Controlling soil erosion

Incorporating former advisory leaflets on grazing livestock, wind, outdoor pigs and the uplands

Revised: September 2005

defra
Department for Environment
Food and Rural Affairs

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This booklet combines advice previously presented in the separate Controlling Soil Erosion leaflets on the management of agricultural land (PB3280); preventing erosion caused by grazing stock (PB4091); erosion risk assessment (PB4092); preventing soil erosion in the uplands (PB5820A); preventing soil erosion by wind (PB5820B); and preventing soil erosion by outdoor pigs (PB5820C). Copies of the original booklets are available free of charge from Defra Publications, Admail 6000, London SW1A 2XX. Telephone: 08459 556000.

This booklet complements advice given in the Defra Codes of Good Agricultural Practice for the Protection of Soil, Water and Air. It is aimed principally at farmers, growers and landowners in lowland England who have erosion problems or whose soils are at serious risk of erosion.

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1. The management of agricultural land

Introduction

Soil erosion is caused by the action of water, wind, grazing animals and human activity. It can affect the profitability of farm businesses, damage the environment and cause a public nuisance.

Erosion has increased in recent years. Problems can occur almost anywhere but the main lowland areas at risk are shown on the map opposite. Problems are likely to increase if cropping and rainfall patterns alter due to climate change.

Action now can protect the long-term productivity of your most valuable asset – your soil.

Care is needed to maintain soils in a fertile condition and to prevent or minimise the economic and environmental impacts of erosion. Losses of soil from the land may appear small in an agricultural context but, when redeposited, they can cause serious damage to rivers, lakes and coastal waters and on neighbouring land. This damage is increasingly unacceptable to affected people and the public in general.

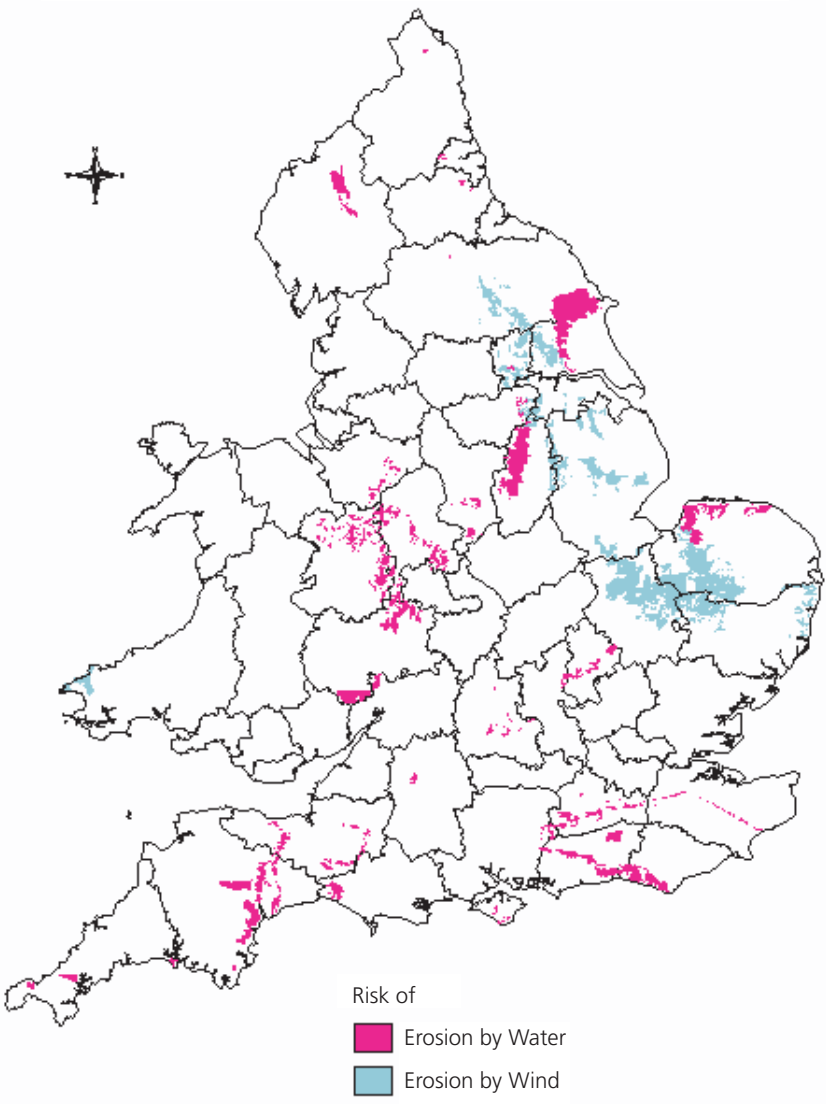
The 19th report of the Royal Commission on Environmental Pollution on Sustainable Use of Soil (published in 1996) drew attention to the erosion of agricultural soils.

While the Commission acknowledged that the major effects are localised and do not damage agricultural productivity in the UK as much as other countries, it expressed particular concern about damage to the off-farm environment.

Farmers, growers and landowners in the United Kingdom are fortunate that erosion tends to be localised or site-specific rather than the large-scale problem experienced in many parts of the world.

However, erosion of agricultural land is more widespread in this country than is commonly thought and the impact of climate change may increase problems in the future. Although the nature of climate change is not yet certain, it is likely that spells of severe rainfall will become more common.

Areas most at risk from erosion



Produced by ADAS Gleadthorpe Research Centre

Water erosion

Sandy soils in South West and South East England, East Anglia, the Midlands and South Wales

Chalky soils on the South Downs, Wolds and in East Anglia

(Uplands and woodlands not shown here)

Wind erosion

Bare sandy and peaty soils between March and June in East Midlands, Vale of York and East Anglia

Economic & environmental effects of erosion

Erosion has long-term consequences for soil quality and short-term consequences on individual crops. Off-site environmental effects are increasing and becoming more unacceptable to those affected as well as the public at large.

Repeated erosion reduces the fertility of the soil by:

- removing top soil which is rich in nutrients and organic matter;
- reducing the depth of soil available for rooting and for storing water available for crop growth; and
- reducing infiltration of water into soil and increasing run off.

Short-term damage and increased costs can result from:

- loss of seeds, seedlings, fertilisers and pesticides, and the need to repeat field operations;
- soil being washed from the roots;
- young plants being blasted with sand during wind erosion; and
- the need to level out eroded surfaces by extra cultivations.

Damage to the off-farm environment takes the form of:

- deposition of sediment onto roads, neighbouring properties and in roadside drains;
- damage to the quality of watercourses, lakes and coastal waters though excess inputs of nitrogen, phosphorus and pesticides;
- sediment in rivers damaging the spawning grounds of fish; and
- increased run off and deposition of sediment causing a greater flood hazard downstream.

Local authorities or the Environment Agency have powers to prosecute or to take other enforcement action if such effects occur (see Appendix A). This may involve recovering costs of clearing up any deposition.

The off-site effects of erosion may not be obvious, Even run off that looks clear can pollute surface waters over long distances by carrying nutrients and pesticides on very small soil particles. Muddy run off from areas of land poached by livestock can have similar effects.

Controlling water erosion

Water erosion may be confined to run off containing fine soil particles, or it may be more serious and cut rills or gullies down slopes. Erosion can be a particular problem when there is little crop cover or the surface of the soil is compacted so that the risk of run off is increased.

