts on DWPA pollutants**

The changes in farming practices/patterns outlined above will impact on pollutants across England. It is likely that the CAP reforms will result in changes in farming practice that will help to reduce (often significantly) overall levels of nitrogen and phosphorus in ground and surface waters – through targeting to crop requirements. However, some increases will probably occur locally and within specific catchments – e.g. through higher concentrations of dairy production in certain regions. The impact on siltation may vary. Farming practice changes such as increasing fallowed land and reducing livestock numbers should reduce siltation.

\(^{14}\) www.defra.gov.uk/environment/water/dwpa/index.htm
levels. However, dairy farming regions where herds are intensively managed outdoors, among other changes, will offset this.

5.12 There will be reductions in organic waste in areas where livestock farming is predominant due to the associated reduction in livestock numbers, although increased concentration within the dairy sector may offset this in certain catchments. Changes in the levels of micro-organisms should follow the pattern of organic wastes (as they are found in livestock faecal waste). Reductions/more targeted use of pesticides are anticipated as a result of CAP reforms, reducing levels in ground and surface waters by varying degrees across areas. Increases in maize production in dairy farming regions (and potential increases in root cropping and vegetable production in arable farming areas) may lead to increased pesticide usage in particular catchments. Reductions in livestock numbers are likely to lead to reductions in the levels of veterinary medicines found in water catchments in the main livestock regions, whereas concentration in the dairy sector may lead to increases in the relevant regions.

Overall indication of contribution to meeting targets

5.13 All of the analysis so far indicates that the general effects of CAP reform are likely to be positive, but that there are certain issues that could lead to degradation of water quality in certain areas. In terms of the overall impacts of CAP reform on targets for water pollution from agriculture, the GFA-RACE/IEEP study notes that the reduction in losses of pollutants to water from agricultural land required to meet our environmental targets are very significant (around 50-80%).

5.14 The study’s qualitative analysis, backed up by the case study work, indicates that the reforms appear to head in the right direction and are likely to result in improvements in farming structures and practice that will, in turn, result in decreases in pollutant levels at varying scales, intensity and locations. However, while these improvements will contribute to meeting targets on water pollution from agriculture, they are unlikely to be sufficient relative to the changes required to meet environmental targets, and it is evident that other measures will be required both nationally, and particularly in certain catchments, in order for farmers to make the changes to management practice required to meet water quality targets. The analysis assumes an effective use of available policy instruments (e.g. cross-compliance and agri-environment schemes) in targeting DWPA issues.

Decoupling

5.15 As discussed above, decoupling CAP payments from production is likely to lead to greater sensitivity to market signals. This is expected to result in a national reduction in arable, livestock and dairy production, but with intensification in certain productive regions such as the east of England for arable crops and the south west for dairy. With reference to the drivers of water pollution discussed in Section 2, decoupling involves removing the policy failures that lead to over-intensification, but does not
alter the market failure that the impacts of water pollution are external to the farm and therefore not accounted for in decision making. This means that although the incentives to over produce have been removed, there remains no reason to anticipate that farmers would voluntarily make changes that increase their costs when the benefits in terms of water quality do not accrue to them. We would therefore not expect the reductions in pollutions required for 'good ecological status' to be achieved through decoupling alone.

Cross Compliance

5.16 Cross compliance will provide further incentives for farmers to comply with existing Directives and maintain land in Good Agricultural and Environmental Condition (GAEC). This should lead to an improvement in basic farm practices, particularly in soil management, that will help to reduce emissions to water. The measures that will be included in cross compliance are the subject of a current consultation. The proposed measures include control against over- and under-grazing; protection of landscape features including dry stone walls, hedgerows and possibly other features; use of 6-10m set aside strips, and potentially management of 2m uncultivated field margins, beside sensitive habitats; protection of permanent pasture and maintenance of land not used for production; and requirements to develop soil management plans. Some of these are already carried out as part of good farming practice, while others will not impact directly on water. However, the measures should lead to some reduction in water pollution from agriculture, especially as they will be implemented on all land in receipt of CAP payments.

5.17 New requirements for cross compliance that exceed current legislation will need to fall within the definition of GAEC. The key aspect of GAEC that could impact on DWPA is soil erosion, structure and content. Therefore, it is likely that some of the soil related measures that would be necessary to reduce DWPA will be included in cross compliance. However, whilst the GAEC soil measures will address some aspects of DWPA, additional types of measures have also been identified as having a role to play in reducing DWPA. Several reports, e.g. WFD report on indicative costs of agricultural measures (2003)\(^ {15}\), have identified a number of groups of measures in addition to reducing soil erosion vulnerability. These include: reduction of nutrient inputs (e.g. lower fertiliser inputs); prevention of runoff enrichment (e.g. limit livestock access to watercourses); and containment of runoff contamination (e.g. collect farmyard and farm track runoff). Further, to avoid 'gold plating', it is unlikely that the soil protection measures under cross-compliance will go as far as including all the potential 'soil erosion' measures identified as potentially beneficial for DWPA.

Whole Farm Approach and Learning, Skills and Knowledge Review

5.18 Two new areas that will contribute to reductions in DWPA are the Whole Farm Approach (WFA) and the Learning, Skills and Knowledge Review (LSK). The former will provide farmers with advice on, among other things, environmentally sensitive land management, which will reduce the information failures that can result in over- or mis-application of polluting inputs. The LSK Review is considering how farmers’ skills could be improved, and the outcome of the review is likely to be the introduction of measures to raise skill levels. These increases in knowledge and skills should enable farmers to implement many of the no-cost measures that would reduce water pollution, and they may also be encouraged to implement a small proportion of the low-cost measures as well.

