

# Odour CONTROL

Odours are one of the main causes of conflict between livestock producers and their neighbours. In most areas, pig producers represent a minority of the population. It is essential that pig producers develop and maintain a positive image within their community. Every reasonable effort should be made to control odours. It should be the goal of all pig producers to design, construct and manage their operations in a manner that minimizes the odour experienced by their neighbours.

It is unrealistic to expect a commercial pig operation to operate without some odour. However, the odour level of a pig operation can be significantly reduced when the facilities are properly designed and operated.

Odour nuisance can be divided into four factors: frequency, intensity, duration and offensiveness (FIDO). This section outlines some methods to manage the FIDO of odours from livestock operations, and to compare their effectiveness with their advantages and disadvantages. Although some practical methods to minimize odour concerns from pig operations are described, no single practice or technique will totally eliminate odour emissions.

Odour control within and around livestock operations should not be regarded as only a public relations issue. The control of odours within the barn is also beneficial for the pigs and the people working within the barn.

## 5.1 Sources of Odours

Odours from pig farms are produced mainly by the decomposition of the manure by various microorganisms. The activity of the different microorganisms (which depends upon temperature, moisture content, oxygen level and other characteristics of the manure) determines the type of gases and the rate at which the gases are produced. When enough oxygen is available, manure decomposes **aerobically**, and most of the gases released have very little odour. However, when the microorganisms are deprived of oxygen, manure decomposes **anaerobically** and most of the gases released have an offensive odour. Liquid manure is stored anaerobically and often results in more odour than solid manure. Both decomposition processes, aerobic and anaerobic, can occur during the various stages of the manure management system.

The two main strategies for odour control are to:

- collect, store, and apply the manure in a way that prevents odours from forming and
- control the release of the odorous gases into the air

## 5.2 Human Response to Odours

Odours from livestock operations are a major concern raised by neighbours who may feel that their health is being adversely affected. People vary in their sensitivity to odours. For some, unwanted odours can be very annoying, and may also result in symptoms such as headache, nausea, eye and throat irritation, anxiety, and depression. At high levels such as directly adjacent to the manure storage structure, odours may induce acute exposure symptoms.

**The keys to reducing odour complaints are proper siting of the livestock operation and good manure management. If producers follow the practices outlined in these Guidelines, there should be low risk to human health from odours.**

### 5.2.1 Other air quality concerns

Community health risks from airborne microorganisms, dust, and other gases such as methane, ammonia, and hydrogen sulfide are generally not a concern. The barn air is diluted when it mixes with outside air resulting in negligible risk to neighbours from manure gases. As well, most dust particles are deposited within a short distance from livestock housing exhaust fans. The use of some high pressure irrigation equipment (such as the "big gun") to apply manure to land, however, should be restricted to remotely located fields because bacteria can be transported downwind of these systems.

Although community health risks due to airborne microorganisms, dust and gases from the barn are negligible, agricultural workers may be exposed to high concentrations of dusts and airborne contaminants within the livestock housing

facilities. Without preventative measures, this can cause adverse health effects for workers. Good ventilation, the use of appropriate masks when performing dust generating operations and dust reduction measures can protect the health of barn workers.

## 5.3 Sites of Odour Production

Odours are generated in three areas:

- facilities where the animals are housed
- areas where manure is stored or treated
- fields where manure is applied for crop production.

In general, barns create continuous sources of odour because they operate year-round. Odours from outdoor manure storage facilities vary seasonally, with negligible odour release in winter months when manure is frozen. High odour levels occur during agitation and pumping of manure from the storage facilities. These activities result in infrequent and intermittent sources of odour.

Depending upon the systems used, application operations, including agitation and pumping, can create the most offensive odours. Properly designed equipment and facilities, together with the use of beneficial management practices, can significantly reduce the frequency, intensity, duration and offensiveness of the odours produced. Odour reduction strategies at the livestock facilities and during application are presented in this section.

## 5.4 Livestock Operation Design

The intensity and offensiveness of odours produced depends to a large extent on the design and management of the barns and storage. The majority of odours come from manure decomposition in barns. Barns that have manure covered floors and dirty animals will have more odour problems than clean barns with clean animals. A clean barn is the product of proper barn design, good management practices and healthy animals. With a properly designed and managed ventilation system, pigs will develop relatively clean manuring habits.