Erosion has increased in recent years. Among the problems are:

- winter cereal crops particularly when they are sown late;
- the use of tramlines and other wheelings;
- the need for fine, flat seedbeds for both arable and vegetable crops to help establishment and increase herbicide efficiency;
- increase in the length of slopes within fields through hedge removal;
- the growing of silage maize in some areas in place of grass;
- the out-wintering and supplementary feeding of livestock;
- the location of outdoor pig units on unsuitable sites;
- the ploughing out or reseeding of pasture on sloping land; and
- damage to riverbanks by grazing livestock.

Plan your erosion control

Clearly identify the situations where erosion occurs regularly or where there is a high risk of run off. Pay particular attention to light soils, headlands and steep or long slopes. Take measures to reduce the risk in these areas.

Valley bottoms where run off can accumulate are particularly vulnerable. Fields with complex slope patterns often lead to channelling of run off, which can cause severe erosion.

Ensure that you:

- reduce run off onto fields from farm roads, tracks and concreted areas by having adequate drains, ditches and soakaways;
- maintain land drains, pipe outlets and ditches to ensure effective drainage of the land; and
- remove sediment that has been deposited in ditches and drains and, whenever possible, return it to the place from which is was eroded.

If in doubt about the need for action or what to do, you should seek specialist advice.

Appropriate management of soils can greatly reduce the risk of erosion. It is important to maintain a good structure in the soil surface so that water can infiltrate. Even sandy soils can become compacted or capped and this can lead to run off and possible erosion.

Erosion in maize stubble

- Develop stable topsoils by using bulky organic manures, but do not apply excessive amounts of nitrogen. The Codes of Good Agricultural Practice recommend a limit of 250kg/ha per year of nitrogen in manures. Always make allowance for this nitrogen when applying inorganic fertilisers.
- Avoid compaction, particularly on the surface, and correct any problems before sowing.
- Avoid fine seedbeds if these will slake, run together and seal the soil surface. Using rotary implements can leave a very fine tilth that has a high risk of slaking. Do not roll seedbeds if this will lead to run off and erosion.
- Set up tramlines after the crops have emerged and do not use them until the spring. If this is not practical, a shallow tine behind the wheel can break up compacted soil.
- Protect the soil during autumn and winter by sowing autumn crops early or by growing cover crops such as rye, mustard or grass.
- Minimum (or non-inversion) tillage will incorporate straw residues into the surface of the soil, which can help prevent erosion.
- Row crops such as potatoes and sugar beet may be unsuitable on moderate and steep slopes.

On other sites, use soil walls to bridge furrows across the slope (tied ridges) and small pits (dikes) along furrow bottoms to improve infiltration and reduce-run off.

- Work across the slope whenever possible, but beware of complex slope patterns which may channel run off and cause the formation of gullies. Contour farming is rarely practical in England but may be possible in large fields with simple slopes.
- Always avoid run off when irrigating land. Pay particular attention on slopes and adjust application water as necessary.
- Select sites for outdoor pigs which minimise the risk of erosion. Take account of slope, soil type and rainfall. Maintain grass cover on any sites where this is necessary to prevent run off. Be prepared to reduce stocking rates or move to a fresh field.

If water erosion is a frequent or serious problem, you may need to take further preventative action. You should consider if you need to:

- introduce grass into your rotation, possibly on set-aside areas;
- plant hedges or build new ditches to restrict run off, or direct run off water away from areas prone to erosion;
- create permanent strips of grass or rough vegetation as buffer zones to slow down run off and trap soil at critical places on a slope or at the bottom of a field. The optimum width will depend on soil type, slope and climate. Buffer zones may not work where there is a severe problem;

runoff from irrigation of potatoes

- as a last resort, construct bunds (embankments) or settlement areas to trap silt-laden water but do not rely on this in subsequent seasons. Take additional preventative measures.

You may need to take expert advice before you undertake such measures.

Regular and severe problems

Poorly planned measures can cause more erosion than they prevent.

If you have regular and severe problems of water erosion that cannot be controlled by changes in farming methods, cropping or by the other control measures outlined above, you should consider reversion to permanent grass or woodland or set-aside on slopes and valley features where run off is likely.

- Permanent strips of grass, rough vegetation, beetle banks or hedgerows can slow runoff and trap sediment if installed at critical places on long slopes.

- Buffer strips, hedgerows and set-aside strips planted around the edge of fields can slow runoff and break links between neighbouring fields that are vulnerable to erosion.
- New ditches or drains can be installed to intercept run off and direct it away from areas vulnerable to runoff and erosion.
- Improving the surface of tracks can increase water infiltration and stop them from channelling water.
- Planting rows of trees or hedgerows provides shelter and wind breaks around fields.
- Bank erosion can be prevented by providing a piped water supply to fields, using fencing to protect bank side stock access points, or building bridges over watercourses at crossing areas.

All of these options should be considered in conjunction with Environmental Stewardship schemes (from March 2005 onwards).

Grass slopes can trap eroding soil

Controlling wind erosion

Wind erosion occurs chiefly when dry seedbeds in light sandy and peaty soils are unprotected by plant cover.

To reduce the risk, provide shelter on vulnerable sites where wind erosion occurs.

- Grow rows of trees or hedges to provide protection for soil and crops grown on the sheltered side and to trap air-borne soil particles. The benefit depends on the frequency and direction of any damaging winds.
- Shelters should allow 30-50% of the wind to pass through. Protection of the soil reduces with distance from the shelter and does not extend more than 20 times its height.
- Use records of wind direction from the Meteorological Office to help you decide where to put shelter belts.

Consider providing extra protection whilst crops are establishing by growing cover or nurse crops or 'planting' straw.

- On peaty or irrigated sandy soils, grow crops such as winter rye, winter barley or mustard as cover or nurse crops to provide protection.

- Kill off cover crops before the spring crop is drilled by cultivation or spraying. Spray off nurse crops during the early life of the crop.
- On peaty soils, mechanised straw planting in rows may provide shelter for early sown vegetable crops.

Consider if you can stabilise the surface.

Mulches

- The application of mulches to the surface of seedbeds on sandy soils at 5-15 t/ha after drilling is an effective control. If you disturb the mulch, the benefit is lost. Suitable materials for mulches include organic manures, sugar beet factory lime, sewage sludge, or paper sludge. Take care not to apply excess nutrients, lime or contaminants by following the advice given in the *Code of Good Agricultural Practice*. The spreading of some of these materials such as sewage sludge and other industrial wastes are subject to legal requirements or local water protection restrictions,. See the *Codes of Good Agricultural Practice* for further guidance. If you want to spread industrial wastes on agricultural land, you must first pre-notify the Environment Agency.

Synthetic stabilisers

- PVA (polyvinylacetate) emulsions or PAM (polyacrylamides) sprayed onto sands after drilling can provide temporary protection for high value crops. This method is unsuitable on peat soils. Appropriate professional advice should be obtained before you use these materials.

Cultivation practices can provide effective control on sandy soils.

- Form an erosion-resistant surface by ploughing and leaving it rough.
- Plough and press lighter soils when moist, preferably just before you sow the crop. Drill at right angles without further cultivations.
- Uncultivated crop stubble provides protection against wind erosion and a spring-sown crop can sometimes be drilled directly into the soil surface. Do not leave compacted surfaces that will increase run off and lead to water erosion.

Use of plough and press to control wind erosion

Further details on controlling wind erosion can be found in chapter 4 of this booklet.

