Environmental Management for Healthy Pig Production

BPEX British Pig Executive

MLC

defra Department for Environment Food and Rural Affairs

CONTENTS

FOREWORD

Ensuring optimisation of the environment in which pigs are reared and finished is important for maximising productivity and animal health and welfare. It also has beneficial environmental implications. This publication describes the elements that must be considered in providing a desirable environment for successful pig production.

This booklet also updates the Meat and Livestock Commission (MLC) publication "Management of the environment to promote pig health and welfare" and summarises current knowledge, particularly on air quality, based on research and development work funded by the MLC, the Department for Environment, Food and Rural Affairs (Defra), the Biotechnology and Biological Sciences Research Council (BBSRC) and the European Union (EU).

A study carried out at the MLC's Stotfold Pig Development Unit has been the first to measure the effects of dust and ammonia on the health and performance of weaner pigs. The results are of particular relevance and are included. A key finding was that dust concentrations at or over 5.1 mg/m^3 reduced growth rates and exposure to this level of dust should be avoided if the performance of weaned pigs is not to be compromised. Funding and research partners in this project were Defra, British Pig Executive (BPEX), MLC, Acorn House Veterinary Surgery and the National Pig Association (NPA).

INTRODUCTION

Pigs are unique amongst farm animals because of their environmental needs. They lack an external insulating coat and modern genotypes bear little insulating fat; that's why pigs are commonly group housed within a compact air space. They are sensitive to draughts and have limited powers of thermoregulation, so their environment must be managed for them to remain within their comfort zone and keep healthy and productive.

In particular, newborn and early weaned pigs are environmentally sensitive. Since growth and feed utilisation in the early stages has a big influence on production efficiency, ensuring that pigs have the very best environment in their early days is crucial. It provides a unique opportunity to establish the pigs and set them up for efficient production.

In addition to thermal control, environmental management also involves maintaining good air quality. This not only improves pig health, performance and welfare but also reduces emissions of greenhouse gases, odours and dust to the environment beyond the farm. Keeping many pigs in a single airspace inevitably creates a lot of microbes, dust and noxious gases, all of which must be removed by the ventilation system. Their elimination will also benefit those who work in pig buildings. The problem is that if the ventilation system removes all of these, it will also remove the heat produced by the pigs, which is needed to keep them warm in cold weather.

However, it is possible to achieve a satisfactory compromise that will mean the pigs will live and grow in a healthy environment, minimising respiratory problems and other diseases. Attention to the action checklist (see opposite) will help create and maintain a good environment for pigs housed within a wide range of ambient temperatures.

ACTION CHECKLIST

- Ensure all new and existing buildings are adequately insulated.
- Calculate the ventilation requirements correctly in conjunction with your equipment supplier or pig consultant.
- If possible design the ventilation system when the building is originally designed.
- Keep air speeds low at pig level other than in warm weather.
- Aim to reduce draughts under slatted flooring.
- Minimise ammonia levels by providing appropriate ventilation and eliminating dirty or wet floors.
- Design pig buildings so that the ventilation system, pen layout and the siting of feeders and drinkers encourage the pigs to keep lying areas clean.
- Site naturally ventilated buildings at least 6 metres apart and ensure they have correctly designed ridge outlets.
- Site dunging areas under the air inlets in naturally ventilated buildings and lying areas under baffled inlets in "low pressure" fan ventilated buildings.
- Use simple measures, such as covering feed hoppers and cleaning regularly, to minimise the build up of dust and other pollutants.
- Ensure that dietary protein meets the pigs' needs so that ammonia emission from the excretion of excess protein is avoided.
- Adopt modern manure management practices.
- Ensure all alarms and fail-safe devices comply with " The Welfare of Farmed Animals (England) regulations 2000 ".
- Maintain all buildings and equipment as directed by the manufacturer.
- Plan all new buildings for all-in, all-out occupation even if this will be the only building on the unit to use the system. The rest can follow in due course.
- Plan to "side-stream" weaker pigs into alternative housing, bearing in mind that they should not be returned to the mainstream production.

INSULATION

The pig needs insulation in most situations to cope with the extremes of the British climate. Often the shell of the pig building is insulated, sometimes straw or other bedding is used to prevent heat loss at floor level and bedding is often used inside kennels within a vast un-insulated building.

The insulation in the shell of a building has a very important function both in the winter and summer. In winter it retains heat from the pigs, helping maintain the right temperature. In summer it prevents heat outside the building, particularly radiant heat from the sun, causing excessive heat build-up within the building.

The level of insulation required depends on several factors such as the surface area of the building and the temperature required inside the building in comparison with the outside. If the building has a large shell more insulation is generally required since there is much surface heat transfer. As an example of this, a building for newly weaned 6kg pigs which requires an internal temperature of 28 to 30°C would require a high level of insulation to cope with external temperatures as low as -5°C. Poor insulation leads to difficulty in maintaining the temperature inside a pig building in cold weather. In poorly insulated buildings there is a tendency to reduce the throughput of air but this can impair air quality.

VENTILATION

Ventilation is essential to prevent a build-up of microbes, dust and exhaled air in any building. It is also required to remove excess heat produced by the pigs in warm weather in order to prevent overheating.

Minimum ventilation in cold weather

The amount of fresh air needed to provide a satisfactory environment within a particular pig building can be calculated by working out how much carbon dioxide (CO_2) is building-up in the room. More CO_2 is produced as pigs grow and eat more food. Given these facts it is possible to predict the amount of fresh air needed to maintain a satisfactory CO_2 level within a particular building. Provided the air in the building is changed without leaving any pockets of stale, still air, and the pigs are not in a draught, an atmosphere containing between 0.25 and 0.3% CO_2 should minimise the problems

arising from microbes, dust and foul air while maintaining a satisfactory temperature. These figures need to be calculated by your building supplier or pig consultant to ensure the building is able to maintain a suitable temperature as well as an acceptable CO_2 level.