### 5.4.1 Manure management system

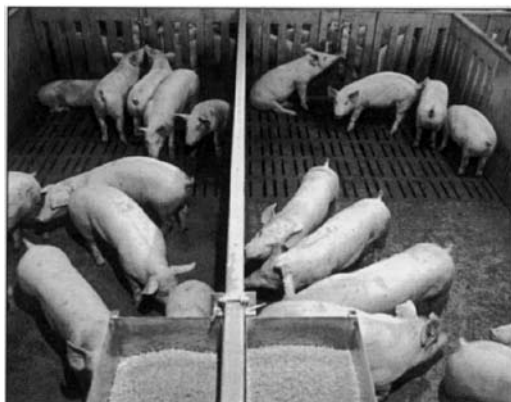
The manure handling system in the barn can affect odour production. Most barns with liquid manure systems are designed with shallow gutters under slotted sections of the pens or stalls. These are emptied when the level of manure approaches the slotted section. Odours can be reduced by removing the manure from the barn as frequently as possible. However, care must be exercised not to affect the operational aspects of the shallow gutter system. A certain depth of manure is required in order for the shallow gutter to drain properly when the plug is

pulled. Also, some of the solid fraction of the manure is decomposed while it is in the gutter. The degree to which it is broken down is a function of the microbial action and the retention time. Removal of manure too frequently reduces the amount of breakdown and can result in an undesirable, accelerated accumulation of solids in the gutters.

Alternate manure handling and housing systems are available that may reduce the odour generated from pig operations. These include:

**Solid/liquid separation** – Much of the odour generated by liquid manure is due to the anaerobic decomposition of the solids in the manure. By separating the solids fraction from the manure, odours from the anaerobic decomposition of the liquid manure can be reduced. The solids fraction must be managed aerobically so that it does not become another source of odours. Solid/liquid separation is achieved through the use of:

- specially designed manure gutters, with the liquids continuously drained to storage and the solids scraped out of the barn each day
- mechanical screens or filters
- screw press equipment



Pig production facilities commonly use slotted floor systems to allow easier manure management



Screw press solid/liquid separator

**Straw-based systems** – Odours can be reduced by creating aerobic conditions for the manure. The use of straw or other bedding can maintain aerobic conditions if enough material is used. The labour requirement for material handling, however, is high.



Straw-based housing system

approaches. Small amounts of very fine water droplets favour the collection of fine dust into larger particles which are less likely to enter the worker's respiratory tract. When using vegetable oil (canola, sunflower, etc.), the application rate must be carefully chosen to avoid slippery floor conditions for livestock and workers.

**Barn air treatment** - Treating air inside barns such as oil sprinkling and ozonation, can improve air quality for the workers and reduce odour released from the barns. When chemical agents are used for air treatment, the levels of these chemical agents should be monitored to ensure they are below the safe limits for the workers and livestock.

**Biofilters** - Biofilters are currently being researched and may be used to reduce odour from livestock barns. Biofilters consist of a bed of very porous granular material designed to allow rapid proliferation of aerobic bacteria. These bacteria thrive on the odorous compounds being exhausted from livestock housing, thereby degrading them. Wood chips, straw, peat moss, compost, coarse gravel or clay bead beds are typical examples of the main component of a biofilter. All air exhausted from the animal housing needs to be moved through the biofilter, with the biofilter operating within specific parameters. This approach is unsuitable to naturally ventilated housing since the exhaust air needs to be collected and treated within the biofilter. Two designs of biofilters can be retrofitted to livestock barns. Vertical-airflow biofilters are easy to construct, but occupy a lot of space surrounding the barn. Horizontal-airflow biofilters are more compact, but require more effort and expense to construct.

#### 5.4.2 Environmental control in barns

In most pig operations, the build-up of odours in the barn can be prevented by following recommended ventilation practices and rates. Proper ventilation rates are required to remove moisture from the barn and to prevent the formation of very unpleasant "pockets of air" in the building. The ventilation system should not draw foul air from the gutter back into the housing. A professional agricultural engineer should be consulted for advice on proper ventilation system design and operation as well as the effectiveness and suitability of the technology for the operation.

