# Best Management Practises to Reduce Diffuse Pollution from Agriculture

R&D Technical Report P40

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This document provides 24 Best Management Practise Methods for combating diffuse pollution from agricultural activity which can be promoted by the Agency. The next phase of this project is to produce this document as a field Manual for use by Water Quality Officers.

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## Amendments
Any corrections or proposed amendments to this manual should be made through the regional Agency representative on the Water Resources National Abstraction Licensing Group.

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# 1. INTRODUCTION

## 1.1 Background

RPS Clouston (RPS) has been awarded a research contract by the National Rivers Authority (now the Environment Agency (EA)) to develop a Manual of Best Farming Practices to overcome diffuse pollution. It is intended that the Manual could be used by EA inspectors to guide farmers on the most appropriate techniques to overcome diffuse pollution.

This report describes the research which has allowed 24 Best Management Practices (BMPs) to be identified. It presents them as a published Manual of Best Management Practices in the form of an R + D Technical Report.

Following completion of this `research stage', agreement will need to be given by the RLUG to produce a `glossy' version of the R&D Technical Report for use in the field. This, if approved, will be subject to a further contract.

Prior to describing the structure of the report, it is important to set out the main approach that has been taken to the research. The guiding principle which has focused this research has been to encourage the adoption of management practices which could maintain or improve water quality. A number of key issues relating to diffuse pollution have been identified which may influence not only how effective BMPs maybe but also how easily they may be adopted by the farming industry. These include:

a) diffuse pollution arises from a large number of aereal entry points to watercourses, it is therefore not possible to identify specific sources in all but the most general terms;

b) events causing diffuse pollution are likely to be remote in both locality and time from the environmental damage, further complicating the identification of the cause;

c) no universal technical solution is available to minimise impact;

d) some practices which lead to diffuse pollution, directly increase agricultural production, although not necessarily profitably; and

e) negative environmental impacts may occur in the long term while farm production benefits occur in the short term, which emphasises the conflicting resource and policy objectives.

Bearing in mind these issues, the best approach to dealing with diffuse pollution is to provide information to farmers which:

a) allows a better understanding of the impacts of land use practices on water quality;

b) describe the physical circumstances (indicative) where diffuse pollution could occur;

c) highlight a potential range of BMPs for avoiding, remedying or mitigating adverse impacts appropriate to the specific site and location; and

d) suggest, wherever possible, how the selected BMPs can provide improvements in production and profits whilst at the same time being beneficial to the environment.

The key to the successful use of BMPs is for them to become accepted as long term farm management practices. To be accepted BMPs must fit into the commercial environment that farmers operate. BMPs which exert conflicting pressures through reduced yields or additional costs, will not be adopted even if scientifically proven. The BMPs selected within this report, therefore, attempt to provide not only benefits to water quality but also to the farm business.

Section 2 describes the methodology. Subsequent parts summarise: the literature review (section 3); describe the practical applications of BMPs following telephone consultations and field visits within the UK, United States and New Zealand (section 4); provide a commentary upon the findings of the research in terms of the likely methods of overcoming diffuse pollution in the UK and the framework within which the prioritisation of BMPs has been made (section 5) and; describe the prioritised BMPs (section 6). The summaries of the 24 BMPs are contained in Appendix 1.

Ultimately, the proposed BMPs would in our opinion either individually or in combination improve water quality. It is therefore intended that at the very least the report and manual will prompt a greater awareness of ways of improving land use management and encourage an `ownership' of the problem of diffuse pollution.

Finally, the authors have taken the opportunity throughout the report to provide commentary on taking the BMPs forward beyond the production of the manual. This commentary is based upon techniques already being adopted in the US and New Zealand.

## Key Words

Diffuse Pollution, Agriculture, Best Practice, Low Cost/Practical/Effective, UK, Literature, Review of all Best Practice, Review of US and New Zealand.

# 2. METHODOLOGY

## 2.1 General

The research contract identifies specific tasks which are to be completed. These include:

a) identify those institutions and organisations which have information upon BMPs;

b) access databases to identify those papers and publications which appear to incorporate technical information on BMPs;

c) review each paper/publication and assess their respective relevance to the UK conditions;

d) classify and prioritise the findings for the BMPs;

e) draw up a list of priority findings for agreement with the RLUG; and

f) summarise the findings for the agreed prioritised BMPs and also provide an A4 summary in a format for use in the field.

The methodology for identifying BMPs has been iterative. As more relevant information has been acquired it has been necessary to revisit organisations, databases and publications to reassess the appropriateness of the BMPs identified. It has also led to the identification of additional publications as a result of further research.

## 2.2 Information Sources

Institutions, organisations and databases were identified from in-house publications and contacts available from RPS. At this stage the majority of contacts were UK based given that the purpose of the study was, in particular, to identify overseas expertise and experience.

## 2.3 Database Search

Searches have been conducted of 5 databases. The searches included all references since 1984 on 5 different key word groupings:

a) diffuse pollution;

b) agricultural pollution;

c) pollution management;

d) water pollution management; and

e) soil erosion management.

Abstracts were obtained for articles which met the key word groupings. The details contained within the abstracts were sieved further to identify whether they were relevant to: diffuse pollution; farming systems and pollution control; best management practices with regard to reducing diffuse pollution and the physical processes involved. Articles which related solely to techniques for modelling and measuring diffuse pollution were not reviewed.

Copies were then acquired for all articles which met the detailed sieve criteria. A pro-forma was used to ensure a consistent appraisal technique and to provide a summary of articles for future reference. The information collected from pro-formas was transcribed onto a database to allow future cross referencing.

The output of the literature review was a list of all the BMPs which appeared to have technical capabilities to reduce diffuse pollution and were being used widely, although not necessarily in the UK. Due to the lack of detailed information related to the practical success, effectiveness or implementation strategies of the BMPs identified, it was not possible at the end of the database search to test their appropriateness to UK conditions. The complete list of BMPs are described briefly in section 3.

## 2.4 Consultations

A list of professionals with either academic experience in the identification/evaluation of BMPs or practical experience in the use of BMPs was generated by the literature review. This list was sorted by reference to type of BMP and country of origin in order to prioritise subsequent direct contact by telephone or field visit.

The consultations were undertaken initially by telephone. Where possible a pro-forma was used to guide the researcher and to ensure consistency in data collection.

The focus of the consultations was to identify sites where BMPs were being used. From the identified sites a selection of field visits were made in the UK, US and New Zealand which sought to identify the practical success of the techniques and mechanisms of take-up.

During field visits, a pro-forma was used for information gathering. This form was also used as the mechanism for prioritising the BMPs and their suitability to UK conditions.

The output from the consultations was the completion of a pro-forma for each BMP, based upon telephone consultations and field visits in the UK, United States and New Zealand.

## 2.5 Prioritising of BMPs

The prioritisation of BMPs was undertaken by reference to the objectives of the research project. This required the identification of **practical, low cost farm management techniques effective in UK conditions.**

It is important to emphasise that the application of these criteria within the existing organisational framework in the UK has resulted in some BMPs being discounted even, though research and practical experience demonstrates that they are effective in reducing diffuse pollution. Reasons for non selection include:

a) need for detailed specialist skills from other disciplines which are not available on farm or within the Agency;

b) lack of base data on for example soil analysis, water quality;

c) lack of management resources within the Agency or capital on farms; and

d) need for significant changes in current farm management practices.

A weighted `scoring system' was used to assist prioritisation. The scoring was calculated by reference to five categories:

a) which processes of diffuse pollution are targeted;

b) pollutants and objectives which could be met;

c) cost;

d) design specifications; and

e) effectiveness.

Each category was weighted according to the importance of that criteria to the objectives of the research project.

Within each category, sub-headings have been used to guide scoring. The score for each category depended upon the responses to detailed questions which were covered within the various pro-formas. The key criteria which have been considered in the scoring are set out in Figure 1.

# 3. LITERATURE REVIEW AND DESCRIPTION OF BMPS

## 3.1 Literature Review

The articles which were suspected of holding relevant information have been categorised as "key" articles. "Relevant articles" were also identified. These refer to those where the abstract does not contain any keywords but contain Best Management Practices, relevant background information or may focus attention to new key areas.

The results of the database searches are summarised in the following table:

| **Keyword** | **Total Found** | **Relevant Articles** | **Key Articles** |
|---|---|---|---|
| Diffuse Pollution | 44 | 25 | 9 |
| Agricultural Pollution | 29 | 12 | 5 |
| Pollution Management | 34 | 12 | 2 |
| Soil Erosion Management | 23 | 13 | 5 |
| Water Pollution Management | 14 | 9 | - |
| Other | | 29 | 17 |
| **TOTAL** | **144** | **100** | **38*** |

* Through further consultations, meetings and visits an additional 51 key articles have been identified. The number of key articles now totals 89.

An initial search on pollution indicated 27,177 records. This was narrowed down to 44 relevant articles using the additional keyword diffuse. From the 44, 25 were relevant with 9 key articles. Of these 25 articles, 14 related directly to BMPs and 11 to diffuse pollution.

The search on agriculture identified 112,810 relevant articles. This was reduced by including the keyword pollution which identified 29 articles. From these 29, 12 were considered relevant to diffuse pollution with 5 key articles. Of these 12 articles, 8 related to diffuse pollution and 4 to BMPs.

The search on pollution initially identified 111,202 articles this was further reduced, by the inclusion of the term management, to 34. Of these 12 relevant articles, 8 were related to BMPs and 4 to farming systems. 2 key articles where identified.

The search on soil erosion management identified 23 articles. Of these 23, 13 were relevant identifying 5 key articles. Of these 13, 9 related to BMPs and 4 to background information concerning farming systems and soil erosion.

The above search was focused further by relating the pollution management to water, this identified 14 articles. 9 were considered relevant articles and of the 9, 6 related to BMPs and 3 to general background information.

A review of the key articles identified a further 29 relevant articles of which 17 where identified as being of key importance.

The remaining part of this section provides a brief description of the 40 identified BMPs. More detailed comments on the BMPs are contained on the selected BMP summaries attached at Appendix 1.

## 3.2 BMPs Identified

### 3.2.1 Nutrient Management Plan

This BMP aims to ensure an accurate balance between the supply of nutrients provided by residual cropping/farm effluent/commercial fertilisers and the crop demand. The farmer is aiming for the "economic" optimum level of inputs. This balance should prevent nutrient loss through run-off or leaching. The BMP, however, requires detailed technical assessments of soil and organic manures, effluent analysis, crop demand and timing/application rates to be successful. Long term use of nutrient management plans have demonstrated economic benefits/higher profitability to farmers.

### 3.2.2 Pesticide Management Plan

This BMP is similar in approach to a Nutrient Management Plan, but it aims to balance pesticide use with demand. This is achieved through detailed attention to the timing and rate of applications. Again a detailed knowledge of crop physiology is required together with crop pests and diseases.

### 3.2.3 Pesticide Handling Facility

To reduce contaminants entering surface and groundwaters during mixing and preparation of chemicals it may be necessary to construct special handling areas. These areas should be designed specifically to ensure that all spillages are contained and directed to separate holding tanks, the contents of which are disposed to licensed disposal points. Less expensive BMPs can be used, but the emphasis should be on preventing uncontrolled run-off to watercourses or leaching to groundwater. It can be combined with farmyard and roof run-off interception. This particular BMP is subject to specific EA research projects.

### 3.2.4 Field Application of Pesticide Residue

This BMP suggests washout water from cleaning of agricultural sprayers should be applied to appropriate farmland rather than disposed of direct to a water course or drains within the farmyard. The technique will reduce the risk of spray residue moving directly into watercourses at concentrations likely to cause pollution. It can be combined with a pesticide management plan, farm centre management, and other BMPs to prevent/ minimise potential run-off to watercourses. The use of this BMP must be within existing specific MAFF guidelines.

### 3.2.5 Triple Cropping

This BMP aims to maintain a crop cover throughout the year particularly during likely heavy rainfall. This is achieved by growing three continuous crops through the year. Typical rotations seen in the United States include maize followed by a fodder crop of wheat/oats followed by soya bean. This continuous cover reduces potential erosion and run-off. The BMP, however, would require significant changes to normal arable rotations within the UK. It could be more appropriate to intensive vegetable and arable growing areas.

### 3.2.6 Green Manure Cropping

This BMP requires the growing of nitrate rich crops such as legumes which are subsequently ploughed into the soil. The green manure crop provides cover during months when soil could be sensitive to erosion or run-off. The green manure crop provides the additional benefit of soil cover with provision of nitrogen for the succeeding crop, thereby reducing requirements for application of artificial nitrogen and improves water retention capacity and soil structure. It can be combined with triple cropping, cover crops and conservation tillage. This BMP is already included within recommended management techniques for Nitrate Sensitive Areas.

### 3.2.7 Grassland Rotation

Integrating grassland into crop rotations either on a permanent basis or short term leys could strengthen soil structure and, dependent upon location, could provide filtration of pollutants and sediment. On arable farms short term leys would be most appropriate to provide cover cropping on land sensitive to erosion. Permanent pasture would be used in very sensitive locations such as steep valley sites. If the permanent pasture is to be grazed attention should be made to livestock management BMPs. It could be combined with strip cropping, critical area planting, water diversions, grass watering, access tracks and livestock trails.

### 3.2.8 Crop Residue Management

This BMP aims to reduce erosion by wind and water. This is achieved by leaving the crop residue on the soil surface. UK examples of crop residue would include chopped straw following harvesting of cereals. It does not include leaving crop stalks and roots in-situ as this alone would not provide sufficient soil cover. This latter technique is covered by the conservation tillage BMP. Managing crop residue forms a critical component of conservation tillage methods of cropping for the next sowing. It also provides additional sources of organic material which provides similar benefits to green crops. Careful attention as to when residue crops can be incorporated is required especially those with high nitrogen residues such as peas and also the degree of cover.