5.19 Cross compliance will result in new requirements for farmers to implement some of the changes that are promoted through WFA and LSK. At the same time, the introduction of WFA and the outcomes of LSK will enhance the effectiveness of cross compliance by improving land management skills and information on nutrient requirements. This should reduce the costs for farmers of complying with the regulations and of the corresponding reductions in water pollution.

Entry Level Scheme

5.20 One of the stated objectives of the Entry Level Scheme (ELS) is to reduce diffuse water pollution. The scheme will involve payments for a range of farm practice changes, some of which will be targeted at water pollution from agriculture. These measures include buffer strips on arable land; forage crop management; management of high erosion risk land; and grassland management with reduced fertiliser inputs. The application process requires farmers to identify high soil erosion risk land, which is intended to raise awareness. There are also management plan options (for crop protection, soil, nutrients and manures) which are designed to encourage improved farm practices to reduce pollution and protect the soil, and are being advocated for adoption in priority catchments. It is hoped the scheme will be launched in early 2005, and it will have an annual budget of £150m in addition to administration costs.

5.21 Only a proportion of the practices supported by ELS address water pollution, and it is up to farmers which options they choose, so they may choose all those with water quality benefits or none. If no options with water protection benefits were chosen, then ELS would not contribute to improved water quality, and if only options with water protection benefits were chosen, farm practice changes up to a total cost of £150m could theoretically be obtained.

5.22 Based on the observed uptake of different options in the ELS Pilot Scheme which ran for one year from August 2003, approximately 23% of the £150m, or £35m, would be spent on options with some benefits for water protection. Uptake of options will vary between different farm types e.g. in the pilot scheme, the proportion of total expenditure spent on options with water protection benefits was 37% in the grassland area;
30% in the upland area; 25% in the mixed area; and 14% in the arable area. These figures are all derived from the uptake results found in the evaluation of the Pilot Scheme\(^\text{16}\). The evaluation has recommended that farmers should be encouraged to adopt a wider range of options than was observed in the pilots, in particular to select in-field as opposed to boundary options. This may increase the uptake of options with water protection benefits.

5.23 These costs of the practices supported by ELS measures are not directly comparable with the illustrative costs of delivering good water status in water bodies throughout England for a number of reasons:

- Changes supported by ELS could improve water quality across the country, but it will be up to farmers whether they are implemented in the places where they are most needed to deliver water quality targets. Although one-to-one advice on the farm will not be possible within ELS, workshops and written guidance will be widely used to encourage the optimal choice and location of options. This could include advice on options which would improve water quality.

- Water protection is only one of a number of aims for many of the ELS options that will contribute to reduced water pollution, and not necessarily the focus. For example, arable margins or conservation headlands have water protection benefits, but are also aimed at biodiversity conservation and possibly protection of archaeological sites. Therefore we cannot assume that the full cost of options will contribute to reduced water pollution.

- Initial comparison of the practices supported through ELS, with the farm practice changes on farms that are likely to be needed to help deliver good water quality show only limited overlap between the two.

5.24 For the purposes of this analysis we have assumed that 30% of revenue spent on ELS options that contribute to water protection will bring about the farm practice changes required, in the places required, to deliver good chemical and ecological status.

5.25 Based on these assumptions, as summarised in table 2, we estimate that ELS-supported changes with water quality benefits could equate to around £10m.

| Table 2: Summary of Assumptions Used to Estimate Contribution of ELS |
|-----------------|-----------------|-----------------|-----------------|
| Total Funding  | Proportion of measures with water protection benefits | Comparability with water pollution reduction measures required for WFD | Estimated contribution to reduced costs of meeting water quality objectives |
| £150m          | 23%             | 30%             | £10m            |

\(^{16}\) http://www.defra.gov.uk/erdp/reviews/agrienv/entrylevel.htm#Finalreport
Higher Level Scheme

5.26 The Higher Level Scheme (HLS) will also involve payments for a range of farm practice changes, some of which will be targeted at water pollution from agriculture.

5.27 Most of the funding for HLS will be gradually transferred from the Countryside Stewardship Scheme (CSS) and Environmentally Sensitive Areas Scheme (ESA) budget, which is approximately £125m in the current year. CSS and ESA do not have water protection as an aim, but they do include support for farm practices and capital investments that have the effect of reducing water pollution.

5.28 As the £125m is existing expenditure, we have assumed that it is contributing to existing water quality levels and will not deliver additional improvements that can be compared to our costs. However, as HLS will contain options aimed specifically at reducing water pollution, this would be expected to raise water quality, relative to levels under existing agreements. This needs to be taken into account in looking at the potential contribution of HLS, but has not yet been integrated into this analysis. In practice, the way in which agri-environment spending is targeted will be critical to delivery of water quality objectives.

5.29 Funding for agri-environment schemes will rise by £15m per year until 2006. This will be used within ESA and CSS in 2004/5 and for HLS in 2005/6 and 2006/7. The budget is currently uncertain after that, however if HLS funding were to continue to increase at a rate of £15m per year for the 7 years of the next England Rural Development Programme, the additional expenditure on HLS in 2012 would be £135m.

5.30 As with ELS, a proportion of the expenditure for HLS will be on options contributing to water protection, but it is not possible at this stage to determine what that proportion will be as it will depend on relative uptake of the options. To provide a rough idea, 29 out of the 116 options (25%) would provide some benefits for water quality.

5.31 Given the greater targeting of options under HLS, we have assumed that 35% of revenue spent on HLS options that contribute to water protection will bring about the farm practice changes required, in the places required, to deliver good chemical and ecological status.

5.32 Based on these assumptions, as summarised in table 3, we estimate that additional changes supported by HLS, ESA and CSS which contribute to reduced water pollution could equate to around £12m.

