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Introduction

Outdoor pig production comprises a significant proportion of the English industry. Owners and managers of outdoor herds face many challenges, not least the management of soils to ensure daily operations can be completed efficiently, good health and welfare of the pigs is delivered and that consequential environmental impacts from water and airborne soil erosion are minimised by good soil management.

Water pollution, especially elevated levels of silt and phosphorous in water bodies, are identified by the Environment Agency as a cause of water quality objective failures. Loss of soil transported by water or wind and deposited onto other land, roads or properties is not only a loss of asset from the field concerned but may cause problems where it is deposited. Pollution and damage caused by erosion can also be costly to rectify and there are risks of enforcement action being taken by regulatory authorities. Good soil management forms the basis of stopping this pollution.

In most situations, outdoor pig keeping forms part of an arable rotation, where root and vegetable or even turf crops, may also be included. Soil management for each site has to start with the preceding crops, in addition to preparing the soil for the following crops.

Over the years, pig keepers and their advisers have learnt to understand and manage the soils they work with. This publication seeks to consolidate knowledge for the benefit of all concerned, in order to help achieve better standards of performance.

A Soil Management Plan (SMP) continues to be a key part to planning how to manage production sites, it is envisaged that this guide will assist the process. The BPEX Soil Management Plan is available on the BPEX website: www.bpex.org.uk
Getting Started
Managing an outdoor pig operation successfully requires one overriding factor to be observed:

**CHOOSE THE RIGHT SITE FROM THE OUTSET**

Even those fully committed to diligent management can struggle to overcome the obstacles presented by an inherently unsuitable site. On occasion, several low-level risk factors can work together to make effective site management difficult.

When assessing new prospective stocking areas or even moving fields on the same holding, you need to be certain of the level of risk of the following **primary risk factors**.

Primary risk factors

**Soil type**
Know your topsoil, especially in terms of depth and what it lies over.

- Relatively impermeable clay/chalk subsoils have limited short-term drainage capability; calcareous clays are preferable to non-calcareous in terms of their self-structuring capability
- Beware of fields offered as “lightest on the farm”; they may react very differently, once stocked. In particular, treat fine silt loams with a degree of caution as they can cap easily
- In practice, coarse loamy sands and sandy loams should be your first choice. Where these are deep and over sand or gravels, effective water infiltration levels can be achieved. Site layout may need to exclude areas of localised variation (for example, a clay seam within a sandy loam).

**Topography**
Fields rarely have the same degree of slope across the entire area. You need to be comfortable that you can effectively manage the area of the field with the greatest degree of slope, otherwise leave that area of the field unstocked.

Ideally, fields should have an average slope below 3°. The severity of slopes is likely to determine the potential level of soil erosion and run-off that you may need to mitigate.

When examining potential land, take into account slope length. Long, gentle slopes can shed large volumes of surface water along wheelings. Plan your site layout to minimise the risk.

For every slope, think: **SOURCE ➤ PATHWAY ➤ RECEPTOR** and ensure that the ultimate potential receptor is not outside the field area.

Water and leachates can travel rapidly to ground water aquifers resulting in measurable contamination.
Location

It is essential that you clearly identify from the outset all potential issues relating to the location of fields. Generally, the importance of location rises in significance if slopes are present. Think: **SOURCE ➤ PATHWAY ➤ RECEPTOR.** Take into account the ultimate destination of water travelling across or through the site.

Avoid sites which could have a potential negative effect on:

- Sites with SSSI or Scheduled Monument designation (remember, this could be farmland)
- Groundwater Protection Zones (water and leachates can travel rapidly to groundwater aquifers resulting in measurable contamination)
- Private boreholes
- Nitrate Vulnerable Zones (NVZs)
- Catchment Sensitive Farming Priority Catchments
- Field drains
- Significant archaeological features within fields
- Surface waters, including ponds and ditches
- On-farm Agri-Environment Schemes
- Public dwellings.
Connectivity
Establish from the outset a “worst case scenario” for each individual field; this requires identification of the potential PATHWAY and the ULTIMATE RECEPTOR in the event of surface water and associated sediment leaving the field.