Maximum ventilation in hot weather

In hot weather, ventilation is used to remove heat produced by the pigs as well as to maintain an acceptable level of microbes and dust in the inspired air. Under these circumstances more air is put through the building to keep the pigs cool. During heat waves, outside temperatures are higher than the recommended room temperature and there is also a temperature lift from the pigs as they try to get rid of surplus heat. It becomes impossible, in these conditions, to achieve target ambient temperatures without the facility of air conditioning.

Most ventilation systems are designed to keep the inside temperature down to either 3 or 4°C above the outside temperature. In times of very high summer temperatures, when the inside temperature is higher than the pigs' requirement, other cooling measures are needed such as sprays or showers in the dunging areas, or very carefully designed systems which blow air over the pigs to prevent heat stress.

Pigs tend to lie where they are comfortable and dung somewhere else. In pens where the pigs have solid floors and no showers, they overcome any heat problems by creating a "wallow" with dung and urine. Clearly this is undesirable, as it provides a way for diseases such as Salmonella to spread from pig to pig. It also encourages the release of ammonia into the atmosphere of the house from the decomposing and drying "slurry". Dirty pigs can also be prone to Skatole taint which impacts on meat eating quality and consumer acceptability.

TEMPERATURE

Like humans pigs do not have the benefit of fur or feather and so they are very temperature sensitive. The exact temperature each pig requires is governed by several factors including the size of the pig, quantity and quality of feed consumed, draughts, whether it is on its own or in a group and whether on a slatted, solid insulated or straw-bedded floor (see Table 1).

Table 1 A guide to minimum temperature selection

Floor type:	Straw Bedded °C	Solid Insulated Concrete °C	Fully Slatted °C
Piglets pre-weaning			
Age			
Day 1	30	31	32
Day 3	28	29	30
Day 5	24	26	27
Day 17	22	24	25
Pigs post-weaning			
Weight			
6 kg (day of weaning)	27	28	30
6 kg (eating solids)	26	27	29
8 kg	24	26	28
10 kg	21	23	25
15 kg	19	20	23
20 kg	15	17	21
30 kg	13	15	19
45 kg	10	12	17
60 kg	9	11	16
90 kg	8	10	15
Dry sows (in groups)			
Service Area (unrestricted feed)	10	12	15
Gestation	15	17	20
Farrowing sows			
Day 1 to 3 post-farrowing	18	20	23
Day 4 to weaning	16	18	20

NB: All the above temperatures are provided as a guide only. They assume that the pigs perform as expected on an *ad-lib* feeding regime and are housed without draughts on dry floors. Pigs fed on a restricted regimen or poor quality rations are likely to require higher temperatures whilst draughts can increase the required temperature by up to 4°C.

High temperatures impair feed intake. Hence the objective is to operate at the lowest temperature at which pigs feel comfortable and do not need to huddle to keep warm. Such a regime is likely to promote good pig health, high feed intake and efficient production. Ultimately, the behaviour of the pigs is the best guide to the suitability of the temperature regime.

Taking all of these factors into account it is possible to predict a band of temperature, known as the thermoneutral zone, for every weight of pig. Pigs feel comfortable within their thermoneutral zone and do not waste energy trying to either keep warm or cool off. Good pig keepers will recognise huddling behaviour as a sign that pigs feel cold, whereas dirty pigs lying outstretched indicate that the pigs feel uncomfortably hot.

Provided that draughts are not a problem, most pigs housed in a well-insulated room or kennel are able to generate enough heat to keep warm in the coldest British temperatures and still maintain satisfactory air quality in the room. Exceptions are the suckling piglet, the newly weaned pig and, in some situations, the 20 kg pig entering second-stage accommodation. These pigs are often provided with artificial heating which is essential if they are not to be chilled. The same controller that regulates the main ventilation system should be used to control automatically any artificial heat source, as this will avoid wasting heat by inadvertently drawing it out of the building or by overheating the pigs.

In the outdoor situation it is not possible to provide supplementary heat, but piglets will survive on "borrowed" heat from their mother. They also tend to move about more and will benefit from a carefully controlled level of bedding. Insulated farrowing huts are proving to be much better at retaining heat in the winter and keeping the huts cool in summer; a practical benefit of this is that sows are more likely to remain in an insulated farrowing hut in adverse conditions rather than abandoning their litter in their search for shade or shelter. Under most circumstances, weaned pigs in unheated outdoor kennels are kept warm by the liberal use of straw. However, it is still important to ensure a minimum level of ventilation within the kennel to minimise the likelihood of respiratory problems.

HUMIDITY

Humidity is not normally a problem in pig buildings. However, low humidity levels can occur particularly in heated weaner housing at low ventilation rates, which can have a negative effect on the pig's respiratory tract. High humidity levels can occur when large areas of liquid are allowed to evaporate, eg from spillages, or when the ventilation is not working properly. Re-stocking buildings before they have had time to dry out after cleaning should be avoided.

Some of the new ventilation control systems measure humidity and increase ventilation if humidity is above a pre-set level. Heaters are needed to prevent the temperature in the room falling, but this system provides good control over air quality.

AERIAL POLLUTANTS

Once pigs are housed at a high stocking density in a building with a low ventilation rate, it is inevitable that aerial pollutants build up to high concentrations. The pollutants come from the pigs, their dung, feed, bedding and incoming air near manure stores or from other livestock buildings. Dust and ammonia are the major pollutants. The types and concentrations of the main pollutants depend on the building's design and environmental management, which is governed by season and weather. Various surveys of the aerial environment have been undertaken over the past decade and the results of the largest are shown in Table 2. Common monitoring procedures were employed, and pollutant concentrations and emission rates were measured over 24 hours. The buildings selected for the survey were typical, representing neither best nor worst practice.

