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Annex 39-UK

Micro- and macro economic analysis

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ANNEX 39 – UK

Water Resources Management in Cooperation with Agriculture

MICRO-MACRO ECONOMIC ANALYSIS

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UK WATER INDUSTRY RESEARCH LIMITED

WATER RESOURCES MANAGEMENT IN COOPERATION WITH AGRICULTURE (WAgriCo)

MICRO-MACRO ECONOMIC ANALYSIS

Executive Summary

WAgriCo is an EU - LIFE co-funded project that aims to develop best practices for approaches to control diffuse water pollution from agriculture. The UK component focuses on several 'pilot areas' within the catchments of the Frome, Piddle and Wey in Dorset. There are 665 farms in the three Dorset catchments and WAgriCo is collaborating with 58 farmers to introduce a number of measures aimed at mitigating the deleterious effects of farming on water quality.

This economic project had as principal objectives, to:

- Critically appraise the costs in the IGER/ ADAS diffuse pollution user manual.
- Identify for farms typical of the agriculture within the pilot areas
    - The likely real costs of implementing 10 mitigation methods with range and caveats.
    - Potential methods of meeting these costs (e.g. agri-environment schemes, farm assurance, etc).
- Calculate the cost of adopting a 'supportive approach' across the pilot areas.
- Scale up farm costs, support costs, plus any other additional costs to provide estimates of the likely total costs of implementing these measures across the pilot.

Detailed review of the IGER/ADAS User Manual concluded that, with few exceptions, the manual provided a reliable guide to the 2006 costs of implementing mitigation methods within a number of model farm systems. The farm management appraisal methods were appropriate as a basis for costing but the manual had a number of deficiencies. Details of the calculations were not generally given, and updating to 2008 prices was not possible. The facility to update is important because of significant changes in commodity prices that have changed the relative costs of different measures and the shape of the marginal abatement cost curve.

It is not clear that the manual can provide a reliable basis for scaling up of costs to specific catchments or national level. That is because the farm systems cannot be readily mapped onto real farms or farm types. The use of robust farm types would provide a better approach but may complicate the technical and cost analysis. In addition, scaled up costs may be over-estimated because, in order to estimate mitigation costs, model farms were assumed not to be adopting the measure under assessment (e.g. cover crops). In practice some farms would be using the management practice.

Measures were generally assessed on a whole farm basis whereas additional partial (per ha, per head) costing would have been helpful particularly for policy purposes. The usefulness of the manual would have been increased if more information on the variation in cost between farms were given. However, this would be a demanding addition to the work.

Nineteen Dorset farms within the pilot areas were randomly selected from those cooperating in WAgriCo and surveyed by face-to-face interview to assess the costs to the farms of implementing 10 mitigation measures (Table E1). The total area of the sample farms was 5,799 ha, and this included 1,081 ha of extensive grass. The mean total area of sample farms was 305 ha. All of the sample farms grew crops but only five were specialist arable farms with no livestock. There were eight dairy farms, eleven with beef cattle (suckler cows or young stock) and six had a sheep enterprise.

Table E1 Measures Costed on the Sample Farms

Type of measure	Description
Fertiliser recommendations.	Apply recommended fertiliser levels based on soil sampling, analysis and advice.
Manure management plan.	Prepare and apply a manure management plan within the scope of existing investment in plant.
Cover crops for spring sown crops.	Introduce cover crops for spring sown crops – maintain until February 15th.
Fertiliser spreader calibration	Calibrate spreaders
Moving from autumn to spring application for slurries and poultry manure.	No spreading between October 15th and January 31st.
N efficiency calculation.	Calculate a nitrogen balance for the farm.
Convert land in arable or intensive grass to extensive grass.	Area in extensive grass to be a minimum of 20% of the farmed area..
Adopt minimum tillage for all crops except roots and grass reseeds.	Minimum tillage to be used in 3 out of 4 years.
Cultivate land in spring (after Christmas) rather than autumn (spring crops).	No pre-Christmas cultivation of spring crops.
Use fertiliser rate 10% below the recommended rate (arable only).	Reduce fertiliser rates to 10% below recommended for arable crops.

For each measure the farmers were asked to estimate the additional costs and benefits of adopting the measure (without any support input from WAgriCo). Three of the measures produced, on average, a net benefit because benefits outweighed costs (Table E2). It was not possible to estimate the cost of moving from autumn to spring application of slurry because farms were already spreading in spring or did not produce slurry. Costs were estimated for the remaining six measures. These ranged from £2.0 per ha for the nitrogen efficiency calculation to £769 per ha of land converted to extensive grazing.

In order to scale up costs we assumed that the sample farms were representative of the total population of 665 farms in the pilot areas. Costs were scaled up from the sample of farms as indicated in Table E2 using the mean cost per farm or per ha as appropriate. Where there was a net benefit on average to farmers of introducing a measure the mean cost was taken to be

zero. The total cost of implementing all measures was £5.61m (£100.2 per ha on average), without attributing any cost to measures that gave farmers a net benefit (e.g. adopting recommended fertiliser levels). This sum was dominated by the high costs of conversion to extensive grassland and reducing fertiliser levels on arable land to 10% below requirements.

Table E2 Mean costs for the ten measures (per year)

Type of measure	Net Cost	No of farms relevant	Scaled up by	Cost for the pilot area catchments (£m)
Fertiliser recommendations.	-£3.72 per ha (benefit)	19		0
Manure management plan.	-£9.3 per ha (benefit)	17		0
Cover crops for spring sown crops.	£68.8 per ha[1]	18	Area of spring crops (6,602 ha)	0.45
Fertiliser spreader calibration	-£14.2 per ha (benefit)	17		0
Moving from autumn to spring application for slurries and poultry manure.	0.0	0		Not known
N efficiency calculation.	£600 per farm (£2.0 per ha)	19	Number of farms (665)	0.40
Convert land in arable or intensive grass to extensive grass.	£769 per ha converted	13	Relevant area (7.7% of 55988 ha)	3.32
Adopt minimum tillage for all crops except roots and grass reseeds.	£15.9 per ha	13	Area of all relevant crops (19,001 ha)	0.30
Cultivate land in spring (after Christmas) rather than autumn (spring crops).	£115 per ha	2	Relevant area (7.4% of 6602 ha)	0.056
Use fertiliser rate 10% below the recommended rate (arable only).	£48.8 per ha	17	Arable area (22,051 ha)	1.08
All measures				**5.61 (£100.2 per ha)**

All farmers in the sample were members of at least one assurance scheme. These schemes made a small contribution to the implementation of mitigation methods. The assurance schemes typically required soil sampling and fertiliser management (and possibly manure management planning). Stewardship offered some scope for mitigation through overwintering stubbles and headland conservation. No schemes apart from set-aside directly pay farmers to reduce fertiliser levels or extensify production on a significant scale.

[1] The benefits from cover crops were not quantified and therefore this is a cost figure not a net benefit figure.

Two types of 'supportive approach' were costed. In the first (**facilitator only**) an adviser is employed to provide environmental awareness through meetings, newsletters etc, and indicate sources of specific services. To offer this service to 2,000 farmers would cost around £30 per year (£20,500 for the Dorset catchments). In practice not all farms would participate if the initiative were voluntary. If only 25% engaged with the facilitator the cost per participating farm would rise to around £120 per farm. A more specialised approach (**facilitator plus**) offering more extensive services to a smaller number of farmers was costed at £670 per farm, mainly because services are provided to a much smaller number of farms.

ADAS derived costs at national level based on the farm level costs estimated in the farm survey. With all measures applied, the net cost was around £240m per year. This figure took into account the benefits which farmers derived from implementing the measures. Reducing fertiliser by 10% was found to be very expensive to implement. If this was excluded the aggregate cost fell to between £36 and £92m per year.

Whilst it is not possible to assess the cost-effectiveness of different measures without information on the extent to which they reduce pollution, it is clear that

- Farmers should be strongly encouraged to adopt mitigation methods which can be introduced at no net cost;
- A facilitation approach is a relatively low-cost way of informing farmers about methods that could reduce diffuse pollution; and
- Measures based on reducing fertiliser usage below recommendations or converting arable land to extensive grass are expensive to implement when grain prices are high.

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1 Research project

WAgriCo (Water Resources in Co-operation with Agriculture) is an EC co-funded project that aims to develop best practices for approaches to control diffuse water pollution from agriculture. The UK component focuses on several 'pilot areas' within the catchments of the Frome, Piddle and Wey in Dorset.

There are 665 farms in the three Dorset catchments. WAgriCo is collaborating with 58 farmers in a number of sub-catchments within the major catchments. These farmers are provided with incentive payments to engage in a range of measures to reduce nitrate losses. It also provides a support framework of catchment advisers and information provision through a range of activities including providing specific information to farmers (e.g. on fertilizer requirements, manure management planning, N balance).

However, a detailed understanding of the economic implications of these actions is required at a range of levels: individual farm businesses, the pilot areas (i.e. catchment-scale) and national (UK). This will inform the WAgriCo project and will feed into the final interpretation of the project and the final report. The micro-macro economic analysis project aims to provide additional information mainly on the cost to farmers of implementing measures to control nitrate losses and improve the efficient use of manures and fertilizers.

2 Objective of Research Work

The following objectives were set out in the project specification:

- Critically appraise the costs in the diffuse pollution user manual (Cuttle et al., 2007) and provide revisions (with justification), where necessary.
- Identify for farms typical of the agriculture within the pilot areas (guideline maximum of 20 farm businesses):
    - The likely real costs of implementing 10 mitigation methods with range and caveats.
    - Potential methods of meeting these costs (e.g. agri-environment schemes, farm assurance, etc).
- Based on information provided by the project partners, calculate the cost of adopting a 'supportive approach' across the pilot areas, e.g. costs of catchment officers, soil/crop/water sampling, provision of technical advice, etc.
- Scale up farm costs, support costs, plus any other additional costs to provide estimates of the likely total costs of implementing these measures across the pilot areas.
- Provide comment and feedback on the national costs calculated from the ADAS spreadsheet model.

3 Review of the IGER/ ADAS User Manual

3.1 Introduction

As part of Defra funded project ES0203 ADAS and IGER produced '*An Inventory of Measures to Control Diffuse Water Pollution from Agriculture. User Manual*' (Cuttle *et al*., 2007). This listed 44 measures (see Appendix 1) that could be introduced on farms to reduce diffuse water pollution from agriculture (DWPA). The measures were classified into six categories:

- Land use;
- Soil management;
- Livestock management;
- Fertiliser management;
- Manure management; and
- Farm infrastructure.

The effectiveness of each of the 44 measures in reducing nitrate (N), phosphorus (P) and faecal indicator organisms (FIO) was assessed. The cost to farmers of introducing the measures was also estimated. Using this process the aim was to assess the cost-effectiveness of each measure as a guide for policy implementation to reduce DWPA.