Erosion by livestock

Grazing livestock systems can also increase water erosion in lowland areas. Avoid any practice which causes the soil to become poached and increases run off. In particular, be careful of:

- high stocking rates, particularly in wet weather;
- feeding areas for outwintered stock, particularly near watercourses;
- overgrazing near river banks and uncontrolled access to watercourses which can cause bank erosion;
- strip grazing of fodder crops;
- farm tracks used by stock, particularly if they cross streams; and
- access tracks for farm machinery.

Further details can be found in chapter 3 of this booklet.

Erosion in upland areas

Soils in upland areas, particularly on peaty or sloping sites, are at high risk of erosion from unsealed tracks or drainage ditches, or from destruction of the plant cover by livestock or recreational activities. In the uplands, gullying is a greater risk than in the lowlands due to steeper gradients and high rainfall whilst the impact of sheet erosion can be dramatic. Both can make land bare and unfarmable. If overgrazing has caused, or is likely to cause a problem, reduce your stocking rates. Take care to limit other activities which may aggravate the risk of erosion including poaching around winter feeding areas. Protect eroding areas by encouraging the regeneration of appropriate vegetarian.

Further details on controlling erosion in the uplands can be found in chapter 6 of this booklet.

Erosion in woodland

When you are establishing or harvesting any short rotation coppice, woodland or forestry, take precautions to avoid run off and soil erosion. Keep a cover of plants or trash where possible and avoid compacting the soil by the use of machinery or equipment, particularly on slopes, shallow soils and in upland peaty areas. Take care when installing ditches, roadways and stream crossings.

2. Field guide for an erosion risk assessment for farmers and consultants

Site characteristics

This chapter provides the basis for preparation of an erosion risk map for the farm.

The criteria of importance at this stage are:

- Soil Texture
- Slope
- Flooding frequency

Subsequently you will need to consider cropping and soil structural condition.

The risk of runoff or soil wash and erosion depends on the physical features of the farm and upon soil management. Actual events are determined by rainfall. Very high intensity storms or repeated storms can cause serious erosion in many situations and the following assessment procedure does not necessarily cover such events.

In making a risk assessment, each field should be examined. Runoff and erosion risk in any part of a field will depend on the soil texture and steepness of slope. The uniformity of slope above and below a particular area, are also important in determining the likelihood of rill or gully formation.

For assessment purposes large fields might be sub-divided if slope, soils or topography differ significantly, but for whole field assessment the worst scenario should generally be mapped. Field entrances should be marked on the map where they may influence erosion by channelling water movements into or out of a field. An example of a typical farm map is illustrated at the end of this section.

If required, soil textures can be obtained from a laboratory analysis of particle size distribution. The diagrams at the end of this Chapter show:

- The percentages of sand, silt and clay within each textural class.
- A hand texture assessment which can be carried out in the field and will be adequate for most situations.

It is helpful to assess slope angles as accurately as possible however slopes are frequently uneven and variable and it is more important to determine the relative overall risk of an area of land than to worry about precise angles of slope.

Typical situations which would fall into different risk categories are outlined in the tables below. The criteria given are guidelines and professional judgment should be used to upgrade or downgrade a site, taking into account additional factors such as:

- Soil structure
- Organic matter content
- Valley features which tend to concentrate runoff water

- Long unbroken slopes
- Land restored following opencast mining or landfill operations
- Very steep slopes (i.e. greater than 11^0)

Very light soils with low organic matter on gentle slopes, even in low rainfall areas, can erode more seriously than indicated in the following risk assessment, sometimes by as much as two risk classes. Therefore, in addition to a field assessment, local knowledge is also useful in estimating risk, as previous erosion occurrences are often well remembered.

The following assessment procedure estimates the risk of runoff from fields carrying nutrients and soil down slopes. Runoff pathways, slope patterns and valley features will influence the likelihood of this runoff causing further erosion or having deposition impacts beyond the field. Areas where this could happen should also be indicated on the plan. You should also consider if your land receives runoff from elsewhere that will increase erosion problems on your land.

The following tables provide a guide to field classification for runoff and erosion. They assume moderately good soil conditions. If the land is currently in grass you should still apply this risk assessment. It will act as a guide to what might happen if you decide to reseed or introduce arable cropping in future.

Water erosion

This part of the risk assessment refers to the movement of sediment within the field and possible transfer to watercourses or other places such as neighbouring properties or on to roads.

Soils	Steep slopes > 7°	Moderate slopes 3° – 7°	Gentle slopes 2° – 3°	Level ground < 2°
Sandy and light silty soils	Very high	High	Moderate	Lower
Medium and calcareous soils	High	Moderate	Lower	Lower
Heavy soils	Lower	Lower	Lower	Lower

Signs of erosion that may be associated with each of the risk classes are described below. Such observations should override an assessment derived solely from the table.

Very High Risk Areas – Rills are likely to form in most years and gullies may develop in very wet periods.

High Risk Areas – Rills are likely to develop in most seasons during wet periods.

Moderate Risk Areas – Sediment may be seen running to roads, ditches or watercourses and rills may develop in some seasons during very wet periods.

Lower Risk Areas – Sediment rarely seen to move but polluting runoff may enter ditches or watercourses.

Runoff or soil wash

This part of the risk assessment refers to runoff which is usually but not always discoloured. This runoff may carry very fine soil particles, soluble pollutants such as plant nutrients and pesticides or manures to watercourses.

Soils	Steep slopes > 7°	Moderate slopes 3° – 7°	Gentle slopes 2° – 3°	Level ground < 2°
All soils	High	Moderate	Lower	Lower

Signs of runoff that may be associated with each of the risk classes are described below. Such observations should override an assessment derived solely from the table.

High Risk Areas – Runoff seen in most years during wet periods

Moderate Risk Areas – Runoff seen in some years during wet periods and in most years during very wet periods