### 3.2.9 Cover Crops

This BMP reduces erosion by maintaining soil cover during periods of high rainfall on soils subject to erosion and in particular on sloping land. The crop can also provide benefits when ploughed into the soil by causing temporary tie-up of plant nutrients especially nitrogen. A cover crop can be either natural regeneration but is more typically a crop which is sown together with a main crop. The cover growing either forward of the main production cycle or provides ground cover following harvesting. It can be combined with a nutrient management plan, triple cropping, green manure cropping and strip cropping.

### 3.2.10 Strip Cropping

This BMP requires the growing of crops in bands or strips with a close growing crop such as grass, alternated with a strip of cropped land. The close growing crops reduce erosion by filtering sediment and also pollutants which may be in suspension through run-off. Strip cropping can be combined with contour cropping/contour cultivation with the strips following the contour. The close growing crop should be of equal width to the arable crop.

### 3.2.11 Critical Area Planting

This BMP targets the best crop to those areas which are most sensitive to erosion and/or leaching. It can relate to growing of grass either as long term ley or permanent pasture in areas adjacent to streams and rivers. Alternatively, bankside vegetation such as shrubs and trees can be provided to increase shade. It can also equate to excluding livestock from areas within fields where the soil disturbance is severe. The major benefits are the targeting of areas subject to high erodability. The effects of introducing livestock to sensitive locations should be considered carefully. It can be combined with permanent pasture, short/long term ley, livestock exclusion, feed/water trough location, livestock trails and field boundary/access points.

### 3.2.12 Contour Cropping

Contour cropping involves extending seed lines or sowing crops across the slope in line with contours. This reduces both erosion and run-off by removing natural drainage channels down the slope as with conventional cropping. The crops provide a perpendicular barrier to run-off due to stem density. Reducing run-off improves infiltration and reduces soil erosion. The technique is considered most cost effective where fields are wide along the contour and perpendicular to field boundaries. Economic savings are achieved through reduction in fuel consumption during cultivation. It can be combined with contour cultivations and strip cropping.

### 3.2.13 Irrigation Management

This BMP follows a similar approach to pesticide and nutrient management. It requires matching demand and supply closely to avoid excess water and therefore potential for run-off and erosion. It requires detailed expertise about the moisture holding capacity of soils and water requirements of crops. It could be combined with pesticide and nutrient management plans.

### 3.2.14 Conservation Tillage

This BMP is an alternative to conventional tillage and aims to minimise soil disturbance by minimising soil preparation. Crops can be directly sown into the uncultivated soil or sown in bands of seedbed up to 4 inches in width. Minimising cultivation reduces erosion by maintaining a stable soil structure and reduces the potential for run-off along drainage channels created through normal cultivation such as ploughing. It can be combined with triple cropping, green manure cropping, crop residue management, contour cropping and cultivation. It generally requires specialist and expensive capital investment in machinery. There are different degrees of conservation tillage from no tillage through to minimum tillage or ridge tillage or merely delaying tillage until immediately prior to seed bed preparation.

### 3.2.15 Water/Sediment Basin/Retention

This BMP is located at the low point of a drainage slope or ditch or surface run-off area such as a farmyard. It aims to retain water flow encouraging infiltration and sedimentation. There are many different types of construction from engineered solutions to bunded areas of natural landform. It can be combined with other BMPs which aim to direct run-off and erosion away from surface or groundwater such as water diversions, ditch management, grass waterways, grass hedges, roof and farmyard run-off intersection and porous pavements. It should, however, be regarded as a `last resort' BMP in that it cleans up from other poor management techniques. It, therefore, should only be employed when nothing else can be achieved.

### 3.2.16 Water Diversions

This BMP aims to reduce speed of run-off and therefore erosion by intercepting water flow across the slope to existing water structures or proposed structures such as retention/water basins. It is generally applied to soils subject to severe erosion due to soil type or slope or climate.

### 3.2.17 Ditch Management

This BMP aims to target the appropriate ditch management techniques to specific requirements. For example, the common practice of ditch clearance and deposition of soil adjacent to the riparian edge should only be undertaken where it is necessary to clear drainage outfalls. Where ditch management is required it should be undertaken in rotation to avoid excessive lengths of cleared vegetation and allow natural re-growth. Maintaining existing vegetation and thereby reducing water flow will improve sedimentation and bank stabilisation. It can be combined with soil spreading and other BMPs orientated towards management of water flow and livestock exclusion.

### 3.2.18 Wetland Restoration

This BMP requires restoration of areas of land which historically would have remained predominantly wet throughout the year. Such areas are recognised to facilitate sedimentation and `fixing' potential pollutants/contaminants through physical or biological processes. The BMP can involve detailed attention to the drainage requirements of the area together with long term ecological management. It can be combined with other BMPs which seek to direct water flow from adjacent farmland or farmyards. This BMP is subject of a separate EA research project.

### 3.2.19 Hedgerow Management

This BMP is aimed at returning to traditional hedgerow management practices such as hedge laying with the objective of creating a more substantial barrier to erosion or run-off. Sedimentation and infiltration could therefore be improved. Current hedgerow management practices tend to create `gappy' barriers requiring additional fencing. It could be combined with hedgerow planting and field boundary/access points. This BMP is incorporated within techniques promoted through Environmentally Sensitive Areas.

### 3.2.20 Hedgerow Planting

This BMP is attempting to achieve two objectives. The first objective is to intercept over land flow or erosion. A second objective is to reduce the concentration of animals or machinery operations away from areas likely to suffer from erosion or run-off. It could, therefore, be combined with a field boundary/access point or livestock exclusion. This BMP is incorporated within techniques provided through the Countryside Stewardship Scheme.

### 3.2.21 Terracing

This BMP aims to reduce the length of a slope by creating a series of steps down the contour. It can be combined with a series of grassed waterways or drainage channels between terraces to direct surface water or run off and also slow down run-off improving infiltration and sedimentation. It requires extensive earthworks and therefore significant potential changes to existing land use practices. It may well result in significant loss of croppable area and would, therefore, tend to be focused on areas where erosion is severe.

### 3.2.22 Contour Cultivations

By focusing cultivations along contours any surface run-off and erosion will be directed across the slope rather than down existing seedbeds/tramlines. As a consequence speed of run-off will be reduced improving infiltration and sedimentation. The success of this BMP is dependent on very careful attention to field slope, shape and soil types. It can be combined with contour cropping. Operational cost savings can be made through reduced fuel usage.

### 3.2.23 Grass Waterways

This practice achieves two functions of both directing run-off to a sediment basin/ wetland restoration areas to allow ecological processes to remove pollutants and secondly unlike diversions or open ditches the vegetation within the channel may act as a filter in removing some of the sediment. It could, therefore, be combined with water diversions and possibly buffer strips.

### 3.2.24 Access Tracks

This BMP can comprise of relocating an existing access route to areas less vulnerable to erosion or run-off, such as at the top of the slope rather than the bottom, and/or providing a hardened surface to reduce the erosive effects of livestock poaching or vehicle rutting. Access tracks can also act as conduits for moving run off from an eroded area to a water body. Careful design of tracks, eg location of curves etc, and location can prevent direction to water courses but to soakaways or other treatment areas. It could be combined with field boundary/access points or livestock exclusion.

### 3.2.25 Field Boundary/Access Points

By re-orientating or re-establishing field boundaries and access points to assist with other BMPs such as contour cultivations and cropping, access track locations and movement of livestock and machinery to and from the main farm buildings. The overall objective is to reduce the potential for over use of land and farming practices which would lead to erosion and run-off.

#### 3.2.26 Stream Bank Stabilisation

By improving stream bank stabilisation direct erosion from bank slippage should be reduced. Stabilisation could be achieved through a variety of techniques which vary considerably in cost from critical area planting, livestock exclusion and ditch management to engineering operations or using supporting materials.

#### 3.2.27 Stream Crossing

This BMP involves provision of a purpose built bridge/culvert across a watercourse for livestock and machinery. It could be combined with provision of watering facilities at the crossing, although as discussed later, direct access of livestock to watercourses should be limited. By focusing crossings to purpose built structures erosion along stream banks would be reduced. It can be combined with livestock trails, access tracks and livestock exclusion.

#### 3.2.28 Compaction Management

This BMP would, through cultivation techniques such as deep ploughing or provision of uncropped areas along the headland, reduce the effects of compaction. Compacted areas are more subject to the effects of run-off and possibly erosion through lower infiltration. It could be combined with provision of access tracks/livestock trails, field boundary/ access points and critical area planting.

#### 3.2.29 Vehicle Movements

This BMP aims to improve the movement of machinery from the main farm centre to individual fields. In particular, attention should be paid to moving the harvested crops from the land during wet conditions. Examples include ensuring tractors move over uncultivated land thereby reducing erosion and through gateways which have been hardened to reduce the effects of rutting. It could therefore be combined with access routes, permanent pasture/long term leys and field boundary/access points.

#### 3.2.30 Filter Strips

This BMP would provide an area which could filter sediment and related pollutant thereby reducing their potential effects on adjacent watercourses. The location of filter strips is however critical to ensure that during heavy run-off or erosion a flushing effect through the filter area does not exacerbate potential pollution. Filter strips should, therefore, be combined with other BMPs such as permanent pasture, short/long term ley, buffer strips and BMPs reducing the potential volume of run-off from large areas.

### 3.2.31 Soil Berms

This BMP aims to redirect run-off or erosion materials away from watercourses thereby reducing direct pollution. It can involve deep ploughing to a riparian edge to create a raised berm or more engineered operations such as strengthened soil structures around a retaining pond or sediment basin or across a field slope to break it up onto segments to prevent run-off. It should only be regarded as a `last resort' as it does not reduce, by itself, pollution levels through management but prevents pollution entering watercourses. The pollutants still need to be managed.

### 3.2.32 Soil Spreading

This BMP highlights to farmers the potential effects of spreading soil on areas prone to erosion or run-off. It is particularly relevant to the practice of clearing ditches and depositing on the riparian edge. It can therefore be combined with ditch management.

### 3.2.33 Livestock Exclusion

This practice is aimed at removing livestock either temporarily or permanently from areas which could be sensitive to erosion or through intensive livestock movements leading to poaching and subsequent vegetation loss or pollution of water courses through direct access. Examples could include fencing riparian edges, relocating feed/water troughs to hardened areas and provision of shelter away from steep slopes or wet areas. It can therefore be combined with many other livestock management BMPs.

### 3.2.34 Riparian Buffer

This BMP moves machinery operations and livestock access away from watercourses thereby reducing the potential direct pollution. Typical examples include prevention of fertilisers and sprays entering directly the watercourse whilst tractors turn on headlands and preventing livestock polluting watercourses through urine/faeces and disturbing stream/river sediment. It can be combined with access tracks, livestock exclusion, filter strips and other techniques which provide a barrier or filtration to run-off or erosion on the riparian edge.

### 3.2.35 Feed/Water Trough Location

By locating feed and water troughs to areas which are not sensitive to erosion the effects of intensive livestock movements can be reduced. It may require provision of hardened areas within particularly sensitive fields. Mobile feeding facilities could be provided where it is not possible to provide permanent facilities. Careful location of feed/water troughs can also reduce the creation of stock trails, by drawing livestock away from watercourses and reducing erosion on steep land. It can be combined with livestock exclusion, access tracks and field boundary/access points.

### 3.2.36 Livestock Trails

This BMP aims to force livestock movements within or between fields to areas not subject to erosion. It will also aim to reduce the potential for livestock trails to direct run-off along uncropped areas. It should also aim to reduce erosion from unsurfaced trails and the potential losses of high concentrations of nutrients in these areas. It can also be combined with stream crossings to prevent animal trails eroding riparian edges when movements are between fields abutting watercourses. This BMP could involve solely management of animal movements within existing fields or locate more permanent tracks away from sensitive areas and/or provide hardened surface.

### 3.2.37 Grazing Management

This BMP requires detailed attention within the overall grazing management strategy to the intensity and duration of grazing appropriate to the soil conditions and proximity to adjacent watercourses. Objectives should be to maintain adequate grass cover together with appropriate recovery time. It can also be combined with livestock trails, field boundary/access points and stream crossings. It may require extensive changes to existing cropping rotations and livestock management.

### 3.2.38 Waste Management

This BMP draws together a wide range of techniques focused on the storage, treatment and disposal of farm effluent. It should be combined with a nutrient management plan. The techniques are discussed widely in existing MAFF/EA guidelines.

### 3.2.39 Roof Run-off Interception

This BMP aims to intercept run-off from the roofs to farm buildings, prior to flow across highly polluted and concentrated areas within the farm centre, such as livestock collecting yards, silage feeding areas and chemical mixing and spraying wash-out areas. It could also prevent high volumes of water during heavy rainfall being directed to land subject to erosion and run-off. It can therefore be combined with water diversions, water/sediment basin/retention ponds and grass waterways.

### 3.2.40 Farmyard Run-off Interception

This BMP aims to direct any potential run-off from the farmyard which may carry a high concentration of pollutants to either land, which is capable of infiltration or filtration of sediment, or to BMPs which can cater for the high concentrations such as water/sediment basin/retention ponds.

# 4. CONSULTATIONS AND FIELD VISITS

## 4.1 United Kingdom

Consultations within the UK revealed the following important issues:

a) considerable attention and capital expenditure has been focused on dealing with point source pollution without taking account of potential effects on land use practices which may cause diffuse pollution;

b) the introduction of Nitrate Sensitive Areas and MAFF Codes of Good Agricultural Practice has highlighted the benefits of BMPs such as the use of cover crops, reducing autumn cultivations, use of fertilisers and reducing or stopping applications of organic manures on sensitive land, and therefore provide a framework for wider applications of BMPs; and

c) practical experience of implementing BMPs and measuring their effectiveness for UK conditions is limited, especially when compared with the USA.