Table 3: Summary of Assumptions Used to Estimate Contribution of HLS

<table>
<thead>
<tr>
<th>Total Funding (New HLS and additional ESA &amp; CSS funding)</th>
<th>Proportion of measures with water protection benefits</th>
<th>Comparability with water pollution reduction measures required for WFD</th>
<th>Estimated contribution to reduced costs of meeting water quality objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>£135m</td>
<td>25%</td>
<td>35%</td>
<td>£12m</td>
</tr>
</tbody>
</table>
Combined Effects of Prospective Measures

5.33 The costs of meeting the Water Framework Directive targets in the arable, sheep and dairy sectors are estimated in the regulatory impact assessment for WFD at between £80m and £200m\(^ {17} \). The costs for the whole agricultural sector would be higher than this. The analysis above has indicated that agri-environment schemes could result in the implementation of a proportion of the required measures with a cost of around £22m. CAP reform, including decoupling and cross compliance will lead to some reduction in the required costs, but it is not clear at this stage what the extent of the improvement of water quality will be. However, as CAP reform is expected to lead to improvements in water quality in some areas, but deterioration in others, significant further action will be required in at least some areas.

Section 6: Stages of Intervention

6.1 The Government could introduce policy instruments to control pollution or encourage improvements at a number of stages in the production process as shown in figure 1.

Emissions

6.2 Instruments are theoretically most efficient when targeted at emissions. In an industrial setting, this could be achieved by improving managers’ knowledge of the causes and impacts of emissions, by setting limits on the total emissions from a factory through voluntary agreements or regulation, or by providing an incentive to reduce emissions to a target level through economic instruments. The advantage of focussing action on emissions is that it allows the producer to address the problem at whichever point in the production process is most cost-effective.

6.3 One of the characteristics of diffuse pollution however, is that environmental damage may be caused by the combined effects of many individually small pollution sources, which are in themselves hard to identify and measure. In agricultural terms it would be difficult and probably prohibitively expensive to set and monitor emissions limits for outdoor farming systems at an individual farm level.

6.4 Setting targets at an aggregate level (for instance by making farmers jointly and severally responsible for keeping pollution within a catchment within a given limit) would be likely to involve substantial issues of fairness and enforceability.
Production

6.5 The Government’s vision for the future of farming as set out in the Sustainable Food and Farming Strategy is of a strong and profitable industry providing good food and a healthy environment through improved management of the countryside. Theoretically, it might be possible to deliver reductions in pollution through large-scale reductions in agricultural production, but that would clearly not deliver this goal and would be incompatible with the principles of sustainable development.

6.6 On a smaller scale, if there are places where sufficient pollution reduction cannot be delivered through improved land management or more efficient use of inputs, achieving good water status may require changes in farm systems which could entail local reductions in levels of production. In other words, in order to follow one of the key principles for sustainable farming and food, to “respect and operate within the biological limits of natural resources” some owners of high pollution risk land may need to consider what the best use of their land is within the water quality constraints of their particular catchment. On the most vulnerable land, this could entail changes to more extensive farming systems, or alternative land uses such as forestry.

6.7 At this stage in the strategic review of diffuse water pollution from agriculture, whilst it is unclear whether (or to what degree) changes in farm systems and land use may be required, the development of policy instruments has concentrated on instruments which address farm management and inputs (although some pressures for wider changes may arise from them).

Farm Management and Inputs

6.8 Emissions of agricultural pollutants could potentially be reduced through changes to farm management, including:

- **Farm Practices**: the way farmers manage their land and farming activities, including soil management, cultivation techniques, livestock husbandry, siting of troughs and feeders, crop fertilisation and protection methods and the timing of activities.

- **Farm Infrastructure**: the provision, design and layout of farm buildings and facilities including manure and slurry stores, guttering and drainage, trackways, bridges and fencing.

- or reductions in inputs into the farm system such as fertilisers, feeds and agrochemicals.

6.9 Many inputs into the farm system cause significant environmental damage if they make their way into watercourses. Inorganic fertilisers, manures and animal feeds contain nitrogen and phosphorus that raise the nutrient levels of water, leading to an overgrowth of invasive plants and algae, which severely degrades the aquatic environment. Some pesticides, herbicides, fungicides, sheep dips and veterinary medicines can directly impair the health of aquatic biota. There is some capacity to reduce inputs of these products through better use and targeting, but
given the close link between inputs such as fertilisers and yields, reductions beyond a given level would result in reductions in production.

6.10 Haygarth et al (2004) suggest that to achieve good water status, measures will need to be introduced to both improve farm management and to reduce inputs.

**Farm Planning**

6.11 One way of approaching the methods and systems of agricultural production is through farm planning. Detailed farm plans cover the last three stages discussed above: farm systems, farm practices and infrastructure and agricultural inputs. They encourage farmers to think strategically about their farming activities within their environmental context and consider what changes could be beneficial. Instruments that aim to encourage the production and implementation of farm plans could therefore produce multiple benefits in promoting a move towards catchment sensitive farming.

**Modelling Emissions**

6.12 Although it would be extremely difficult to measure emissions from each farm in order to target policy instruments directly at emissions, a possible alternative approach is to model emissions based upon activities on a given farm. At its simplest this could involve setting targets for nutrient balances which subtract the theoretical uptake of nutrients by crops from the level of inputs. Over the longer term it may be possible to develop models which also take farm management practices and infrastructure into account.
Section 7: Analysis of Broad Approaches

7.1 This section provides qualitative analysis of the four broad approaches to reducing water pollution from agriculture that have been proposed in the main consultation document. It covers the expected benefits to water quality and the corresponding likelihood of meeting the WFD targets, and the likely costs of the measures in terms of both the costs of pollution abatement and the administrative costs that would be incurred.

7.2 This represents an initial assessment of the approaches, which will be developed further over forthcoming months on the basis of responses to this consultation; additional stakeholder involvement; and further detailed research and analysis into the expected impacts of the alternative options.