**Modifications of exhaust ventilation system** - Attempts have been made to further reduce the odour levels of exhaust ventilation air by removing the dust from the air. Among the newer approaches to reducing dusts in pig barns, the misting of water in the air or sprinkling of vegetable oil directly onto the floor are promising

**Feeding practices** – Producers should ensure that their rations are properly balanced for the pigs being fed. For example, excessive protein levels can result in elevated ammonia levels and represent a wasteful expense.

**Manure and feed additives** - A wide variety of chemical and biological products are marketed as a means to mitigate odours for the benefit of the farm workers and the operation's neighbours. Research centres in Canada and the United States report very disappointing results with manure additives due to either low and unpredictable efficacy of the product or high costs. However, some of these additives may prove helpful in liquefying the solids in liquid manure, which would be beneficial for pumping liquid manure out of the storage structure. New developments may still yield products with merits for specific applications. It is advisable that conclusive proof from scientifically sound experiments conducted by a reputable research organization be obtained prior to investing in such products.

Manure additives may be grouped into the following five categories:

- masking agents - products that have a strong characteristic odour of their own designed to cover up (mask) the manure odour with a more desirable one
- counteractants – products that cancel or neutralize the manure odour such that the intensity of the mixture is less than that of the constituents
- digestive deodorant - bacteria or enzymes that eliminate undesirable odours through biochemical metabolic degradative processes

- adsorbents - products with a large surface area that adsorb odour compounds
- chemical deodorants - strong oxidizing agents or germicides that alter or eliminate microbial action responsible for odour production or chemically oxidize compounds that make up the odour mixture

Recent research showed promising results for some feed additives in either improving feed digestibility by swine, implying less excretion of odour forming compounds, and/or changing the odour of fresh feces and urine. However, the latter effect often disappears when anaerobic decomposition of manure begins in the gutter or in the storage. Nevertheless, the improvement of feed digestibility, along with potentially lower odour levels in the swine housing may give an economic benefit to some of these products. Prior to being commercially available, feed additives must be registered under the federal *Feeds Act* and regulations.

### 5.4.3 Landscaping

Well kept grounds, attractive shelterbelts and other common landscaping features will ensure that the owner's pride in their operation will be conveyed to nearby neighbours and users of the rural roads. Well maintained livestock operation yards, surrounded by trees, are usually not the source of as many odour complaints from neighbours.

**Shelterbelts** – Carefully designed rows of trees or the maintenance of existing treed buffers around the perimeter of a livestock operation yard will help blend the physical facilities of the operation (buildings, yard, manure storage facility, heavy truck traffic, etc.) with the surrounding features of the local landscape. In addition to providing visual screening and a sound barrier, rows of trees may also be planted to help trap dust, minimize erosion, or reduce snow accumulation around low lying areas such as manure storage structures.

Rows of trees may help disperse odours and trap dust, however, the amount of wind porosity varies in shelterbelts with changes in height and leaf density. Therefore, there is no way to predict the impact of shelterbelts on odour. As such, there are no known design standards or recommendations specifically for odour control.

Historically, landowners have designed shelterbelts to meet their personal needs and/or improve farm efficiency. Since each farm is different, there is no simple recommendation on how to design a shelterbelt system. Although Agriculture and Agri-Food Canada’s (AAFC) *Basic Shelterbelt Establishment Guidelines* can be found in Appendix J, it is essential to understand that the context and purpose of this document is to provide generic advice that can be adapted to suit



Maintaining trees around the yard of a livestock operation is an asset

individual requirements, and that it is not intended to be used as a regulatory template. The choice of the number of rows, width between rows and/or spacing between trees is as unique as each site and the landowner’s reasons for planting trees. Typically, however, a three to five row shelterbelt is used.