Table 2 Mean concentrations and emissions of aerial pollutants in pig housing in England

	Mean concentration			Mean emission rate		
	Inhalable dust mg/m^3	Respirable dust mg/m^3	Ammonia ppm	Inhalable dust emission mg/hr/pig	Respirable dust emission mg/hr/pig	Ammonia emission mg/hr/pig
Sows on bedding	0.63	0.16	5.1	57	23.1	303
Sows on slats	0.86	0.09	11.0	59	5.7	503
Weaners on slats	5.05	0.43	7.8	17	1.5	26.0
Finishers on bedding	1.38	0.15	4.3	57	6.5	108
Finishers on slats	2.67	0.29	12.1	55	8.4	185

Each of 8 buildings in each type was surveyed over 24 h, once in winter and once in summer.

Figure 1 Measurements of aerial pollutants in pig housing

Apart from dust and ammonia, there are many other pollutants in the air of a piggery, including the following:

Micro-organisms

Bacteria Most are non-pathogenic at high concentrations of up to 106 colony forming units per m^3. Pathogens can be found but at low numbers, eg *Pasteurellamultocida, E. coli,* and *Bordetella bronchiseptica*.

Viruses Normally only present in specific disease outbreaks and at low concentrations. Pathogens isolated from the air include Porcine Respiratory and Reproductive Syndrome virus, Foot and Mouth Disease virus and African Swine Fever virus.

Fungi Contaminated feed and bedding are the main sources of airborne fungi. Concentrations are lower than airborne bacteria.

Odours

Over 100 odourants have been found in the air of pig housing. The common chemical compounds are fatty acids, phenols and indoles, and methylamines. These occur at very low concentrations relative to ammonia but are responsible for the characteristic smell of a piggery. Some of these odourants can be absorbed on dust particles, so reducing the dust burden will also help to reduce malodours.

WHY DOES THE AERIAL ENVIRONMENT MATTER?

Respiratory disease

Farmers and veterinarians have long believed that long-term exposure of pigs to aerial pollutants such as dust, hydrogen sulphide and ammonia increases the incidence and severity of respiratory disease. This belief is backed up by some, but not all, research and then only for certain diseases. Recent research carried out at Stotfold Pig Development Unit under commercial conditions suggests that weaned pigs may be able to tolerate poor air quality provided that all other aspects of husbandry are sound. This includes an all-in all-out policy, minimal movement and mixing of pigs, thorough cleaning, disinfection and drying between batches, and high standards of nutrition and stockmanship.

Figure 2 ***Many respiratory diseases in pigs can be controlled by vaccination and eradication of the pathogens, eg enzootic pneumonia and PRRS. However, there is evidence that certain diseases, such as atrophic rhinitis, are exacerbated by poor air quality.***

Lungs: normal, healthy.

Lungs: PRRS.

Lungs: pleurisy.

The small pig is suffering from PMWS and pneumonia, in comparison to a healthy contemporary.

Pig exhibiting signs of clinical atrophic rhinitis.

Main respiratory diseases of pigs:

- PRRS Porcine Reproductive and Respiratory Syndrome; Blue ear
- EP Enzootic pneumonia - Mycoplasma hyopneumoniae
- APP Actinobacillus pleuropneumoniae
- Flu Swine influenza
- PMWS Post-weaning Multisystemic Wasting Syndrome
- Atrophic rhinitis

On the basis of clinical experience, the costs of respiratory disease are estimated to be substantial (see Table 3).

Table 3 Costs of respiratory disease in a 100 sow herd taking 2000 pigs to 90kg (Muirhead and Alexander, 1997)

	Decrease in food conversion efficiency	Increase in period, days	Net cost, £000 per annum
Atrophic rhinitis	0.1 – 0.2	4 – 15	15
Pneumonia complex	0.5 – 0.1	3 – 21	10 – 16

Performance

Aerial pollutants can affect performance by their interaction with respiratory disease, and they may also affect performance directly. Recent research at Stotfold PDU has examined this in weaned pigs (9-25 kg). Surprisingly there was no effect of ammonia at concentrations up to 37 ppm on growth rate and feed intake. Weaners with inhalable dust concentrations of 2.7 mg/m^3 and lower had 20 to 30 g per day faster growth rates, equivalent to a saving of at least 1 to 2 p per kg deadweight. It is not yet known whether growers and finishers would benefit in the same way.

What the pig prefers

When given a choice, the pig prefers fresh air to an atmosphere contaminated with ammonia. When faced with a choice between thermal comfort and access to fresh air, the pig increasingly chooses warmth as the ambient temperature drops below its lower critical temperature. This demonstrates the pig's desire for both a satisfactory thermal and satisfactory aerial environment and provision of this will help to optimise animal performance, health and welfare.

Pig keeper health

Chronic exposure to aerial pollutants over a number of years can cause occupational respiratory disease in those who look after pigs. No single aerial pollutant has been identified as being solely responsible; instead, it seems that the combination of aerial pollutants act together. Exposure can be reduced by wearing an approved mask, especially during tasks that give rise to high concentrations, eg sorting, weighing and cleaning. Keeping the aerial environment clean will certainly make the stockmen's work more enjoyable.

Environmental impact of aerial pollutants

Many authorities now recognise the potential harm that aerial emissions can cause to the countryside. The major pollutants of concern for this reason are listed in Table 4; further information is given in the MLC booklet 'Environmental factors in pig production'. The Integrated Pollution Prevention and Control (IPPC) regulations are of particular relevance. However, there are no plans to monitor or set emission targets for individual farms and a standard cannot be set based on this criterion.