3.2 Aims

The aim of this section is to critically appraise the costs in the diffuse pollution user manual concentrating on the approach and methodology used. The appraisal is focussed on whether the methods used for the costing provide a reliable guide for policy. As part of this review discussions were held with ADAS UK Ltd. who originally produced the cost data in the user manual (Harris, 2008). No attempt has been made to update the costs which were based on 2005-2006 prices.

3.3 Approach used in the manual

The user manual began as a technical document in which scientists identified a set of measures that appeared to have potential to reduce DWPA. In order to estimate the effect of each measure a series of model farm systems was established with each measure being assessed in the context of each of the systems in which it could be applied (Table 3.1). We understand from ADAS that the model systems originated from a nutrient based approach rather than one directed at measuring cost-effectiveness. The technical approach required simple structures to avoid the confusion of mixtures of enterprises.

The model systems were defined by scientific staff in terms of the characteristics of major types of farms which were known to be important sources of nutrient leaching and FIOs. The technical aim was to specify the systems and measures in sufficient detail to allow calculations of the N, P and FIO losses. They were therefore defined in terms of those factors that determined DWPA. The location, structural and financial characteristics of the model systems were not defined in detail. Each system or 'farm type' was stated to be located in a medium rainfall region (850mm) and either have a sandy loam or a clay loan soil. With the exception

of the suckler beef system, which was located in Durham/Cumbria, the basic systems (Table 3.1) have no precise location

Table 3.1 Model Farm Systems

Farm system	Animal Count	Excreta (t/year)	Managed as Manure (%)	Field Area (ha)	Average N (kg/ha)	Average P_2O_5 (kg/ha)
Arable	0	0	N/a	300	165	60
Arable plus manure	0	2,700	100	300	140	58
Dairy	270	5,040	60	150	190	35
Suckler Beef	220	1,850	50	100	80	30
Broilers	150,000	2,550	100	437	145	48
Breeding Pigs (Indoor)	1,330	2,125	100	71	145	48
Breeding Pigs (Outdoor)	2,536	3,568	0	24	0	0

The systems are defined further in broad farm management terms in the manual's Appendix 1. There, each system is defined in terms of herd sizes, stocking rates, slurry handling arrangements etc. However, the price and cost baseline for each system is not explicitly defined nor are the cost calculations for the measures given in detail. This has two effects. First, it makes the manual fairly impenetrable in terms of understanding how the cost figures were derived, and second, it is not possible for an external user to revise the cost estimates in the light of changed commodity prices or costs. We understand that the detail was restricted in order to avoid the manual becoming too large. Nevertheless, this lack of transparency limits the use of the cost information especially in relation to significant changes in commodity prices and enterprise gross margins that have occurred since the user manual was produced.

The manual is in fact dealing with a set of abstract, simplified systems and it is not clear how they are related to real farms. There is a case for linking the analysis to Defra's robust farm types so that there would be a stronger link to real farming. This aspect is discussed later. The intention in the costings is to indicate the costs of implementing the measures in practice. But actual costs may be influenced to a major degree by the specific farm context and its financial performance. This limitation is appreciated in the manual which gives a warning against extrapolating from the models and applying them to the whole of the farming sector. Similarly the estimates of cost and effectiveness, it states, should not be applied to specific farms except where they closely resemble one of the model systems.

3.4 Analysis of specific measures

In Table 3.2 each measure is taken in turn and assessed in terms of whether the context and methodology can be expected to result in a satisfactory cost estimate. It was not always possible to determine how the results presented in the manual were derived. In a number of cases ADAS UK Ltd provided further details at our request.

Table 3.2 Detailed Analysis of Measures

Measure	Context	Comment on costing method	Comments on costs	Cost implications
1 Convert arable land to extensive grassland	Costed as a complete conversion of the whole farm. It would also have been useful to cost a marginal change of say 10% of the arable land (as a type of set-aside).	The cost of conversion depends crucially on the existing baseline income and the income from the extensive grassland. Both are highly variable in practice and a range, rather than a 'mean' cost would have been useful. Much would depend on individual circumstances and how the grassland was utilised (if at all). No income was attributed to the livestock when livestock are introduced but farmers may discount this.	Extremely difficult to produce meaningful costs without a clearer farm baseline and context. Loss of £90 net farm income will underestimate the loss on many specialist arable farms (mean £153 per ha on general cropping farms, 2005-06, SAC, 2007).	Highly variable in practice. Some indication of this variation would have been useful.
2 Establish cover crops in the autumn	The assumption is that cover crops are relevant for the whole 300 ha. This is slightly confusing since only 25% is in spring crops. Total costs are hence overestimated but per ha costs are not affected. It is assumed that volunteer plants/weeds would provide cover on a % of the area. A better approach would be to cost the formal establishment of all cover crops since this would be required in any policy implementation.	We suggest that a range of costs from farm labour to full costs for establishing cover crops by undersowing or direct seeding would be preferable. Costs at £67.50 per ha of cover crops are reasonable.	Costs at an average of £17 per ha are low because of assumptions about using farm labour and allowing weed growth to count as a cover crop on part of the area.	Costs are appropriate.
3 Cultivate land for crop establishment in spring rather than autumn	This is slightly ambiguous but is taken to refer only to spring corps. The costs refer to 10% of the arable farm in spring crops whereas the system description states that 25% of the area is in spring crops.	Whether there is yield loss depends critically on sowing date. There are risk aspects from delayed sowing that are difficult to incorporate into the cost-effectiveness calculations.	The expected yield loss of 25% seems high but if this is accepted then the loss in output should be around £100 per ha at 2005 prices.	Cost may be underestimated but much depends on the extent of the expected yield loss. A range of possible costs would be useful.

Measure	Context	Comment on costing method	Comments on costs	Cost implications
4 Adopt minimal cultivation systems	This is not a clearly defined measure because it is not clear how much flexibility is permitted in the use of minimal cultivation. In practice it would be more realistic to plough periodically.	In practice some farmers would kit up with minimal cultivation equipment whereas others would use a contractor. The savings would be greatest where labour could be reduced. There may be little saving in equipment costs.	The costs or savings would vary considerably with context and a range would be helpful. Where equipment for a plough system was retained there would be additional costs unless labour could be reduced.	There will be a wide range of costs/ savings from the introduction of minimal cultivation and this range is greater than indicated.
5-8	These all introduce relatively small changes in soil management. In some cases costs in practice would depend on the precise context and configuration of a farm..	Appropriate	Because costs will vary with context they will vary in practice. A range of costs would have been helpful,	Ranges preferred to allow for individual farm variation in soil conditions and field configurations.
9 Establish in-field grass buffer strips	It is assumed that 10% of the farm area is put into grass buffer strips. This does not apply to farms already in grass.	It is assumed that the strips can be achieved from natural regeneration and light cultivation. No details of the cost calculation are given in the text but all relevant costs are included.	The cost of £31.6 is per farm ha. The cost per strip would have been a more useful figure for wider application. This is based on a gross margin loss of £302 per ha plus establishment and maintenance costs. The assumed gross margin is high in situations where the buffer strips requires little management. A gross margin of £210 per ha (2005) would be more appropriate.	The cost may be rather high.
10 Loosen compacted soil layers in grassland systems		This is a single operation, readily costed.	Appropriate	The cost is £43 per ha treated. This is an annual cost if grass is subsoiled once every four years.
11 Maintain or enhance soil organic matter levels	In practice costs would depend on whether organic manures were available on the farm as part of a mixed system or whether transport was required (assuming a local source). The costings are done for an 'arable with manure' system - a variant on the arable system.	Appropriate in the context of the assumptions about availability and travel distance.	No details of the cost elements are given – in particular what savings in fertiliser costs are included.	A difficult measure to cost given the variation in context. More information on the range of costs likely to be experienced would be helpful
12 Allow field drainage systems to deteriorate	This is extremely difficult to cost because impacts will vary hugely with circumstances and increase over time. In some cases arable farming would become untenable.		Costs are based on a loss of output of £491 per ha.	Costs are reasonable for the loss of outputs assumed.

Measure	Context	Comment on costing method	Comments on costs	Cost implications
13 Reduce overall stocking rates on livestock farms	This measure is not adequately defined to cost with any precision. A 50% reduction in animal numbers on the same area of land is assumed.	In the absence of a detailed context a broad-brush approach is used in which typical gross margins are reduced by 50%. Some reduction in fixed costs would also occur in many cases as labour and machinery costs would be reduced.	Costs are based on a 50% loss of gross margin net of nitrogen fertiliser costs. The dairy gross margins are low as compared with average figures (around £720, Nix, 2006) and this would give a cost of £360 per ha. Beef cattle costs are reasonable.	Costs are very difficult to specify and there would be considerable variation in practice depending on financial performance and circumstances. Costs may be in practice be higher than estimated for dairy cows unless fixed cost savings can be made. A range of costs would be helpful.
14 (15) Reduce the length of the grazing day or grazing season	This measure is not well specified. It requires some adjustment in land use and feed managements in order to provide the additional conserved or zero grazed feed that the stock require when not grazing.	Cost are based on the additional costs of silage making and slurry spreading In practice stocking rates may have to be reduced to provide the additional silage. Amy loss of output would increase costs substantially.	The costs are appropriate in a context where minimal adjustment is assumed.	These costs are probably underestimated because stock numbers may have to be reduced to provide land for additional silage.
16 Move feed and water troughs at regular intervals	Feed troughs can be moved almost without cost. Water troughs movement is allowed for by fixing one additional trough per field	The method is based on farm labour. A contractor cost for increased water supply would be useful as farmers are likely to use this option in practice.	No details of the calculation are provided.	Costs will be higher if contract labour is used.
17 Reduce dietary N and P intakes	The baseline N and P intakes are not defined for the model systems nor the extent of reduction required under the measure. This makes the measure virtually impossible to cost.	Ideally this needs yield response curves to N and P so that the effect of reduction from baseline could be measured. Without this any costing is very problematic.	Very difficult to estimate and reliability uncertain.	Uncertain but probably in the right order of magnitude.
18 Adopt phase feeding of livestock	Costs could vary considerably depending on current equipment.	Appropriate		Costs seem reasonable.
19 Use a fertiliser recommendation system		Based on soil sampling and analysis costs which is appropriate. Advice is usually available free	Soil sampling is costed at £2 per ha. In practice cost would vary with average field size.	Costs are low where advice also has to be purchased..
20 Integrate fertiliser and manure nutrient supply		Appropriate. Slurry substitutes for fertiliser.		Saving is reasonable.