**5.4.4 Setbacks from neighbours**

Measures to reduce the intensity of odours that reach neighbouring properties should be taken in the planning phase for new operations when they can be located far enough from neighbours to maximize the dilution of odours. Section 6 contains recommended separation distances from livestock operations of different sizes to neighbouring residences. Whenever practical, the siting of the operation should also consider the prevailing wind direction to reduce the frequency of odours transported to the closest neighbours. Abiding by these recommendations will minimize the odour frequency and intensity in most situations. However, certain landscape features can concentrate odours in an undesirable direction. Producers should check with their local municipalities to determine what distances may be required under local planning regulations. The province also encourages local governments to ensure that incompatible land uses do not encroach on livestock operations.

## 5.5 Storage Odour Control

Manure is a valuable source of plant nutrients. Due to the cold climate in Manitoba, manure must be stored until such time as it can be applied to soil for optimum crop production. This requires storage during winter months. Manure that is stored in deep manure storage structures (three to five metres) undergoes anaerobic decomposition and can be the origin of significant nuisance odours when the gases are released into the air. Enclosed concrete structures and open manure storage structures that develop a crust on the surface reduce the release of odorous gases.

The most common type of liquid manure storage structure is the earthen manure storage structure. The manure in these structures is anaerobic and the large exposed surface area may permit increased quantities of odorous gases to be released. Also a significant release of odours may occur in the spring when the surface thaws and manure warms.

A significant advantage of earthen manure storage structures is that they are often designed with sufficient volume to only require emptying and application once per year. The more expensive concrete structures are often constructed with a smaller storage volume, requiring both spring and fall emptying. Agitation of the manure during the emptying



The agitation required to pump solids out of the storage structure releases considerable odours

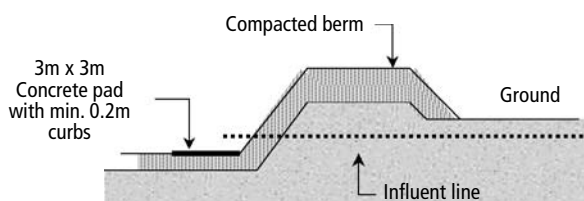
operation releases significant odours. Therefore, reducing the number of times the manure storage is agitated and the manure is applied will decrease the frequency that neighbours experience unpleasant odours from these activities.

In addition to maintaining maximum practical separation distances between storage structures and neighbours, several approaches have been used to help control odours from open storages. These include:

- transferring the manure from the barn to the storage with a bottom loading transfer pipe
- planting shelterbelts around open storages
- using covers to prevent the movement of air over the surface of the manure and the release of gases
- aerating the manure in the storage so that the decomposition changes from an anaerobic to aerobic process

**Separation Distances** - Odours naturally disperse in the air around the storage structure. Under normal climatic conditions, large separation distances between the storage and residences dilute the odours and reduce their impact on neighbours. When planning a new operation, providing adequate separation distances between the closest neighbors and a manure storage structure and, if possible, siting the storage so that predominant spring, summer, and fall winds blow odours away from them, are very good ways to prevent future nuisance problems. Since larger storage structures have a larger surface area for odour emissions, separation distances must be greater for larger operations. Section 6 lists minimum separation distances recommended for siting manure storage structures. Local municipalities may also have specific requirements for separation distances.

**Bottom loading of the manure storage –** Pumping manure from the barn into the manure storage under the manure surface minimizes turbulence of the manure and the release of odorous gases. Bottom loading of the manure storage requires that a few additional components be added to the manure handling system.



Representation of a bottom loading inlet to transfer liquid manure from the housing to the storage

**Shelterbelts –** Shelterbelts may help disperse and dilute odours from the manure storage structure. Rows of trees around the manure storage also improve the appearance of the operation (see Appendix J).

**Storage covers –** Liquid manure storage covers control odour effectively by creating a physical barrier between the manure surface and the air, thus reducing gas and odour emissions. There are many types of covers available including positively pressurized

synthetic covers, negatively pressurized floating synthetic covers, non-pressurized floating synthetic covers, straw, and geotextile woven covers. When choosing a cover, cost, odour reduction, durability, and ease of installation and emptying should be considered.

The most commonly used covers are straw and synthetic covers. A straw cover involves applying straw uniformly, typically 20-25 cm (8-10 in) thick with a special blower. When good quality straw is properly applied, the straw cover can last up to five or six months. Poor quality straw, insufficient coverage depth, or significant rainfall events can result in the cover lasting as little as one month. If a straw cover starts to break or sink, additional straw should be applied. Typically, barley straw is used because it floats better and lasts longer than other straw.