Lower Risk Areas – Runoff seen in some years during very wet periods

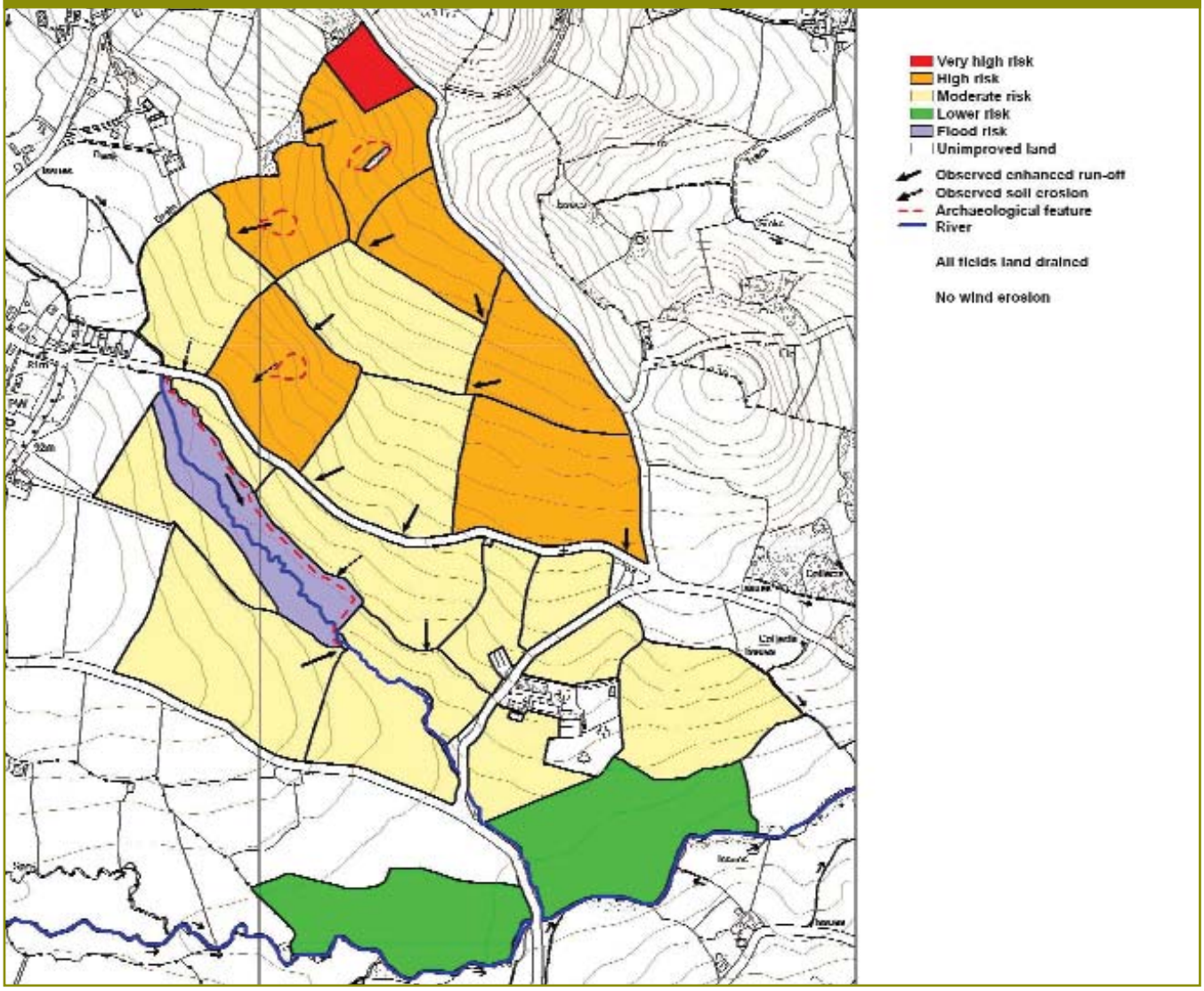
Remember that: The accumulated runoff from a catchment with a large proportion of only lower risk fields can still cause serious damage to watercourses and may require action to be taken.

Flood risk

Land that floods is susceptible to erosion and runoff, particularly when under cultivation. Land that floods regularly (at least 1 year in 3) must be regarded as highly vulnerable and should be indicated on your map.

The map overleaf showing the erosion risk categories outlined above should serve as a basis for planning crop rotations and management to reduce run-off risks and soil loss.

Example of farm erosion risk map:



Farm and crop planning

The risk map shows which fields or parts of fields are most at risk when exposed to heavy or prolonged rain or flooding. At this stage, it might become clear that new hedge plantings could usefully reduce erosion risks or relocation of field entrances could reduce deposition of sediment onto roads or into watercourses.

The next step is to plan crop rotations and land use to minimise exposure of bare, vulnerable land to the erosive effects of rainfall.

The susceptibility of soil to erosion is dependent upon the land cover or livestock enterprise using the land, and can be considered in three broad categories. Some examples of land management practices within each category are listed below.

Highly susceptible land use

On Very High Risk and High Risk sites, avoid these land uses unless precautions are taken as outlined in Chapters 4 and 5. If these precautions do not control the problem then discontinue the land use. Some of these precautions may be necessary on all sites.

- Late sown winter cereals
- Potatoes
- Sugar beet
- Field vegetables
- Outdoor pigs
- Grass re-seeds
- Forage maize
- Outwintering stock
- Grazing forage crops in autumn or winter

Moderately susceptible land use

On Very High Risk and High Risk sites these moderately susceptible land uses can be carried out with care.

- Early sown winter cereals
- Oilseed rape – winter and spring sown
- Spring sown cereals
- Spring sown linseed
- Short rotation coppice/Miscanthus

Less susceptible land use

Consider the following land uses on Very High Risk and High Risk sites as a means of reducing the overall erosion risk.

- Long grass leys
- Permanent grass
- Woodland (excluding short term coppice)

By altering rotations and changing land use, for example, switching from late sown autumn to spring sown crops on higher risk sites, the likelihood of erosion can be reduced significantly.

Soil texture

Texture classes for mineral soils are defined by the relative proportions of sand, silt and clay sized particles.

Particle sizes

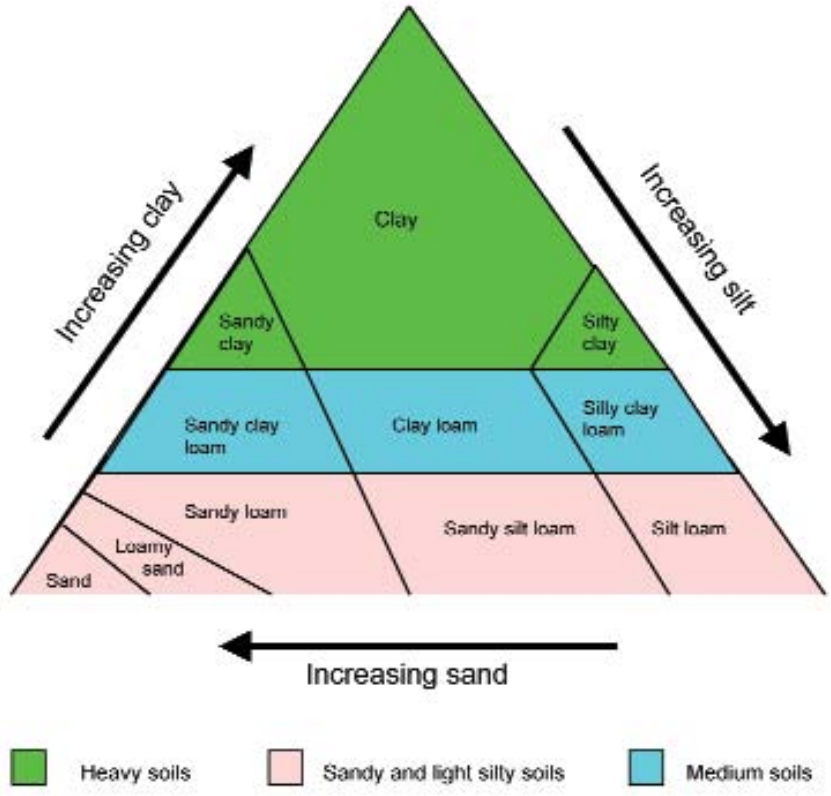
	Particle Diameter mm
Sand	2–0.06
Silt	0.06–0.002
Clay	less than 0.002

Triangular diagram

Limiting percentages for the 11 main texture classes are defined within the triangular diagram below.

Sand, loamy sand, sandy loam, sandy silt loam and sandy clay loam classes may be subdivided according to the sand size.