Measure	Context	Comment on costing method	Comments on costs	Cost implications
21 Reduce fertiliser application rates	Three reductions are analysed – 10%, 20% and 50%.	The impacts are based on nutrient response curves but no details are given. The approach seems to assume the same % yield reduction regardless of crop or grass. With livestock enterprises a reduction in N would require an adjustment in stock numbers and it is not clear if this is accounted for.	It would require detailed research to re-estimate the costs.	
22-24	These are all small adjustment to fertiliser practice. Costs per farm would vary substantially with situation depending on the area than was relevant to the measure.	Appropriate, although details of the calculations not given.	Better to state the cost per relevant ha rather than over the whole farm.	Costs per relevant ha are small and reasonable.
25 Increase the capacity of manure stores	This relates to an additional 90 days storage for the dairy and pig systems	Limited detail on the calculations.	No allowance seems to be made for spreading equipment but we understand that maintenance costs are included.	Cost may be slightly underestimated and would best be presented per day of additional storage.
26-32 Other manure management measures than involve capital investment	These all refer to changes in manure handling. They use varying baseline storage and handling systems such that the measures can be implemented.	The calculations are based on an annual charge relating to the capital investment.	Allowance does not seem to have been made in all cases but costs would be small and vary with farm.	Cost may be slightly underestimated.
33-36 Manure handling measures	These measures relate to restrictions on spreading in high risk situations, and manure incorporation. Costs would depend critically on the farm context.	Appropriate, although details of the calculations not given	Better to state the cost per relevant ha rather than over the whole farm	Costs per relevant ha are small and reasonable.
37 Transport manure to neighbouring farms	Costs depend on % of manure transported and distance travelled. These will vary widely with circumstances	Appropriate		Appropriate.
38 Incinerate poultry manure	Only feasible where a plant exists.	Zero cost		Zero cost.
39-44 These are infrastructure investments	Scope for application of the measures and their cost) will depend critically on the baseline situation.	The calculations are based on an annual charge relating to the capital investment plus a labour cost.	Details of the assumptions are not given.	Costs best presented per unit of the new investment rather than pre ha or per farm.

3.5 Summary of the costing analysis

3.5.1 Method and detail of calculations

The actual methods used are those typical of farm management practice based on standard costs from reference manuals such as Nix (2006) and SAC (2007). However, in most cases the basic data and calculations are not shown in the manual. This lack of detailed content makes it impossible to identify exactly how figures are derived. The manual would be more useful and more easily applied to alternative circumstance if more content had been given.

3.5.2 Baseline characterisation

It would have been useful if the model systems had been defined in greater detail with baseline commodity prices, enterprise gross margins and net farm incomes. This information could then have been linked to the costing of measures that involved changes in the size or management of enterprises (e.g. 1, 13). This would clarify the basis on which costs were estimated and allow re-estimation with changed assumptions about costs or prices (see below).

An alternative approach using robust farm types has much to recommend it. These are derived from Census data and provide a better basis for applying costs to catchment and national scales. We consider that in further research on mitigation costs this approach should be investigated. It would complicate the technical estimates of loss reduction because the farms would be more complex. It would also ideally require more detailed information on the baseline status of the farms (especially management practices). Some of the information could be provided by Defra's Farm Practice survey.

3.5.3 Capital investment

A considerable number of measures require new investment, for example, in slurry storage, hedges and cultivation equipment. Although the methods of converting capital costs to annual costs are not described in the text, Harris (2008) has indicated the amortisation procedures used. A 7% interest rate was used and asset life varied according to the type of investment. These follow normal practice. One aspect that is less clear is the extent to which a maintenance charge was included in cases where equipment maintenance would be required. With much fixed equipment this would be very low but with mobile equipment some allowance for repairs would be appropriate. Some costs may be set slightly too low because of this (see Table 3.2).

3.5.4 Ranges in cost

Most costs are calculated as single numbers. This is perfectly reasonable when there is little variation in the cost of implementing a measure. However, costs will typically vary with circumstances, and in some cases this variation will be considerable. For example some farmers may use farm labour to implement a measure, others with less flexibility or skills may choose a contractor, at a higher cost. Also, differences in baseline conditions between farms (current financial performance) would feed through to the costs involved in taking land or stock out of production (e.g. with extensification, buffer strips, reduced stocking rates). In these cases some indication of the range of costs likely to be encountered would have been useful. For most of the measures, and especially those central to income generation, the costs of implementation will vary substantially depending on the farm in question**.** Presenting cost ranges in the manual would have added a useful dimension to the output.

3.5.5 Partial versus total implementation of measures

In many instances measures could be implemented on part of a farm (partial) or across the whole of the farm. In the manual, measures are usually costed on the basis of implementation across the whole farm. Thus, under measure 1 (convert arable land to extensive grassland), the whole farm is converted. Under Measure 42 (establish new hedges) all field boundaries are assumed to have new hedges under the measure. The Land Use and Farm Infrastructure measures are all interpreted as measures applied across the farm.

In practice, policy is likely to offer some partial options (e.g. part conversion to extensive grassland). Here the cost per ha of conversion may be quite different from a whole-farm adoption of the measures. Changes to the farm operations would be less profound and variation in land characteristics would mean that in some cases partial adoption of a measure could be achieved at a lower cost per hectare. For example, less productive land would be offered first for extensification.

The value of the manual would be enhanced and made more easily used for policy purposes if such measures were costed on a partial basis (per ha, per head or per km).

3.6 Updating to 2007/08

The calculations in the user manual were based on 2005/06 prices. Since then, there have been substantial increases in cereal and soyabean prices. Expected arable gross margins and livestock feed costs for 2007/08 are higher than those two years previously. Dairy margins are also expected to increase but by a lower percentage. This will impact on the relative cost of different measures. Those measures that involve a loss of output on arable farms (e.g. extensification, reduced fertiliser levels) will become relatively more costly to implement than those requiring changes that leave output unchanged.

It is beyond the remit of the study to analyse these effects of commodity prices in detail. This would in any case be difficult given the lack of detailed content in the user manual. However, it demonstrates that the cost-effectiveness of measures is not static and needs periodic revision. A more transparent user manual or a supporting spreadsheet would assist this.

3.7 Scaling up

Using the manual to scale up to specific catchments or the nation level is problematic. First, the baseline systems were not selected with scaling up in mind. A more classification-based set of farm types would be preferable. Second, most of the mitigation method costs are estimated assuming that the system does not already implement the method (i.e. no cover crops, no soil sampling etc.). Scaling up without adjustment for current practice will lead to an over-estimation of costs.

3.8 Specific cost estimates

Within Table 3.2 comments are made on each of the costings in so far as the level of detail provided allows the costs to be analysed. Most calculations follow conventional procedures as indicated above and provide a guide to the costs of implementation. However, the cost estimates have to be interpreted in relation to the specific assumptions made for the baseline context and the way the measure is applied. In a number of cases our analysis suggests a degree of under- or over-estimation of cost.

3.9 Conclusions

The analysis of the cost data in the user manual concentrated on methods and approach rather than the fine detail of the estimates. The method adopted for costing the measures was an appropriate one, given that the prime objective was to deliver a broad assessment of cost-effectiveness. But the manual could have been more transparent, flexible and informative for policy. The following are specific comments:

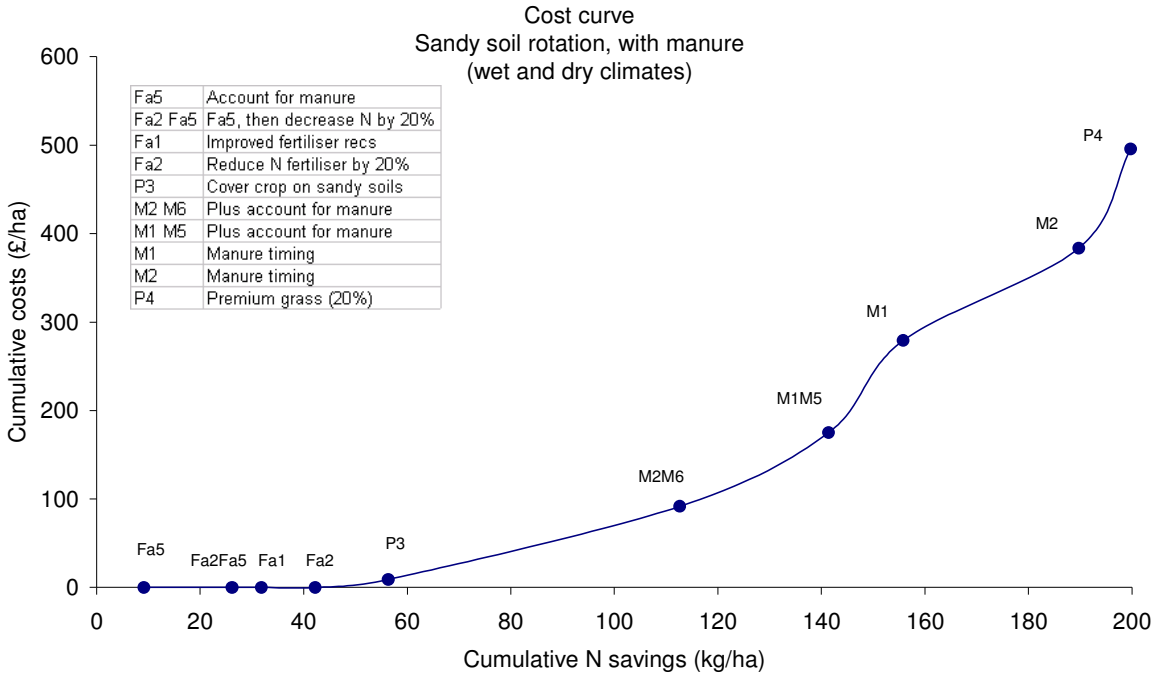
- The baseline systems were not financially transparent and not specified in sufficient detail to provide a clear baseline for the costing calculations. However, we understand that this was deliberate policy in order to reduce the size of the manual.
- The costing calculations were generally not given in detail and there was a lack of detailed content throughout the analysis.
- In only a few cases were cost ranges given whereas the variation in cost in practice can be substantial. The cost would have been more informative if an indication the extent of the variation could have been included. However, we appreciate that providing a sound basis for the ranges would be challenging and the workload would be much increased.
- Measures were generally assessed on a whole farm basis whereas additional partial (per ha, per head) costing would have been helpful particularly for policy purposes.
- In some cases we suggest that costs are over- or under-estimated but the extent of under-or over-estimation is generally thought to be small.
- With recent significant increased in commodity prices the manual needs to be updated because the relative costs of introducing different measures will have changed.

Two broad questions can be posed in relation to the reliability of the cost data in the user manual:

- First, is the method sufficiently reliable to give a broad indication of the cost-effectiveness of different measures in practice?
- Second, can the costs be applied to groups of farms in catchments or at the national scale?

With the proviso that recent changes in commodity prices will change the relative cost-effectiveness of the measures, the conclusion on the first question is broadly positive. Table 3.2 suggests that the great majority of costs are reliable. However, small modifications to the estimated costs (following from the analysis in Table 3.2) are unlikely to radically alter relative cost-effectiveness because the range is cost-effectiveness across the measures is expected to be very large. The manual does not give this range but Figure 3.1 below shows the cost-effectiveness results from another study on nitrate pollution that used similar methods (IGER, 2004). Here, several measures achieved reductions in nitrate loss at minimal cost, whereas other measures could only be introduced at a much higher cost.