Make a contingency plan which can be quickly and easily implemented should the worst case scenario arise and which will minimise or prevent the potentially most damaging effects.

Farm tracks, public roads, ditches and wheelings in adjacent arable fields can all act as PATHWAYS. Identify exactly what could be at risk; can you reduce this risk through site management?

If the risk cannot be reduced through site management, the field may represent an unacceptable risk and should be avoided. Overall, and especially to cope with extreme weather events which are becoming more common, good soil drainage is key. Maintenance of the pathways to take water away from the field, having firstly filtered it through a correctly structured soil is essential. Land drains can benefit many soils but do require maintenance.

Previous management
If possible, you should monitor the effects of field operations carried out in prospective fields in the year leading up to site layout. Bear in mind that there could be longstanding unseen issues present, such as plough pans. There are various high-tech methods available but one easy cost-effective option is to dig some inspection pits with a spade which will reveal the structure of the soil.

• Plan and carry out any remedial measures required before stocking takes place
• You are looking for well-structured topsoil with little evidence of horizontal plates; horizontal plates are an indication that the land is compacted
• The interface between the topsoil and subsoil should not show evidence of a historic cultivation pan
• Light soils often show a compacted layer at 10–15cm, especially where shallow cultivations have taken place. Subsoiling should be carried out at the effective working depth, which is just below the compacted layer, any deeper is less effective, inefficient and expensive
• Subsoiling needs to be carried out at appropriate soil moisture levels which allow the soil structure at the problem depth to crack, fissure and break apart, as opposed to being compressed; soils need to be dry enough for this to occur
• Regular de-stoning can inhibit the natural drainage capabilities of the soil, exacerbating run-off risks
• Regular de-stoning and extensive cultivations reduce soil organic matter (OM) levels. In turn, low OM results in poor soil resilience and high susceptibility to compaction, sealing and damage
• Harvesting crops in wet conditions can cause the formation of run-off pathways along wheelings; these localised areas of compaction should be identified and removed before site layout.

Never treat run-off as an acceptable risk, but do differentiate between risk levels of ultimate receptors.

Manage compaction before the site is laid out. Remember what you set up on is what you’re stuck with for the duration.
Understanding soil loosening

Soil loosening is often needed to undo the effects of compaction, restoring the soil to good condition where air and water can permeate and crop roots develop healthily. Loosening is normally achieved by cultivations which disturb the soil. Deeper compaction, below the depth of normal tines or disced implements, means there is a need to work deeper, typically using a subsoiler.

The aim is to break compacted soil layers into smaller elements such as aggregated blocks. This is achieved by applying shear forces to the solid soil layer causing fracture. For this to occur, the soil must be in a friable condition.

These operations, if carried out incorrectly or if the soil is too moist, may result in further damage to the soil rather than improvement. It is, therefore, important to understand some important principles of soil loosening practice.
Soil moisture content
If soil is too moist and in a plastic condition then it will deform (mould) and remain compacted. In fact, it could be made denser (compacted), making the problem worse.

Before starting to loosen the soil using a subsoiler or other tine-type cultivator, check that the soil is below its plastic limit (to the full depth you intend working). Land which has not supported a growing crop will not have benefited from water being abstracted by plant roots. Therefore, while the surface may appear dry, lower depths may still be wet.

If soil conditions do not allow working to the full depth required to remove the compaction, it may still be possible to loosen upper layers of the soil, which will assist it drying out prior to returning later to repeat the work to a greater depth.

Plastic Limit
Plastic Limit (PL) is defined as the moisture content at which soil begins to behave as a plastic material. To test if the soil is friable or plastic:
- Take a small handful of soil from the desired working depth
- Use your hands to make it into a ball, taking care not to dry it out
- Try to roll it into a long thread 3mm in diameter
- If it crumbles and breaks then it is friable
- If the thread holds, it is in a plastic state and too wet for subsoiling.