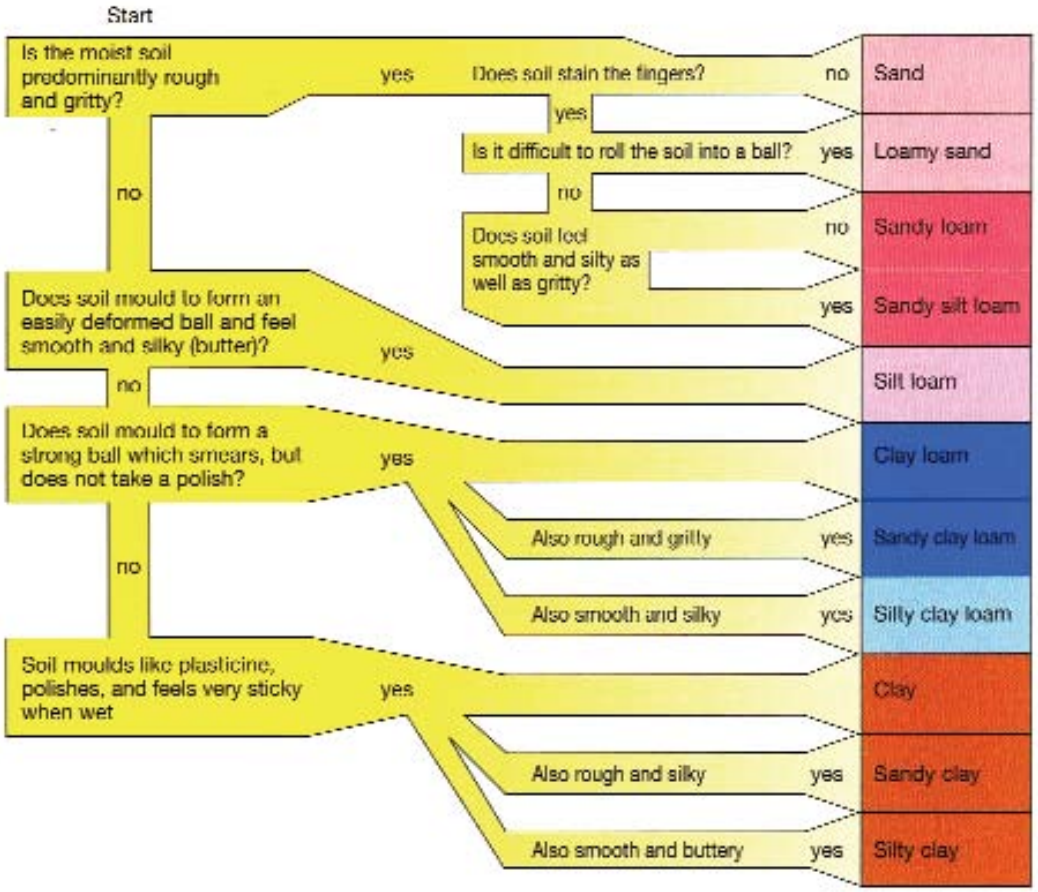
Fine – more than two thirds of sand less than 0.2mm
Coarse – more than one third of sand greater than 0.6mm



Assessment of soil texture

Accurate measurements of soil texture requires laboratory analysis, but for practical purposes, texture can be assessed by hand, using the following method:

Take about a dessert spoonful of soil. If dry, wet up gradually, kneading thoroughly between finger and thumb until soil crumbs are broken down. Enough moisture is needed to hold the soil together and to show its maximum stickiness. Follow the paths in the diagram to get the texture class:



3. Preventing erosion caused by grazing livestock in lowland England

This chapter is based on the defra booklet 'Controlling soil erosion: a manual for the assessment and management of agricultural land at risk of water erosion in lowland England'.

It shows how livestock can cause soil erosion from fields and river banks. It explains how to avoid damaging fields, and how to reduce the pollution of rivers and damage to fisheries by preventing soil, dung and urine being washed into ditches and watercourses.

To prevent soil erosion from grazing livestock:

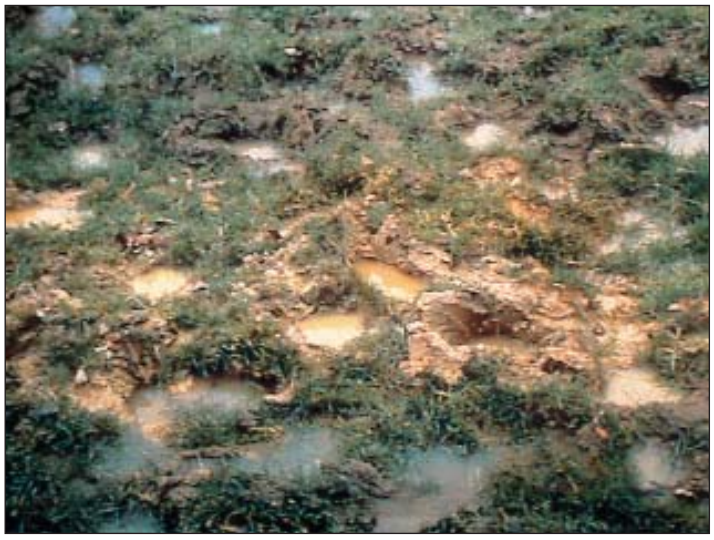
- Manage grazing livestock to avoid poaching.
- Take particular care when strip grazing grass and forage crops.
- Maintain field drainage to keep soils drier where appropriate.
- Site water troughs and feeding areas away from ditches and watercourses.
- Protect river banks and watercourses from uncontrolled access by livestock.
- Manage farm tracks to avoid polluting watercourses.

Stocking rates and grazing management

Problems of run off and erosion start in pasture when poaching by stock takes place. This is possible on all soil types, but is much more serious on naturally wet soils or land grazed during the winter.

The run off from poached land can cause pollution if the area drains to a watercourse.

From healthy pasture to mud can take just 2-3 days. When the soil dries out again, it is often badly compacted. This can lead to poor spring growth and loss of grass yield. Weeds and inferior grasses take over and poached areas often need to be re-seeded. As a guide, if hoof marks from cattle appear, which are deeper than 50 mm (2") then move stock immediately from at risk sites.



To reduce soil damage and pollution risks:

- Select drier fields for winter grazing.
- Check fields regularly where stock are grazing.
- In wet periods remove livestock from land which is susceptible to poaching and where run off and erosion can enter a ditch or watercourse.
- Maintain or improve drainage to keep soils drier – where this is compatible with nature conservation objectives.

Stock feeding and watering areas

Fields can often become seriously poached around feeding and watering areas, especially during the wetter months.

The risk of pollution is particularly high because dung and urine collect in these areas and may be washed into watercourses.

To reduce soil damage and pollution risks:

- Move feeders regularly where it is necessary to prevent pasture damage.
- Where possible, site water troughs and feed areas along the tops of fields and away from watercourses and gateways.
- Improve access on farm tracks to reduce wheelings in fields when supplying feed areas by tractor.
- House stock during wet periods if the above measures are not effective.

Grazing of fodder crops and stubbles

Where fodder crops (kale, turnips, etc) are grazed, soil erosion can occur as the area of exposed soil increases. This should be taken into account when sowing and managing fodder crops, especially when strip grazing.

To reduce soil damage and pollution risks:

- Do not grow fodder crops for grazing on fields at risk of soil erosion or where run off can enter a ditch or watercourse.
- If this is not possible check fields regularly where stock are grazing, limit daily grazing time to reduce soil damage and be prepared to remove stock.
- When grazing fodder crops on slopes, leave temporary ungrazed strips of crop across the slope to break the flow of surface run off.
- On longer slopes consider growing grass strips 10-20 metres wide across the slope, or against any ditch or stream at the bottom of the field to help intercept run off.

River banks and watercourses

Grazing pressure on the banks of streams and rivers can be high especially where these are unfenced. Stock frequently gathers here in summer to drink and stand and will poach wetter areas of pasture which are often found adjacent to watercourses.

Where treading by livestock results in steep banks, these may be eroded by the river when water levels rise, resulting in increased sediment in the river and a loss of productive land.