Figure 3.1 Cost curve for Nitrogen



Hence, with the caveats above about content and transparency, the manual should provide provides a broadly sound basis as a first cut system of selecting those measures which produce greatest benefit per unit cost. It should also identify which farm systems offer the greatest scope for cost-effective reduction in pollution.

As regards the second question the answer is broadly negative especially where the implementation costs vary substantially with farm context. This in part reflects the fact that there is no clear link between the model farms and real farms such that the cost of a measure can be interpreted as some sort of 'average' cost for a set of actual farms.

However, where the costs of a measure do not vary to any degree between farms, the model costings can be applied with more confidence. This only applies to simple, well-defined measures (e.g. small changes to infrastructure or farm management). Where major changes to a farm system are implied (e.g. reducing stocking rates) cost are likely to vary widely because of the variation in existing farm performance. The manual's authors appreciate this limitation and a caveat to this effect is given in the text.

To achieve costs that could be used for aggregation to catchment or higher levels would require a much more detailed piece of research. Ideally, this would involve a classification of farms according to their pollution and technical/financial characteristics, and the costs of implementing pollution-reduction measures (related to their farm management characteristics). The robust farm types are probably the best starting point for this.

It would also be important to include information on current farm practice in order to estimate the potential for implementing a measure. Direct use of the manual will overestimate catchment costs because the costs are derived on the assumption that measures are not currently being adopted at all (e.g. minimum tillage, cover crops). This will in many cases by incorrect.

4 Costs of mitigation measures to farm businesses in the pilot area catchments

4.1 Measures to be costed

Ten measures were defined by the steering group for costing (Table 4.1). The aim was to calculate the private cost to farmers of adopting each measure. Six of the measures were closely related to the existing WAgriCo measures and four were additional. In each case the measures were defined such that all costs were to be met by the farmer. This differs from the WAgriCo project where many of the services are provided under the project at no cost to the farmer.

Table 4.1 Measures Costed on the Sample Farms

Code	Type of measure	Description	WAgriCo related measure ?	WAgriCo payment
GAP1	Fertiliser recommendations.	Apply recommended fertiliser levels based on soil sampling, analysis and advice.	Yes	£5 per ha (but sampling and advice provided free)
GAP2	Manure management plan.	Prepare and apply a manure management plan within the scope of existing investment in plant.	Yes	£250
EGAP1	Cover crops for spring sown crops.	Introduce cover crops for spring sown crops – maintain until February 15th.	Yes	No cultivation until February 15th - £60 per ha. No cultivation until December 31st- £30 per ha.
EGAP2	Fertiliser spreader calibration.	Calibrate spreaders.	Yes	Contractor cost
EGAP3	Moving from autumn to spring application for slurries and poultry manure.	No spreading between October 15th and January 31st.	Yes	£1000
EGAP4	N efficiency calculation.	Calculate a nitrogen balance for the farm.	Yes	Payment based on improved efficiency
ADD1	Convert land in arable or intensive grass to extensive grass.	Area in extensive grass to be a minimum of 20% of the farmed area.	No	N/A
ADD2	Adopt minimum tillage for all crops except roots and grass reseeds.	Minimum tillage to be used in 3 out of 4 years.	No	N/A
ADD3	Cultivate land in spring (after Christmas) rather than autumn (spring crops).	No pre Christmas cultivation of spring crops.	No	N/A
ADD4	Use fertiliser rate 10% below the recommended rate (arable only).	Reduce fertiliser rates to 10% below recommended for arable crops.	No	N/A

4.2 Sample of farms and interviews

The aim was to select a sample of 20 farms already collaborating in the WAgriCo study for detailed cost investigation. The steering group provided information on the principal 38 farms that were participating in the project. From this population a sample of 20 was selected on a proportionate random basis by farm area. This was done so that every ha in the population of 38 farms had an equal probability of being included in the sample. One farmer dropped out at a late stage which left a sample of 19.

Each of the 19 farmers was interviewed using a standard questionnaire. The aim was to obtain basic information on farm size and enterprises, membership of assurance and related schemes and the cost to the farm business of implementing each of the ten measures. In some cases measures were inapplicable (e.g. manure measures on specialist arable farms). Where there was a benefit from introducing a measure this was included in the calculation of cost to give a net cost to the farmer. In some cases there was a net benefit because the benefit from introducing the measure exceeded the cost.

The baseline for the calculation of cost was the situation without the measure. This was straightforward where a measure was not currently being applied or where it had not been applied prior to involvement in WAgriCo. But in many cases farmers had already adopted a measure either voluntarily or because it was a requirement of a farm assurance scheme. In these cases they were asked to envisage a situation without the measure and calculate the cost of applying it. Some farmers found this difficult because they could not identify any realistic baseline from which to estimate costs. In some other cases farmers refused to contemplate the introduction of a measure, even in a theoretical sense, because of adverse effects on their farming system. This often occurred with the extensification measure. Many farmers were unwilling to contemplate reducing their productive area regardless of any compensation that might be paid. In such cases it was not possible to obtain an implementation cost for that farm.

The estimated costs are those based on the useable responses received.

4.3 Characteristics of the sample farms

Table 4.1 summaries the characteristics of the sample as recorded in the interviews. The total area of the sample farms was 5,799 ha, and this included 1,081 ha of extensive grass. The area of extensive grass was sizeable (18% of the total) and much of this would be steep land that could not be cultivated.

The farms varied considerably in their mix of enterprises. All grew crops but only five were specialist arable farms with no livestock. There were eight dairy farms, eleven farms with beef cattle (suckler cows or young stock) and six had a sheep enterprise. Seventeen of the farms had some extensive grass.

Table 4.1 Characteristics of the Sample Farms

	Total	Mean	Range	Number of farms with this crop/livestock	Mean (those with the enterprise)
Winter crops (ha)	2396	126.1	0-380	18	133.1
Spring crops (ha)	1111	58.5	0-164	18	61.7
Intensive grass (ha)	1081	56.9	0-332	12	90.12
Total excl. extensive grass (ha)	4588	241.4	31-876	19	241.1
Extensive grass (ha)	1211	63.8	0-400	17	71.3
Total incl. extensive grass (ha)	5799	305.2	31-976	19	305.2
Dairy cattle	1951	102.7	0-675	8	243.9
Beef cattle	1757	92.5	0-650	11	159.7
Young cattle	1210	63.7	0-300	10	121
Sheep	2936	154.5	0-1000	6	489

4.4 Costs of implementing measures

4.4.1 GAP1 Fertiliser recommendations

This is a WAgriCo measure and all farmers had taken it up.

The cost is the cost of soil sampling and analysis, on which recommendations are based, together with the cost of advice to formulate the recommendations and apply them. All farmers would have had their soil sampled irrespective of WAgriCo because it was seen as an essential management tool. Some farmers paid for soil sampling/fertilizer recommendations whereas others obtained it as part of an agronomy package or were required to undertake soil analysis as part of an assurance scheme. These differences led to some variation in the way farmers perceived the cost of obtaining recommended fertilizer levels.

The mean cost of soil sampling and advice was £8.49 per ha (Table 4.2) but savings in fertilizer costs were £11.89 per ha. None of the farmers considered that output would be affected by using recommended fertiliser levels. There was thus a net benefit from using recommended levels which averaged just under £5 per ha.

Table 2.2 Cost of fertiliser recommendations

	Number responding	Mean (£ per ha)	Standard deviation (£ per ha)	Range (£ per ha)
Sampling and advice cost	19	8.49	5.60	0.7-21.0
Saving in fertiliser cost (ha)	18	11.89	5.83	0.0-23.0
Net benefit	18	4.97	5.64	-3.4-18.6

Note: the standard deviation is a measure of the variation about the mean. Approximately 95% of observations lie within the mean ±2 standard deviations. The mean net benefit (£4.97 per ha) cannot be derived from the component elements in the rows above because of differences in the number of responses.

4.4.2 GAP2 Manure management plan:

This measure assumes that a farmer is already applying GAP1 (fertiliser recommendations). Costs are additional to those incurred under GAP1. It deals with the cost of preparing a manure management plan and putting it into practice with existing facilities (no new storage or equipment). It is only applicable to those farms which apply manure either from livestock or from the purchase of manure (mainly poultry manure). Sixteen farmers said that they were applying this measure under WAgriCo.

The cost of preparing a plan was quite variable. The average was £228 but the range was £0-£1,050. In the case where the cost was zero this reflected the fact that the manure management plan was prepared by CMi (a food safety and assurance company) as part of an assurance package. Per hectare, the average cost was £1.37 (Table 4.3). Much depended on the type and complexity of the livestock enterprises, with higher costs on dairy farms. On some farms manure was unimportant and the cost of producing a plan was minimal. Some farmers prepared manure management plans themselves or through advisory packages which reduced costs. Most farmers identified a saving in fertiliser costs though better use of manures but spreading costs were often increased. Only one farmer considered that output would increase with a manure plan. This was a farm that had some particularly poor fields that had responded well to large quantities of manure as result of the plan.

Table 4.3 Cost of a manure management plan

	Number responding	Mean (£ per ha)	Standard deviation (£ per ha)	Range (£ per ha)
Plan preparation	15	1.37	2.03	0.0-7.50
Change in output	16	+10.0	40.0	0.0-160.0
Saving in fertiliser cost	16	22.2	25.9	0.0-112.6
Additional spreading cost	16	11.9	10.89	0.0-42.7
Net benefit (excluding output change)	15	+9.3	17.8	-6.7-69.4
Net benefit (including output change)	15	+19.9	47.6	-6.7-179.9

Table 4.3 gives statistics on the various costs and benefits associated with the preparation of a manure management plan. Since the cost of a plan is a one-off investment which lasts until there is a change in farm system it is strictly a capital cost. However, given the low per hectare cost of plan preparation it is included in the table as an annual cost along with the other items. On average, the benefit from a manure management plan is £9.3 per ha (excluding any effects on output), mainly due to savings in fertiliser use which outweigh any additional spreading costs. If the one farmer reporting an output increase is included, the mean benefit increases to £19.9 per ha.

The largest benefits were on dairy farms where substantial savings in fertiliser costs could be made. Also some farms importing poultry manure had been able to effect considerable savings with better manure planning. Some farmers indicated small or negative benefits. This was where manure management was an insignificant part of the farming or where adherence to the plan imposed very long and costly spreading distances.

4.4.3 EGAP1 Cover crops for spring sown crops:

Twelve farmers took up this measure under WAgriCo. Those not taking up the measure gave a variety of reasons. Some had no spring cropping or stockless systems with no means of utilizing the cover crop. Others said that they would put too much pressure on spring cultivation or create problems burying the trash. One farmer said that his pasture land was not suitable because it was very difficult to plough and best not ploughed at all. If it was planted it would very difficult to utilize. Livestock farmers were generally more positive about cover crops seeing them as a good source of feed and a way of improving soil quality.