The example of dealing with point source pollution can be explained by reference to Farm Waste Management Plans and expenditure on slurry stores. Undoubtedly, pollution incidents from these sources have declined and the waste plans developed have identified the risks and `no-go' areas. However, the risk of diffuse pollution from land use management practices needs to be reviewed, so that it does not focus solely on nitrate leaching. Many lessons which have been learnt from research on nitrates could be applied to reduce other processes of diffuse pollution. In addition the storage of effluent has created new problems of disposal of large volumes of effluent.

The benefits of some BMPs such as buffer strips have been recognised but actual examples, such as in the Forth River Protection Board, have shown that the need to set-aside arable land rather than the positive benefits to preventing diffuse pollution were the main reason for implementation. Changing EC support policies or external economic forces such as rising world grain prices would show how vulnerable these good land use practices would be. In other examples, such as Linking Environment and Farming (LEAF), BMPs appear as a tool within Integrated Crop Management (ICM). The LEAF approach does much to raise farmer awareness. However, in our view, a more direct focus on critical land use practices in sensitive locations should be drawn out from the 14 demonstration farms.

There has been a tendency to encourage adoption of BMPs through an emphasis of the nature conservation benefits and also the physical water quality benefits. The economic aspects/impacts including the detail/application/availability of grants have been overlooked.

In the UK it is only now that diffuse pollution in general is being recognised as a significant issue. Attempts to deal with it are currently haphazard and are not promoted or integrated with other policies or measures dealing with point source pollution or agricultural support. The work on nitrate leaching needs to be applied across agriculture. In addition, many other environmental support policies could be focused better onto BMPs, as adoption would produce wider environmental benefits.

## 4.2 United States

Consultation visits were made to two states namely Wisconsin and North Carolina. Within each state there were various organisations at local, state and federal level who participated in either:

a) carrying out research into the effectiveness of various BMPs;

b) identifying the most appropriate technique for an individual farm; and

c) implementing the BMPs, including providing the necessary technical support to the farmer.

Consultations were also made with representatives from the States and local extension service responsible for keeping the farming community abreast of developments in BMPs, and educating farmers more generally of the problems associated with diffuse pollution. In addition to the consultations, visits were made to various farms to view BMPs in the field.

The main conclusions were:

a) in Wisconsin and N. Carolina considerable resources are devoted to minimising diffuse pollution from agriculture. Assistance to farmers includes both financial and technical support;

b) factors influencing the type of BMPs implemented included:

- type of diffuse pollution eg was the main concern overland flow or leaching;
- type of farming being carried out where diffuse pollution was of concern;
- the physical characteristics or environmental setting of the site;
- cost; and
- technical support required.

c) consultations with staff identified leaching and overland flow to be the most common processes causing diffuse pollution. Whilst erosion was of concern, the bulk of diffuse pollution appeared to be caused by run-off or leaching;

d) in Wisconsin there has historically been a focus on engineering techniques eg. farm yard management schemes, terracing, etc. These required detailed technical specifications together with a great deal of staff support and are often costly to implement. Local representatives in Wisconsin stated that there now appears to be a shift away from these engineering techniques to management practices which reduce diffuse pollution at source eg. nutrient management, conservation tillage, etc;

e) the decision-maker on which techniques were most appropriate varied between the two states. In Wisconsin the most suitable techniques tended to be driven by the state, although there was room for local selection in certain circumstances. In N.Carolina choice of the BMP was much more locally based; and

f) those BMPs which were most widely adopted in both states included: nutrient management plans; conservation tillage and pesticide management. Whilst there was Cost Share Dollars available to the farmer to implement these techniques for the first few years, many of these techniques continued to be adopted by the farmer after the grant aid stopped because they actually increased profitability.

The overall approach was first to minimise the potential for diffuse pollution at source through nutrient and pesticide management plans and secondly to ensure that BMPs were used to prevent leaching/run-off.

## 4.3 New Zealand

Historically, considerable central government funding was available for large scale introduction of riparian management and woodland planting schemes in vulnerable areas in the North Island between 1970-1989. The benefits of these schemes is only just beginning to be evaluated but suggest that:

a) only 60% of the riparian schemes would have been required to achieve similar water quality standards; and

b) the woodland planting will produce a good economic return (given current high values of commercial pine), but there are concerns about environmental impacts of harvesting techniques.

The move within New Zealand to an unsupported agricultural sector and the adoption of the Resource Management Act in 1991 has lead to a cessation of all government support/funding for dealing with diffuse pollution. The emphasis is now on:

a) an educational rather than prescriptive approach. Resource consents (ie. permission) are only required for effluent disposal to watercourses not disposal on land (permitted activity);

b) disposal on land, or other permitted activities, however, needs to be undertaken in compliance with certain conditions similar to those set out in the UK Codes of Good Practice;

c) the educational approach focuses on a vision that the farming community needs to set its own rules/guidelines to meet the domestic and international environmental standards. The Regional Councils assist by providing technical guidance and information to the farming community to:

- identify environmental impacts of farming;
- produce feasibility reports and business plans for different BMPs;
- summarise supporting scientific evidence to support BMPs; and
- run `environmental' award schemes for best practices which highlights techniques to farmers.

d) encourage the land-user to become involved in the decision making process to identify BMPs which would be suitable.

The approach has culminated in the production of Manuals identifying guidelines to improve land management and ensure that farming is a sustainable land use. The use of farmers own manuals are expected to evolve and become widely used.

# 5. DISCUSSION/COMMENTARY

The research has identified a number of important issues which are relevant to identifying which BMPs will be taken into the Manual. The issues are:

a) diffuse pollution is now recognised within the UK as a source of contamination of surface and ground water;

b) currently, the majority of UK government policy and guidance is geared towards either point source pollution or specific problems such as nitrate leaching, without a recognition of the potential problems which exist from traditional farm practices;

c) UK voluntary schemes such as LEAF have focused on the whole farm approach with the LEAF audit providing procedures to test the sustainability of environmental practices; and

d) there are a wide range of organisations who have a direct or indirect interest in diffuse pollution. The review has identified an overlap between different initiatives. In order for the BMP programme to be more successful it needs to be co-ordinated at a strategic level

There is a clear distinction between the United States and New Zealand with respect to diffuse pollution. The United States have a policy led approach to agricultural pollution with much financial support (Cost Share Dollars) to ensure take-up. New Zealand opts for a less prescriptive approach, focusing on integrating land with water resource management and promoting the responsibilities of land users. Our consultations suggest that diffuse pollution is much more of an issue in the USA than in New Zealand and this factor has heavily influenced each countries approach to reducing diffuse pollution.

Both countries however start from a common consensus which includes:

a) a good understanding of the process of pollution from farming with an integration of point source and diffuse;

b) BMPs are an accepted means of reducing diffuse pollution;

c) BMPs are most effective when employed in combination rather than individually;

d) BMPs are either targeted to critical areas on individual farms or applied in a systematic manner to improve a specific management objective such as nutrient management;

e) there is a recognition that the application of many BMPs requires expertise from more than one discipline notably, water resource specialists, scientists, agriculturalists and those with skills in agricultural extension;

f) the list or toolbox of individual BMPs is well known and in most circumstances there is scientific evidence to show that the BMPs do reduce diffuse pollution. Some of the more simple and low cost BMPs, however, have been promoted based on intuition and logic. The success of these latter BMPs has been achieved through specific targeting; and

g) long term success of BMPs requires an acceptance by the farming sector that they maintain or improve economic wealth.

Research shows that for BMPs within a voluntary programme to be effective requires a high level of take-up within catchments/rivers. It is therefore recommended that the most effective method to deal with diffuse pollution would be:

a) to define the problem within individual rivers ie. catchment or sub-catchment;

b) promote/publish a campaign within that catchment, through farmer group meetings, to highlight the problems and causes to the land users and identify their responsibilities;

c) demonstrate a range of BMPs which are both strategic and tactical;

d) target a range of BMPs to deal with diffuse pollution at source, within field, backed up by BMPs aimed at preventing pollutants entering surface or groundwater, end field;

e) demonstrate that identified BMPs can easily be integrated into improving the overall management of a farm objective including adding economic wealth; and

f) integrate other agencies throughout the entire process so that resources, including grants and other support mechanisms, can achieve common goals.

This approach could be adopted within the existing Catchment Management Plan (now Local Environment Action Plans) regime through stated policies ((a) and (b)) and objectives to overcome the problems ((c), (d) and (e)).

This approach lies beyond the scope of this research contract. We have, however, sought to ensure that the selection and prioritisation of BMPs fit into this broad strategy. The selection has, however, recognised the limitations of the current situation with regards to resources available to mitigate diffuse pollution. The study has, therefore, prioritised the BMPs, which we consider could most reasonably be promoted by the EA inspectors, without the need to obtain either significant technical or capital support.

It should also be recognised that the adoption of any BMP by farmers within the UK would have to be on a voluntary basis. There is currently no legal requirements which can force take-up although recent introduction of legislation (1 January1997) which provides the EA with ability to issue enforcement notices to prevent pollution under the Environment Act may be an additional encouragement. The economic or practical advantages to farmers must therefore be clearly demonstratable.

It may be possible to encourage take-up through grants, some of which may already be in existence. This is beyond the scope of this research contract, but it is recommended that further research be implemented to co-ordinate and direct EA inspectors to available aid. An example could be funds from the Countryside Stewardship Scheme towards hedgerow planting/maintenance. The availability of grants could be included on the BMP sheets.

To understand the selection and the prioritisation of BMPs described in Section 3 it is necessary to establish a framework within which the BMPs would operate. This framework requires:

a) a definition of diffuse pollution;

b) a recognition of the physical characteristics (indicators) of different processes causing diffuse pollution;

c) an understanding of the broad farm management objectives which, if improved, would lead to a reduction in diffuse pollution;

d) an understanding of which BMPs either singularly or in combination lead to improvements in farm management; and

e) identifying which BMPs could reasonably be suggested by EA pollution inspectors.

# 6. SELECTION AND PRIORITISATION

## 6.1 Diffuse Pollution

Generally, diffuse pollution is the pollution of waters caused by rainfall moving over and/or through the ground. As the run off moves, it picks up and transports natural pollutants and pollutants resulting from human activity, finally depositing them in streams, rivers, lakes, wetland, coastal waters and ground waters. This contrasts with point source pollution which is typically pollution from defined structures or areas on a farm eg. silage or manure stores.

## 6.2 Diffuse Pollution Sources

There are 3 main processes which may cause diffuse pollution. These include:

### 6.2.1 Erosion

Erosion of soil takes place when the rate of rainfall exceeds infiltration. On certain soils eg. soil with high silt content rainfall can lead to the breakdown of soil aggregates to form a surface cap which inhibits infiltration. The main factors influencing erosion include: soil type, slope and agricultural management practices.

Once run off occurs, the risks of erosion increase with increasing slope, since the erosive power of water increases markedly with increasing velocity. It should be noted that erosion is a natural phenomenon and usually becomes a problem when soil loss exceeds natural background levels.

Surface water pollution occurs directly from sediment entering channels and indirectly from pollutants attached to soil particles eg. nitrogen, phosphorous and various pesticides.

Other than rare weather events, erosion is most likely to be caused where agricultural activities are inappropriate to an individual location. Typical examples include: arable cultivations on over steep slopes and having bare soils during heavy rainfall in autumn and winter periods.

### 6.2.2 Surface Run-Off

Surface run-off like erosion occurs where rainfall exceeds the infiltration rate of the soil. Typically, erosion is seen as channels, such as gullies or rills in fields, whereas there are usually no channels associated with run-off.

Surface run-off can be mitigated by incorporating measures to impede the flow of water. This can include improving the infiltration rate of the soil through cultivation or cropping or slowing down/preventing run-off entering the water course again via cultivation techniques, cropping or livestock management.

### 6.2.3 Leaching

Leaching occurs when water infiltrates through soil materials and dissolves soluble compounds. Pesticides and herbicides are flushed from the soil prior to uptake by the crop or when fertiliser and pesticides are over applied.

Measures to reduce leaching predominantly relate to matching nutrient applications with demand, and changing the application rates and timing of pesticides/herbicides.

## 6.3 Selecting Potentially Effective BMPs

In carrying out the review it became apparent that the BMPs can generally be placed into 2 categories. There are those which are strategic ie. BMPs which tend to reduce diffuse pollution at source and secondly those that are tactical. Tactical BMPs do not reduce the problem of diffuse pollution at source, but rather mitigate the effects of diffuse pollution.

Those BMPs which tended to be strategic included:

a) nutrient management plans;

b) pesticide management plans;

c) conservation tillage; and

d) waste minimisation and management.

Typical tactical BMPs included inter alia:

a) grassland rotation;

b) critical area planting; and

c) roof run-off interception.

## 6.4 Selection of BMPs

Identifying whether the BMPs selected would be appropriate, involved cross referencing each BMP against a scoring system developed by RPS. There were 5 main parts to the scoring system. A discussion of the elements to the system follows:

**1. Process** - How many different processes does the BMP mitigate? The larger the number of processes mitigated the higher the score.

**2. Pollutants -** How many different types of pollutant does the BMP affect? The wider the range of pollutants affected the higher the score.

**3. Cost** - What are the capital and operational costs associated with the project? The lower the costs the higher the score.

**4. Design Specification** - What are the design requirements of the BMP? The more complicated the design specification the lower the score.

**5. Effectiveness** - How effective is the BMP? The more effective the BMP the higher the score.

Further details of the scoring system are shown in figure 1.