To protect river banks and watercourses:

- Fence them off to prevent stock access.
- Provide a piped water supply or a livestock activated trough drawing from the stream.
- If stock must drink from watercourses, the access areas should be fenced and stock prevented from standing in the main flow.
- In some locations it might be possible to divert a small flow from the stream to a separate drinking area or trough.

Farm tracks

Disturbed soil and dung often build up on farm tracks. During heavy or prolonged rain this may be washed into watercourses.

Tracks can also intercept and channel run off which can cause further problems if this discharges to land prone to erosion.

Wheelings caused by machinery running over wet land can also lead to erosion and pollution.

To protect fields and rivers from run off:

- Relocate any farm tracks if they could channel water and cause soil erosion.
- Divert run off from tracks to grass fields where it can be intercepted and filtered.
- Try to avoid moving stock on tracks where run off to watercourses can occur.
- Prevent poaching and dunging at stream crossings – provide a bridge if possible.
- Plan grazing management carefully, particularly with respect to often-used tracks.
- Improve livestock paths in fields (e.g. where cows return to graze after milking) by laying concrete, stone, or bark-based tracks. These speed progress and dispersion of cows into the field, and result in less grass and foot damage.
- Avoid rutting fields with machinery particularly when spreading manures and fertilisers.

Buffer strips

In some circumstances, it may be beneficial to create buffer zones alongside streams and watercourses. These are vegetated strips of land of perhaps 5-50 metres in width, located at the bottom of fields, which are managed separately from the rest of the field – normally by fencing and excluding livestock. They can help to protect the river bank from erosion through the stabilising effect of root systems and may also intercept dung and soil particles carried in run off.

In some situations, where grazing pressure is expected to be heavy, a temporary buffer zone some 10-20 metres wide should be left at the bottom of the field. This can be left for a conservation cut, or grazed where there is sufficient re-growth on the ground above and the risks of soil damage are lower.

Remember: Prevent damage to grassland to maintain yields and avoid extra feed costs.

4. Preventing soil erosion by wind

This chapter explains the problems caused by wind erosion, where it is most likely to occur and ways of reducing the risks of damage.

The problem

Erosion by wind can result in:

- Loss of topsoil.
- Loss of seed, fertiliser and agrochemicals.
- Damage to crops by abrasion.
- Soil blocking roads.
- Ditches filled with soil.
- Streams and rivers polluted by soil and agrochemicals.

Where does it occur?

Risk Areas

Susceptible soils in the drier parts of the country are most at risk i.e. parts of the East Midlands, Yorkshire and East Anglia.

Soil types

Wind erosion is most likely to occur on:

- Fine sandy soils with soil particles of 0.1-0.2 mm diameter.
- Light peaty soils with soil particles of about 1 mm diameter.

Clay particles help to make stable crumbs and clods which resist movement. Organic matter contents of up to 20-30% help but above this the risk increases because of lower soil density and looser structure.

Other Factors

Wind erosion is most common:

- When wind speed is greater than 20 mph.
- On bare arable land between the months of March and June.
- On fine dry seedbeds e.g. for sugar beet, carrots and onions.

Sugar beet and carrots are vulnerable for up to 5 weeks after emergence and onions for up to 9 weeks. Rainfall decreases the risk of wind erosion because moist soil particles stick to each other and resist movement.

Methods of control

Wind erosion can be reduced by measures which:

- Reduce wind speed at the soil surface.
- Stabilise the soil surface.
- Trap soil particles already in motion.

The costs of different measures can vary greatly. The most appropriate method for a particular farm or field will depend on soil type, cropping, the size of the area affected and the availability of any specialist equipment or materials required.

Shelter Belts

Hedgerows and belts of trees will provide protection downwind for up to 20 times their height.

To be most effective they should:

- Permit 30-50% of the wind to pass through.
- Be evenly permeable from top to bottom.
- Run at right angles to the damaging winds.

Allow existing hedgerows to grow taller in vulnerable areas but do not allow gaps to develop at the bottom.

Payments for establishing new hedgerows and belts of trees may be available under the Environmental Stewardship Scheme (from March 2005 onwards) or the England Woodland Grant Scheme (from July 2005 onwards).

Artificial windbreaks such as polyethylene netting or webbing can be appropriate for protecting small areas of high value crops.

Cultivations

On sandy soils, cultivations which leave a rough or cloddy surface can be the most cost-effective methods of erosion control for sugar beet. A number of techniques are practised. Consider using:

Furrow Press – plough and furrow press the land using a 45° angle press to leave steep ridges. Drill at an angle to the ridges. To be effective the soil must contain sufficient clay for the ridges to be stable.

Loosened Stubble – remove compaction by underloosening and drill the crop directly into stubble. The system can be designed so that drill units directly follow the subsoiler tines.

Clod Forming – plough the land early in the year. Follow with a Cambridge roller when the soil is still wet to create a surface crust. Break the crust into clods with a slow moving tined harrow. Use press wheels or tines on the drill unit to break the clods around the seed. Remember – low ground pressure machinery is essential when working wet soil.

Nurse Crops

These may be used on very erodible peaty soils and sandy soils where higher value crops are grown. Barley is commonly used as a nurse to protect the row crop and may be broadcast or drilled.

Broadcast – spread barley seed in time for it to establish ahead of the row crop. This can give good overall protection.

Drilled – sow barley between each, or between some, of the proposed crop rows. Consider using machines which form beds and drill barley in one pass. Damaging blows can occasionally cause erosion along the rows.

Both techniques can give good protection but require careful management of the nurse crop. Ensure it is established in time to provide adequate protection and does not reduce yield by competition.

Sowing dates and seed rates of the nurse crop must be carefully selected. Appropriate rates of selective herbicides must be used to control growth and to remove the nurse crop.

Straw Planting

This technique has been used successfully on peaty soils and some light sands. Straw is planted between the crop rows just before or after drilling. The operation is slow and requires special machinery, but has advantages over nurse crops of:

- Giving immediate protection.
- No risk of competition.
- No requirement for extra herbicide applications so can be used with sensitive crops.
- Suitable for organic farming systems.

Synthetic Stabilisers

Proprietary soil stabilisers including PVA (polyvinylacetate) emulsions or PAM (polyacrylamides) can provide temporary protection when sprayed onto sands after drilling. They are not suitable for peats and are generally expensive but can be:

- Applied quickly and easily if a blow is forecast.
- Useful in protecting small areas of high value crops.

Mulches

Mulches applied to the surface after drilling can provide effective control for sugar beet seedbeds. They are not generally suitable for vegetables. Materials applied at 5-15 t/ha include:

- Farmyard manure.
- Sugar beet factory lime.

Thin even spreading is necessary to minimise risks of reduced crop emergence or poorer weed control. Take care not to apply excess nutrients, lime or contaminants by complying with the Defra 'Soil Code' and 'Water Code'. Certain industrial wastes may also be suitable but you must consult the Environment Agency and take expert advice before spreading.

Clay Addition/Marling

Increasing the clay content of surface soils is a long-term solution to wind erosion. Application rates of 400-1000 t/ha are likely to be needed to achieve a suitable increase in clay content. This may be practicable if marl or clay rich waste materials such as lake dredgings are available locally. Seek professional advice before using waste materials. You must consult the Environment Agency before dredgings or industrial wastes, including waste soil, are spread.

5. Preventing erosion by outdoor pigs

This chapter shows how sows and growing pigs can cause soil erosion when reared outdoors. It provides information on how to avoid soil erosion and damage to the land, and how to reduce pollution by preventing soil, dung, and urine being washed into watercourses.