Figure 3 Ammonia flows in the atmosphere (courtesy of Defra, 2002)

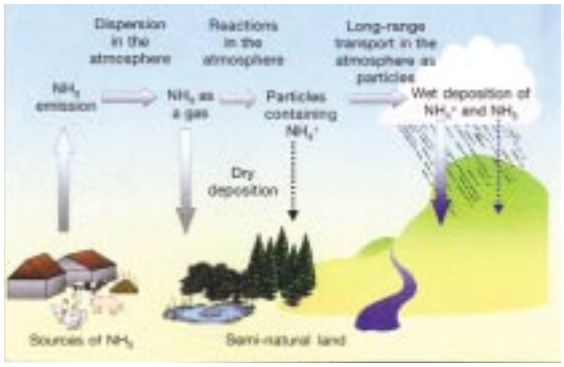


Table 4 Common aerial pollutants emitted from pig housing (Phillips and Pain, 1998)

Type of gas	Mechanism(s) of production	Reasons for concern
Ammonia	Enzymic degradation of urine Microbial (anaerobic) degradation of faeces	Contributes to acid rain Upsets natural ecosystems by deposition of N Implicated in the aetiology of some environmental respiratory diseases of pigs
Methane	Enteric fermentation Microbial (anaerobic) degradation of excreta	Greenhouse gas
Nitrous oxide	Incomplete microbial denitrification or nitrification of mixed bedding and excreta	Greenhouse gas Harms ozone layer
Carbon dioxide	Pig metabolism Microbial action on excreta	Asphyxiant, if allowed to accumulate Greenhouse gas, though this source is mostly non-fossil in origin
Hydrogen sulphide	Microbial (anaerobic) degradation of faeces	Toxic
Odour (can contain traces of over 100 gases)	Microbial degradation especially anaerobic	Nuisance

* It is important to note that pig production is not the sole source of these aerial pollutants. Other industries, both agricultural and non-agricultural, contribute significantly to the emission of these gases.

TARGETS AND TECHNIQUES RELATING TO THE AERIAL ENVIRONMENT

Targets

The Welfare of Farmed Animals (England) Regulations 2000 (S.I. 2000 No. 1870), Schedule 1, paragraph 13 states that: air circulation, dust levels, temperature, relative humidity and gas concentrations shall be kept within limits which are not harmful to the animals.

The Welfare of Farmed Animals (England) (Amendment) Regulations 2003 (S.I. 2003 No. 299), Schedule 6, Part II, paragraph 17 states that: Pigs shall not be kept in an environment which involves maintaining high temperatures and high humidity (known as the "sweat box system").

Table 5 shows current statutory limits and guidelines for dust and ammonia in pig housing. The limits apply to workers and are set by the Health and Safety Commission. Air quality in all pig buildings must satisfy these statutory limits to protect worker health. The guidelines are recommendations only and are based on current knowledge. These guideline concentrations can be achieved in a well-designed and managed building with good control of nutrition, ventilation and biosecurity.

Assessment of air quality

Simple, reliable equipment to monitor air quality is not yet available for pig farmers. However, both direct and indirect techniques can be used as a guide:

1. Self-assessment of odours, dust and ammonia levels on entering a building, though this is highly subjective.
2. Field tests with specialist equipment by environment consultants.
3. Indirect evidence from the build-up of dust on horizontal surfaces.
4. Abnormally high levels of respiratory disease and/or poor performance.

Table 5 Guidelines and limits for dust and ammonia in pig housing

	Total inhalable dust, mg/m^3	Respirable dust, mg/m^3	Ammonia, ppm
Occupational exposure limits for human health			
UK statutory limit - Health and Safety Commission:			
Long-term exposure limit, 8h time weighted average	10	4	25
Short-term exposure limit, 15 min	-	-	35
American guideline, Donham *et al.* (2002)	2.4	0.23	7
Exposure limit for pig health and performance			
Defra guideline	-	-	20
UK guideline	2.7	0.27	10
American guideline, Donham *et al.* (2002)	3.7	0.23	11

Control and abatement techniques for aerial pollutants

The Integrated Pollution Prevention and Control (IPPC) regulations currently focus on two aerial pollutants from livestock production systems, namely ammonia and dust. The emphasis is on the environmental impact of these pollutants, ie the emission from livestock production systems in general to the environment. The approach taken in assessing the potential reduction of pollutant emissions is to assess the complete chain of processes involved. For ammonia this includes the following phases:

- Housing
- Manure storage
- Manure spreading (ie use as organic fertiliser)

Models for this complete system approach have shown that the most cost-effective route to reduce ammonia emissions is to keep the ammonia in the manure and use low emission spreading techniques. This costs approximately £2–£4 per kg of ammonia saved.

However, this approach does not improve the internal climate in pig housing and therefore brings no benefit to pig health, welfare and/or production. Alternative measures directly involving housing systems have to be considered for this.

Short-term solutions - are there any?

Ammonia

For ammonia, no specific short-term systems or techniques exist to date that will remove and/or reduce ammonia concentration inside buildings. However, more general approaches can be considered that do have a limited impact on ammonia concentration/emission without requiring significant building alterations and/or new investments.

Low-protein diets can help to reduce the excretion of ammonia. These diets are finely tuned to match the specific needs of the pig by adding synthetic amino acids so that an 'ideal protein' is provided and surplus nitrogen is avoided. Ammonia emissions can be reduced by up to 50% using this technique but often the cost is prohibitive. Practices such as phase feeding can also help to reduce ammonia emissions. Many pig producers also have an opportunity to lower protein levels in the late finishing stages once protein deposition rates have peaked. If the trend to higher slaughter weights continues this will become more important.

General good management of the building also helps in reducing ammonia emission. The main methods are:

- Reduce the contact area between air and slurry in the pit
- Keep the flooring area dry, whether slatted, solid floors or the straw
- Prevent a build up of slurry

Dust

Reducing the dust concentration by controlling the source of dust is difficult, as the pig itself is a very large factor in this. It has been suggested that a reduction in dust concentration could be achieved by changing from dry to liquid feeding, thus removing one source of dust. However, ongoing trials at MLC's Stotfold Pig Development Unit have shown no significant difference in air-borne dust between rooms with dry-fed and liquid-fed pigs.