The individual elements were weighted according to importance with cost, design specification and effectiveness being most important and process and pollutants being least important. The points scored for each element were then summed, and if the score passed a certain threshold it was selected.

## 6.5 Classification of Selected BMPs

The results of the selection process are shown in Table 1. Each BMP selected was matched to an appropriate farm management technique which consisted of: nutrient, pesticide, crop, livestock, land and farm centre management.

The BMPs have been linked to established farm management techniques to assist not only with identifying where a BMP is best focused, but also to demonstrate that there is a natural link between BMPs and existing farm practices. This link should promote a higher level of uptake by the farming community, especially if the technique leads to increased profitability or improvements in management time. The BMPs have been placed into one of three categories:

a) multiagency;

b) prioritised BMPs; and

c) non selected.

The **multiagency** BMPs were classified as meeting the threshold of effectiveness. The nature of those BMPs were such, however, that they would require considerable human and financial resources to implement and maintain. These resources, including technical expertise, would probably only be available from more than one agency or organisation. These BMPs could be classified as strategic and for this reason many have already been integrated into pollution control and environmental improvement measures within existing legislation and guidance. The overall complexity and resource commitments required suggest these BMPs would not be promoted effectively by EA Inspectors. However, EA inspectors should be aware of their existence. The multiagency BMPs are:

nutrient management plan
pesticide management plan
conservation tillage
water/sediment/basin retention
wetland restoration
grazing management
waste management

24 BMPs (excluding multi-agency BMPs), exceeded the threshold criteria and are considered to be effective in producing water quality improvements but could also be readily introduced into day to day farm operations.

7 BMPs were not selected because:

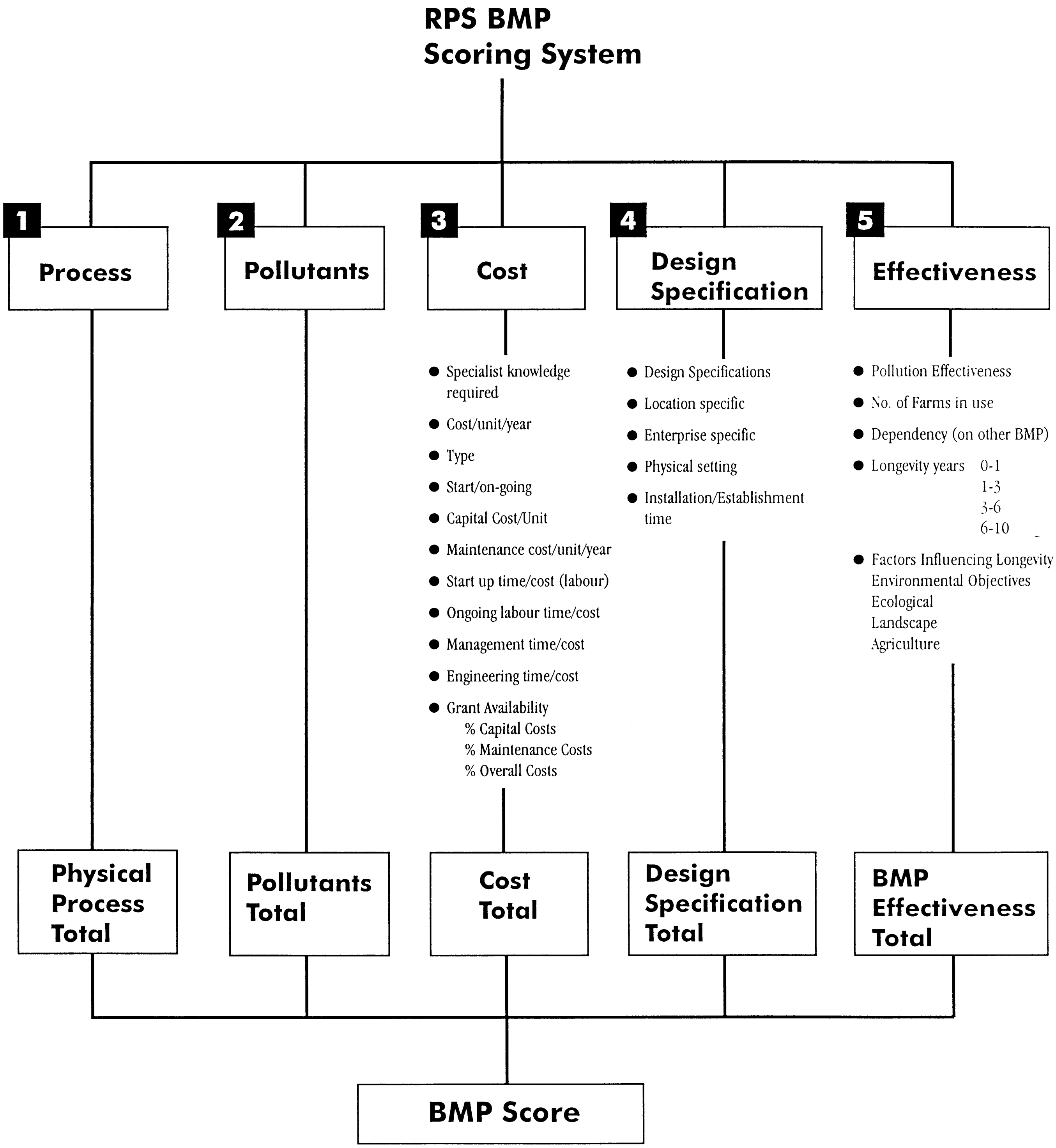
a) they are too costly to implement and support;

b) inappropriate to existing UK farm practices; or

c) inappropriate to UK physical conditions ie. climate, soils, field sizes and shape.

Summaries for the 24 selected BMPs are attached in Appendix 1.

## Figure 1: BMP Scoring System



## TABLE 1: Classification and Prioritisation of BMPs by Farm Management Objectives

| NUTRIENT MANAGEMENT | PESTICIDE MANAGEMENT | CROPPING MANAGEMENT | LAND MANAGEMENT | LIVESTOCK MANAGEMENT | FARM CENTRE MANAGEMENT |
|---|---|---|---|---|---|
| Nutrient Management Plan | Pesticide Management Plan | Triple cropping | Conservation tillage | 21 Livestock exclusion | Waste management |
| | Pesticide handling facility | Green manure cropping | Water/sediment basin/retention | 26 Riparian buffer | Pesticide handling facility |
| | 1 Pesticide residue field application | 2 Grassland rotation | 6 Water diversions | 22 Feed/water trough location | 24 Roof run-off interception |
| | | 3 Crop residue management | 7 Ditch management | 23 Livestock trails | 25 Farmyard run-off interception |
| | | Cover crops | Wetland Restoration | 13 Field boundary/ access points | 12 Access tracks |
| | | Strip cropping | 8 Hedgerow management | 15 Stream crossing | 18 Filter strips |
| | | 4 Critical area planting | 9 Hedgerow planting | Grazing management | 21 Livestock exclusion |
| | | 5 Contour cropping | Terracing | 12 Access tracks | |
| | | Irrigation Management | 10 Contour cultivations | | |
| | | | 11 Grass waterways | | |
| | | | 12 Access tracks | | |
| | | | 13 Field boundary/ access points | | |
| | | | 14 Stream bank stabilisation | | |
| | | | 15 Stream crossing | | |
| | | | 16 Compaction management | | |
| | | | 17 Vehicle Movements | | |
| | | | 18 Filter strips (grass hedges) | | |
| | | | 19 Soil berms | | |
| | | | 20 Soil spreading | | |

**KEY**

Multi Agency BMPs

Prioritised BMPs and Reference

Non-selected BMPs

BMPs selected are not ordered according to importance

# Appendix 1

## Summaries of BMPs

# 1. FIELD BOUNDARIES AND ACCESS POINTS

## 1.1 What are field boundaries and access points?

This BMP identifies locations where field boundaries and access points can be altered to reduce diffuse pollution.

## 1.2 Purpose of the BMP

The field boundary BMP will allow alternative farming practices to be adopted within a field reducing the destabilising of a soil and reduce erosion. Changing the location of access points within a field shifts the focus of intensive land use to more appropriate areas thereby reducing erosion.

## 1.3 Problem Indicators

- Field boundaries too narrow to allow contour farming.
- Disturbed soil at the access point and on the machinery and livestock routes to it.
- Sediment flowing from access points onto external roads or farm tracks.

## 1.4 Application

Field boundary alteration could be considered where the physical characteristics and design of a field and the current condition of the soil would benefit from contour cultivation and planting but are restricted by field shape or slope.

Areas of intensive land use around access points may break up soil structure giving rise to significant soil loss and overland flow. Two options are open to the farmer:

- changing the surface characteristics of the access point, or by
- changing the location of the access point to an area where surface run-off has less pollution potential.

## 1.5 Associated BMPs

- Contour Cultivation
- Contour Planting
- Hedgerow Management
- Hedgerow Planting
- Access Track

## 1.6 Implementation and Management

**Field Boundaries**

- Prior to implementing a change in the fence line a farmer should review the applicability of the adjoining fields physical characteristics for the proposed crop including variables: soil, slope, climate, aspect and exposure.

- The proposed field boundary should involve the siting of hedgerows in order to maximise the potential to reduce erosion and to provide potential nature conservation value.

## 1.7 Access Points

- Access should be located to allow the efficient movement of equipment and livestock whilst ensuring that soil erosion is kept to a minimum.

- Access should not be located where water can accumulate naturally. Vehicle tracks to and from the access will concentrate the flow of water and cause soil saturation and erosion.

- Ideal locations should be unsuitable for overland flow accumulation whilst maintaining the purpose of the access tracks.

- Access should not be located in natural animal gathering areas. The concentration of animal manure if combined with natural accumulation of run-off could result in more heavily contaminated run-off.

- Selection of the type of material used to provide a hard surface should take into account the type of machinery operating and the damage it may cause, slopes and the climate of the region. If the access point is to remain unsurfaced access should be controlled, in particular in times of high precipitation. Toxic or acidic materials should not be used to provide a hard surface.

- The chosen surface material should be monitored to identify whether degradation is taking place. At access points where soil erosion is evident, retention ponds, sediment traps and buffer zones may be used as final resort.

## 1.8 Benefits to the Farm

### Field Boundaries

- Wider fields may increase farm profitability through less operating costs.
- Allow better soil maintenance and stabilisation increasing longevity of soil and sustainability of farm operations.
- Reduce siltation of farm ditches and ditch clearing costs.

### Access Points

- All year round access to fields by farm machinery and livestock.

# 2. FIELD APPLICATION OF PESTICIDE RESIDUE

## 2.1 What is Residue Pesticide?

This BMP outlines the method by which farmers should dispose of pesticide residue. Pesticide residue result when pesticide is left within the tank following field application or from the tank washing/cleaning after the spraying activity.

## 2.2 Purpose of the BMP

The BMP identifies the benefits to a farmer disposing of the residue pesticide, after dilution, to appropriate field locations. The technique reduces the risk of the residue reaching the surface waterways or the drains in a farm holding. This in turn should reduce the likelihood of high concentrations of pesticides entering a watercourse at a level causing a potential pollution threat.

## 2.3 Problem Indicators

- High pesticide concentrations on surfaces such as riparian zones or in groundwater; and
- High pesticide concentrations within a farm drainage system.

## 2.4 Application

The technique should be used in association with pesticide management and farm centre management plans involving the use of pesticide management facilities. Advice for appropriate areas for applications of pesticides are given in MAFF's 'Code of Good Agricultural Practice for the Protection of Water' and 'Code of Practice for the Safe Use of Pesticides on Farm Holdings' and FWAG's 'Farming and Pesticide Guidelines'. General areas unsuitable for residue pesticide applications are similar to those areas that can be identified by a 'Farm Pollution Risk Assessment' which can be prepared free on an individual farm basis through consultation with ADAS.

## 2.5 Associated BMPs

- Pesticide Handling Facility
- Pesticide Management Plan.

## 2.6 Implementation and Management Specification for the Disposal of Unavoidable Waste Pesticides

- Spraying should occur away from abstraction points, water courses and drainage systems thereby reducing risk of contamination. Only apply pesticide residues when the wind conditions will not cause spray drift into watercourses;
- Application intensity should not create surface puddles or overland flow;

- Spraying should be on either suitable cropped areas or un-cropped fields (keeping within the label requirements);

- Spraying should be onto areas where the previous spaying will not be impaired by following applications or the following application of the residue will have additional beneficial effect.

- Spraying should be away from ditches or managed habitats.

- Consider using an on site waste water treatment plant. After treatment the waste water can be applied to fields following the implementation specification as defined above.

### 2.7 Benefits to the Farm

- Safe disposal of potential hazardous wastes in a cost effective manner.
- Decreases pesticide usage on the farm.
- Aids the economic performance of farms through minimising the pesticide wastage.

# 3. GRASSLAND ROTATION

## 3.1 What is a Grassland Rotation

Grassland rotation is the integration of grass into a crop rotation. This may be a long-term (permanent) or short-term ley. The BMP extends and increases the grass cover over the land. The technique can be applied to arable and livestock farming.

## 3.2 Purpose of the BMP

The BMP provides cover to unvegetated areas thereby reducing soil erosion. The grass will reduce the overland flow and hence soil erosion through increased infiltration, increased friction to flow, increased interception and increased soil stability. Additional benefits are a resting of the soil from intensive production, increased organic matter content, reduced leaching and in some cases a disruption of disease transfer.