7.3 Four broad policy approaches have been characterised in the consultation document in order to aid discussion among stakeholders about the general types of possible intervention, and the same approaches will be considered here. However, they are not mutually exclusive, and the optimum approach to catchment sensitive farming may in fact include aspects of each.

7.4 The analysis is informed by a variety of issues, which have been discussed earlier in this document and are summarised here for convenience:

Benefits to Water Quality
- The Water Framework Directive requires that measures be put in place to achieve good ecological status in all waterbodies by 2015.
- The financial and non-market costs of Water Pollution from Agriculture are significant. Current indicative estimates, representing only a proportion of the total damage, show that damage costs are likely to be in excess of £250m p.a. Total damages are likely to be significantly higher.
- There will often be significant time lags between action being taken and improvements in water quality being observed. Therefore, the earlier action is taken, the more likely it is that water quality targets will be met.

Other Environmental Benefits
- Reducing water pollution from agriculture will contribute to several other targets including:
  - Sustainable Farming and Food Strategy targets on soil management, local air quality and greenhouse gas emissions
  - Measures required under the Habitats Directive
  - The Government’s Public Service Agreement targets to bring 95% of SSSIs into favourable condition by 2010; and to achieve 50% improvement in Riverwater Quality Objective compliance
UK Biodiversity Action Plan: restoring wetland habitats

Costs of measures

- Preliminary indications are that the farm practice changes required to meet the environmental objectives of the Water Framework Directive will cost between £80 and £200 million. However, these figures only apply to the arable, dairy and beef sectors.

- The Water Framework Directive requires that by 2012, “programmes of measures” be implemented in all catchments in order to achieve “good water status” by 2015. These must include “basic measures” to control the input of pollutants from diffuse sources. Such measures could include regulation, authorisation including environmental licensing, and registration based on general binding rules.

- Thus, action is required, by 2012 at the latest. It is extremely likely that taking action later, over a shorter timescale, will mean higher overall costs since there will be less time to identify the most cost-effective measures and for farmers to acquire the necessary knowledge and skills. A more incremental approach would allow actions to be piloted, results monitored and further research undertaken in order to identify the least costly means of achieving targets.

Other considerations

- Infraction fines under the Water Framework Directive could be imposed in respect of each waterbody deemed not to have satisfied a definition of good water status. Past experience indicates that such costs could be £25-50million per infraction per year. The likelihood of infraction will depend not only on the observed water status but also on the measures that are seen to be put in place. This is particularly relevant given the time lags and uncertainties (including the influence of weather) in the relationship between measures and environmental outcomes.

Option 1: Baseline plus Late Regulation

7.5 The baseline accounts for the effect of existing measures, including CAP reform, agri-environment schemes and other policy initiatives, on water quality. This option therefore involves doing no more than this until required to do so under the Water Framework Directive.

7.6 Additional voluntary action could lead to wider adoption of cost-neutral best practices, but is unlikely to deliver the more costly changes required. This is because farmers do not have to bear the costs of the pollution they cause and therefore do not have to take it into account in their business decisions. There is therefore little incentive for individual farmers to spend their limited resources on preventing it.

Water quality and other environmental targets
The baseline analysis in section 5 shows that if no additional action is taken we would not expect to deliver our targets, which would in turn lead to failure to meet the terms of the Water Framework and other directives.

Given that many of the farm-level changes required to achieve good water status, such as no input zones or restrictions on timing, would be difficult to monitor, there would be a risk of hidden failure to comply with regulation once regulation was introduced.

There would be environmental losses from the delay in improving water quality. As the baseline measures would provide some improvements to water quality, these losses would amount to a proportion of the £250m at which the damages due to water pollution have been valued (see section 3).

Existing targets, including that on SSSIs, would be missed. Early action to reduce water pollution is required to help deliver favourable condition of, particularly aquatic, SSSI’s by 2010.

**Costs of measures**

- Basic regulatory measures under the WFD would need to be implemented by 2012. It is possible that delay would lead to a better understanding of what is required to achieve our targets leading to a more cost-effective choice of required farm-level changes, but there would be less opportunity for learning lessons about the most cost-effective measures from early implementation. In addition, implementation of regulatory measures at a national scale would lead to higher administrative costs than gradual implementation starting in priority areas.

- Farmers would be faced with implementing a large number of changes in a very short time period, which could have implications for both costs and the effectiveness of implementation as farmers would have less time to learn the skills and techniques required. However the costs of implementation would not be incurred until 2012.

- The need for farm-level identification of some problems and solutions also means that a wholly regulatory approach risks excessive costs because measures would need to address the problems in all areas. Late regulation would rule out the introduction of other, possibly more appropriate, policy instruments.

- Whichever approach to regulation was adopted, there would be considerable costs involved in monitoring a large number of small farm businesses. Costs would also be involved in having to adjust regulation in response to any technological improvements.
Option 2: Early Regulation

7.7 The early introduction of regulation would allow a more gradual approach, which would provide more time for farmers to adjust to new standards. Early regulation could start at a fairly basic level, with the stringency of environmental controls gradually increasing until good water status is achieved. This would make it easier for the Department to identify the most cost-effective measures and ensure that the right level of regulation was set to achieve the targets and would help to ensure that good water status was delivered without the imposition of unnecessary changes.

7.8 In many cases, environmental regulation can set limits on emissions which effectively control the amount of pollution within a sector. This would be difficult if not impossible in agriculture because of both the difficulty of measuring diffuse pollution and attributing it to a particular diffuse source. Therefore, comprehensive regulation of water pollution from agriculture could essentially take three forms:

- regulations limiting inputs of pollutants, or requiring the implementation of certain farm practice changes on a national basis
- more targeted regulations based on the identification of high pollution risk areas, as in Nitrate Vulnerable Zones
- discretionary powers for the regulator (probably the Environment Agency) to require action to control diffuse pollution where doing so would not entail disproportionate cost.