A large number of methods have been suggested for reducing dust concentration in the building, ranging from showers to electrostatic filters. The only viable method currently used in piggeries is automatic spraying of diluted vegetable oil (5 –10 % oil in water) twice a day for 15 seconds during feeding times. This method can reduce total dust concentrations by 50% or more (see Table 6).

Table 6 ***Effect on dust concentrations of spraying an oil/water mixture 1 to 4 times a day, using a single nozzle fitted 2 metres above floor level in the centre of a pen***

	Control, mg/m^3	Treatment, mg/m^3	% Reduction
Piglets	0.54	0.13	76
Weaners	0.50	0.23	54
Finishers	0.31	0.15	52

Daily oil usage was 5-10 ml per pig per day.

BUILDING DESIGN AND VENTILATION SYSTEMS

There have been considerable developments in pig building design and ventilation systems during the last decade. There has been a steady shift from non-bedded slatted systems with mechanical ventilation to more finely tuned straw-based solid floor systems that make use of natural ventilation with the benefit of automatic control. The driving force behind this change has been reduced power input and perceived benefits to animal welfare. Straw-based systems, and especially deep litter systems, have been shown to reduce ammonia emissions, but at the same time the nitrous oxide (laughing gas) emission increases significantly, effectively cancelling the benefits of the reduced ammonia emission.

A current project conducted by ADAS and Silsoe Research Institute is considering simple modifications to slatted-floor buildings, which may reduce ammonia emissions. These modifications are all aimed at either reducing the slatted area and/or reducing the surface area of the slurry pit that is in contact with air. Results to date have shown that conventional UK part-slatted floors have a significantly lower emission than fully slatted buildings. However, simple measures to convert a fully slatted system to part-slatted, such as putting down rubber mats in the centre of a pen, did not have a significant effect and sometimes the ammonia emission increased due to fouling of the mats. Covering over the central area of a pen with a convex solid floor and relocating drinkers to the slatted area did reduce ammonia emission, especially when combined with strategies aimed at reducing the surface area of slurry under the slats.

An extreme version of this is a novel part-slatted floor with sloped non-fouling plates under the slats, which significantly reduces the slurry surface area under the slats. This design also uses a novel ventilation system that is recommended in The Netherlands. A version of this system without the novel ventilation system has proven to reduce ammonia emissions by 50% compared to a fully-slatted building using UK stocking densities. This system does, however, require significant investment in new buildings.

End of pipe solutions

Strategies to reduce the emission from the actual pig building have been extensively tested in Western European countries, such as Germany, The Netherlands and Denmark. These measures include biological and chemical air scrubbers and biofilters. All of these methods have been shown to be highly effective and in the case of bio-filters and bio-scrubbers to reduce the odour emission as well. However, the operating costs of these measures are prohibitively high costing as much as £12 per kg of ammonia saved.

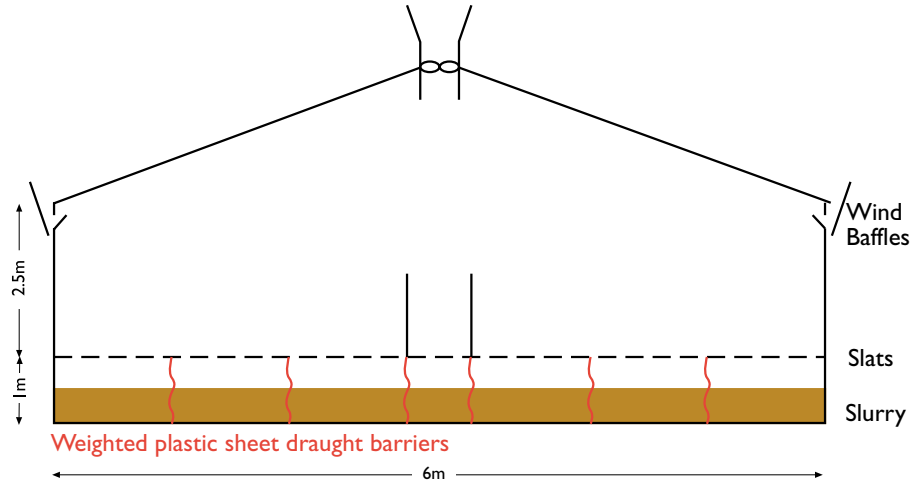
High air speeds (draughts)

Pigs are more sensitive to draughts than most other farm animals. A room apparently kept at the right temperature will be too cold for the pigs if they are subjected to excessive air movement. In general it is better to keep the air speed at pig level as low as possible, preferably below 0.2 m per second which is less than that needed to extinguish a candle. The air speed in a pen can be measured with an air velocity meter as used by ventilation equipment suppliers and pig consultants. If it is necessary to keep the pigs in higher air speeds, it is essential that the room temperature is raised to compensate or the pigs will huddle together, just like they do when the temperature is too low.

One of the main sources of draughts can be from under any slatted floors, particularly where the airspace under the slats has not been divided up with walls or plastic sheets (see Figure 4) or where the external slurry extraction point has not been properly sealed. It is always wise, as a short-term measure, to cover over any slatted floors with boards, paper bags or shredded paper for vulnerable pigs such as newborn or newly weaned pigs.

The only time high air speeds are useful is when the temperature in the pig house approaches the point where the pigs will be uncomfortably hot. Provided the pigs have the choice to lie in a draught or not, those feeling particularly challenged by high temperatures will benefit from the cooling effect of higher air speeds. The main problem can be that this draught may force the pigs to abandon their normal lying and dunging pattern, resulting in dirty pens. It is usually more satisfactory to incorporate a spray system over the dunging area, as a pig with a wet skin is likely to feel comfortable in a temperature some 3 to 4°C higher than one with dry skin.