To prevent soil erosion from outdoor pigs:

- Plan the overall system to avoid run off and erosion.
- Select appropriate sites.
- Plan paddock layout to suit site topography.
- Site water troughs and feeding areas away from ditches and water courses.
- Manage the paddocks to avoid poaching and minimise run off.
- Manage farm tracks to avoid polluting watercourses.

Topography, soil type and rainfall

Site selection has a major impact on the risk of soil erosion. The factors that need to be considered are topography, rainfall, and soil type. The ideal site for outdoor pigs consists of flat or gently sloping, freely draining land in low rainfall areas. Pigs can be kept on sites which are less than ideal but these will require particularly careful management. Not all sites within the UK are suitable for outdoor pigs and a combination of sloping land, heavy soils and high rainfall will lead to damage to the soil and run off.

To reduce soil damage and pollution risks:

- Select sites which have free draining soils.
- Avoid high rainfall areas, ideally pigs should be sited in areas were rainfall is less than 800mm.
- Always avoid steeply sloping fields.
- Avoid moderately sloping fields in medium to high rainfall areas.
- Where conditions are less than ideal provide green cover, rotate the stock or reduce stocking rate to protect the soil.

Paddock management

Ground cover, which would normally be grass, will improve the integrity of the soil surface and aid drainage through the soil profile, thus reducing soil erosion. Outdoor herds often utilise arable stubbles with little or no ground cover. In these circumstances great care is needed to minimise erosion, as there is no vegetation to hold together the soil surface and "catch" soil particles carried in run off.

To reduce soil damage and pollution risks:

- Use grass or encourage natural regeneration where this can be efficiently incorporated into the rotation.
- Allow as long a period as possible for ground cover establishment before pigs are moved on.
- Manage stocking rates to prolong grass survival.

Nose ringing is used by some farmers to minimise paddock damage and promote grass survival. Although nose ringing can protect ground cover and has environmental advantages, there are serious welfare concerns over this practice, and it should be avoided wherever possible. Where it is necessary to nose ring pigs, it should only be carried out by a suitably trained and competent operator. All equipment should be cleaned and disinfected between pigs.

Stocking and rotation

Stocking rate has a major influence on soil damage, run off and thus erosion. High stocking rates, for example 25 or more sows per hectare, can lead to poaching and may reduce the longevity of vegetation cover in the paddocks. Higher stocking rates are less of a problem on free draining soils.

To reduce soil damage and pollution risks:

- Select stocking rate appropriate to site conditions.
- Avoid stocking at more than 25 sows per hectare.
- Incorporate spare paddocks into the system to allow rest periods for paddocks on marginal sites.

- Where paddocks show signs of damage reduce stocking rates or remove animals to fresh paddocks to limit damage.
- Re-establish ground cover and good soil structure as soon as possible after pigs are moved off the land.

Conventional outdoor pigs are typically stocked on land which is dedicated to pigs for 1 to 2 years. Soil erosion can be reduced by using a 'wave motion' stocking policy where the outdoor pigs are more integrated into the farm rotation with paddocks being moved across the land every 3 to 4 months.

Weaner rearing areas

Where weaners are reared in outdoor kennels, high numbers of animals can be concentrated in relatively small areas. This can result in high volumes of farm traffic to move and feed stock and resultant soil damage.

- Locate weaner sites away from slopes and watercourses.
- Relocate the site if it becomes heavily damaged.

Feeding, watering and wallows

Within paddocks the most heavily used areas are the feeding and watering points.

- Spread feed over a wide area.
- Vary the area on which feed is distributed.
- Move any ad-lib feeders regularly to prevent soil damage.
- Avoid excessive overflow from water troughs.
- For sloping paddocks site water troughs and wallows at the top of the slope.

Trackways

Access tracks for feeding and movement of stock are vulnerable to soil damage and erosion.

To reduce soil damage and pollution risks:

- Site tracks to maximise the use of hard road ways where available.
- Plan layout of paddocks so access does not rely on a single trackway.
- Minimise traffic when soil is very wet or waterlogged.

- On sloping land try to make the trackway follow the contours.
- Avoid routes which slope steeply.
- Allow for wide trackways e.g. 10m to avoid repeatedly having to travel across the same ground when conditions are unsuitable.
- If trackways become badly damaged relocate where feasible.
- Divert run off from tracks into field margins or soak away areas where it can be intercepted and filtered.

Gateways

Gateways into individual paddocks are frequently crossed by farm traffic.

- Site gateways where the land is least vulnerable to damage.
- Position gateways at the top of a sloping paddock so any run off will be retained within the paddock.
- Move gateways if the land becomes badly damaged.

Buffer zones

As a last resort it can be beneficial to create buffer strips – vegetated areas of land of perhaps 5 to 50 metres wide – at the bottom of sloping fields containing pig paddocks. The stabilising effect of the root systems reduces erosion and the vegetation cover intercepts soil particles carried in any run off. The buffer zones should be managed separately from the rest of the field, normally by fencing to exclude livestock. They should be as wide as necessary to be effective.

6. Preventing soil erosion in the uplands

This chapter shows how the uplands are at risk from erosion and advises on land management practices that help to give protection.

Uplands and erosion

The uplands are an internationally important habitat for wildlife and are also used for agriculture, recreation and sport, and for water collection and mineral abstraction.

The uplands are very susceptible to erosion because of their climate, soils and landscape. Today, this risk of erosion is very high because of increasing use of the uplands.

A complete vegetation cover protects fragile upland soils from erosion by water and wind. Erosion begins when vegetation is removed for example by burning, overgrazing or traffic, and bare soil is exposed to rain and wind. Erosion is most severe on peat soils and steep slopes, where it may take years for the vegetation to recover.

Consequences of erosion

Upland erosion not only results in soil loss:

- Stock carrying capacity is reduced.
- Loss of vegetation increases grazing pressure on the remaining vegetation.
- Eroded landscapes are less attractive to visitors.
- Rare plants and animals that cannot survive in eroding landscapes may be replaced by more competitive species.
- Eroded soil may end up in reservoirs where it reduces water quality and storage volumes.
- Fish stocks may be threatened as sediment suffocates eggs laid in streambeds.
- The risk of flooding increases as rainfall is no longer retained by the soil and instead rushes into streams and rivers.

Traffic

All upland traffic, whether due to grazing animals, humans or vehicles, may damage vegetation and expose the soil to erosion.

To minimise the risks of erosion through traffic:

- Use management practices that minimise the need for vehicle use.
- When vehicles are necessary, use low ground pressure machinery.
- Restrict vehicle use to dry periods and to gentle slopes.
- Keep to established tracks and paths to avoid vegetation damage.
- Plan track construction and maintenance carefully, paying particular attention to position and drainage to minimise run off.
- Maintain gates and stiles and way-mark paths to restrict damage caused by walkers.

Grazing

Overgrazing by domestic or wild animals breaks up vegetation cover and once the soil is exposed, the grazing area is reduced and the soil can erode. Recent changes in government support in the uplands should encourage reductions in stock numbers. Erosion is common where stock gather in large numbers in a small area, such as for supplementary feeding.

- Shepherd animals to ensure the entire grazing area is used and to prevent localised overgrazing.
- Place feed racks 250 metres away from sensitive vegetation and preferably on level ground with a cover of coarse grass or dead bracken.
- Place feed supplement blocks 250 m away from feeding sites already used.