Critical depth
Soil loosening relies on sheer force applied by the implement tine to break the compacted soil. For this to occur, the mass of soil above the depth of working has to be moved. The foot or shoe of the tine is designed to lift the soil upwards to create the shattering forces. For shattering to occur, the mass of soil and the forces holding it together have to be overcome by the tine shoe or foot and wings where fitted.

The depth at which the transition from loosening to deformation mode occurs is known as the critical depth. Thus, the subsoiler or tined implement has to work above the critical depth to be effective.

The use of a wing on the foot increases the lift for little extra draft (pulling force), which is required to improve the effectiveness of the operation.

Types of subsoiler
There are different combinations of subsoiler tine and foot which influence the condition the soil surface is left in. Some create heave, leaving a rough and open surface while others, typically used on grassland, leave the surface relatively flat and even. For land in pig occupancy the latter is often more appropriate, whereas for restoration after the period of occupancy the first type may be preferred.
Site management

Green cover
There can be little doubt that stocking pigs on an established grass sward has benefits in terms of overall site management. Generally, retention of some short rotation grass leys usually takes place only when there are other livestock groups on site. A typical situation might be:

**Year one:** Spring barley undersown with ryegrass
**Year two:** Silage taken from ryegrass
**Year three:** Pigs stocked onto well-established sward

This system works well and ensures there is a high degree of grass cover on the periphery of the site. In effect, all headlands are buffered and non-stocked areas retain cover to assist in the sequestration of nutrients. However, this option is not available within many rotations, with pigs moving onto ‘bare’ land within weeks of crop harvest taking place in many instances.

Experience has proven that any type of green cover can be beneficial; the flush of annual arable plants often seen within rested outdoor pig paddocks can play a part in taking up nutrients.

From May 2015, the Basic Payment Scheme rules state that, when payments are claimed, land recorded as being “Fallow” cannot be grazed by livestock. Pigs may occupy “Temporary Leys” for which there is a list of grass and herbaceous forage which can be established. You must check the rules in force at the time of decision-making.

Site managers have learned to exploit this in two ways, cultivating farrowing grids between batches and adopting the ‘flip-flap’ layout of individual radial segments, where pigs are rotated between two sub-paddocks allowing green cover to re-establish between rotations.

The frequency and shape of naturally occurring stone within a field can also be a factor in retaining green cover. Pigs are able to move large quantities of topsoil where the stone is round and comfortable for them. This is often the reverse where stone is large and angular; overall soil movement is reduced and hence a greater degree of green cover retained.
Feeding
Thoughtful feeding operations can have spin-off benefits affecting overall site management. The adoption of feeding troughs associated with standard paddock layout has delivered advantages in key areas:

- Feeder wagons follow a set route reducing the risk of damage to peripheral buffers (particularly important where buffers are managed under an Agri-Environment scheme)
- Pigs will not dung and eat in the same area. Feeding via a trough increases the area available for defecation, potentially reducing nutrient ‘hotspots’ previously associated with fence lines. This is an important factor in the management of the subsequent crop
- Trough feeding concentrates feeding activity in one area, reducing the level of localised daily compaction. In turn, a reduction in local compaction discourages formation of surface water, limiting the appeal of the site to gulls.

Troughs are not a ‘fit and forget’ fix for every site. They need siting carefully and require routine maintenance to ensure pigs do not undermine them on light land. Drain plugs need checking regularly to prevent excessive water build-up.

Layout
Site layout must observe any primary risk factors and adopt a robust management regime to effectively deal with any SOURCE ▶ PATHWAY ▶ RECEPTOR risks identified during an initial site assessment.