Figure 4 Section through fully slatted building to show draught barriers



Lying pattern

It is well known that pigs divide up their living quarters into a "dunging" and a "lying" area. This fact has been the basis on which most pig housing systems have been designed in the past, as the dung can be easily removed from the dunging area, either by scraping it out or letting it fall through a slatted floor.

Most ventilation systems try to take this lying pattern into account and direct the cooler incoming air into the desired dunging area. Even in fully slatted houses there should be nominally separate dunging and lying areas. A major cause of stress in pigs arises when they are subjected to a constantly changing lying pattern, often caused by cold air falling where it shouldn't, or falling in a different place in the pen from day to day. Careful planning and good control of air movement patterns inside a building should help to prevent this and help to reduce the likelihood of disease.

It is vital to ensure that all the pen furniture, feeders and drinkers, are positioned so that the pigs' lying pattern as determined by the ventilation system is not compromised. Pigs prefer to dung in corners away from feeders and they do not like to lie near feeders and drinkers because they will be disturbed by other pigs climbing over them. Consequently feeders, particularly ad-lib feeders, should not be placed in the dunging area and drinkers should not be placed in the lying area. Ad-lib feeders placed in the lying area are less of a problem but ideally they should be placed between the lying and dunging area where this is practical. Failure to get this right not only results in dirty pens and dirty pigs but can also lead to feeders and water bowls being contaminated by dung.

Natural ventilation systems

Natural ventilation systems have been around for all time, and most of us use them to ventilate our own homes.

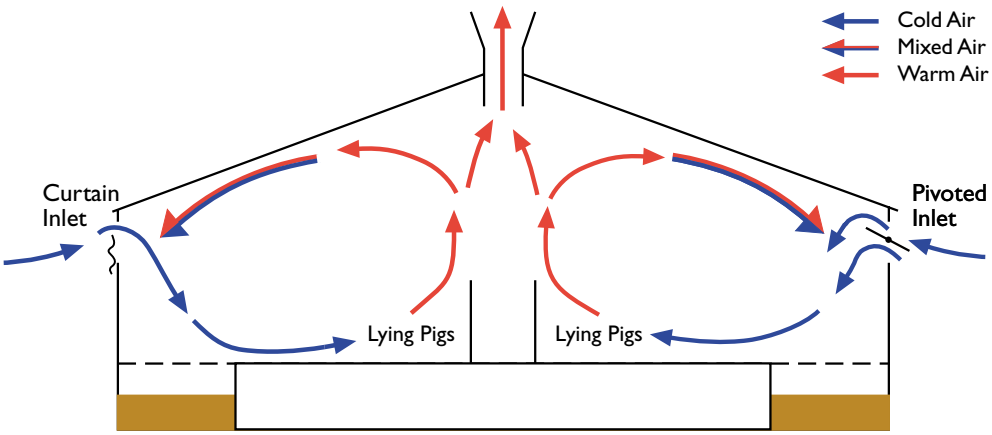
Traditionally, hand-adjusted inlets and outlets have been used to control the amount of air going in and out of pig buildings in an attempt to both regulate the internal temperature and provide acceptable levels of microbes, gas and dust; in other words to maintain good air quality. The main disadvantage in a manual system is the difficulty in altering all the inlets and outlets as the weather conditions change, and knowing exactly how warm or cold it is in the pig pen as opposed to the access passage from which the pig keeper usually makes observations.

More recently there have been systems available to control the inlets and outlets automatically and these facilities help provide a steadier temperature within the pen. These are called automatically controlled natural ventilation systems (ACNV).

Most natural ventilation systems rely on the natural airflow created by the heated air from the pigs rising inside the building towards the ridge of the house and escaping. This is then replaced by cooler air entering the building at the eaves. The size of the necessary openings can be calculated, and opening or closing them provides more or less ventilation as required. Some systems use a cross-flow air pattern without ridge outlets but these assume a minimum wind speed outside to work properly. These can give problems during periods of high ambient temperatures on calm days. Without a ridge outlet, such systems tend to retain the dust, and, consequently, the microbes in the building, leaving the pigs more prone to respiratory diseases such as enzootic pneumonia.

In all situations, naturally ventilated houses must have enough air space surrounding them for the ventilation to work properly, which in practice means a minimum of 6m between pig buildings. In naturally ventilated houses the cooler incoming air tends to enter quite slowly and fall to the floor quickly. This will mean that any intended dunging area should be placed under the main inlets where the cold air falls (see Figure 5).

Figure 5 Approximate airflow pattern in a naturally ventilated building



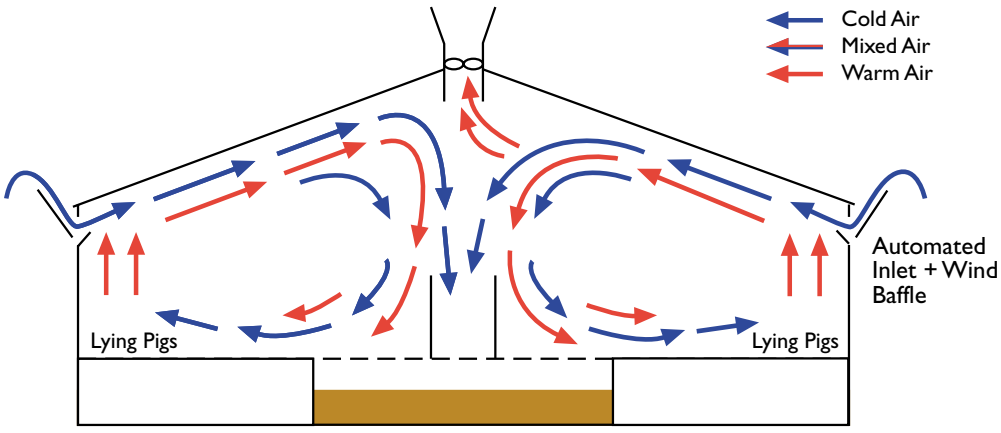
Fan ventilation systems

Many ventilation systems depend on fans to remove air from pig buildings. Fresh air that is then brought in through inlets should be ducted or baffled so that there is a degree of control over its direction of movement. Some older systems used fans to "blow" and distribute air throughout the building, allowing it to escape from baffled outlets either in the ridge or under the slats.