Additional measures must be undertaken on land designated as a Site of Special Scientific Interest or held within any agri-environmental scheme.

Burning

Heather, purple moor grass and mat grass are frequently burned to encourage new growth for grazing and grouse moors. Correct timing is essential to avoid damaging young vegetation and the risk of uncontrolled fires on older vegetation. Incorrect or ill-planned burning can cause long-term damage to the underlying soil and so result in extensive erosion.

Careful planning is the key to successful heather burning

- Burn in small areas for greatest benefit and safety.
- Avoid steep ground, wet blanket bog and deep peat where loss of vegetation can cause serious and rapid erosion.
- Most benefit is obtained by burning heather on freely-drained, gently sloping ground.

Further advice on burning is contained in the Defra Heather and Grass Burning Code.

Bracken control

To avoid erosion caused by removal of bracken, a bracken management plan can help to avoid bare areas and result in the establishment of a good cover of diverse vegetation.

- Avoid steep slopes.
- Avoid leaving bare areas.
- Look for evidence of grass or other vegetation under bracken.
- Do not remove bracken if other vegetation is unlikely to establish.

Moorland drainage/gripping

Grips are small ditches dug at regular intervals over moorland to improve heather growth. By allowing the faster and channeled loss of water, grips encourage peat erosion. As soil is washed away, grips can develop into large, unsightly and hazardous gullies.

Where erosion is occurring:

- Do not maintain existing grips and do not dig new ones.
- Block existing grips wherever possible.
- Remove a block of peat from near the grip and push it into the grip to form a dam, keeping the vegetation at the top.
- Use a 360 degree tracked excavator with wide ("Bogmaster") tracks.
- Straw or heather bales can also be used to form dams but are generally less effective and not readily colonised by surrounding vegetation.
- Dams should be built up to the level of the adjacent ground and be 2-3 times the width of the grip in length. The spacing between dams depends on the slope of the land.
- Large grips can be blocked with timber or plastic piles.
- Specialist advice should be obtained, before blocking grips, for example from ADAS, English Nature or FWAG.

Grants may be available for grip blocking. If you farm on an SSSI or have an agri-environment scheme agreement, seek advice from English Nature or Defra Rural Development Service before doing any grip blocking.

Appendix A

Off-site effects of erosion: aspects of legislation

Off-site damage following erosion may involve you in legal proceedings or enforcement action.

The Environment Agency can take legal action if pollution occurs (Water Resources Act 1991, Section 85). This could apply in situations where soil erosion causes water pollution. The Agency can also do work to prevent or clear up pollution and recover the cost from the person responsible (Water Resources Act 1991, Section 161).

Local authorities can serve a notice requiring works to prevent soil being deposited on the highway. Failure to comply can result in magistrates' courts imposing a maximum fine of level 3 on the standard scale – at the time of print £1000 (Highways Act 1980, Section 151). There is further offence if the contravention is continued after conviction with a maximum fine of £1 per day.

Local authorities are required to serve an abatement notice if soil erosion is causing a statutory nuisance. You may be able to claim a 'best practical means' defence if you have taken all reasonable steps and erosion still occurs (Environmental Protection Act 1990, Section 79).

You may also be sued for nuisance under civil law. This could result in an award of damages and an order to prevent the nuisance continuing.

This booklet provides general guidance on the legislation relating to off-site effects of soil erosion. Further details are given in the Defra Codes of Good Agricultural Practice. However, for definitive information, you are advised to consult the legislation itself or to seek independent advice.

Further reading

The following publications are available free of charge from Defra Publications, Admail 6000, London SW1A 2XX. Telephone: 08459 556000. Many are also available to download from the Defra website.

Defra *Code of Good Agricultural Practice for the Protection of Air* (2002, PB0618). Available to download from: **http://www.defra.gov.uk/environ/cogap/aircode.pdf**.

Defra *Code of Good Agricultural Practice for the Protection of Soil* (1998, PB0617). Available to download from: **http://www.defra.gov.uk/environ/cogap/soilcode.pdf**.

Defra *Code of Good Agricultural Practice for the Protection of Water* (2002, PB0587). Available to download from: **http://www.defra.gov.uk/environ/cogap/watercod.pdf**.

Defra *Code of Good Upland Management* (1992, PB0745).

Defra *Conservation Grants for Farmers* (2000, PB0983).

Defra *Controlling Soil Erosion: A Manual for the Assessment and Management of Agricultural Land at Risk of Water Erosion in Lowland England* (revised 2005, PB4093). Available to download from: **http://www.defra.gov.uk/environment/land/soil/publications.htm**.

Defra *Heather and Grass Burning Code* (1992, PB1029). Available to download from: **http://www.defra.gov.uk/corporate/rds/hgbc.pdf**.

Defra *Pig Welfare Advisory Group Booklet No 8: Outdoor Sows* (1997, PB3091).

Defra *Single Payment Scheme: Cross Compliance Guidance for Soil Management* (2005, PB10222B). Available to download from: **http://www.defra.gov.uk/farm/capreform/pubs/pdf/Soil-hb.pdf**.

Defra *Single Payment Scheme: Cross Compliance Handbook for England* (2005 edition, PB10222A). Available to download from: **http://www.defra.gov.uk/farm/capreform/pubs/pdf/Cross-compliance-3011.pdf**.

Defra *Site Suitability for Outdoor Pig Farming* (1999, PB4444).

Defra *Your Livestock and Your Landscape: A guide to the environmental conditions attached to livestock subsidy schemes* (1996, PB2188).

Appendix B

Also available:

Defra *Arable Area Payments Scheme literature*. Available free from Defra Rural Payments Agency.

Environment Agency *Best Farming Practices: Profiting from a good environment* (2003). Available from Environment Agency Head Office: 0870 8506 506. Also available to download from: **http://www.environment-agency.gov.uk/business/444304/444312/668607/669460/797683/?version=1&lang=_e**.

Forestry Commission *Forests and Water Guidelines* (2003). Available from: Forestry Group, Forestry Commission, 231 Corstorphine Road, Edinburgh, EH12 7AT. Telephone: 0131 334 0303. Also available to download from: **http://www.forestry.gov.uk/website/PDF.nsf/pdf/fcgl002.pdf/$FILE/fcgl002.pdf**.

NSRI *Guide to Better Soil Structure* (2001). Available from: NSRI, Cranfield University, Silsoe, Bedfordshire, MK445 4DT. Telephone: 01525 863242. Also available to download from: **http://www.silsoe.cranfield.ac.uk/nsri/pdfs/structure_brochure.pdf**.

RCEP *19th Report of the Royal Commission of the Royal Commission on Environmental Pollution: Sustainable Use of Soil* (CM 3165, 1996). Available from: The Stationery Office Ltd, PO Box 29, Norwich, NR3 1GN. Telephone: 0870 600 5522, priced £24.50.

Government response to the 19th Report of the Royal Commission on Environmental Pollution: Sustainable Use of Soil. Available from the Defra Soils Team: soils@defra.gsi.gov.uk.

Soil Association *Soil Management on Organic Farms* (2003). Available from: Soil Association, Bristol House, 40-56 Victoria Street, Bristol, BS1 6BY. Telephone: 0117 914 2446, priced £5.00.

SMI *Guide to Managing Crop Establishment* (2002). Available from: SMI, 1 The Paddocks, Powey Lane, Mollington, Chester, CH1 6LH. Telephone: 01572 717220. Also available to download from: **http://www.smi.org.uk/docs/news/1037639465SMIguide2001.pdf**.

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