Difficulty during the pump-out of straw-covered earthen storages has been a concern. However, plugging of pumps or outlet nozzles on transport tankers are rare and can be generally attributed to insufficient agitation. Directing the agitator nozzle to large straw clumps and having an agitator with chopper blades mounted on the end of the pump to help break up and shred straw clumps helps to create a homogeneous product that can be pumped more easily.



Synthetic cover on an earthen manure storage in Manitoba



Straw cover on an earthen manure storage in Manitoba



Synthetic covers have a high capital cost, but they may last up to ten years. Synthetic covers are made of high-density polyethylene that floats on top of the storage. On earthen manure storage structures, the edges of the cover are anchored at the top of the dike by laying the plastic into an excavated trench and refilling the trench with the excavated soil. Precipitation, which remains on the top of the cover, helps hold the cover in place. Excess water on top of a non-permeable cover should be removed with a small pump. Negative pressure synthetic cover systems use an exhaust system to hold down the cover and remove manure gases that are trapped under the cover. Agitation of the manure necessitates removal of the cover and reinstallation after cleanout.

**Storage aeration** – Theoretically, aeration of a liquid manure storage structure should change the decomposition process from anaerobic to aerobic and reduce unpleasant odours. Manitoba winters and the high costs associated with equipment and operation have prevented the widespread use of aeration as a means of controlling storage odours. Aeration and other methods of treatment are discussed in greater detail in Appendix D.



Draghose or pipeline injector for liquid manure

## 5.6 Odour Control with Manure Application

Odours from the application of manure can be a major concern for neighbours of livestock operations. Although manure is often applied on fields only once or twice a year, it can cause odours that may last for a few days. Producers must be considerate of their neighbours when choosing application techniques and planning their annual manure application.

### 5.6.1 Equipment selection

The amount of odour released during manure application depends on the exposure of the manure to the atmosphere. The less manure is exposed to the air, the fewer odours are emitted. The application equipment used will determine the amount of odours released. More careful timing and field selection are necessary when the application equipment creates increased odours. For liquid manure, the most effective means of odour control during application is direct soil injection. When manure is injected, nutrient loss and runoff are minimized.

There are two types of direct injection systems. One system consists of injectors mounted on conventional manure tankers. The other system is the pipeline or draghose injection system, where a tractor powered implement, connected by a long flexible hose to a pump and irrigation



Tanker system used for applying manure

pipeline, injects the manure into the soil. The latter system combines the time saving features of an irrigation system with the benefits of direct injection.

For forage crops and direct seeding systems, low disturbance, disk-type injectors have the ability to inject large volumes of liquid pig manure with very little residue or soil disturbance. High disturbance shank-type injectors, using sweeps or spikes, create considerable soil and residue disturbance. However, they may produce less odour than the low disturbance injectors. Both types of injectors should provide acceptable liquid placement at generally practiced rates of manure application. Another type of low disturbance applicator has a series of knives mounted on an axle which penetrate the soil creating a soil aeration effect. Liquid manure is delivered through a drop hose behind or in front of each knife set and into the holes. This low disturbance applicator is an excellent tool for minimum till, zero till applications, or forage fields as it allows for immediate infiltration of the manure into the soil while greatly reducing the odour versus surface application.



Low disturbance type applicator system

Manure tankers for broadcasting manure are often used to apply liquid manure to land. The potential for odours is greater with broadcast manure tankers than with injection systems or low-level applicators as the manure is discharged into the air during application. Liquid manure tankers typically hold 6,000 to 45,500 L (1,300 to 10,000 imp. gal) and have a low to moderate capital cost, depending on the application options and axle configuration. One disadvantage of liquid manure tankers is the amount of time required to apply the manure. Even when fields are near the storage, a large part of the time is spent traveling back and forth. Another disadvantage is the potential for soil compaction that occurs when transporting heavy loads over moist soil. High floatation tires should be used to reduce soil compaction. Heavy truck tires and used airplane tires should be avoided, as they limit floatation and may induce severe compaction.