## 3.3 Problem Indicators

**Soil Erosion**

- Sheet Erosion - uniform flow of water down slope removing loose soil particles and/or slow build up of eroded sediments at slope base.
- Rill erosion - channelled flow along or cutting cultivation lines running down the slope causing significant erosion channels. In extreme cases gullying may occur. Indicators are build up of sediment at the end of the channels and visible channel presence.
- 'Muddied water' along natural and unnatural flow paths; e.g. vehicle tracks and roads and animal tracks.

**Agricultural Production**

- Reduced in-field crop performance. Crop failure may occur in areas of severe erosion.
- Washing out of organic matter and nutrients.

Problem indicators may be most evident in periods of extreme conditions, such as precipitation after a period of low precipitation or prolonged intensive rainfall.

## 3.4 Application

The BMP can be applied either as a short-term leys or long-term (permanent) leys.

- Short term leys are appropriate for arable farming providing temporary protection for land sensitive to erosion, allowing a respite between commercial crops and providing protection against periods of intensive rainfall.

- Permanent leys should be considered for application on fields of a high erodibility risk due to soil type or to steep in-field gradients or a combination of both. The permanent ley will provide an improved soil structure and resistance to erosion.

The ley grass can be grazed for economic gain, however, livestock management should be undertaken in such a manner to reduce the likelihood of causing erosion.

### 3.5 Associated BMPs

- strip cropping
- critical area planting
- water diversions
- access tracks
- livestock trails and exclusion zones.

### 3.6 Implementation and Management Specification

- The grassland should be designed to provide complete cover within a field at a particular seeding density creating sufficient cover to reduce erosion. Seeding density and grass variety will be defined by the soil type, gradient of the slope, the severity of the erosion problem and the proposed usage of the field.

- Check the field for evidence of further erosion after the establishment phase. Where appropriate, reseed at higher densities or use other BMPs to protect the soil and vegetation.

- If there are access tracks across the field, checks should be made to identify whether vehicle and stock movement along and on either side of the track are causing damage. Damage to the soil and vegetation cover should be addressed in order to minimise its impact.

- If the field is used for grazing then good livestock management should be implemented to reduce the likelihood of soil erosion taking place.

- Good implementation and management of grassland rotations should significantly reduce the amount of soil erosion within a field.

### 3.7 Benefits to the Farm

- Reduced soil erosion increasing the soils longevity.

- Increased long-term crop production.

- Increasing area available for grazing

- Reduced siltation of drainage ditches and streams.

# 4. CROP RESIDUE MANAGEMENT

## 4.1 What is Crop Residue Management?

This BMP recommends leaving the crop residue, e.g. crop stalks or chopped straw, on the soil surface post harvest in order to protect the substrate from rain and wind erosion.

## 4.2 Purpose of the BMP

This BMP is used to absorb the energy of rain drops imparting on the soil; the velocity of water on the surface is reduced as is the air speed over the surface of the soil after the harvest period. This BMP should increase the entrainment of soil particles from overland flow leading to a reduced risk of erosion.

## 4.3 Problem Indicators

**Soil Erosion**

- Sheet Erosion - uniform flow of water down slope removing loose soil particles. Slow build up of eroded sediments at slope base.

- Rill erosion - channelled flow along or cutting cultivation lines running down the slope causing significant erosion channels. In extreme cases gullying may occur. Indicators are build up of sediment at the end of the channels and visible channel presence.

- 'Muddied water' along natural and unnatural flow paths; e.g. vehicle tracks and roads and animal tracks.

**Agricultural Production**

- Reduced in field crop performance. Crop failure may occur in areas of severe erosion.

Problem indicators may be most prominent in periods of extreme conditions; intense precipitation after a period of low precipitation or prolonged wet periods after the harvest.

## 4.4 Application

The technique can be used to reduce the likelihood of soil erosion during periods of no vegetation cover, in particular in the post harvest period. The technique involves the partial covering of the bare soil with the residue of a former crop

This technique is only applicable if the field crop leaves a natural `residue'. It would be uneconomic to transport crop residues from other fields/crops to create an effective cover on bare soils. The technique will not apply to those areas where conditions of slope and soil type give rise to severe erosion problems.

## 4.5 Specification

Crop residue management is designed to slow run-off and protect the soil from run-off, wind and rain splash. The success of the operation will depend upon the density of the residue material left on the soil. This density is determined by the extent of the erosion problem, the type of residue, the intensity of the precipitation or wind and what other BMPs are being used in association with this technique. Low density cover will provide low protection benefit.

## 4.6 Associated BMPs

- Conservation Tillage

## 4.7 Implementation and Maintenance

- Leave crop residue from the crop within the field
- Identify an appropriate density.
- Where possible spread the residue evenly across the soil surface.
- Prior to seed bed preparation the residue may be ploughed in to increase organic matter content or directly drilled through, as depicted in the Conservation Tillage multi-agency BMP.

## 4.8 Benefits to The Farm

- Reduced soil erosion and corresponding increase in soil longevity.
- Decreased siltation of drainage channels and water courses reducing maintenance requirements.
- Better soil composition due to increased organic matter content and lower fertiliser costs.
- Improved crop germination for seeds directly drilled through the residue due to increased soil temperatures.

# 5. CRITICAL AREA PLANTING

## 5.1 What is Critical Area Planting?

This technique involves identifying areas of very high erosion within a field and planting crops or vegetation which will stabilise soil conditions and reduce risk of erosion. The BMP should be integrated with other appropriate methods to minimise the erosion potential over the critical area.

## 5.2 Purpose of the BMP

A vegetative cover is provided on land which is highly sensitive to erosion. The erosion could be caused through inappropriate cropping/grazing, poor soil structure or steep slopes.

## 5.3 Problem Indicators

### Soil Erosion

- Sheet Erosion - uniform flow of water down over the critical area causing erosion creating a slow build up of eroded sediments at slope base.
- Rill erosion - channelled flow along or cutting cultivation lines running down the slope across the area causing significant erosion channels. In extreme cases gullying may occur. Indicators are build up of sediment at the end of the channels and visible channel presence.
- 'Muddied water' along natural and unnatural flow paths; e.g. vehicle tracks and roads and animal tracks.
- Bare soil or collapse of the riparian edge or within fields.

### Agricultural Production

- Complete failure of commercial production within certain areas of a field or the development of areas unsuitable for livestock grazing.

## 5.4 Application

The design of the BMP should consider: the species of vegetative cover required to meet the requirement; whether the critical area is to be taken out of production permanently or temporarily; the rate of planting; the site preparation required for healthy growth; the time of planting and associated BMPs required to protect the site to allow vegetative cover development. If the site characteristics are suitable planting should be with vegetation which can provide some economic return, woodland in the form of coppice or conifers may be suitable.

## 5.5 Associated BMPs

- Permanent/Short/Long Term Leys
- Livestock Exclusion; Feed/Water Trough Location; Livestock Trail
- Field Boundary and Access Points; Access Tracks
- Crop Residue Management;
- Water Diversions; Grass Waterways; Soil Berms and Filter Strips.
- Bank stabilisation

## 5.6 Implementation and Management Specification

- If site conditions allow, use machinery to prepare a seed bed and regrade the site to remove all soil erosion channels. Lime the site according to soil type and the vegetative type to be planted to create an ideal seed bed.

- Seed or plant established vegetation or use ready prepared legume sods on the site. If the area is unsuitable for machinery or too large for seeding by hand hydroseeding may offer an alternative.

- Monitor establishment phase to check growth is healthy and erosion is prevented.

- Identify whether the critical planting is effective in this period. If failing alternative options should be considered such as deeper rooting vegetation types or more engineered solutions.

## 5.7 Benefits to Farm

- Decreased siltation to drainage system.

- Eventual rehabilitation of critical area into commercial productivity.

# 6. CONTOUR CROPPING

## 6.1 What is Contour Cropping?

Contour cropping is the planting of the crop along the contour to provide crop barriers to the flow of surface water down a slope. The BMP is suitable for arable production and the growing of livestock fodder crops.

## 6.2 Purpose of the BMP

The standing crop in the field is planted such that it reduces soil erosion from field slopes by reducing overland flow and encouraging infiltration . The reduction in soil erosion will in turn improve the water quality in drainage channels and watercourses down stream.

## 6.3 Problem Indicators

**Soil Erosion**

- Sheet Erosion - uniform flow of water down slope removing loose soil particles. Slow build up of eroded sediments at slope base.
- Rill erosion - channelled flow along or cutting cultivation lines running down the slope causing significant erosion channels. In extreme cases gullying may occur. Indicators are build up of sediment at the end of the channels and visible channel presence.
- 'Muddied water' along natural and unnatural flow paths; e.g. vehicle tracks and roads and animal tracks.

**Agricultural Production**

- Reduced in field crop performance. Crop failure may occur in areas of severe erosion.

## 6.4 Application

This technique can be adopted to stabilise, maintain and enhance the soil condition of all sloping cropped fields on a farm. Consideration should be given to field boundary alterations where planting along the contours will cause a significant increase in operation costs.

The uptake of the technique is dependent upon the cost effectiveness and practicality of operating machinery across the slope. Field size, shape and slope will depict whether the farmer is willing to adopt the technique.

If precipitation is high there will be a flow of water along the swathe of stalks and if water puddles at these locations the use of water diversions may be necessary for controlled drainage.

## 6.5 Associated BMPs

- Conservation Tillage
- Contour Cultivation
- Water Diversions

- Field Boundary/Access Points

## 6.6 Implementation and Management

- A survey of the field contours needs to be conducted to identify the required machinery movement. Reference points should be made in the field to establish the contour pattern for field operations to follow.

- Field knowledge and local climatic conditions will identify the requirement of drainage channels.

- The gradient of the field will dictate whether or not machinery can operate across the slope face.

- Where field boundaries are too narrow or located across the slope to allow cost effective or practical machinery operation within field boundary widths may need to be altered.

- Once established monitoring of the water movement within the field will identify the need for further water drainage systems.

## 6.7 Farm Benefits

- Decreased siltation of farm drainage systems and water courses.
- Increasing the likely hood of farm sustainability through maximising the soil longevity.
- Reduced operating costs through lower fuel usage.

# 7. GRASSED WATERWAYS

## 7.1 What is a Grassed Waterway ?

This BMP uses broad channels which are permanently grassed and through which run-off is channelled during heavy rainfall and waterlogged conditions. Grassed waterways are best established on arable land, but can also be promoted on pasture where extra dense cover may be required.

## 7.2 Purpose of the BMP

To convey run-off through broad grassed channels which are not at risk of erosion and to improve water quality by entrapping sediment.

## 7.3 Problem Indicators

- natural concentration of surface water within fields during heavy precipitation where inappropriate crop cover has become stunted or died-back.
- sheet erosion or rills showing run-off occurring across fields.

## 7.4 Application

The technique may use the opportunity afforded by natural broad channels to carry run-off. This technique does not apply to areas where waterways are subject to constant or prolonged flows. In these instances more robust drainage requirements may be considered e.g. underdrainage or stone centre drainage. Grassed channelised depressions requiring these extra specifications are out of the scope of this topic sheet.

Grassed waterways may be specially designed and constructed to contain and channel runoff. In some cases it may be of advantage to extend the grass cover beyond the edges of the broad depression.

All grassed waterways require a stable outlet e.g. another vegetated channel or an earth ditch with adequate capacity to prevent ponding or flooding and or further erosion downslope.

## 7.5 Associated BMPs

- Ditch Management
- Contour Cropping
- Contour Cultivation
- Diversion Ditches
- Soil Berms

## 7.6 Implementation and Management

- Apply lime and fertiliser according to soil tests. Work the lime and fertiliser into the soil and continue working until a smooth seedbed is formed. Operating seeding equipment across the slope will reduce drilling during establishment.
- Seeding rates, fertiliser and lime applications will be dependent on the characteristics of soils and the grass species mix to be established
- Check the grassed waterway after rain for damage. Repair, re-seed, and mulch if needed. An additional application of fertiliser is necessary within the first year to get vegetation established.
- The grassed waterways should not be used as access tracks and may therefore require fencing.
- Vegetation damaged by livestock, machinery, herbicides or erosion must be repaired promptly.
- Where grass waterways are being established on pasture to promote extra dense cover consider the exclusion of livestock in these areas.
- Mow and apply fertiliser annually to maintain a vigorous sod. Repair eroded or damaged areas as they occur to avoid excessive drainage and major repairs later.
- A successful grassed waterway depends on good conservation treatment of the contributing watershed and regular maintenance program. The better the land management practices within the catchment which the grassed waterways serve the less silting there will be in the waterway. Good conservation practices also reduce the peak rate of runoff and the volume of water which will be carried by the water way. When good conservation treatment of the drainage area is not obtained, greater maintenance of the grassed waterway is usually required.

## 7.7 Benefits to the Farm

- Assist to reduce silting of ditches and thereby maintain effectiveness of field drains.
- Easy to establish and maintain
- The strip may be used to produce fodder or grazed.
- The waterway may be used as an amenity feature, used for public access or integrated with plans for game conservation or equestrian activities.

# 8. DITCH MANAGEMENT

## 8.1 What is Ditch Management ?

The BMP involves the appropriate ditch management techniques which are required to prevent erosion in the ditch due to poor management and also to reduce diffuse pollution which has settled out in the ditch.

## 8.2 Purpose of the BMP

To allow the appropriate flow of water from farm ditches whilst maintaining the condition of the ditch. This will allow the safe management of field runoff and its appropriate transfer to external water courses. Properly constructed and managed ditches should allow effective field drainage without acting as a non-point pollution source.

## 8.3 Problem Indicators

- Ditch slumping or destabilisation.
- Bed Erosion of the ditch.
- 'Muddy waters' in channel flow
- Drainage channel sedimentation and if an open channel, stationary water
- Excessive in-channel vegetation
- Sediment dredged out of ditches dumped on edge of ditch

## 8.4 Application

The technique should be adopted where it is clear that drainage ditches are becoming ineffective in the following ways: bank and bed erosion or sedimentation; inappropriate vegetative cover on bank; stationary water or high flow rates in open channels and flowing water in closed channels.