Thirteen farmers indicated the costs they had experienced or would experience in using cover crops (Table 4.4). The average area was 38 ha at a cost of £68.8 per ha. Costs varied considerably (from £20 to £150 per ha). The lower costs occurred where farmers used their own labour and machinery and did not include the full costs of cultivation. High costs were explained by the use of contractors (rather than own staff) or perceived problems with burying trash and the need for additional sprays.

Table 4.4 Cost of cover crops

	Number responding	Mean (£ per ha)	Standard deviation (£ per ha)	Range (£ per ha)
Area (ha)	13	38.0	25.4	5.0-180.0
Cost of establishment and management (£ per ha)	13	68.8	36.1	20.0-150.0

Farmers found it difficult to quantify the benefits in monetary terms but many (especially livestock farmers) were very happy to grow cover crops. Some commented on their value as feed and the provision of residual N – which could save on fertiliser costs. However, on many farms cover crops were seen as problematic because of difficulty in dealing with the trash.

4.4.4 EGAP2 Fertiliser spreader calibration

All farmers owning spreaders (17) had signed up to this WAgriCo measure. The two not participating either used a contractor or a neighbour's spreader. For those without spreaders

calibration was not relevant. Most farmers were unaware of the costs of calibration because WAgriCo paid a contractor to undertake this. Where this was the case we used a standard cost of £180 per spreader which was provided by ADAS.

The mean cost was £179 per spreader (Table 4.5). Benefits were difficult to estimate because it depended on the performance of the spreader without calibration which was often unknown. Many respondents had their spreaders calibrated as a matter of course or because a crop assurance scheme required it. Generally, benefits were significant, averaging £15.4 per ha up to a maximum of £49.0 per ha for one large farm. The net benefit averaged out at £14.2 per ha.

Table 4.5 Cost of fertiliser spreader calibration

	Number responding	Mean	Standard deviation	Range
Cost per spreader (£)	17	179	13.4	185.1-320.7
Cost per ha (£)	17	1.44	1.32	0.2-5.29
Benefits (£ per ha)	12	15.4	12.5	1.5-49.0
Net benefit (£ per ha)	12	14.2	13.6	-0.02-48.8

4.4.5 EGAP3 Moving from autumn to spring application for slurries and poultry manure

Only four farmers said that they were signed up to this under WAgriCo, although not all of these were clear on whether they were participating. Those not participating gave as reasons that they did not produce slurry on the farm either because there were no livestock or because the livestock system did not produce slurry, or that slurry was already spread in the spring. Those using poultry manure already spreading it in the spring.

In the cases where farmers were signed up it appeared that there were no costs involved either because they were already spreading in spring or because the change had not increased storage and spreading costs. We were therefore unable to locate examples in the sample of farms that were spreading in the autumn and where they would incur costs if spreading was moved to the spring. This is not to say that on some other livestock farms (not in the sample) moving to spring spreading could incur large costs because of additional storage costs and the logistical difficulty of spreading manure over a shorter time period.

4.4.6 EGAP4 N efficiency calculation

This is listed as a WAgriCo measure with payments based on estimated improvements in efficiency of N use. However, none of the respondents were aware that this had been implemented on their farm. This appears to be an 'in progress' measure.

Since the supporting calculation is to be provided under WAgriCo and no farmer had independently sought to obtain a N balance for his farm it was not possible to cost this measure from the farm survey. Advice to us from ADAS was that the preparation of a nitrogen balance would take a day's work at a consultant cost of, say, £450. There would be

some additional cost to the farmer for providing the information for the calculation and this would vary with farm type and complexity. The total cost on average might be around £600.

4.4.7 ADD1 Convert land in arable or intensive grass to extensive grass

This is an additional measure not offered under WAgriCo. Farmers were asked to cost the conversion of land to extensive grassland to bring the total extensive grassland on the farm to 20%. Extensive grass was defined as grassland with a low or zero fertiliser application.

Some farms (6) already had 20% of the farmed area in extensive grass and in these cases the measure was not applicable. This usually reflected the type of holding where steep land or water meadows made up a significant part of the farm. In one case, part of the farm had been extensified under the organic conversion scheme. On another, land was being extensified under ELS. In total there were 450 ha (from a total land area of 5,878 ha) that were appropriate for this measure).

In calculating the costs of conversion we did not impute any cost to the creation of the grassland on the assumption that this could be done easily for intensive grassland by reducing fertilizer levels. On arable land it was assumed that ground cover would grow although some farmers indicated a preference for establishing grassland on previous arable land. There was also a question of how the grassland was to be managed especially if livestock did not utilize it. In practice much would depend on whether the land was temporarily or permanently in extensive grass. It was assumed that this would be a long-term change.

Of the 13 respondents, the gross margin foregone from extensification averaged £1,058 per ha (Table 4.6). On dairy farms the loss was much larger (maximum £2,740 per ha) because of the high gross margins per hectare under dairying. The potential for utilizing the extensive grass was critical in determining the income from the grassland. Many livestock farmers were able to utilize the grass but all-arable farms had more limited possibilities. The average gross margin from the extensive grass was £289 per ha, giving a total net cost, on average, of £769 per ha. Net costs were very variable (from £231 to £2,340 per ha) depending on the farm situation. Highly stocked dairy farms had the highest net costs. Most farmers expressed very strong antipathy to extensification because of the loss of income that it entailed and the disruption to the farm system. Some said that they would require massive incentives to convert.

Table 4.6 Cost of conversion to extensive grass

	Number responding	Mean	Standard deviation	Range
Area to be converted (ha)	13	34.7	29.2	3.6-96.0
Gross margin lost from extensification (£ per ha)	13	1,058	660.6	581-2,740
Gross margin from extensive grass (£ per ha)	13	289.6	136.6	26-425
Total cost (£ per ha)	13	769.0	671.6	231-2,340

4.4.8 ADD2 Adopt minimum tillage for all crops except roots and grass reseeds.

Estimating the cost of this measures proved quite problematic. A number of farmers already used minimum tillage on at least 75% of their arable area and found it difficult to calculate the benefits since the counterfactual plough system was rather abstract. Others did not use the system because of perceived disadvantages in introducing it (e.g. small scale, weed problems, high conversion costs etc.). They were in some cases unable to estimate costs. Only eight farmers were able to estimate costs and this may not give a reliable indication of the cost of conversion because of the small numbers and the limited information on machinery costs that some farmers had available.

If minimum tillage equipment is purchased the capital costs are substantial. Eight farmers estimated a mean of £54,000 for the purchase of equipment and £5,000 per year for maintenance. The estimates of capital cost varied substantially depending on the number of pieces of kit required, whether a new tractor was needed and whether farmers bought new or second-hand.

Where costs were calculated these were based on the additional contractor charges over and above any current contractor costs. Additional costs and costs saved are given in Table 4.7. None of the respondents expected any change in output from the change to minimum tillage. Overall the average cost was £15.9 per ha. Overall, it appears that minimum tillage has a small cost. But there was quite a range in costs and views on minimum tillage. Some farmers were adamant that minimum tillage had advantages in timeliness, speed of operations and improved soil structure. Others said that their land was unsuitable or that additional chemical costs outweighed other cost advantages. Some farmers had gone to minimum tillage because contractors were offering the service. Others clearly saw a benefit to their specific circumstances and land type. They said that there was definitely an advantage in using a contractor because they were able to get over the ground much quicker.

Table 4.7 Cost of conversion to minimum tillage

	Number responding	Mean	Standard deviation	Range
Additional costs (£ per ha)	8	32.6	27.1	0.0-69.0
Cost saved (£ per ha)	8	16.7	24.7	0.0-76.0
Net cost (£ per ha)	8	15.9	28.1	-15.0-53.0

4.4.9 ADD3 Cultivate land in spring (after Christmas) rather than autumn (spring crops)

This measure was hardly relevant in the catchments either because the farms had no spring crops (2) or because they already cultivated the spring sown land in spring. The measure was only applicable on two farms – those that had spring crops and cultivated before Christmas. These had 82.6 ha of spring crops out of a total of 1,111 ha in the sample. In both cases they envisaged additional spraying costs and some loss in output (net cost, mean £115 per ha).

4.4.10 ADD4 Use fertiliser rate 10% below the recommended rate (arable only)

Fifteen farmers provided cost information for this measure. Those not responding either had no arable land or were already operating at levels below recommended, or would not contemplate any reduction in fertilizer levels.

The average loss in gross margin was £64 per ha (Table 4.8), with costs saved at £15.2 per ha, giving a net cost of £48.8 per ha. Most farmers said that they would be extremely reluctant to reduce fertiliser levels with the current cereal to fertilizer price ratio. At the current high cereal prices there was a strong disincentive to reduce yields by cutting fertilizer inputs. Some said that if fertiliser prices increased substantially they might have to review their fertilizer policy.

Table 4.8 Cost of using fertiliser 10% below the recommended rate

	Number responding	Mean	Standard deviation	Range
Lost gross margin (£ per ha)	15	64.0	34.0	0.0-160.0
Cost saved (£ per ha)	15	15.2	3.94	10.0-23.0
Net cost (£ per ha)	15	48.8	33.6	-10.0-147.0

4.5 Potential methods for meeting the costs of implementing mitigation measures

All the farmers in the sample were members of one or more farm assurance schemes and 16 were in the Entry Level Scheme. Membership was as follows:

- Assured Combinable Crops: 12
- National Dairy Farm Assurance Scheme: 6

- SAI Global/ FABBL: 6
- Other assurance schemes: 4
- Organic or organic conversion: 2
- Entry level stewardship (ELS): 16
- Higher level stewardship (HLS): 1
- Countryside Stewardship (CSS): 4

There are two principal ways in which membership of an assurance or environmental scheme might 'meet the cost' of mitigation measures. The first is as a requirement of a scheme, where the benefits of membership exceed the costs of implementing measures to meet requirements. In this case there is no contribution to costs but farmers cover costs by benefiting from assured quality outputs that can give higher or more secure market returns than would otherwise be the case.

The second method is one of incentives for changing farm activities that directly or indirectly lead to a mitigation of nutrient losses to water. Apart from organic conversion the main examples are the ELS, HLS and CSS. In the ELS, farmers adopting relevant measures earn points towards a successful application. ELS measures may also contribute to an HLS application. The CSS is now closed to new applicants and therefore no longer relevant.

Table 4.9 summarises the main requirements and option available under assurance and environmental schemes. The arable assurance schemes impose several requirements on fertiliser use including soil sampling but fall short of requiring the adoption of fertilizer requirements. Arable schemes also require spreader calibration. The dairy assurance schemes have a requirement to produce a manure management plan. ELS/HLS incorporate nutrient and manure management plans and pay for over-wintered stubbles and uncropped headlands.