The use of modern electronics has meant that fan systems are now very reliable and sophisticated. They offer many useful features such as temperature curves, so that temperatures within a room can be reduced automatically as the pigs grow, and systems to allow temperatures to lift appropriately if air speeds are likely to be high.

A significant development in fan systems has been the adaptation of the poultry inlet "vent" to the pig industry. The design of these vents and their linked automatic operation with the fans, has meant that it is now possible to predict where the pigs will lie and dung for any given pen layout as well as providing a very even temperature and good air quality. The system requires each separately controlled room to be airtight when the doors are closed to create "low negative pressure" in the room. This allows the air from the inlet vents to enter at speed and be directed towards the dunging area (see Figure 6).

Figure 6 Approximate airflow pattern in a 'low pressure' fan ventilated house



Alarms and failsafes

Legally, under "The Welfare of Farmed Animals (England) Regulations 2000" (S.I. 2000 No. 1870) all automatic ventilation systems on pig farms, whether natural or fan-controlled, need an alarm to indicate that the system has failed or the temperature has risen or fallen below a pre-set level in a room. Alarms and fail-safes must be regularly tested.

- Most new systems are supplied with an alarm
- It is important to ensure that all old houses comply
- It is important to establish a procedure which ensures that someone is "on duty" to hear the alarm at all times or, alternatively, a telephone "dial-up" system can be used "after hours"

Under the same 2000 regulations it is also a legal requirement that no pigs suffer unnecessary distress from heat (or cold) stress during a ventilation breakdown. In practice this means that all pig farms need some sort of plan to optimise natural ventilation temporarily during a breakdown. Fresh air must be brought into the room through "fail safe" openings that might be in the walls, roofs or doors. A reliable automatic-start generator would also ensure compliance with this law.

Maintenance

All ventilation systems will only work as well as their designer intended if they are maintained as the designer intended. Many older buildings may have design problems but these are often made much worse by poor maintenance. They can often be improved by installing more modern equipment.

Common maintenance faults associated with fan systems are:

- Worn fan bearings
- Burnt out fans
- Dirty or rusty blades
- Inlets blocked with rubbish
- Poorly fitting doors
- Broken windows
- Damaged or poorly maintained controllers

Natural ventilation systems often don't work due to:

- Poorly fitting vents
- Rusted up vent hinges
- Rodent damaged flaps or curtains
- Broken linear actuators or winch and cable systems
- Missing or broken panels

Many older buildings do not work well due to their insulation having been destroyed by rodents.

All-in, all-out

One of the main factors affecting pig health is the close proximity of lots of other pigs with potentially infectious conditions. This can be exacerbated by mixing pigs of different ages in a "continuous use" pen.

One of the most beneficial effects on pig health can be obtained by planning pig housing for different stages of production. In this way groups of pigs of the same age are housed together in a room or rooms, with no contact with other pigs. They can then all be removed to the next stage together, allowing a thorough cleaning out and disinfection plus time for resting and drying the rooms between "batches" of pigs. This avoids contact with, and possible infection from, other pigs. Any build up of dust should be removed by thorough cleaning prior to disinfection.

This can be easier to plan for larger herds since they are more likely to be weaning sufficient numbers of pigs on a weekly basis to fill the rooms. Smaller herds should consider batch-farrowing groups of sows every three weeks to provide the required numbers.

General management

Good ventilation and all-in, all-out management practice will go a long way to ensuring a healthy environment for pigs. However, the importance of an adequate supply of clean water and fresh food cannot be underestimated. It is vital to ensure the flow rate of water from the drinkers is adequate and that the correct numbers of drinkers are installed at the right height (see Tables 7–10).

Smaller, weaker pigs are often at a disadvantage if housed with their larger siblings. There is a great deal of benefit to those pigs and to the overall disease level on the unit by "side-streaming" the weakest pigs and housing them separately from the main pig flow.

Pig pens are very barren environments and pigs are very inquisitive and destructive creatures. The Welfare of Farmed Animals (England) (Amendment) Regulations 2003 (S.I. 2003 No. 299), Schedule 6, Part II, paragraph 16 states that: *To enable proper investigation and manipulation activities, all pigs must have permanent access to a sufficient quantity of material such as straw, hay, wood, sawdust, mushroom compost, peat or a mixture of such which does not adversely affect the health of the animals.*

The provision of "entertainment" items in the pen such as any sort of bedding, 50 mm strong plastic tubes suspended on chains, or a "rack" containing mushroom compost or shredded paper suspended at shoulder height, again on chains, will enrich the pigs' environment considerably. The key feature of any successful "entertainment" item seems to be that it must be possible for the pigs to destroy it and then it be replaced. Anything that remains in the pen and is, in effect, indestructible like a car tyre, soon tends to lose its appeal as the pigs quickly become bored.