Low-level manure applicators and dribble-bar systems, that direct manure toward the ground, reduce odours considerably during application by reducing the exposure of the manure to the air during application. When used on a growing crop, dribble bars deposit manure directly on the soil beneath the crop canopy. Fewer odours are released following application using low level application systems than with broadcast applicators.

Incorporation of manure, whether in liquid or solid form, on the same day as application can reduce odours neighbours encounter following application (see Table 11). When manure is incorporated into the soil very soon after application both nutrient loss to the atmosphere and runoff are minimized and nutrient retention for

crop use is maximized. Each day that passes without incorporation increases the risk of potential runoff and for nuisance to neighbours.

Stationary or traveling irrigation equipment, can be used to apply liquid manure. Irrigation equipment saves a great deal of labour, however, it has the potential to create the greatest odour nuisance (see Table 11). Unless the manure is applied on isolated fields under normal circumstances, irrigation

equipment should not be used because it results in the uneven application and creates the greatest odour nuisance.

The success of any application method depends largely upon the abilities of the operator. With proper management, each system should be used in a manner that prevents pollution, minimizes odour nuisance and applies manure at a rate that matches the crop requirements.

**Table 11: Recommended Distances From Residential Areas, Residences And Property Lines For Applying Manure <sup>1</sup> (m)**

Application method	Odour suppression	Designated residential area	Residence	Property line with residence	Property line without residence
Irrigation	None	1600	300	15	1
Surface applied, no incorporation	Moderate to none	800	150	10	1
Surface applied, incorporated within 48 hours	Good	400	75	10	1
Injection	Maximum	75	15	3	1

<sup>1</sup> See Appendix C for imperial units.

**5.6.2 Consideration for neighbours**

Neighbours are less likely to complain if they understand the problems of odour control and see that a genuine effort is being made by the producer to minimize the odours. Maintaining good communication with neighbours is important in avoiding conflicts. Most people will recognize good intentions and will not have unreasonable expectations.

The following points should be considered as part of the preparation steps for the annual manure application operation:

- inform your neighbours ahead of time of your intentions to apply manure and attempt to accommodate them by applying at times when odours are least likely to be a problem

- avoid applying manure immediately before or during weekends and holidays when neighbours are more likely to be outdoors
- incorporate manure as soon after broadcast or irrigation application as practically possible
- consider injection for fields near residences
- use fields with windbreaks or shelterbelts that mix and dilute the odours

When applying manure, maintain setbacks that are reasonable for the type of equipment used. Table 11 should be used as a guideline for manure application setback distances from residential areas, residences and property lines.

These minimum distances are designed to minimize odour nuisances to neighbours and should be used in conjunction with good management practices. Each application method should be optimized for particular conditions to achieve maximum odour suppression.

### 5.6.3 Weather conditions

The capacity of the manure storage will determine how often manure must be applied. The storage should be large enough to permit some flexibility in timing application. Application should also occur at an optimal time for crop uptake of the manure nutrients. The storage size should allow the producer to avoid unsuitable weather and poor field conditions. See Section 3.4.3 for information on sizing a manure storage structure.

There are a number of odour mitigating factors to consider when deciding on where and when to apply manure.

- **Weather conditions:** Manure applied in cool or cold weather will create less odour than applying in warm weather. On calm, humid days, rapid drying of the manure and dilution of the odours will not occur and a gentle breeze may carry undiluted odours toward neighbours.
- **Wind and direction.** Caution must be used to avoid situations where winds will carry odours directly toward neighbours.
- **Location of fields.** Preference should be given to sites furthest away from neighbours.

## 5.7 Odour Control Plan

Determining the source of odours impacting a neighbour may not be an easy task. The frequency, intensity, duration and offensiveness of odours from each source should be considered and an odour abatement plan developed for the most probable source of odour or nuisance concerns. The odour abatement plan should include the most appropriate actions and technologies to remedy the odour problem. Advice from Manitoba Agriculture, Food and Rural Initiatives may be beneficial when developing an odour abatement plan.

When considering air treatment systems or manure and feed additives, advice from independent sources, such as the University of Manitoba or Manitoba Agriculture, Food and Rural Initiatives should be obtained on the product's safety, efficacy and on the most recent research results.