7.9 The most cost-effective approach is probably a combination of these and that is the assumption we have used for our initial analysis of Option 2. The issues involved in analysing this option include:

Water quality and other environmental targets

- Early regulation is more likely than late regulation to deliver the environmental targets, given the increased time available for the effects of actions to be observed. However, the fact that many of the required farm practice changes would be difficult to monitor and enforce under a regulatory approach is likely to compromise the effectiveness of the policy in meeting targets.

Costs of measures

- As with the baseline scenario, the unevenly distributed nature of the problem and the need for measures to be targeted, means that a wholly regulatory approach risks excessive costs if the same action is required in all areas. A targeted regulatory approach would address this to some extent, but would be highly resource intensive, particularly as identification of some of the changes involved would require detailed analysis of, for example soil structure, to identify the changes required.
- Costs of monitoring a large number of small businesses are likely to be significant, and the farm-level changes difficult to verify. There
would also be administrative costs involved in adjusting regulations in line with technological changes over time.

- Early regulation is likely to be more cost-effective than late regulation, due to the scope for incremental action and for the policy to develop as information about effectiveness of action is gathered.
- Regulation would impose costs on farmers including capital costs for new equipment, and the ongoing costs of undertaking new measures. In addition some stakeholders have argued that UK farmers will be at a competitive disadvantage in the EU if the UK regulates early.

Option 3: A Supportive Approach

7.10 Meeting environmental targets is likely to require new skills and new business approaches and there would be benefits in gaining the cooperation of farmers in introducing these changes. One way of achieving this could be through a package of measures including voluntary action, information, some regulation and possibly some financial instruments:

- Voluntary action on the part of farmers either individually or in groups could help to introduce many of the changes required, particularly those that are low cost, or will improve farm profitability.
- Information instruments such as catchment officers, awareness raising or advice services could help farmers to understand why and how to manage their land in an ecologically sustainable way within the context of their catchments.
- Financial support such as grant aid could provide farmers with incentives to appraise and plan their activities, invest in environmentally sustainable farm infrastructure and move to more catchment sensitive land management practices.
- Regulation could help to enforce basic standards of good practice to ensure that poor land management on a small number of farms was not undermining other farmers’ efforts to improve water status within their catchments.

7.11 The issues that inform this analysis include:

Water Quality and other Environmental Targets

- Given the site specific nature of many of farming’s water pollution problems, a targeted and where necessary transitional approach involving farm planning may be the only way of identifying and resolving some of the problems and would increase the chances of achieving the targets.
- Many aspects of this approach are potentially voluntary and it could not therefore be guaranteed to deliver all of the change required. However, the potential win-win outcome (of improving the environment whilst helping farmers to adapt to new regulatory standards) could provide an incentive for farmers to make the
required changes whilst help is on offer. Some farmers could delay changes until required to undertake them by regulation, but in doing so would increase the likelihood of more stringent regulation in their catchments and reduce the opportunities for support in implementing them.

**Costs of measures**

- A gradual approach to the introduction of changes would help to ensure that the right level of change was introduced to meet water quality targets. The experience and knowledge gained in the early phases would help to define what policy approaches and instruments were required in the longer term, increasing our understanding of how much change is needed overall. Estimated costs of targeted action in 4-12% of the agricultural land in England would be between around £22-66m per year in the initial stage, although clearly the costs would be higher in later stages.

- The spending measures involved would involve significant additional expense to the taxpayer. However, the costs to farmers would be low and the total cost of achieving the changes required is likely to be relatively low because of the extent to which they could be targeted at the areas requiring most action and the ultimately reduced impact of future regulation.

- Many of the measures would be targeted, and would probably be “piloted” in a limited area before potentially being rolled out nationally. This would both focus early action on areas of greatest need, and would provide opportunities to gather better evidence of the effectiveness of specific measures that could then be used more widely.

**Option 4: Economic Instruments**

7.12 Taxes and trading schemes mean that farmers are faced with some of the external costs of their pollution, meaning that the costs imposed on society should be included in decisions about how much to produce and what methods to use.

7.13 Incentives to reduce pollution may be performance-based (i.e. relating to emissions or ambient pollution levels) or design based (i.e. relating to the scale and techniques of production). The former could include applying the instrument to total farm runoff or ambient water pollution, while the latter could include focus on inputs, farm practices, or expected runoff based on combinations of inputs and farm practices.

7.14 As well as the decision about the focus of the economic instrument, there is a choice about whether it should be implemented locally or at a national scale. A local instrument allows targeting according to local variations in costs from diffuse pollution, but is likely to be relatively expensive to implement. A national instrument will be less costly to administer but will also have lower benefits because it cannot be targeted at the areas of greatest need.
Water quality and other environmental targets

- Levies on nutrient inputs in other countries have been shown to reduce input use, with elasticities of demand\(^ {18} \) of 0.2 to 0.4\(^ {19} \). There has been less experience with trading schemes, but initial findings from the Dutch MINAS scheme indicate some reductions in nutrient pollution.

- Economic instruments are most suited to addressing broad pollution problems. Although they could be applied at a local or regional scale, the administrative costs of doing so would be extremely high. Therefore, it can be assumed that while the national environmental impacts would depend on the level at which the instrument was set, an economic instrument is unlikely to be effective for addressing site specific problems.

Costs of measures

- Economic instruments enable those for whom reducing pollution is relatively expensive to do so to a lesser extent than those who can reduce pollution easily and cheaply. This means that the overall costs of the on-farm changes to reduce diffuse water pollution should be minimised.