The opportunity for surface water to collect should be minimised by adopting a range of specific site management criteria:

- Trackways should not travel the length of long slopes
- Localised areas containing steep slopes should not be stocked
- Ensure run-off cannot leave the site via access points to/from public roads
- Sensitive adjacent habitats should be well buffered from site operations, as should all watercourses
- Fence lines may need to reflect localised variation in soil type
- Fence off any individual features such as in-field trees (these may be a chosen option within the farm’s Agri-Environment agreement) and significant archaeological features such as burial mounds
- Areas that may be subjected to higher degrees of traffic, such as farrowing grids, should be sited to avoid build-up of surface water, using slope to an advantage if it is present
- Heaps made from old hut bedding should be treated as muck heaps and sited sympathetically to minimise the risk of contaminating surface or groundwaters
- Ensure leachate from muck heaps cannot travel along wheelings to other sections of the field. Do not site heaps in areas of high traffic use.

Correct alignment of trackways should be central to a well considered site layout.
Many run-off incidents stem from careless use of vehicles.
Compaction from farm traffic is a far higher risk than compaction caused by stock.
**Stocking rate**

- Adjustment of stocking levels to suit localised risks can be an effective tool where alternative land availability is limited.
- As a rule and where possible, localised high-risk areas should not be stocked.
- In some cases, the risk of sloping bare ground being eroded by rainfall cannot be overcome by adjustment to stocking rates.
- Depending on the potential for green cover to re-establish, frequency of stocking may reduce risks more effectively than adjusting rates.

**Buffering**

Site buffering takes two main forms:

1. **Medium-term buffers** maintained as part of an Agri-Environment Scheme; these must not be trafficked by site operations.
2. **Mitigation buffering**, put in place for the duration of the stocking period.

If the stocking period is of two years or more, effective grass buffers should be established where run-off risks are present. These need to be 6m plus in width and sown with a tussock grass mix (e.g., Cocksfoot and Timothy) to be effective against surface water. Site traffic should not use them and they should not be used for storage of equipment.

In reality, local topography, soil type, site layout and potential connectivity to sensitive adjacent habitats could combine to render 6m of grass ineffective against significant run-off incidents. Such situations may better utilise a corrugated buffer, created by means of ploughing or pulling a bed-ridger through the area potentially at risk from inundation by surface water. Invariably, this area will be at the base of a slope and needs to be wide enough (often 12m plus) to arrest sediment in its troughs.

Be aware, if large volumes of water are trapped behind a furrow or bund, consider the possible consequences should this burst out.

Periodically, the area may need to be reworked in suitable dry soil conditions.
Ecopig project
The Ecopig 2 project was initiated in order to improve the long-term sustainability of pig production in the eastern region and aimed to optimise nutrient resource management, biodiversity and landscape conservation through a combination of farmer collaboration and management practices. The aim was also to deliver economic sustainability and business security through improved competitiveness, by reducing inefficiencies and maximising productivity. The project was managed by BQP.

Observation
Soil compaction can reduce soil aeration and infiltration and can lead to increased waterlogging, ponding and run-off.

Solutions
• Reduce soil compaction by using wide low ground pressure tyres
• Maintain as much green cover as possible, both within the paddocks and on trackways
• Using ‘flip-flap’ paddocks can help to maintain green cover
• Try not to use the same route for every task
• Use reverse-tread front tractor tyres on trough filler trailers to improve grip
• Avoid using turf tyres, which create a smooth surface for run-off and are ineffective in ice or snow.

Observation
Indiscriminate feeding via the use of a nut-chucker can lead to several problems:
• Food can end up in wet areas and puddles
• Large numbers of gulls and corvids are attracted to the feed, which can lead to:
  – The spread of diseases from the birds
  – The birds spreading diseases between paddocks
  – The gulls and corvids predating nearby ground-nesting birds
  – Food wastage.

Solutions
Targeted feeding via the use of long troughs (‘nut-chuckers’ can be modified to deliver food to the troughs).

Positive findings
• Larger farrowing huts improve performance
• High prolificacy genetics improve carbon footprints
• Vents on dry sow huts may reduce straw usage
• Using muck as a soil conditioner and source of nutrients can help save money by reducing the costs of buying inorganic fertilisers. Testing the soil levels of nutrients regularly can help to identify the best places for spreading manure.
Case study: David Robinson, Suffolk

David has been a pioneer in trialling new techniques to improve the sustainability of pig farming and it was one of his units that was used by BQP in the Ecopig trial. He has continued to innovate since the end of the trial and has recently been improving feeding techniques.