With regard to the other measures, the stewardship schemes offer a potential source of funding for limited extensification and overwintering stubbles but not for conversion of arable land or intensive grassland on a large scale. Other measures are not 'supported' under any assurance or environmental scheme.

Table 4.9 Contribution of Assurance and Environmental Schemes to Mitigation

Type of measure	Arable assurance schemes	Dairy assurance schemes	Environmental and stewardship schemes
Fertiliser recommendations.	No requirement to adopt recommended fertiliser levels but members are typically required to record the date, type and rate of all fertiliser and organic manures applied to each field. Members must also undertake regular soil analysis for major nutrients to help optimise fertiliser applications and maximise soil potential.	No requirement	ELS: Points awarded for nutrient management plan (No longer applicable)

Type of measure	Arable assurance schemes	Dairy assurance schemes	Environmental and stewardship schemes
Cover crops for spring sown crops.	No	No	No
Manure management plan.	No requirement to produce or adopt a manure management plan but contributing elements are a requirement. Members are required to record the date, type and rate of all fertiliser and organic manures applied to each field. Fertiliser applications, including organic should be avoided wherever possible to continuously frozen ground or in waterlogged conditions, to minimise leaching and pollution of watercourses.	The farm must have a waste management plan. This plan identifies areas where manures can be spread and the manure output of the farm. It restricts total N to 250kg N per ha on the spreadable areas. Manures and fertilisers must be spread in accordance with legislation and good practice. The requirement is similar to that in the arable assurance schemes.	ELS: Points awarded for manure management plan (No longer applicable)
Fertiliser spreader calibration	Fertiliser spreaders must be adequately maintained and calibrated annually or when changing from one product to another. Full records of both maintenance and calibration will be inspected by the assessor.	No requirement	No
Moving from autumn to spring application for slurries and poultry manure.	No specific requirement apart from good practice.	No specific requirement apart from good practice.	No
N efficiency calculation.	No	No	No
Convert land in arable or intensive grass to extensive grass.	No	No	ELS: Points awarded for conservation headlands and uncropped margins HLS: Conservation headlands
Adopt minimum tillage for all crops except roots and grass reseeds.	No	No	No
Cultivate land in spring (after Christmas) rather than autumn (spring crops).	No	No	ELS: Points awarded for over-wintered stubbles. HLS: Over-wintered stubbles
Use fertiliser rate 10% below the recommended rate (arable only).	No	No	No

4.6 Conclusion

Three of the ten measures resulted in cost savings or increased yields such that farmers, on average, derived a net benefit from their introduction. The measures in question were: (i) establishing recommended fertilizer levels, (ii) manure management planning and (iii) calibrating fertilizer distributors. We would therefore expect most farmers to implement these measures voluntarily and there was evidence that this was the case. Many were in any case required to do so as part of an assurance scheme. Since the N efficiency calculation had not been implemented as yet it was not possible to say indicate whether benefits in fertilizer or feed saving might cover the costs involved. Further experience on this aspect is needed.

The remaining measures all involved net costs for the majority of farmers and in some cases the costs were very high. This was especially true of extensification where the costs of lost output was a prime consideration – particularly so on arable farms in an era of high cereal prices. The current high returns from cereals was also an element which led to the high cost of reducing fertiliser rates on arable crops. Conversion to minimum tillage was expensive on farms using conventional cultivation and many farmers were reluctant to consider minimum tillage because of unsuitable soils, high costs or problems with trash.

Farm assurance schemes provide an important route for supporting basic good practice as regards fertiliser and manure management, and the calibration of spreaders. The ELS used to support fertiliser and manure planning through points allocation but this is no longer the case. Stewardship now only offers support for limited extensification and overwintering of stubbles. In the Dorset catchments farm assurance schemes appeared to be more important than Stewardship in facilitating good environmental practice. However, there are no incentives currently available to support the more major measures to reduce N losses such as were offered under the Nitrate Sensitive Areas scheme.

5 Cost of adopting a supportive approach

5.1 Introduction

The WAgriCo project provides a supportive approach to farmers in the specified Dorset catchments. Farmers are provided with information, advice and defined services (soil sampling, manure management planning, spreader calibration, N balance calculation etc). at no direct cost to the farmer. In fact they are given incentives to participate. This is one model of a supportive approach where the aim is to encourage farmers to adopt methods that reduce diffuse water pollution, especially from nitrate loss.

However, it is clear that there is no unique set of components that constitute a supportive approach. Whilst the focus is the catchment, a catchment officer can provide a variety of different services. Much will depend on the budget available and the extent to which farmers are required or encouraged to finance activities themselves.

Here we investigate two possible forms of supportive approach. The first is where there is a **facilitator only** (catchment officer) who will facilitate the provision of both generic advice and farm specific advice or services. The second is a **facilitator plus** approach which extends to provide a set of farm-specific services. Here these are treated as free services but in practice they could be provided under an arrangement where farmers pay on an at-cost basis.

5.2 Facilitator only

In this the catchment officer has responsibility for providing general pollution-reduction advice to farmers. The key objective is to provide a central information point and stimulate awareness much in the same ways to English Catchment Sensitive Farming Delivery Initiative officers. The facilitator would (i) provide information through training courses and follow up workshops; and (ii) facilitate provision of subcontractors and monitor their services.

In practice the output of a facilitator is not limited by the area farmed but by the number of farming businesses, i.e. the number if individuals that provide the client base. It should be possible for one facilitator to cover around 2,000 farms. Farm size is unlikely to have a significant impact on facilitator output.

The facilitator would match farmer requirements in the catchments with the skills of sub-contracted specialists. The facilitator would attend, in a passive role, most workshop/training events. Working on 220 annual working days with 1 day a week spent on administration, the facilitator has 180 days of direct work time available.

We assume that the officer is part of a larger scheme that provides backup to individual officers. This allows the employment of relatively low cost staff. Were the situation more stand-alone then labour costs would be higher. The 'overhead' costs for a catchment officer are as follows:

- Salary £18,000
- Transport (8,000 miles @ 40 pence per mile) £3,200
- National Insurance and employer expenses £3,000
- Allowance for office overheads including telephone, computer, stationery £3,500
- Total cost £27,700 per year

The total cost does not include office rental, supervisory, indemnity insurance or pension costs.

The main roles are described in more detail below.

5.2.1 Training courses (workshop delivery)

These provide information on DWPA and measures for reducing it. It is assumed here that they are run mainly by sub-contracted experts with the facilitator present. Preparation time should be considerable and 2/3 of a day per day of workshop delivery is suggested. Very little additional preparation time is needed if more than 5 identical training events or workshops are to be run in same catchment.

A pre-training or workshop host farm visit will typically be required – a minimum of half a day per pre-training/workshop day is required to visit and plan the event.

Additional costs are as follows:

- Hire of expert, labour cost £1,000 plus £50/day travel and subsistence.
- Invitations – at return rate of 5% 400 invitations should be sent per event. At estimated cost of 60 pence per invitation giving a total cost per event of £240.
- Handouts of workshop papers based on 20 pages, £1.20/copy. (20 copies x £1.20 = £24).
- Refreshments – 20 @ £8.5/hd (to include one course hot lunch plus morning coffee) = £170. No cost is imputed for a venue which is normally obtainable free of charge.

The total direct cost per training day is £1,484. Based on 15 training courses per year the annual cost is £22,260.

5.2.2 Follow up group meetings

These are evening meetings post training/workshop events run by the catchment officer and aimed at re-emphasising points and providing participants with an opportunity to question trainers based on personal experiences from their own farm activity. Costs, based on 30 invited, 20 attending are:

- 1.5 advisor day allocated per event to allow for venue location, preparation and delivery.
- Refreshments based on £8.5/head rate to include hot buffet (£170).
- Invitation cost 60p/invitation (£18).

The total direct cost per follow up meeting is £188. The total annual cost based on 20 follow up meetings per year is 3,760.

5.2.3 Provide newsletters

Preparation of 1 sheet, two sides, newsletter to support and follow up either individual or workshop/training day activity. 1.5 days of advisor time writing and formatting content. Printing and postage to recipient at rate of 60 pence/one sheet newsletter (£1,200 for 2,000 farmers). We assume four letters per year.

The total direct cost per year of providing a newsletter is £4,800 per year.

5.2.4 Provide a telephone helpline

This would offer technical phone support for farmers who have engaged in either one to one or workshop/training day. These would include a brief summary of the query (50 words) and advice given (50 words). There would be no additional costs over and above those included above for the office.

5.2.5 Establish a website

This would require setting up and regularly updating. The cost would vary depending on the level of sophistication but we estimate £3,000.

5.2.6 Provide advice and reports to individual farmers

The facilitator would advise farmers on sources of specialism including soil sampling, preparation of manure management plans etc. The reports of the specialists would be monitored so that the facilitator was keep abreast of the information farmers received. Individual farm visits require at least half a day and the minimum for report writing is half a day. These costs are met from the overhead costs of providing an officer apart from postage and printing at £2 per report. We assume 100 reports per year at £2 giving £200. This does not allow for the cost of the specialist in producing the report.

5.2.7 Provide reports to funding sources

Report writing by delivery team to funders would take 5 days. There is no additional cost for this activity.

5.3 Total costs of facilitator only

Table 5.1 adds up the various costs in providing a catchment officer. The total is £61,720 for 2,000 farmers. This is £31 per farm. Applying this to the Dorset catchments (665 farmers, assuming all participate) on a pro rata basis gives £20,548. This assumes that the officer also covered other catchments in a larger scheme. There would be severe under-employment if this were not the case and a part-time catchment officer would be appropriate.

It should also be noted that the costs of providing a facilitator depend heavily on salary and office costs, and the number of farms that are served by the faciltator. We have taken a low salary level and assumed that there are no office rental costs (home working). In practice such a facilitator is likely to be part of a larger organisation with its own supervisory staff and overheads. We should thus treat the £31 per farm as a minimum cost.

Table 5.1 Costs of Facilitator only

	Unit cost per farm (£ per year)	£ per year
Catchment officer, office, travel and overhead costs	13.85	27,700
Training courses	11.13	22,260
Follow up group meetings	1.88	3,760
Newsletters	2.4	4,800
Telephone hot line	0	0
Website	1.5	3,000
Advice and reports to individual farmers	0.1	200
Reports to funding sources	0	0
Total per year	**30.9**	**61,720**

Note: based on 2000 farms

5.4 Facilitator plus

In this role the facilitator would deliver all the services of the 'facilitator only' together with a package of additional services. The adviser would be more highly skilled (agriculturally and environmentally trained) and cater for fewer clients. In practice it may be difficult to aattract suitable staff if contracts are short-term contract with little job security. The extra services included would be soil sampling and preparation of nutrient and manure management plans together with advice and reports based on the above.