- However, if the benefits of reducing water pollution vary between catchments, a national instrument could lead to a greater reduction in pollution than necessary in some areas in order to achieve the required amount in other areas.

- The administrative costs of a national instrument targeted at nutrient inputs would be expected to be relatively low because it would only require knowledge of commercial transactions outside the farm gate, which are already recorded in farm accounts, and would not require monitoring of individual farm practices.

- In contrast, using a geographically variable instrument and targeting emissions would involve much higher administrative costs for both government and farmers, and monitoring emissions of pollutants from diffuse agricultural sources would be extremely difficult.

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\(^{18}\) the percentage reduction in input use that results from a percentage increase in the price of inputs.

\(^{19}\) WRc (1999) Diffuse Pollution: sources of N and P. Report to DEFRA. Ref: DETR 4755
Section 8: Appraisal of individual instruments

8.1 Section 7 presented an initial appraisal of four broad approaches to tackling water pollution from agriculture. This section provides an underlying qualitative appraisal, against similar criteria, of the individual policy instruments that could make up these approaches. It also outlines the extent to which each of the instruments under consideration could have synergies with and any other instruments in the sense that they particularly complement one another, or that additional instruments may be required to meet water quality targets.

Regulatory Instruments

8.2 Regulation involves mandatory legislative requirements to meet certain standards or to do things in a certain way. Issues that apply to regulation in general are:

- Regulation is thought less likely than other approaches to bring about the changes in water quality required given that (a) many farmers are yet to be convinced of their contribution to water pollution; (b) many farmers are unclear of the practical changes they will need to make; (c) a regulatory framework is unlikely to win their support in making the changes required; and (d) such support is likely to be required given that many of the changes required would be very difficult or costly to monitor. This appraisal may change if improved understanding reveals practices that would be both easily monitored and suitable for widespread application.

- It is expected that there would be significant costs to farmers of making changes to farm practices, and that monitoring and enforcement costs would be high.

- The risks of non-compliance and the difficulty of monitoring and enforcing some of the changes required mean that there is some uncertainty regarding water quality benefits. There could also be a risk of excessive abatement costs, particularly if regulation is non-targeted and/or applied in a non-incremental way.

- Costs of measures would be borne by farmers, often those who are performing least well financially, but with significant costs to the taxpayer for monitoring and enforcement. Regulation would be broadly compatible with the polluter pays principle.

8.3 Synergies: Regulation could form an approach in its own right. However, given the difficulty of monitoring and enforcing some of the changes thought to be required, a combination of regulation and other approaches such as financial incentives, planning and support may be more cost-effective.

8.4 Three types of regulation that could contribute to the broad approaches outlined above are considered here, namely national, area-based and targeted regulation. Issues specific to these types of regulation are as follows:
8.5 *National Regulation* would involve setting national, uniform standards for farm practice and infrastructure and could be used to limit levels of potential polluting inputs e.g. by limiting the content of animal feed. Specific issues are that the imposition of uniform standards by national regulation would be most likely to lead to unnecessary costs, given that the action required in some areas to meet the required standards may be minimal. Given the presence of unnecessary costs, the ratio of benefits to costs is likely to be unfavourable unless the regulatory requirements were set at a very low level. However, regulation of worst practice could be relatively cost-effective in raising standards on the less well-managed farms.

8.6 *Area-Based Regulation* would set specific standards for defined zones, e.g. those with particular sensitivity to diffuse source pollution. Specific issues are that costs would be likely to be lower as measures account for the requirements specific to the areas in question.

8.7 *Targeted Regulation* could be used to set specific standards for small areas, including individual farms and fields. Therefore this could minimise unnecessary costs and produce the best ratio of benefits to costs of the regulatory options. However regulatory and administrative costs would be high.

**Farm Planning**

8.8 Farm Planning involves providing the bottom-up assessment of pollution problems and possible solutions, particularly in parts of the catchment or particular farms identified as being at high risks of causing pollution. Detailed plans at the farm level would incorporate measures appropriate for individual fields, farms, or areas of farms.

8.9 The English Nature/Environment Agency field development report suggests that:

- Detailed farm planning is the only way to identify many of the specific field-level problems that can contribute to reduced water quality, and the changes needed to reverse them
- To produce sufficiently robust and effective plans, most farmers would want and need to work with a qualified adviser

8.10 To reflect the expert input (and perhaps the farmers own time) needed to produce a sufficiently robust plan, the production of plans would be financially supported. This could be achieved either through direct employment of farm advisers, or through grant payments to farmers, who could then choose their own (suitably qualified) advisers.

8.11 Farm planning to reduce water pollution would need to focus on three areas:

- Nutrient Planning (including manures and slurries)
- Soil Management Planning
Crop Protection Planning

8.12 In terms of appraising farm planning, issues that apply particularly are:

- The role of farm planning would be to identify the changes that need to be made within a catchment, rather than to bring them about. Where no-cost measures can be identified, farm planning may produce direct results for water quality benefits. Otherwise, farm planning would need to be supported by other measures to bring about water quality benefits.

- Farm planning would be relatively resource intensive due to requirements for expert input. However, given that it may be the only way of identifying required actions at the level of the farm, abatement may be cost effective.

- The outputs of farm planning would not be subject to significant uncertainty. Well constructed plans are likely to identify changes whose benefits are relatively well-known. However, significant uncertainty would relate to implementation of the plans.

- The distributional impacts would depend on the sources of funding for the development of the plans.

Synergies: As noted, farm planning would be limited to identifying required changes at the level of the farm. Bringing about the required changes would be likely to require further measures, for instance grant aid. Well targeted regulation of worst practice and incentive mechanisms to internalise general environmental externalities could be a more cost-effective way to bring about some types of change.