He has been working on two particular issues:
- Ground mounted troughs on wet sites are prone to retaining water
- 3mm pellets tend to stick to pigs’ feet, which leads to an increase in soil ingestion.

Solutions

Troughs have been fitted with 4” x 4” timbers 4 feet apart to their bases. This has the following benefits:
- Troughs are more stable on the ground
- Water ingress is prevented
- Pigs find these troughs more difficult to move
- The troughs are easier to stack and are less prone to damage while being stacked (forklift tines are set 5 feet apart)
- The stacks of troughs are easier to move.

Although 3mm pellets are the most efficient in terms of production (they offer the greatest carbon saving option), they are problematic to use as they stick to pigs’ feet. The food stuck to the pigs’ feet becomes mixed with the soil and the pigs are then attracted to the scent of food in the soil and ingest it.

David now feeds with 6mm pellets for most of the year which reduces the amount of food sticking to pigs’ feet and, hence, soil ingestion; he still has the option to use rolls if conditions are particularly wet.
Dealing with the potential impacts of climate change

The government’s latest Climate Change Risk Assessment (CCRA) identifies flood risk as likely to become an increasing problem and especially flooding from heavy downpours. It also predicts that summers will become warmer and drier. Both of these scenarios have implications for the management of the soil in outdoor pig paddocks.

Sustained heavy rainfall brings its own particular issues. Heavy rain falling onto baked dry soil can result in particularly severe run-off as water penetration of hard surface layers of soil will be minimal.

To minimise run-off in both of these situations the pig farmer needs to be particularly mindful of the following:

• The need to locate paddocks only where the soil type is optimal (coarse loamy sands and sandy loams over sands or gravels)

• Avoid steeply sloping sites; sites with a slope of 3° or less are preferable

• Perfectly level sites may also produce problems as water tends not to be shed in this type of situation. This has animal health implications for the location of farrowing grids, which tend to be sited on level ground

• Maintain as much green cover as possible, eg by establishing green cover prior to moving pigs onto the paddock and using flip-flap paddocks once the pigs are on site

• Maintain good soil structure at all times, eg by creating a corrugated buffer by ploughing or pulling a bed-ridger through any areas potentially at risk, these will usually be at the base of slopes and need to be wide enough (often 12m+) to arrest sediment

• Carefully manage vehicle movements on site to prevent the formation of compacted wheelings, which can act as channels for water

• Use buffer strips next to water courses or sensitive habitats.

There is also the possibility that crop rotations and the types of crop may change, which could result in changes to the times of year when paddocks become available.

Higher temperatures in the summer months may also have implications for animal welfare; hut design may need to change to provide more ventilation and, as a result, site layout may also need to change to accommodate them.
Regulations

Nitrate vulnerable zones and cross compliance

Whether you are an owner/occupier or a tenant with an outdoor pig unit, establish from the outset whether the farm/outdoor pig land is:

- In a Nitrate Vulnerable Zone (NVZ)
- In receipt of the current Single Farm Payment (SFP) or, from 2015, the Basic Payment Scheme (BPS)
- An Environmental Stewardship (ES) scheme and, if so, what options are on or near the land used for outdoor pigs.

Make sure you are fully aware of your obligations under Cross Compliance and/or under the NVZ rules. From the Rural Payment Agency’s viewpoint, the SFP/BPS/ES recipient is responsible for ensuring the requirements of Cross Compliance are met for the full calendar year on the land for which they are claiming payment, even if they are not in occupation of the land for the entire year. The responsibility for ensuring compliance with the rules relating to the identification and traceability of pigs lies with the keeper, ie the person with day-to-day responsibility for the animals. This applies regardless of who owns the animals and whose land they are on.