Again, farm size is unlikely to have a significant impact on facilitator output. However, the number of fields on a farm and the variety of enterprises will significantly impact on the time required to produce management plans. Farm type will also have an impact. Specialist arable farms will have less manure related issues making production of manure and nutrient plans much simpler and quicker.

As before there would be 180 days per year of direct time available. We assume 3 days per farmer are required to deliver a mix of training, workshops and individual services. The costs are based on servicing 60 farmers.

The 'overhead' costs for a catchment officer are as follows:

- Salary £25,000
- Transport (12,000 miles @ 40 pence per mile) £4,800
- National Insurance and employer expenses £3,000
- Allowance for office overheads including telephone, computer, stationery £3,500
- Total cost £36,300 per year

The main additional roles would be as given below.

5.4.1 Soil and manure sampling and analysis

This is commonly done as part of an assurance scheme or agronomy contract. We therefore leave the farmer to meet any cost.

5.4.2 Preparation of a nutrient plan (fertilizer use)

This takes 1.5 days (half a day on farm and one day report writing and sorting out queries). The nutrient plan will need updating each year, requiring one day. Since the facilitator undertakes these activities no additional cost is incurred.

5.4.3 Preparation of a manure management plan

This is a one-off preparation of a risk-based farm map showing manure spreading restrictions across all land farmed. Calculations are made setting out the N loading and manure storage situation. The plan would be produced to Defra specifications as set out in the Water Code. 1.5 days of time are required to prepare the plan (half on farm and 1 report writing and sorting out queries). The plan will only need updating if the area farmed or stock numbers change significantly. Since the facilitator undertakes these activities no additional cost is incurred.

We assume that all the above services would be provided free to participating farmers. The only additional direct costs are those for soil and manure sampling.

5.4.4 Spreader calibration

This is typically a requirement of assurance schemes and will incur no additional cost.

5.5 Total costs of facilitator plus

Table 5.2 adds up the various cost of providing this supportive service. The total is £36,725 for 60 farmers. This is £670 per farm. Applying this to the Dorset catchments (665 farms) on a pro rata basis gives £446,000.

Table 5.2 Costs of Facilitator plus

	Unit cost per farm (£ per year)	£ per year
Catchment officer, office, travel and overhead costs	605.0	36,300
Training courses	11.1	668
Follow up group meetings	1.9	113
Newsletters	2.4	144
Telephone hot line	0.0	0
Website	50.0	3,000
Reports to funding sources	0.0	0
Total per year	**670.4**	**40,225**

Note: based on 60 farms

5.6 Conclusions

These two approaches to the supportive approach reveal that very sizeable differences in cost can occur depending on what services are provided. The **facilitator only** costs £31 per farm to offer services on 2000 farms per year (£20,500 for the Dorset catchments on a pro rata basis). In practice not all farms would participate if the initiative were voluntary. If only 25% engaged with the facilitator the cost per participating farm would rise to around £120 per farm.

The **faciltator plus** is much more costly per farm (over £600 per farm) because relatively few farms can be serviced. Even then, the package did not incorporate a number of elements that may be valuable in controlling N losses (e.g. N balance for the farm).

These are not the only alternatives. There exist a range of intermediate supportive mechanisms in which advisers do offer more specific services but on a paid basis. In practice the role of a support approach will be defined by a wider assurance, environmental or regulatory scheme which uses a facilitator to inform, encourage and possibly regulate activities under a scheme. The specific costs of a supportive approach will thus depend on the context. All that can be concluded here is that, because of its high cost per farm, the **faciltator plus** approach is unlikely to be financed on a national basis from public funding. This leaves the **facilitator only** as the most likely route for informing and stimulating action by farmers. It is the cost of the **facilitator only** that we use in the scaling up of costs below.

6 Scaling up costs to the pilot areas

6.1 Farming in the pilot area catchments

There were 665 farms in the pilot area (June Census 2004) covering 559.9sq km (Table 6.1). Summary statistics provided by ADAS are given in Table 6.1.

Table 6.1 Land use in the pilot area catchments

Catchment	Rough Grazing (ha)	Arable (ha)	Grassland (ha)	Total (ha)
Frome	2,200.8	13,723	13,465	37,326
Piddle	1,215.9	8,018	5,362	17,929
Wey	15.2	310.0	293.4	732
Total	**3,431.9**	**22,052**	**19,120**	**55,988**

6.2 Scaling up of costs

In order to scale up costs we assumed that the sample farms were representative of the total population of 665 farms in the pilot catchments. Costs were scaled up as indicated in Table 6.2 using the mean cost per farm or per ha as appropriate. Where there was a net benefit on average to farmers of introducing a measure the mean cost was taken to be zero.

Table 6.2 Scaled-up costs (per year)

Code	Type of measure	Net Cost	No of farms relevant	Scaled up by	Cost for the pilot area catchments (£m)
GAP1	Fertiliser recommendations.	-£3.72 per ha (benefit)	19		0
GAP2	Manure management plan.	-£9.3 per ha (benefit)	17		0
EGAP1	Cover crops for spring sown crops.	£68.8 per ha[2]	18	Area of spring crops (6,602 ha)	0.45
EGAP2	Fertiliser spreader calibration	-£14.2 per ha (benefit)	17		0
EGAP3	Moving from autumn to spring application for slurries and poultry manure.	0.0	0		Not known
EGAP4	N efficiency calculation.	£600 per farm (£2 per ha)	19	Number of farms (665)	0.40
ADD1	Convert land in arable or intensive grass to extensive grass.	£769 per ha converted	13	Relevant area (7.7% of 55988 ha)	3.32

[2] The benefits from cover crops were not quantified and therefore this is a cost figure not a net benefit figure.

Code	Type of measure	Net Cost	No of farms relevant	Scaled up by	Cost for the pilot area catchments (£m)
ADD2	Adopt minimum tillage for all crops except roots and grass reseeds.	£15.9 per ha	13	Area of all relevant crops (19,001 ha)	0.30
ADD3	Cultivate land in spring (after Christmas) rather than autumn (spring crops).	£115 per ha	2	Relevant area (7.4% of 6602 ha)	0.056
ADD4	Use fertiliser rate 10% below the recommended rate (arable only).	£48.8 per ha	17	Arable area (22,051 ha)	1.08
All measures					**5.61 (£100.2 per ha)**

The total cost of implementing all measures in the pilot catchments was £5.61m. Across the total area (55,988 ha) this averaged out at £100.2 per ha. Some measures provide benefits and have no net cost whereas others are extremely costly to implement – especially the extensification measure. Because of the small sample and the fact that it was not a randomized sample of all land in the catchments the total cost should be treated with some caution. It is also heavily influenced by the cost associated with two of the measures (conversion to extensive grass and reduced fertiliser use). It is not possible to compare the cost effectiveness of the different measures without information on the extent to which they reduce water pollution.

The total cost is not increased much by the inclusion of a supportive approach in which all farmers have access to a catchment adviser. With the **facilitator only** approach the cost is an additional £20,500. Again it is difficult to comment on the cost effectiveness of the supportive approach as compared with direct measures without information on how the approach might change farm management. However, given the relatively low cost of the **facilitator only** (£30 per farm[3]) it would not be surprising if this did not prove effective as a way of encouraging farmers to adopt management systems that reduced nutrient losses.

7 Scaling up costs to the national level for England

7.1 Introduction

ADAS UK Ltd raised the cost estimates given in Chapter 4 to the national level. The aim was to give a broad indication of the aggregate cost of implementing the measures across England. The text below was contributed by ADAS UK Ltd. The final paragraph of the Chapter gives comments on the method and results.

[3] Not all farms would participate, so the cost per participating farm would be higher.

7.2 Method

Anthony (2006) developed a modelling approach for scaling the costs of combinations of mitigation methods to generate a total estimate of cost and effectiveness. The method is based on spatial distribution of land management. Several other pieces of information are required:

- Estimates of effectiveness of individual mitigation methods
- Estimates of effectiveness of mitigation methods when combined
- Likely uptake of mitigation methods by land managers
- Efficiency of implementation of measures by the land managers

This model was used as a policy support tool to determine the likely effects of policy measures for encouraging uptake of mitigation methods. Shepherd *et al*. (2007) similarly adapted the approach to take account of the effect on diffuse pollution of possible land use changes to 2015 and beyond, as affected by EU agricultural policy reforms.

Costs were dealt with in a similar way to that described in this report, i.e. expressed as a unit of land or per head of animal numbers and multiplied up, based on farming statistics. When combining mitigation methods and calculating effectiveness, effects are not additive because methods may be working on the same pool of pollutant; it is therefore necessary to adopt a multiplicative model (Shepherd *et al*., 2006). However, this is not necessary when considering costs alone.

The report here allows another calculation using independently derived set of costs from those used in previous work (previous projects used costs that were based upon the User Manual – Cuttle *et al*., 2006 – described in this report). These were applied to general farming statistics to determine an estimate of the likely total cost of applying a suite of mitigation methods across England.

The ADAS database MAGPIE (Lord & Anthony, 2000) provides these statistics, split between 2004 designated NVZ and non-NVZ areas for England. About 55% of England was designated as an NVZ in 2004, though this is under review in 2008 and could extend to about 70% of England. For the purpose of this calculation, we excluded areas of England where the selected measures would not apply, predominantly rough grazing and forestry land. The areas of land that were used for calculations are shown in Table 7.1.

Table 7.1 Areas of crops in England ('000 ha), separated into NVZ and non-NVZ designations. 'Grass' means managed grassland and excludes rough grazing

	Arable	Grass	Total	Spring crops
2004 NVZ	3,800	2,705	6,505	491
2004 non-NVZ	342	988	1,330	66

As some of the measures only apply to spring crops, it was necessary to separately determine the area of tillage crops sown in spring. It was also necessary to quantify the area of land that received manure. The British Survey of Fertiliser Practice provides an estimate of this by

individual crop and also as a total of tillage and non-tillage crops. These data were summarised by Goodlass *et al*. (2004) and are reproduced in Table 7.2. This allowed an estimate of total area receiving manure.

Table 7.2 Proportion of area (%) of individual crops receiving manure (from Goodlass et al., 2004), excluding excreta directly deposited by grazing animals

Crop	% area	Crop	% area
Spring Wheat	10	Leafy forage crops	69
Winter Wheat	14	Arable silage/other fodder crop	39
Spring Barley	25	Peas - human consumption	4
Winter Barley	17	Peas - animal consumption	18
Oats	15	Beans - animal consumption	10
Rye/Triticale	38	Vegetables (brassicae)	21
Seed potatoes	40	Vegetables (other)	8
Early potatoes	21	Soft Fruit	0
2nd Early/Maincrop potatoes	28	Top Fruit	2
Sugar Beet	27	Other tillage	16
Spring oilseed rape	22	All tillage	18
Winter oilseed rape	7	Grass under 5 years	46
Linseed	2	Grass 5 years and over	41
Forage maize	88	All grass	42
Rootcrops for stockfeed	63	All crops and grass	31

Combining these statistics with the unit cost of the application of mitigation measures then allowed an estimate of the total cost of the measures scaled to the national level (Table 7.3).