Catchment Officers

8.13 Catchment officers would provide a focus for activity to reduce water pollution in each target catchment. Their functions would include:

- Organising “top-down” analysis of water pollution issues at the catchment scale and prioritising areas for action

- Identifying priority farms for detailed pollution risk and mitigation planning, advice and farm practice and infrastructure changes

- Collating information from “bottom-up” farm planning analysis of water pollution issues gathered from farm planning on priority farms

- Raising awareness of the causes and impacts of water pollution problems within the catchment

- Organising and promoting action to reduce water pollution impacts and helping farmers to implement changes

- Co-ordinating use of grant aid and farm planning support to identify and resolve pollution problems within catchments

- Identifying schemes to provide resources and/or financial assistance to farmers seeking to implement changes
• Co-ordinating the monitoring of changes in farm practice, pollutant loss, water quality and ecological response to assess the effectiveness of measures implemented.

• Managing engagement from local stakeholders with an interest in reducing water pollution from agriculture

8.14 Catchment officers would share administrative support and be supported by a national centre which would provide technical, financial and publicity services.

8.15 In terms of appraising Catchment Officers as a policy instrument, particular issues include:

• Similarly to farm planning, the role of catchment officers would be to identify and raise awareness of the issues and required changes. Direct results in terms of water quality could follow from the implementation of no- and low-cost measures and where resources are made available to bring about changes. Otherwise, supplementary instruments would be required to bring about improvements in water quality.

• Catchment officers would be less resource intensive than farm planning.

• Assuming that the actions identified by catchment officers are well targeted, most uncertainty would relate to the extent to which the actions are implemented.

• There would be no impact on farmers’ incomes assuming catchment officers to be government funded. This could be thought to be contrary to the polluter pays principle.

8.16 **Synergies:** As with farm planning, bringing about the required changes would be likely to require further measures, for instance grant aid. Regulation of worst practice and incentive mechanisms to internalise general environmental externalities may be a cost-effective way to bring about some types of change. Targeted advice could also help in implementing key changes.

**Voluntary Initiatives**

8.17 The success of catchment officers in promoting change within catchments will be to some extent dependent upon the co-operation of local farmers in addressing the issues. One way of increasing the degree of co-operation would be to seek to establish voluntary initiatives of local farmers working together with the support of the catchment officer to agree and implement solutions to local pollution problems.

8.18 The Pesticides Voluntary Initiative led by the Crop Protection association is seeking to reduce the impact of pesticides on the environment. It provides an example of how the agricultural industry can work with other interested parties to tackle the environmental impacts of farming. If there is sufficient interests from farmers and industry bodies, a similar voluntary initiative could be established to tackle water pollution from agriculture.
8.19 Voluntary initiatives help participants to appreciate and take ownership of an issue and seek their own solutions to the problems they are causing. They can therefore lead to cost-effective and creative action from the people who know their business best.

8.20 In terms of appraising Voluntary Initiatives, particular issues include:

- Could be valuable in bringing about no- and low-cost measures, but voluntary initiatives are unlikely to extend as far as introducing changes that will significantly effect the profitability of an enterprise, particularly where margins are tight, as in farming. This would in turn mean that there would be limited scope for improvements in water quality.
- Costs would be expected to be relatively low.
- Levels of expected benefits are relatively low; there would be some uncertainty related to the extent to which farmers willing to undertake low-cost measures.
- Voluntary initiatives can provide incentives to improve over time, particularly where there is the prospect of more demanding requirements should the objectives of the initiative not be realised.
- There should be relatively little impact on farm incomes, and compatible with the polluter pays principle.

8.21 **Synergies**: May operate particularly effectively in conjunction with catchments officers, as a means to enforce and capitalise on raised awareness and as a means of implementing no- and low-cost measures identified. Unlikely to bring about a significant proportion of the changes required and therefore additional instruments would be needed.

**Co-operative Agreements**

8.22 A number of organisations share an interest in reducing diffuse water pollution from agriculture. For instance water companies could benefit from a reduced need for water purification and food retailers such as supermarket chains from the ability to market more environmentally-friendly food. These organisations could work with the agricultural industry in co-operative agreements to promote and implement catchment sensitive farming.

8.23 Co-operative agreements have the potential to bring additional expertise and resources to the task of tackling agricultural water pollution. They are likely to be more closely connected with market forces and could provide incentives for improvements to farm practice that are not available to the Government.

8.24 Co-operative agreements could reimburse farmers for implementing practices that improve water quality and therefore provide a mechanism by which farmers in priority areas could implement high cost changes without suffering competitive disadvantage. Reimbursement could be provided for activities from farm planning to changing cultivation techniques or reducing livestock numbers. Agreements could be based
on short-term transfers aimed at bridging the gap for farmers to shift to new sustainable farming practices. In many cases the partner organisation will require a level of certainty that changes implemented would provide a cost-effective way of improving water quality, which could involve taking high-pollution-risk land out of cultivation.

8.25 Local co-operation between farmers and water suppliers represents a potential vehicle for linking action by water companies and agricultural policies.

8.26 In appraising Co-operative agreements, particular issues include:

- Provision of resources means that the agreements could bring about valuable higher-cost measures.
- The expected costs depend on resources allocated by the funding party, but assuming actions well targeted and monitored, should be cost-effective.
- Uncertainty about the impacts would be relatively low on the assumption that funding partners would be unlikely to subsidise activities with uncertain links to pollution.
- There should be relatively little impact on farm incomes, but co-operative agreements would not be compatible with the polluter pays principle.

8.27 **Synergies**: Such agreements would be applicable only in locations, and on water quality issues, where there is an interested funding party. Therefore, additional instruments would be needed to meet targets where this is not the case. Other instruments, such as regulation of worst practice and provision of information, may be more cost–effective in bringing about certain aspects of change.