Table 7 Drinker flow rates

Category of pig	*Litres / Minute / Drinker*	*Daily requirement, litres*
Weaners (from 5 – 30kg)	0.5 – 1.0	1.5 – 2.0
Growers (30 – 50kg)	1.0 – 1.5	2.0 – 5.0
Finishers (50 – 110kg)	1.0 – 1.5	5.0 – 6.0
Dry sows and gilts	2.0	5.0 – 8.0
Lactating sows	2.0	15 – 30
Boars	2.0	5.0 – 8.0

(Ref: Defra Code of Recommendations for the Welfare of Livestock: Pigs)

Table 8 Drinker availability: group size

ABP and Genesis certification standards	*Restrict-fed*	*Ad-lib fed*
Nipples/mini-bowls	1: 10	1: 15
Bowls	1: 20	1: 30

SSSFA - Pigs certification standards	
Nipple drinker	1 : 15, 2 : 30 and 3 : 50
Nipple drinker with bowl	1 : 15, 2 : 30 and 3 : 50
Mini bowl where pig action triggers water provision	1 : 15, 2 : 30 and 3 : 50
Bowl from which water is permanently and freely available	1 : 20, 2 : 40 and 3 : 70

Table 9 Troughs (number of pigs per linear foot of trough space)

Pig liveweight (kg)	*ABP, Genesis and SSSFA - Pigs certification standards*
> 15 kg	40
≥ 35 kg	30
≥ 90 kg	25

NOTE
- "Wet" feeding systems require only one separate clean water drinker per pen in addition to the wet feed.
- All pens should have a minimum of two drinking points (at least 600 mm apart) except where troughs of 450 mm (1'6") minimum length are used.

Table 10 Height of drinkers

Category of pig	*Height mm*	*(inches)*
Suckler	150 mm	(6")
Weaners 7–18 kg	250 – 350 mm	(10 – 14")
Growers 19–35 kg	350 – 450 mm	(14 – 18")
Finishers 35–60 kg	500 – 600 mm	(20 – 24")
Finishers 60–95 kg	600 – 750 mm	(24 – 30")
Maiden Gilts	750 mm	(30")
Dry Sows / Boars	800 – 950 mm	(32 – 38")

SUMMARY

A combination of an adequately insulated building, a well-designed ventilation and heating system and good maintenance should provide a comfortable and healthy environment for correctly stocked pigs. If this can be combined with an all-in, all-out housing policy and side streaming the weakest 6% of pigs, the health of the pigs on any unit will be second to none. This has been demonstrated in recent years by the results from the MLC's Stotfold Pig Development Unit. In a recent refurbishment project, changes were made to ventilation systems and management practices. Days to slaughter at 90 kg have since improved by 19% (see Table 11), and medication costs have reduced by two thirds.

Table 11 Effects of refurbishment programme at Stotfold PDU

	Before	**After**
Lifetime growth rate (DLWG g/day)	571	680
Days to slaughter at 90 kg liveweight	156	131
Feed costs (grower 7-25 kg phase) (p/kg daily liveweight gain)	55.7	42.8
Feed costs (finisher 25-90 kg phase) (p/kg daily liveweight gain)	41.3	33.6
Lung scores (55 point scale)	9.4	2.4
Snout scores (5 point scale)	1.3	0.5

FURTHER INFORMATION

Other MLC/BPEX Booklets:

Management of the environment to promote pig health and welfare
Contact MLC Technical Division on 01908 844734 for a copy or download from
www.stotfoldpigs.co.uk/pdfs/pighealth.pdf

Environmental Factors in Pig Production
Contact MLC Technical Division on 01908 844734 for a copy or download from
www.stotfoldpigs.co.uk/publish/pdfs/environ.pdf

Books:

Title: Pig Environment Problems
Authors: Paul Smith and Hugh Crabtree
Publisher: In Press (Nottingham University Press)

Title: Livestock Housing
Editors: C.M. Wathes and D.R. Charles
ISBN: 0 85198 774 5
Publisher: CAB International

Title: Practical Pig Keeping
Author: Paul Smith
ISBN: 1 86126 388 0
Publisher: Crowood Press

Title: Pig Production Problems - John Gadd's Guide to Their Solutions
Author: John Gadd
ISBN: 1 897676 34 4
Publisher: Nottingham University Press

Multimedia Training Packages:

Pig Enterprise CD ROM - developed for the training of stock-workers and new entrants to pig production and has three main elements:

1. Stockmanship and husbandry
2. Health management
3. Cost-effective feeding strategies

Pig Enterprise 2 CD ROM - more advanced, targeted at unit managers and includes:

1. Staff management
2. Financial planning
3. Food Safety
4. Biosecurity
5. Legislation
6. Product quality

Contact MLC Technical Division on 01908 844734 or order online at **www.stotfoldpigs.co.uk/training/training.html**

General internet resources:

BPEX	www.bpex.org.uk
MLC's Stotfold PDU	www.stotfoldpigs.co.uk
NPA	www.npa-uk.net
Defra	www.defra.gov.uk/sci
Environment Agency	www.environment-agency.gov.uk

Contacts:

Mr Derek Armstrong	MLC Veterinary Scientist Tel: 01908 844216 Email: derek_armstrong@mlc.org.uk
Mr Nigel Penlington	MLC Pig Technologist Tel: 01908 844276 Email: nigel_penlington@mlc.org.uk
Dr Jayne Thompson	MLC Senior Pig Scientist Tel: 01908 844243 Email: jayne_thompson@mlc.org.uk
Prof Christopher Wathes	Silsoe Research Institute, Director of Science Tel: 01525 860000 Email: christopher.wathes@bbsrc.ac.uk
Dr Theo Demmers	Silsoe Research Institute, Research Division Tel: 01525 860000 Email: theo.demmers@bbsrc.ac.uk
Mr Paul Smith	Pork Chain Solutions Tel: 01603 713073 Email: paulsmith@porkchain.com
Stotfold Pigs Technical Forum	http://forums.stotfoldpigs.co.uk/

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BRITISH PIG EXECUTIVE
PO Box 44, Winterhill House • Snowdon Drive • Milton Keynes MK6 1AX
www.bpex.org.uk • www.stotfoldpigs.co.uk • Tel: 01908 844368 • Fax: 01908 844289

For technical enquiries contact MLC's Technical Division • Tel: 01908 844734 • Fax: 01908 844214

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