## 8.5 Associated BMPs

- Soil Spreading
- Bank Stabilisation
- Livestock Exclusion

## 8.6 Implementation and Management Specification

- If significant siltation or puddling is occurring in open drainage ditches then regrading and dredging should be undertaken to maintain suitable flow levels. Flow in closed drainage channels should be minimised through relevelling of the drainage channel bed and removal of accumulated sediment.

- If there is evidence of bank and bed erosion then the ditch will probably need regrading or some flow may need to be diverted into other ditches. Ditch banks may be stabilised by use of various techniques details of which are available in other documents.

- Vegetative cover should be maintained in order to maximise bank stability and improve biological degradation of pollutants. In-appropriate tree and shrubbery species may increase the down force on the bank causing destabilisation.

- Bank clearing and dredging should be carried out in a sequence around the farm to minimise drainage ditch erosion and maintain nature conservation value. Ditch clearing deposits should be disposed away from the riparian edge or spread on land

- Livestock should have restricted access as they may cause damage to bank sides and the bed condition.

## 8.7 Farm Benefits

- Decreased sedimentation of channel ditches
- Increased conservation importance
- Improved drainage performance
- Longer time periods between regular maintenance thereby reducing operating costs

# 9. HEDGEROW MANAGEMENT AND PLANTING

## 9.1 What is Hedgerow Planting and Management?

These BMPs identify the most appropriate way to incorporate hedgerows onto farmland in order to minimise diffuse pollution.

## 9.2 Purpose

These techniques possess two objectives:

1. to ensure that by the management of existing hedges they act as a prominent barrier against overland flow and wind derived soil erosion.
2. to arrange the planting of new hedgerows so that are integrated with other BMP objectives such as field boundaries and livestock exclusion.

## 9.3 Problem Indicators

**Soil Erosion**

- Sheet Erosion - uniform flow of water down slope removing loose soil particles. Slow build up of eroded sediments at slope base.
- Rill erosion - channelled flow along or cutting cultivation lines running down the slope causing significant erosion channels. In extreme cases gullying may occur. Indicators are build up of sediment at the end of the channels and visible channel presence. 'Muddied water' along natural and unnatural flow paths; e.g. vehicle tracks and roads and animal tracks.

**Agricultural Production**

- Reduced in field crop performance.

## 9.4 Application

This technique should be applied to field boundaries which are either fenced/barbed wired and where existing hedgerows are planted and maintained in a 'gappy' manner with thin coverage in the lower sections.

## 9.5 Associated BMPs

- Field Boundaries/Access Points
- Livestock Exclusion
- Ditch Management

## 9.6 Implementation

- Identify the field boundaries without hedgerows where either: wind erosion is prevailing from and to, or to which overland flow is running to, or the livestock exclusion areas which need fencing off.

- Prior to planting create an appropriate seed bed using fertiliser and lime where necessary.

- Plant the vegetation at such specific intervals in order to provide healthy growth, and good cover against wind and overland flow.

- The hedgerows will intercept and reduce surface flow more effectively if they are implemented on a raised soil profile with a ditch on the lower slope. Ditches should be maintained in accordance with the associated BMPs.

- Manage the hedgerows using traditional layering techniques which encourage thick basal growth, creating a barrier against soil erosion and creates a good conservation habitat.

- Monitor the effect of livestock on the fencing, and damaged caused, weak locations etc.

## 9.7 Farm Benefits

- Farm enterprise sustainability through increased soil longevity.
- Decreased sedimentation in drainage channels.
- Increased nature conservation value.

# 10. WATER DIVERSIONS

## 10.1 What are Water Diversions ?

Channels constructed with raised lower banks across the slope in order to direct flow from critical areas on the farm and shorten field length.

## 10.2 Purpose of the BMP

The BMP is designed to intercept the flow in areas where there is severe soil erosion due to soil type, slope or climate and divert it to areas where there is appropriate drainage management so that re-establishment of the site can take place. The length of run-off can be reduced thereby minimising erosive effects.

## 10.3 Problem Indicators

### Soil Erosion

- Sheet Erosion - uniform flow of water down slope removing loose soil particles. Slow build up of eroded sediments at slope base.
- Rill erosion - channelled flow along or cutting cultivation lines running down the slope causing significant erosion channels. In extreme cases gullying may occur. Indicators are build up of sediment at the end of the channels and visible channel presence.
- 'Muddied water' along natural and unnatural flow paths; e.g. vehicle tracks and roads and animal tracks.

### Agricultural Production

- Reduced crop performance and some infield crop failure.

## 10.4 Application

This technique should be applied when serious soil erosion is occurring leading to need for emergency action. The BMP should be employed to divert overland flow from around the sensitive location into managed water drainage facilities in order to allow remediation BMPs to be implemented i.e. Critical Area Planting.

The design of the diversion channel should be sufficient to manage the flow of water above and from the sensitive area. The 'emergency' and temporary nature of the diversion means that there is no managed vegetation in the channel. Water diversions are an emergency tool without managed vegetative cover and should be only employed in 'critical conditions'.

## 10.5 Associated BMPs

- Grassed Waterways
- Critical Area Planting

- Vegetative Filter Strips
- Livestock Exclusion Zones

## 10.6 Implementation and Management

- The diversion is created by constructing a barrier to flow thereby impeding the flow. The barrier can be created by any quickly implemented method for example: deep ploughing a ridge or depositing stones.

- The diversion channel should be designed to create a flow of the water away from the 'critical' site to an appropriate drainage facility where erosion can be controlled.

- Implementation should, where applicable, use existing vegetation to minimise in channel erosion.

- The technique should only be considered as a temporary measure. If the channel has a prolonged use it may well become an erosion problem in itself. In such cases where erosion is a continuing issue vegetative strips and other BMPs should be used to control the surface runoff higher up the slope.

- The 'critical' area should be restored using critical area planting techniques.

## 10.7 Farm Benefits

- Bringing unproductive areas back into commercial use
- Reducing siltation of drainage channels
- Increasing longevity of soil and sustainability of farm enterprise

# 11. CONTOUR CULTIVATION

## 11.1 What are contour cultivations?

This BMP involves field cultivations taking place along the contour.

## 11.2 Purpose

Contour cultivation creates a natural barrier to surface flow by aligning drainage flows created by ploughing and tramlines along the contour rather than down the slope. The BMP tries to reduce soil erosion, help maintain or develop good soil tilth.

## 11.3 Problem Indicators

**Soil Erosion**

- Sheet Erosion - uniform flow of water down slope removing loose soil particles. Slow build up of eroded sediments at slope base.
- Rill erosion - channelled flow along or cutting cultivation lines running down the slope causing significant erosion channels. In extreme cases gullying may occur. Indicators are build up of sediment at the end of the channels and visible channel presence.
- 'Muddied water' along natural and unnatural flow paths; e.g. vehicle tracks and roads and animal tracks.

**Agricultural Production**

- Reduced crop yields and possible complete failure in various locations.

## 11.4 Application.

This technique can be adopted to stabilise, maintain and enhance the soil condition of all sloping cropped fields. In particular the technique should be applied where soil erosion is degrading the soil structure of a field. Careful attention should be made to infield steepness and the boundary design as these components may increase operating costs and the risk to machinery stability accordingly affect the safety of the operator. To decrease operating costs the BMP should either not be implemented or a change in field boundary design should be considered.

Alignment of the cultivations must be conducted with extreme precision so that run-off in the furrow or tramline does not occur or accumulate at specific locations unless appropriate drainage techniques are used to transport runoff.

The technique should only be applied if the change from contour tillage does not significantly increase the operation costs.

### 11.5 Associated BMPs

- Contour Planting
- Grassed Waterways
- Vegetative Filter Strips

### 11.6 Implementation and Maintenance

- Contour Cultivation must be strictly along the contour or used in association with grassed waterways to transport any accumulated runoff.

- The longer the furrow the greater the volume of surface water that can accumulate at any one location. Steep fields will increase the erosive potential and peak flow rates of the overland flow. Where fields possess a steep gradient consideration should be given to the length of the furrows in order to reduce the potential of water accumulation and breaching of the furrow sides.

- Contour cultivation should be conducted in association with vegetative filter strips and grassed waterways in order to ensure good protection against accumulation and breaching any surface water in furrows.

- Particular attention should be addressed to spring lines or surface depressions, in the field slope. These locations should be either established as grassed waterways or contoured with high levels of precision as the potential for water accumulation is more likely.

- Careful attention should be addressed to machinery operation across the contour on steep slopes. Steep slopes increase the likelihood of soil damage and potential danger to the operator.

- Some crops are inappropriate due to the sensitivity of sowing and harvesting machinery to field slope, e.g. direct drilling equipment and potato harvesters.

### 11.7 Farm Benefits

- Increase in yield and productivity.
- Decreased operational costs due to operation no long travelling up and down the field slope.
- Increased soil longevity and farming sustainability.
- Decreased siltation in drainage channels.

# 12. ACCESS TRACKS

## 12.1 What are Access Tracks?

This BMP includes the best positioning, management and construction of access tracks within a field by building or altering their location and construction materials.

## 12.2 Purpose

To provide a fixed route for travel and to provide access for moving livestock while reducing the potential for the track to act as pathway for overland flow to drainage systems and minimise erosion from the tracks surface.

## 12.3 Problem Indicators

- 'Muddied' waters flowing down the access tracks.
- Deterioration in the tracks surface.
- Rills and gullies developing parallel to the access track.

## 12.4 Application

This BMP should be applied where movement of machinery or livestock up and down hill slopes is causing the development of routes and pathways through the fields for the flow of run-off and eroded soil. The design criteria for building new access tracks should also apply to existing tracks if they are currently acting as pathways for overland flow and erosion.

## 12.5 Associated BMPs

- Vegetative Filter Strips
- Drainage Ditches
- River Bank Stabilisation
- Field Boundaries/Access Points
- Stream Crossing
- Stocking Trails

## 12.6 Implementation and Management

- Tracks should be located to serve the purpose intended i.e. to convey machinery or livestock movements to and from farm enterprises. However, the routes of access tracks should be examined and modified to try to ensure that they do not form pathways for land run-off and give rise to soil erosion by flowing water.

- Tracks should generally follow natural contours reducing the grade of the road and potential run-off. Any surface run-off should be directed into structures and spill ways where the water can be managed appropriately. This may increase spilling into filter strips or managed drainage ditches running parallel to the track. Drainage channels should be designed and maintained to remain stable. To reduce pollution, the tracks should not be located in close proximity to watercourses.

- Alignment should be chosen so gradients are kept to a minimum. Width and alignment should take into account the type of machinery operating on the site and its intensity of use.

- Surface type should take into account the area draining surface water towards the track, the type of machinery operating and the damage it may cause, slopes and the climate of the region. If un-surfaced, controlled access use should be implemented, in particular in times of high precipitation. Toxic or acidic materials should not be used in order to maintain soil condition.

- In dips or areas where surface flow may accumulate drainage facilities should be provided.

- If raised or in a cutting the design should make sure that the slopes are stable.

- Location of corners should be designed to minimise the water coming off these locations and where unavoidable appropriate drainage facilities should be implemented.

- The condition of access tracks should be monitored after construction to check whether there has been any deterioration in surface quality. In areas where turning or parking is adjacent, damaged areas should be planted to avoid severe erosion.

## 12.7 Farm Benefits

- Stable track surfaces and ease of movement around site.
- Access to all fields all of the time improving efficiency of cropping/grazing.
- Increased erosion management and decreased siltation of drainage channels.

# 13. STREAM BANK STABILISATION

## 13.1 What is Stream Bank Stabilisation?

This technique uses vegetation and structures to stabilise and protect banks of streams, drainage banks, lakes, and excavated channels.

## 13.2 Purpose

To reduce sedimentation of channels and loss of field size through bank failure. To maintain the capacity of the channel, to control water course meandering and to improve the conservation habitat of the water

## 13.3 Problem Indicators

- Water course channel siltation
- Visible bank undercutting
- Visible massive bank slumping and rotational slip
- Areas of low vegetative cover on banks
- Livestock congregation within stream

## 13.4 Application

This technique should be applied in conditions where the water course bank is seen to be susceptible to erosion from water, debris or livestock.

The technique will primarily involve the use of appropriate vegetation to bind the soil together reducing erosion. In severe areas of bank destabilisation simple structures such as groynes can be used. The technique will require a high cost input and should not be used if its failure will potentially cause hazard to human health.

Where bank stabilisation is carried out there are likely to be knock on downstream effects including: reduced sediment loads and possibly increased water discharge. Before any work commences consideration should be given to these potential effects.

## 13.5 Associated BMPs

- Drainage Ditch Maintenance and Implementation
- Critical Area Planting
- Livestock Exclusion Zones
- Riparian Buffer Strips
- Stream Crossings

### 13.6 Implementation and Management

- The choice of stabilising structure should be made after considering the overall cost of implementation versus the benefits, i.e. the economic value of the protecting the area of field under threat.

- Bank stabilisation activity should be applied in a manner compatible with work being carried out by others on the channel.

- Bank stabilisation should begin on a stable reach of river, cross the 'critical' area and finish on a stable reach down stream.

- Vegetation should be carefully selected in order to bind and strengthen the bank structure whilst minimising the downward force applied through its inherent weight. Advice should be obtained on the appropriate plant species. Vegetation should be preferred to mechanical structures if the banks are frequently inundated by water.

- Bank stabilisation structures should be low cost and should be designed to resist storm floods. The structures may include: natural vegetation matting revetments i.e. reed or willow matting, groynes and geotextiles. Reduction in the bank slope will aid stabilisation but will incur some land loss and should only be considered if protective measures fail.