**Grant Aid**

8.28 Some of the changes in farm practice and infrastructure that are likely to be needed to help deliver our water quality targets will entail considerable expenditure. This would particularly be the case where changes to farm systems or improvements to farm infrastructure such as better slurry storage or riverbank fencing are required. Farmers are unlikely to undertake costly changes, which could effect their competitiveness and profitability, without sufficient incentives or requirements to do so. In the initial phase of action intended to help farmers to prepare for a new regulatory framework, time-limited grant aid could be used to pay for both high-cost infrastructure improvements and the transition to new ways of operating that would help to reduce pollutant loss.

8.29 The use of grant aid in targeted catchments would have to comply with State Aid rules. It is important to note that such support would not provide an unfair competitive advantage to farmers receiving it, given that the benefits arising from the subsidies are to the environment and not to the farm business.
8.30 The amount of grant required in each catchment would depend upon:

- the extent of damage to that catchment that needs reversing, and
- the agricultural sectors operating in that catchment, as the costs of the operational and infrastructure changes that are likely to be needed can vary widely between sectors.

8.31 Decisions would need to be made on whether to fund the full costs of changes and whether to make grants available for all of the changes expected to be needed in a catchment, or incremental proportions.

8.32 In appraising Grant Aid, particular issues include:

- Significant levels of well-targeted expenditure should bring about significant levels of benefits to water quality.
- Expected costs would be substantial, but assuming actions well targeted and monitored, should be cost-effective.
- Targeting and monitoring should reduce levels of uncertainty. However, there would be uncertainty about take up of the grant aid as it would be voluntary.
- There should be relatively little impact on farm incomes, but grant aid would not be compatible with the polluter pays principle.

8.33 **Synergies**: Targeted grant aid could address higher (and possibly low) cost measures and thus could provide a valuable means to address problems that would be dealt with less effectively, and cost-effectively, than other measures. A cost-effective outcome may require some more general measures, e.g. regulation of best practice, alongside grant-aid. Moreover, information instruments such as catchment officers may be required to identify the actions that should be supported by grant aid.

**Trading Schemes**

8.34 Trading schemes involve setting up a market in environmental goods or bads in order that targets can be met, theoretically at the lowest possible cost. Trading schemes could in theory be applied to emissions, or alternatively, to inputs or technologies. In all cases, a scheme would involve setting a limit to the total quantity of the relevant pollutant(s), and allocating permits for units of pollution, or for activities that are assumed to result in pollution, up to that limit. Farmers would not be allowed to use or emit more of the pollutant(s) or inputs than they had permits for, but could buy or sell permits to adjust the level of pollution they were allowed. The outcome of this is that the costs of reducing pollution should be minimised because those who would find it expensive to reduce the level of pollution would buy permits, while those who could reduce pollution more easily and cheaply would have an incentive to do so and sell their permits.

8.35 In appraising Trading schemes, particular issues include:

- Water quality benefits would be expected from reducing nutrient surpluses and/or implementing farm practice changes.
In theory costs to farmers should be minimised but would depend on the scale at which schemes could be implemented, given the need to target measures. It is likely that such considerations will make it difficult to design schemes that bring about effective trading and at reasonable administrative cost. Moreover, nutrient accounting and monitoring costs could be substantial. It is also possible that small businesses may not have the information or resources to optimise trading decisions.

The total cap on pollutants could be set with relation to water quality targets. However, there would be some uncertainty resulting from potential difficulties in monitoring and enforcement.

Particular incentives to improve efficiency over time given that improving performance would result in a marketable asset, i.e. units of tradable permit.

Impacts on farm incomes, which may be relatively severe in the case of those already doing badly financially, but fully compatible with the polluter pays principle.

8.36 **Synergies**: Trading schemes could contribute to addressing issues that must be applied at a general level. They would therefore complement other instruments such as targeted regulation, regulation of worst practice, catchment officers and grant aid, which could address more specific issues.

**Environmental Levies**

8.37 Environmental taxes impose a charge for each unit of pollution emitted, polluting input used, or on each unit of a product as a proxy for pollution emitted. Many inputs into the farm system cause significant environmental damage when they make their way into watercourses. There is a broad national problem with nutrients emissions and there appears to be a close correlation between levels of inputs and the emissions which cause environmental damage. A tax could be designed to incorporate some or all of this damage cost in the price that the farmer pays for a product. This would mean that farmers have to take account of the environmental as well as the economic costs and benefits when making decisions about what crops or livestock to produce on their land. The strong signal sent by the introduction of a tax would also be likely to increase awareness among farmers of the environmental impacts of the taxed product.

8.38 In appraising Environmental Levies, particular issues include:

- Some water quality benefits likely to accrue from reduced use of potentially polluting inputs.
- Some increased cost of inputs for farmers, but offset at the national level by revenues, less costs of administration.
- Uncertainty would stem from uncertain response to levy by farmers. However, the risk of excessive abatement costs is low as a levy
would be unlikely to be applied at levels that would reduce input use more than is required at a national level.

- Particular incentives to improve efficiency of input use over time given that improving performance would result in reduced payment of the levy.

- Impacts on impact on farm incomes, which may be relatively high in the case of those already doing badly financially, but fully compatible with the polluter pays principle.

8.39 **Synergies**: The direct environmental contribution of environmental levies would not be sufficient for them in isolation to constitute an approach to addressing the problem. However, they could contribute to reducing the use of polluting inputs at a broad and shallow level, and could complement other instruments such as targeted regulation, regulation of worst practice, catchment officers and grant aid, which could address more specific issues. Particular synergies arise because levies provide signals as to the types of activity that Government wishes to discourage, and therefore could raise the profile of and actively enforce the aims of other measures. Likewise, the information and advice provided under some of the other measures discussed (e.g. Catchment Officers) could increase the response to the environmental levies, increasing the environmental benefit and reducing the cost to farmers.