Responsibility for the welfare of all farmed animals lies with both the keeper (as defined above) and the owner of the animals. The SPS/BPS/ES recipient must show compliance with the NVZ rules (if relevant) on the claimed land. However, ‘the occupier of the holding’ is taken by the Environment Agency to be the party ultimately responsible for complying with the NVZ rules; in the case of a tenancy, this is likely to be the tenant. Because of the potential pitfalls surrounding the roles of the different parties, it is strongly recommended that a formal written agreement is put in place between landlord and tenant to make clear the responsibilities of each in relation to the NVZ and Cross Compliance rules. If necessary, take advice from the Environment Agency and/or the RPA.

Factsheets and guidance are updated regularly, for the latest versions visit the BPEX website: [www.bpex.org.uk](http://www.bpex.org.uk) and the Environment Agency website: [https://www.gov.uk/government/organisations/environment-agency](https://www.gov.uk/government/organisations/environment-agency)

Ideally, both landlord and tenant should maintain and keep (for at least five years) identical sets of all the relevant records, minimising the risk of breaching any of the rules.

Both Cross Compliance and the NVZ rules may change over time, so ensure that you keep up to date with any changes and have access to the appropriate guidance information. The current NVZ rules and processes are set out in the ‘Guidance on complying with the rules for Nitrate Vulnerable Zones in England for 2013-16.’ Copies can be obtained online at: [www.gov.uk/nitrate-vulnerable-zones](http://www.gov.uk/nitrate-vulnerable-zones).
Further information
www.bpex.org.uk

What’s in my back yard for farmers (Environment Agency): http://bit.ly/1w06IDb

Other publications covering agricultural soil management which contain useful information include:

• Think Soils, examining soil structure. A practical guide to digging a hole. Environment Agency, 2010
• Think Soils, soil assessment to avoid erosion and runoff. Environment Agency, 2008
• Simply sustainable soils, six simple steps for you to improve the performance, health and long-term sustainability of your soil. Linking Environment and Farming (LEAF).
• Key Actions for farmers relating to water Management. Environment Agency: http://www.cfeonline.org.uk/key-actions-core-doc-final-041013/
Soil: Your forgotten resource

Farm facts
Name: Terry Ledbury, Fawley Farms Ltd
Location: Whitchurch, Hampshire
Farm size and enterprise: Outdoor breeding herd, 1,200 sows and 20 boars

Background
The BPEX Soil Management Plan (SMP) helps outdoor pig keepers assess the risk of soil erosion and damage to the land and identify suitable measures to prevent and record this. The SMP is not a substitute for the Soil Protection Review or ELS Plan where these are needed.
The SMP is a working document compiled, often in collaboration with landlords or other users of the land, before moving onto a new site, during occupancy and finally on vacation. It demonstrates diligence and professionalism to landlords, regulators and inspectors.

The system
Using the key information below, an erosion risk assessment map is drawn which assists in identifying potential problem areas and areas most suited to different aspects of pig keeping. If high risk areas are identified, then mitigation measures can be put into place to help prevent soil erosion or run-off.

Key information required
- Soils – texture and structure
- Slopes – gradient and length
- Annual rainfall
- Proximity to watercourses
- Location of field tracks
- Proximity to roads and residential buildings
- Previous land use and field cover
- Previous experience of that land or similar land

Benefit
Mitigation measures can prevent soil erosion and damage to top soil texture and structure. Soil compaction or erosion can destroy the structure making for expensive remedial action.

Key to success
Terry chose the ideal time to carry out a SMP as the pigs were not yet on the land and pre-stocking field design and layout could be altered according to potential risks. However, all outdoor units could benefit from carrying out a SMP, no matter what stage of the process they are in.

For more information contact Anna Davis, Environment Projects Manager: 0247 647 8798 or email: anna.davis@bpex.ahdb.org.uk
To download your own SMP visit: www.bpex.org/KTRandD/environmentHub/SoilManagementPlan.aspx

Anna Davis, BPEX Environment Projects Manager, helping Terry Ledbury assess soil type and identify risks before compiling a soil management plan.