- Bank vegetation removal should be carried out in such a manner that debris is not entering the channel and will not change the current bank vegetation characteristics.

- In-channel deflection measures including: gravel deposits, fences, rock and in-channel vegetation may protect the bank from undercutting.

- Damage caused by livestock entering the channel should be controlled through livestock exclusion and stream crossings.

- Monitoring should be conducted to ensure that any construction does not cause air and water pollution.

- Advice on bank stabilisation should be obtained from the Environment Agency prior to carrying out work.

### 13.7 Farm Benefits

- Maintaining maximum field size and therefore profitability
- Maintaining drainage channel efficiency and correct drainage of land

# 14. STREAM CROSSING

### 14.1 What is a Stream Crossing ?

This BMP is a trail or bridge or culvert constructed through or over a watercourse.

### 14.2 Purpose

To improve water quality by controlling erosion where livestock or equipment must cross a ditch or stream by providing a single , stable crossing that permits the exclusion of livestock from other areas of the channel.

### 14.3 Problem Indicators

- Stream Bank destabilisation
- 'Muddied' waters in drainage channel
- Livestock congregation within stream

### 14.4 Application

The BMP should be used in areas where livestock require a crossing and where at present they are wading through the river. If the bed is susceptible to damage then disturbance will occur causing degradation and pollution. The BMP can include the building of a bridge, culvert or water crossing.

Stream Crossings should not be employed in areas where the bed or banks are unstable and where practical should be placed upstream of a natural barrier. Location should also avoid the confluence of tributaries and any point in the river bed where there is a change in grade.

Crossings can be either within stream e.g. ford or above stream e.g. culvert or bridge.

### 14.5 Associated BMPs

- Livestock Exclusion
- Livestock Trails
- Access Tracks
- Bank Stabilisation

### 14.6 Implementation and Maintenance

During the construction phase, great care should be taken to avoid any pollution of the watercourse.

### 14.7 In stream Crossing

- Where necessary, prior approval should be obtained from the Environment Agency.

- Pre construction survey of bank cross section, water dynamics and profile of river above and below location.

- Bank design should provide a shallow gradient to the river course with appropriate surface material to allow the passing of livestock and machinery without soil disturbance.

- Stream bed material should be chosen in order to protect the surface from damage. This may include geotextiles, gravel deposits, sands or a combination of these materials. Care must be taken to avoid use of materials which could contaminate water quality.

- Designs of bank and bed surface material should take into account: the water channels dynamics; the type of use, magnitude, and frequency in order to avoid erosion of the crossing by the stream or by usage of the stream crossing.

- Livestock exclusion on the bank is required to focus movement of animals towards the crossing point and in stream to restrict the animals to the specific crossing point. This may include the use of electric fencing at the access point and suspended across the stream channel.

- Continual monitoring should take place to assess any damage occurring to the bank or to the stream bed.

### 14.8 Culverts and Bridges

- Where necessary and before any construction work is undertaken, advice and approval must be obtained from the Environment Agency.

- Culvert and bridge structures require careful design in order to minimise their impact on the waters flow regime which may lead to knock on effects down stream.

- Careful consideration concerning: width; materials; strength of design should be related to the intensity, type of use and cover.

- Design should be sensitive to the change in: water dynamics in different flow regimes; channel morphology; groundwater conditions and the aquatic habitats.

- Monitoring of the impact post construction will indicate whether bank stabilisation is required below or above the bridge.

- Farm animals should be directed towards the bridge by the use of livestock exclusion zones, hedgerows and access/livestock tracks.

### 14.9 Farm Benefits

- Increased access between farm enterprises improving efficiency
- Cost saving due to reduced degradation in the channel maximising productive field area;
- Decreased siltation of channels and therefore reduced drainage clearance.

# 15. COMPACTION MANAGEMENT

## 15.1 What is compaction management ?

Through operations and the climatic conditions within a field, soil may become increasingly 'compacted' causing a reduction in the soil porosity. Compaction management aims to break-up 'hardened' areas in order to increase infiltration.

## 15.2 Purpose

Compacted soils impede infiltration due to reduction in soil porosity, As a result, precipitation may accumulate on the surface and combine to create either sheet or rill flow. Increased surface run-off leads directly to increased soil erosion. Compaction management should aim to increase infiltration and reduce surface run-off and soil erosion.

## 15.3 Problem Indicators

- Rapid surface runoff post precipitation.
- 'Muddied' waters flowing down tracks .
- Areas of hardened surface soil i.e. pan layers.

## 15.4 Application

The compacted areas within a field may include: tramlines of operating machinery; livestock trails; access tracks; access points and field boundaries. Such areas can be either cultivated in a manner to encourage infiltration or left to become uncultivated providing pockets of high infiltration to reduce surface run-off. Compaction can also occur beneath the soil surface through inappropriate cultivation techniques.

## 15.5 Associated BMPs

- Access Tracks
- Field Boundaries/ Access Points
- Livestock Exclusion

## 15.6 Implementation and Management

- Identify area of compaction or areas where surface run off is at a maximum.

- Use machinery to break up soil compaction and to create a soil condition in order to maximise infiltration. Depth of cultivation will depend upon soil type, geology and slope.

- Vegetative cover should be developed where appropriate and managed in order to protect the newly cultivated soil from potential for erosion. Mowing and applying fertiliser annually will be necessary to maintain a healthy sod. Vegetation damaged by livestock should be repaired immediately.

- Choice of vegetation should aid the development of the soils porosity through the break-up of compacted soils. Vegetation type should also be selected on the ability to trap suspended sediments in overland flow and reduce subsurface flow through increased evapo-transpiration rates.

## 15.7 Farm Benefits

- Reduced Siltation of Drainage Channel
- Easy to Establish and Maintain
- Increased habitat and conservation value to the farm
- Improvement in yields and livestock productivity

# 16. VEHICLE MOVEMENTS

## 16.1 What are Vehicle Movements ?

Vehicle Movement identifies the most appropriate routes and techniques for vehicle and equipment movements around a farm.

## 16.2 Purpose

Vehicle movements create compaction, pathways for the flow of sediments and disturb the soil surface. Compaction and pathways create concentrated overland flow posing a greater potential for soil erosion to occur.

## 16.3 Problem Indicators

- Overland flow down tramlines
- Soil disturbance and erosion at access points and down tramlines
- Rutting at Access Points and along field boundaries.

## 16.4 Application

The BMP identifies all the considerations that should take place prior to any vehicular operation on farm holdings in particular where vehicle operations are on cultivated land or after prolonged precipitation.

## 16.5 Associated BMPs

- Field Boundaries/Access Points
- Access Tracks
- Stream Crossings
- Permanent Pasture & Short Term Ley

## 16.6 Vehicle Movement Design

- Forward thinking may avoid compaction or rutted pathways for laid run-off. Particular care should be taken during periods of heavy rainfall.

- Travel where possible should be along managed tracks

- Travel where possible should be through managed access points

- When managed access tracks and points are unavailable vehicle movements should on un-cultivated areas and along the contour when possible.

- Access should be restricted when soil structure collapses under vehicular operations.

- Approach to ploughing/harvesting should minimise area of bare soil used for access e.g. harvest and clear headland prior to main field.

## 16.7 Farm Benefits

- Increase in productivity and yields
- Decreased siltation of drainage channels
- Reduced fuel consumption
- Reduced compaction and clean up costs

# 17. FILTER STRIPS

## 17.1 What are Filter Strips?

This BMP creates areas of managed vegetation for removing sediment, organic matter, and other pollutants from run-off.

## 17.2 Purpose

To protect water quality by removing sediment and other pollutants from run-off by filtration, absorption, deposition thereby protecting surface and ground waters.

## 17.3 Problem Indicators

- Eutrophication and Siltation of Drainage Channels
- Surface Run-off and Soil Erosion

## 17.4 Application

The selected vegetation and width of filter strip is dependent upon a wide range of variables: the type and quantity of pollutant, slopes, soils. Different vegetation will have differing abilities to cope with the differing pollution types.

The width should be designed to ensure that the time the water takes to flow through the strip is sufficient to remove pollutants. Sediments can be removed from strips as little as 1 meter in width, generally the wider the more effective the filter strip. Strips should either be in natural depressions or along the contour in order to maximise the barrier effect of the vegetation.

Filter strips work best on slopes less than 5%. Failure of filter strips can occur if the grass swathes becomes flattened by excess surface flow providing little resistance.

## 17.5 Associated BMPs

- Grassed Waterways
- Soil Spreading
- Field Boundaries
- Livestock Exclusion
- Access Tracks

## 17.6 Implementation and Maintenance

- Fertilise and lime soil to create the ideal seed bed for particular vegetation type. Liming and fertilising rates will depend upon soil condition.

- Timing of seeding should be chosen to maximise rapid vegetation. Wild and native vegetative mixes will increase the farm and potential habitats.

- Mowing and weed management should be conducted once a year to maximise the density of the lower swathe. Mowing operations should be conducted in periods of low rainfall to reduce damage to the vegetation and soil and to ensure maximum cover in periods of high precipitation.

- Caution should be made when spraying crops near to the filter strip, damage can occur to the filter strip with selected herbicides.

- Soil levels within the filter strips should be at the same level as the adjacent cropped areas to allow maximum flow through the filter strip. Build up of sediment over time will restrict the flow rate and success of the filter strip. In extreme cases a natural soil berm will be created restricting and redirecting flow to an accumulation point where breaching of the filter strip may occur. In cases of sediment accumulation, surplus soil should be removed and the filter strip re-established.

- The better the land management practices within the catchment which the filter strips serve the less silting there will be in the waterway. Good soil conservation practices also reduce the peak rate of runoff and the volume of water which will be carried by the water way. When good conservation treatment of the drainage area is not undertaken, greater maintenance of the filter strip is usually required.

- Repair or protect damaged areas of the filter strip to minimise soil erosion in these periods.

- Livestock should generally be excluded although very extensive grazing can be achieved in dry periods.

## 17.7 Farm Benefits

- Reduces siltation and eutrophication of water channels
- Increased habitat value
- The strip may be grazed in dry periods

# 18. RIPARIAN BUFFER

## 18.1 What is a Riparian Buffer?

This BMP creates areas of managed land parallel and up to the edge of a watercourse. The riparian land may be specially vegetated or may be an uncropped field margin.

## 18.2 Purpose

To improve water quality by removing sediment and other pollutants including phosphates, nitrates and herbicides from run-off and sub-surface flow through root uptake, filtration, absorption, deposition protecting surface and ground waters or removal of spray and fertiliser operations away from the riparian edge.

## 18.3 Problem Indicators

- Eutrophication and Siltation of Drainage Channels
- Surface Run-off and Soil Erosion

## 18.4 Application

This practice applies to the riparian zone and is specifically designed to reduce the concentrations of pollutants prior to their delivery into the water courses. If designed correctly a riparian buffer has the ability to absorb pollutants from ground water through the uptake of excess nutrients through the root system. The buffer can also prevent direct pollution of watercourses by moving machinery operations away from the riparian edge.

The design of the buffer is dependent upon a wide range of variables: the type and quantity of pollutant that is being targeted, slopes and soils. Different vegetation will have differing abilities to cope with the differing pollution types. Grass is advised for the removal of sediments, however there is a range of grasses, shrubs and trees which have the potential for removal of nitrates and phosphates. The riparian buffer strip should be targeted in particular detail at the critical pollutants pathway. Refer to the Environment Agencies pamphlet "Understanding Buffer Strips".

The width of the riparian buffer is dependent upon the type of pollutant that is being targeted. A high percentage of soil erosion can be removed with buffers as little as 1 meter, however the distance advised to remove nitrate and phosphate ranges between 5 and 100 meters wide.

The success of removing sediments from overland flow through a riparian buffer strip is well acknowledged, however removing phosphates and nitrates depends upon a wide range of variables, including groundwater height and is highly site specific. Current width recommendations vary so it is suggested that riparian buffers are as wide as you can make it.

## 18.5 Associated BMPs

- Grassed Waterways
- Soil Spreading
- Field Boundaries
- Livestock Exclusion
- Filter Strips

## 18.6 Implementation and Maintenance

- Identify the pollutant(s) pathways and design the BMP in detail at these locations.

- Identify hydrological characteristics of a buffer zone to establish depth and quality of groundwater.

- Identify natural vegetation zones and incorporate into riparian buffer to increase diversity. A mix of grass filter strips, shrubs and woodland zones is currently favoured.

- For sub surface removal of nitrates/phosphates vegetation should be chosen so it can interact with the groundwater.

- For planted areas fertilise and lime soil to create the ideal seed bed for particular vegetation type. Liming and fertilising rates will depend upon soil condition.

- Seeding timing should be chosen to maximise rapid vegetation. Wild and native vegetative mixes will increase the farm biodivesity and potential habitats.

- Mowing and weed management should be conducted once a year to maximise the density of the lower swathe. Mowing operations should be conducted in periods of low rainfall to reduce damage to the vegetation and to the soil and to ensure maximum cover in periods of high precipitation.

- Caution should be made when spraying crops near to the riparian buffer, damage can occur to the zone with selected herbicide use.

- Soil levels within the riparian buffers should be at the same level to the cropland to allow maximum flow through the riparian buffer. A build up of sediment will restrict the flow rate and success of the Riparian Buffer. In extreme cases a natural soil berm will be created restricting and redirecting flow to an accumulation point where breaching of the riparian buffer may occur. In cases of sediment accumulation, surplus soil should be removed and the Riparian Buffer re-established. Excess soil spreading should be conducted as in guidance.