Table 7.3 Costs of uptake of measures assuming (a) total compliance, (b) most likely compliance and (c) baseline level of uptake (£'000)

			Assumes best uptake					Expert estimates of uptake (WQ0106)					Baseline			
Mitigation method	£/ha		Uptake	NVZ	non NVZ	Total		Uptake	NVZ	non NVZ	Total		Uptake	NVZ	non NVZ	Total
Fertiliser recommendations	-3.72		100%	-£24,198	-£4,947	-£29,145		80%	-£19,358	-£3,958	-£23,316		70%	-£16,938	-£3,463	-£20,402
Manure management plan	-9.3		100%	-£17,682	-£4,708	-£22,390		70%	-£12,377	-£3,296	-£15,673		25%	-£4,420	-£1,177	-£5,597
Cover crop	68.8		100%	£33,760	£4,515	£38,275		80%	£27,008	£3,612	£30,620		2%	£675	£90	£765
Fertiliser spreader calibration	-14.2		100%	-£92,368	-£18,885	-£111,253		80%	-£73,894	-£15,108	-£89,003		10%	-£9,237	-£1,889	-£11,125
N efficiency	2		100%	£13,010	£2,660	£15,669		50%	£6,505	£1,330	£7,835		0%	£0	£0	£0
Extensive grass	769		2%	£58,438	£5,254	£63,692		1%	£29,219	£2,627	£31,846		0.5%	£29,219	£2,627	£31,846
Minimum tillage	15.9		80%	£48,331	£4,345	£52,676		70%	£42,290	£3,802	£46,092		30%	£18,124	£1,630	£19,754
Spring tillage	115		100%	£56,430	£7,547	£63,977		80%	£45,144	£6,038	£51,182		30%	£16,929	£2,264	£19,193
Below recommended rate	48.8		100%	£185,420	£16,671	£202,092		90%	£166,878	£15,004	£181,882		0%	£0	£0	£0
Total				**£261,141**	**£12,452**	**£273,593**			**£211,414**	**£10,051**	**£221,465**			**£34,352**	**£82**	**£34,434**

7.3 Assumptions and estimates

The assumptions were:

- Fertiliser recommendations, manure management plan and fertiliser calibration would all bring a net benefit to the farm.
- Manure management plan only applicable to the area receiving manure (from Table 7.2).
- Cover crops only applicable to area of spring crops (Table 7.1).
- Similarly, spring tillage only applicable to area of spring crops.
- Minimal tillage; not applicable to all soils because of soil texture constraints; assumed that only 60% of the area would be suitable for minimal tillage.

Table 7.3 presents three sets of costs:

- The cost of all appropriate land adopting the measures: note that for extensive grassland conversion, the maximum was set at 2% of the arable area. This was because this would be impracticable to adopt on a large area.
- The cost of likely maximum uptake, based on expert judgement of farm practices (reported in Defra report WQ0106: Anthony *et al*., 2006).
- The 'baseline' costs of uptake, based on assumptions about the level of uptake of each measure now.

Table 7.3 shows that the total cost of compliance is £274 million. Clearly, simply using 'total costs' is an overestimate of additional costs of take up of measures, since a proportion of farms are already using some of them ('total costs' assumes a move from zero uptake to complete uptake). Thus, adjusting total costs for a baseline position (third set of columns in Table 7.3) is a more realistic measure of costs. The cost of baseline uptake is relatively small at £34 million and provides a total cost of compliance of £239 million.

Table 7.3, however, shows that the major cost of compliance would be the use of a 10% below recommended N cap on fertiliser rates; a cost of £202 million for total compliance, zero at the baseline.

If we consider that this measure is particularly stringent and least likely to be implemented in practice, then the total annual costs decline considerably; a net cost of *c*. £71 million for the remaining measures, or an additional £36 million after deducting the baseline.

Fertiliser calibration appears to offer a large net gain at the national level; £111 million benefit. If we assume that this is the best possible outcome, and halve the benefit to avoid providing too optimistic a view, this gives a benefit of *c.* £55 million after adjusting for the baseline, i.e. increases the costs of compliance by *c*. £55 million (total £126 million - £34 million baseline = £92 million).

Thus, a broad estimate would be that the annual costs of implementing measures (excepting the 10% N fertiliser reduction) would be of the order of £36 million - £92 million. A worst case scenario would be a total cost of *c*. £240 million, however.

We have not included a cost of spring slurry application (shifting from autumn) because a cost was not provided.

It is interesting to note that expert view from Defra project WQ0106 is that under the current policy landscape, uptake of some of the measures would fall below 100%.

In terms of effectiveness, various projects have assessed the likely decrease in nitrate leaching at the national level for England. Implementation of NVZ measures, for example, gave a national effect of 2-7% reduction in nitrate loss (Defra, 2007). Shepherd *et al*. (2007) suggested the effect of a suite of measures (i.e. beyond those included in this project) was a decrease for England of 5%; however, this did not assume 100% uptake of measures (similar levels were used to those estimated in project WQ0106 – 'expert view' in Table 7.3), and also factored in a reduction in livestock numbers due to CAP reform.

Thus, the conclusion is that the overall effect on nitrate leaching would be a reduction of <10% against the current baseline. Modelling within WAgriCo is suggesting a similar result.

7.4 Commentary

The national level costs of implementing the measures investigated in this report must be interpreted as indicative only since they are based on a small sample of estimates from one region of the country. In some cases there were too few farms where measures were relevant to allow reliable cost estimates at micro level.

Nevertheless the procedure used by ADAS provides a route for raising local cost estimates that is clear and consistent. The main problem is to estimate the number of farms (or area) on which particular measures can be applied. ADAS calculate alternative assumptions about uptake using the current baseline to get the net uptake. Greatest reliance can be placed on expert judgment from previous studies. Given the caveats indicated above the method gives order of magnitude costs that are in line with other estimates.

8 Conclusions

1. With a few exceptions the IGER/ADAS User Manual provides a reliable guide to the 2006 costs of implementing mitigation methods within a number of model farm systems. It is less certain that it provides a sound basis for scaling up to catchment or national levels. There is no mechanism for relating the systems to the real structure of farming and the mitigation methods are costs with a 'method-off' baseline that leads to potential overestimate of costs. Use of robust farm types for cost-effectiveness analysis is recommended.

2. The manual gives little detail on the calculations and this does not facilitate either comprehension or updating - an important consideration given recent changes in commodity prices that would alter the relative cost-effectiveness of different measures substantially.

3. Measures were generally assessed on a whole farm basis whereas additional partial (per ha, per head) costing would have been helpful particularly for policy purposes. The usefulness of the manual for policy purposes would have been increased if more information on the variation in cost between farms were given. However, this would be a demanding addition to the work.

4. The survey of farms provided information on the net costs farmers of implementing mitigation methods. The mean costs of the different measures varied from zero (when there was a net benefit from implementation) to £769 per ha of arable land converted to extensive grassland. Three measures provided net benefits to farmers because savings in fertiliser use exceeded the cost involved. These were: establishing recommended fertilizer levels, manure management planning and calibrating fertilizer distributors. The costs to farmers of implementing the other measures varied from £2.0 per ha (N efficiency) to £15.9 per ha (minimum tillage) and £769 per ha (conversion to extensive grass).

5. Assurance and environmental schemes made a small contribution to the implementation of mitigation methods. All farmers in the sample were members of at least one assurance scheme. These typically included soil sampling and fertiliser management (and possibly manure management). Stewardship offered some scope for mitigation through overwintering stubbles and headland conservation. No schemes apart from set-aside directly pay farmers to reduce fertiliser levels or extensify production on a significant scale.

6. Two types of supportive approach were costed. In the first (facilitator only) an adviser is employed to provide environmental awareness through meetings, newsletters etc, and indicate sources of specific services. To offer this service to 2000 farmers would cost around £30 per farm. A more specialised approach offering services to a smaller number of farmers was costed at £670 per farm.

7. Costs from the sample farms were scaled up to the pilot area catchments (665 farms). The total cost of implementing all measures was £5.61m, without attributing any cost to measures that gave farmers a net benefit (e.g. producing fertiliser recommendations). This sum was dominated by the high costs of conversion to extensive grassland and reducing fertiliser levels on arable land to 10% below requirements. Including the supportive approach (facilitator only) increased costs by £20,500.

8. ADAS derived costs at national level based on the farm level costs estimated in the farm survey. With all measures applied, the net cost was around £240m per year. This figure took into account the benefits which farmers derived from implementing the measures. Reducing fertiliser by 10% was found to be very expensive to implement. If this was excluded the aggregate cost fell to between £36 and £92m per year.

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Appendix 1

List of Methods to Control DWPA

Land use

1 Convert arable land to extensive grassland

Soil management

2 Establish cover crops in the autumn

3 Cultivate land for crop establishment in spring rather than autumn

4 Adopt minimal cultivation systems

5 Cultivate compacted tillage soils

6 Cultivate and drill across the slope

7 Leave autumn seedbeds rough

8 Avoid tramlines over winter

9 Establish in-field grass buffer strips

10 Loosen compacted soil layers in grassland fields

11 Maintain and enhance soil organic matter levels

12 Allow field drainage systems to deteriorate

Livestock management

13 Reduce overall stocking rates on livestock farms

14 Reduce the length of the grazing day or grazing season

15 Reduce field stocking rates when soils are wet

16 Move feed and water troughs at regular intervals

17 Reduce dietary N and P intakes

18 Adopt phase feeding of livestock

Fertiliser management

19 Use a fertiliser recommendation system

20 Integrate fertiliser and manure nutrient supply

21 Reduce fertiliser application rates

22 Do not apply P fertilisers to high P index soils

23 Do not apply fertiliser to high-risk areas

24 Avoid spreading fertiliser to fields at high-risk times

Manure management

25 Increase the capacity of farm manure (slurry) stores

26 Minimise the volume of dirty water produced

27 Adopt batch storage of slurry

28 Adopt batch storage of solid manure

29 Compost solid manure

30 Change from slurry to a solid manure handling system

31 Site solid manure heaps away from watercourses and field drains

32 Site solid manure heaps on concrete and collect the effluent

33 Do not apply manure to high-risk areas

34 Do not spread farmyard manure to fields at high-risk times

35 Do not spread slurry or poultry manure to fields at high-risk times

36 Incorporate manure into the soil

37 Transport manure to neighbouring farms

38 Incinerate poultry litter

Farm infrastructure

39 Fence off rivers and streams from livestock

40 Construct bridges for livestock crossing rivers and streams

41 Re-site gateways away from high-risk areas

42 Establish new hedges

43 Establish riparian buffer strips

44 Establish and maintain artificial (constructed) wetlands

from Cuttle et al. (2007).