- The better the land management practices within the catchment which the riparian buffers serve the less silting there will be in the buffer strip and reducing the effectiveness of the BMP. Good conservation practices also reduce the peak rate of runoff and the volume of water which will be carried by the waterway. When good conservation treatment of the drainage area is not obtained greater maintenance of the riparian buffer is usually required.

- Repair or protect damaged areas to minimise soil erosion in these periods.

- Livestock should be generally excluded although very extensive grazing can be achieved in dry periods.

## 18.7 Farm Benefits

- Reduces siltation and eutrophication of water channels;
- Increased habitat value e.g. creation of Beetle Banks and habitats for other predators of crop pests;
- The strip may be grazed in dry periods;
- Cost savings by not forming field margins with low yields;
- Creation of regular field areas more workable with farm machinery;
- Bank stabilisation to prevent loss of valuable agricultural land;
- enhanced numbers of game birds and improved fisheries; and
- reduction in the need for the management of hedges along the riparian edges.

# 19. SOIL BERMS

### 19.1 What are soil berms?

This BMP is a ridge created using deep ploughing techniques generally running along the contour to intercept run-off at a field boundary or adjacent to the riparian boundary. The BMP will usually be used on arable land but can also be promoted on pasture where extra protection is required.

### 19.2 Purpose

To intercept run-off, reducing flow velocity creating added infiltration thereby preventing sediment and overland flow directly entering drainage channels.

### 19.3 Application

The technique should be applied in areas where siltation of drainage channels is causing concern or to delay the peak flow of surface run-off. This BMP may be damaged if there is prolonged overland flow creating accumulation and breaching of the berm. This risk is intensified if the berm does not follow the contour and water accumulated in depressions. These areas may be strengthened by using more than one berm.

The BMP should be implemented along the contour to reduce potential accumulation of water in depressions. The ploughing depth will be dependent upon equipment, the condition of the soil and slope. Where applicable vegetative field strips should be placed in front of the BMP to reduce the run-off velocities before hitting the berm.

### 19.4 Associated BMPs

- Soil Spreading
- Vegetative Field Strips
- Livestock Exclusion

### 19.5 Implementation and Maintenance

- Survey should be conducted to estimate as precisely as possible the location of contours to attain zero flow conditions in the berm channel.

- The berms furrow should be deep enough to hold the volume of surface run-off and to give time for the water accumulated to infiltrate.

- Frequent inspection of the berm condition should be undertaken to check for in-channel flow, erosion and ponding.

- The berm may need re-implementing as it becomes progressively silted up and the soil aggregates begin to breakdown. Soil spreading should be carefully undertaken to minimise re-extraction and erosion.

- Livestock, recreational pursuits and farm operations should be excluded from the berm area as any damage to the berm in periods of high precipitation will lead to major soil erosion and silting of drainage ditches.

### 19.6 Farm Benefits

- Better Field Drainage
- Reduced Siltation within drainage channels

# 20. LIVESTOCK EXCLUSION

## 20.1 What is livestock exclusion ?

This BMP is the deliberate 'penning off' of livestock from particular areas of land on either a temporary or permanent basis. Such areas might include a riparian zone, berm or an area of severe erosion. The restriction might be put in place through fencing or through the planting of hedgerows.

## 20.2 Purpose of BMP

To reduce the impact and potential damage of over grazing and stock trails on a critical area which may exacerbate existing problems of pollution.

## 20.3 Problem Indicators

- livestock congregating within water or adjacent to trees, water troughs.
- unstable riparian banks.
- poaching of riparian land.
- bare soil from livestock tracks/trails or access points.

## 20.4 Application

The technique is to be used in association with other BMPs, such as critical area planting, to rehabilitate a particular area of land, riparian edge or riverbed allowing it to re-stabilise.

## 20.5 Specification

The restriction of access of a site should be achieved either by constructing fencing or through the implementation of hedgerows around a particular area. In areas where permanent exclusion is required hedgerows provide a more environmentally friendly tool than fences and can be used to create a windbreak or to reduce overland flow.

## 20.6 Associated BMPs

- Critical Area Planting
- Berms
- Waterways
- Bank Stabilisation and Maintenance
- Stream Crossings
- Stock trails and Feed/Water Trough Location
- Hedgerows Planting and Management
- Riparian Zones and Filter Strips

## 20.7 Implementation and Management

- Identify the area from which livestock must be excluded and decide whether the critical area is temporary or permanent. Temporary measures can be any barrier restricting movement. More permanent restrictions can be provided through fencing and hedges.

- Hedgerows should be planted at appropriate spaces to provide solid barrier to livestock and layered where appropriate.

- Surveys should be conducted to check whether implemented exclusion zones are working.

## 20.8 Farm Benefits

- Unproductive areas of farms can be re-stabilised and brought into production using associated remediation BMPs.

# 21. FEED/WATER TROUGH LOCATION

### 21.1 What is Feed/Water Trough Location?

Feed and water troughs act as a focus for livestock activity increasing intensity of use in a small area of the field. By re-locating feed and water troughs to areas of limited erosion risk, effects of intensive livestock movements can be reduced.

### 21.2 Purpose

To spread the impact of livestock activity around a field to minimise potential erosion or to manage a specific trough site in a manner to reduce potential erosion and pollution.

### 21.3 Problem Indicators

- Bare or damaged soil around trough locations
- Damaged livestock trails to and from the troughs
- 'Muddied' Waters flowing down the site.

### 21.4 Application

The technique can be used to either: a) by removing the threat of specific areas eroding by spreading them around a site using a mobile trough and allowing them either to rehabilitate, or by installing a hard surface so that the site can withstand prolonged high intensity of use. Careful location of feeding and water troughs will draw livestock away from sensitive locations within a field including the riparian edge and steep land.

Trough location should be in places of low erosion risk indicated by: a) wide areas of gently sloping land; b) long distances from drainage and water courses and established vegetative cover. Areas chosen should possess both low erodibility and still be easily accessible for livestock. The sites should have carefully sited and well maintained livestock trails leading to and from the trough location.

Permanently sited trough locations should have an established hard surface with some drainage protection, filter strips and grassed waterways absorbing the waste water run-off.

### 21.5 Associated BMPs

- Livestock Trails
- Filter strips
- Grassed Waterways
- Critical Area Planting
- Livestock Exclusion

## 21.6 Implementation and Maintenance

- Location for troughs should take into account: current managed stock trails; erodibility state of soil and ease of access for livestock.

- Areas damaged should be rapidly planted and livestock excluded.

- In situations where troughs are moved around a site, monitoring of erosion should be conducted regularly in particular in periods of high precipitation.

- Surface material on permanent managed trough locations should be chosen with respect to the type of livestock and intensity of use.

- Appropriate drainage techniques should be implemented to reduce the impact of run-off from the managed surface.

- Managed trough locations should be reviewed to estimate the success of drainage considerations.

- All construction activities on site should keep pollution and soil disturbance to a minimum.

## 21.7 Farm Benefits

- Reduced siltation to ditches
- Increase field productivity
- Increased access for livestock to feed and water troughs allowing there best utilisation.

# 22. SOIL SPREADING

### 22.1 What is Soil Spreading ?

This BMP emphasises the need to take great care when disposing of excess soil.

### 22.2 Purpose

To best dispose of excess soil in a manner to reduce the amount being re-eroded or affecting field drainage and to permit its use for agricultural production.

### 22.3 Problem Indicators

- soil heaps located on sites which suffer erosion e.g. slopes, close to gateways or in natural drainage channels.

- soil heaps located adjacent to the riparian edge.

### 22.4 Application

This technique applies to sites where spoil material is present from the excavation of channels or where it is to be exported off site.

### 22.5 Associated BMPs

- Ditch Management

### 22.6 Implementation and Management

**Soil heaps**

- Minimise trafficking over soils during creation of heaps.
- Locate heaps where soil materials will not be disturbed by farm machinery.
- If heaps likely to remain for sometime, consider grassing, both to stabilise them and integrate them into surrounding landscape.

**Considerations for Re-spreading**

- The soils should have the same texture as the soils into which it is to be spread. Soil mixing will be detrimental to overall soil quality.
- Ensure that the machinery selected will not cause significant compactions. Organise vehicle operation to minimise repeated trafficking over land.
- Do not carry out soil moving operations when soils are wet and liable to damage.
- If damage is thought to have occurred, consider secondary treatments (subsoiling) to alleviate any compaction caused.

### 22.7 Farm Benefits

- Reduced deposition in ditches
- Managing good on field drainage to drainage ditches
- Ensuring agricultural production post soil spreading.

# 23. LIVESTOCK TRAILS

## 23.1 What are livestock trails ?

A livestock trail is a maintained or constructed route which allows grazing distribution and access to forage and water. Livestock trails can be used to: provide or improve access to areas of forage or managed water resources; to reduce livestock concentrations within fields; to improve ease of access for livestock movements between fields creating planned grazing systems and proper grazing use and to improve grazing efficiency.

## 23.2 Purpose

The purpose is to allow movement of livestock through land without causing damage to vegetation and soil structure so reducing the risk of soil erosion.

## 23.3 Problem Indicators

- High intensity stocking densities within fields
- Erosion and 'muddied' water flowing down eroded unmanaged trails
- Poor vegetation cover in intensely stocked areas

## 23.4 Application

The introduction of managed livestock trails should reduce pollution by leading the cattle away from erodible areas to more stable sites within the field.

## 23.5 Specification

Livestock trails should not run in close proximity to watercourse and a filter strip should be between the trail and the channel.

Surface type depends upon type of livestock within the field, the intensity of use and the gradient the trail encompasses.

Livestock trails should not be sited on steep gradients and sharp corners on the trail should be avoided to ensure safe, ready access to grazing areas.

## 23.6 Implementation and Maintenance

- Suitable management methods should be designed to disperse surface water flowing from the trail in order to reduce erosion and treat which may possess pathogens and cause erosion. Surface water should be managed to encourage infiltration ensuring that watercourses are not contaminated as a result of runoff.

- Surface water from the animal trail should be infiltrated into the soil taking care not to contaminate watercourses as a result of the run-off.

- If vegetation is used as a protective cover then the animals should have restricted access in this period to allow establishment.

- Livestock trails should be routed to maximise the other BMPs on the site including stream crossings; existing access tracks, access points and managed drainage facilities.

- Monitoring of the condition of stock trails should ensure that erosion and surface deterioration is kept to a minimum.

## 23.7 Farm Benefits

- Decreased soil erosion and associated increase in soil longevity and farm enterprise sustainability.
- Decreased livestock movement times
- Increased pasture productivity
- Decreased siltation in ditches and reduced drainage ditch management costs.
- Increased surface stability of trails will lead to fewer livestock accidents and decrease the potential of foot diseases.

# 24. CONSERVATION TILLAGE

## 24.1 What is Conservation Tillage?

This practice is an alternative to conventional tillage practices, such as inversion ploughing, in order to minimise the disturbance to the soil structure. The term 'conservation tillage' encompasses a wide range of practices including: no tillage; minimum tillage, tied ridge tillage and delayed tillage.

## 24.2 Purpose of the BMP

The differing techniques termed as 'conservation tillage' will have a wide range of benefits depending upon which is adopted. Conservation tillage will develop a planting strategy that causes the least disturbance to the soil condition, or develops a seed bed in a fashion that resists erosion. The majority of the tillage practices aim to maintain a significant degree of vegetation cover in un-cropped periods (including the use of crop residue) in order to: resist overland flow; encourage infiltration thereby reducing erosion and minimise activities which disturb soil structure.

## 24.3 Problem Indicators

- High pollution loads in watercourses and drainage channels post tillage operations.
- Significant soil erosion from established seed bed.
- Surface flow along furrows and indication of soil erosion within field.
- Bare soil during high periods of precipitation e.g. over winter or sept/oct/nov.

## 24.4 Application

Conservation tillage is applied to fields where there is a significant pollution risk caused through conventional practices. The practice is particularly pertinent in areas changing land use, e.g. from permanent pasture to arable production or long periods between successive crops.

There are wide range of conservation tillage practices but common ones include and involve:

- ***No Tillage:*** direct drilling through existing vegetation and substrate.
- ***Minimum Tillage:*** decreasing the intensity of tillage practices to a level where soil stability is maintained whilst ensuring that crop productivity is not significantly affected.
- ***Tied Ridge Tillage:*** alteration in tillage practice to create barriers perpendicular to surface water flow.
- ***Delayed Tillage:*** delaying seed bed preparation until the latest practical moment before planting. The technique minimises the breakdown of the soils structure and limiting its exposure to weathering and leaching.

The choice of tillage practice will depend upon the soil type, crop requirements, timing and cost of operation and machinery availability. Particular types of tillage practices require the use of sophisticated expensive machinery in order to achieve the desired benefits. The adopted technique should accommodate the farmers resources and the crop requirements.

## 24.5 Associated BMPs

- Contour Cultivation.
- Contour Planting
- Residue Management

## 24.6 Implementation and Management Specification

- Prior to adopting conservation tillage review: soil type, crop requirements (timing and seed bed), appropriate requirements and farming resources (time and money).

- Prior to implementation seek technical advice for the adopted practice from appropriate sources. Guidance to these sources may be given through the MAFF regional service centre and local ADAS officer.

- If crop residue is applied or existing vegetation remains monitor the field for indications of weed/pest infestation and disease.

- In areas where 'no tillage' is adopted monitor the field for indications of overland flow and surface erosion.

- Consider selective herbicide treatment on the field to remove vegetation prior to seeding to allow unimpeded establishment which would reduce crop health and yields.

## 24.7 Benefits to the Farm

- Reduced erosion leads to increased soil longevity and improves farming Sustainability
- Decreases siltation of ditches and waterways, reduced drainage management costs.
- Decreased leaching.