Farm Practices Guidelines for Livestock Producers in Manitoba:

ODOURS

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Manitoba

Contents

Nuisance Complaints 4
Odours 4
Human Response to Odours 4
Odours from Manure 4
Sites of Odour Production 5
Planning and Managing to Reduce Odour Nuisance 5
- Siting the Operation 6
  - Separation distances 6
  - Wind and air drainage 7
  - Naturally treed areas and landscape features 8
  - Landscaping and planting shelterbelts 8
- Livestock Housing Systems 8
  - Beef 9
  - Dairy 9
  - Layers 10
  - Broiler chickens and turkeys 10
  - Pigs 10
  - Sheep 11
- Practices for Managing Odour from Livestock Housing Systems 11
  - Ventilation 11
  - Frequency of manure removal 11
  - In-barn dust reduction 12
  - Biofilters 12
  - Feeding practices 12
  - Manure and feed additives 12
- Manure Storage Facility Design and Management 13
  - Maintaining a crust on liquid dairy manure 13
  - Covered liquid manure storage structures 13
  - Bottom loading of the manure storage 15

Field Storage of Solid Manure 15
Composting of Solid Manure 15
Burning of Solid Manure 15
Land Application Practices and Technologies 15
Equipment selection 15
Consideration of neighbours 17
Odours from Mortalities 18
Rendering 18
Burial 19
Composting 19
Incineration 19
Storage, Refrigeration, Freezing and Transport 19
Nuisance Complaint Resolution 20
The Farm Practices Protection Act 20
APPENDIX A: Animal Unit (AU) Summary Table 22
APPENDIX B: Shelterbelt Establishment 23
Introduction 23
Planning a Shelterbelt 23
Shelterbelt Design 23
Shelterbelt Maintenance 23

Nuisance Complaints

Agricultural operations are a source of traffic, noise, flies, dust and odours. The most common nuisance complaints related to livestock operations are about odour. In this document, odour nuisance is discussed in the context of various farm practices used by Manitoba livestock producers. An overview of the complaint resolution process in Manitoba is also provided.

Odours

Odours are one of the main causes of conflict between livestock producers and their neighbours. Every reasonable effort should be made to control unwanted odours. It should be a goal of all livestock producers to design, construct and manage their operations in a manner that minimizes the odours their neighbours experience.

It is unrealistic to expect a commercial livestock operation to function without some odour. Although some practical methods to reduce odour from livestock operations are described in this publication, not every practice is suited to every farm, and no single practice or combination of practices will eliminate odour emissions completely.

Neighbours are less likely to complain if they understand the challenges 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.

Odour control within and around livestock operations is more than a public relations issue. The control of odours in the barn is also beneficial for the livestock and people working in the barn.

FIDO

Odour nuisance can be divided into four factors:

Frequency, intensity, duration and offensiveness

(FIDO).

Human Response to Odours

People vary in their sensitivity to odours. For some, unwanted odours are simply unpleasant or annoying. However, as the FIDO of the odours increases, the reaction may escalate to include emotions such as anger, frustration, anxiety and depression. Odours from livestock operations are a major concern raised by neighbours who feel their health or the enjoyment of their property is being adversely affected.

Odours from Manure

On a livestock operation, manure is usually the primary source of odours. The storage, management and land application of manure in Manitoba must be in accordance with the Livestock Manure and Mortalities Management Regulation (MR 42/98). Additional measures, as discussed here, may be necessary to further reduce odour nuisance from manure.

The intensity and type of odour is a function of the physical and chemical characteristics of the manure. All manures contain ammonia\ ammonium, but some manures, such as poultry manure, have very high natural levels. Ammonia has a characteristic pungent odour and is easily volatilized, contributing to the odour intensity of the manure.

The decomposition of manure also produces a large number of other gases. The types of gases and the rates at which they are produced depend on the temperature, moisture, oxygen level and other characteristics of the manure.

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. Both decomposition processes, aerobic and anaerobic, can occur during the various stages of the

manure management system. Liquid and semi-solid manures decompose anaerobically and often result in more odours than solid manures.

Sites of Odour Production

On a livestock operation, manure odours are generated in three areas:

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

In general, barns and outdoor confined livestock areas such as feedlots, are frequent or continuous sources of odour, because they operate year-round. Odours from barns may be more intense during the summer, because barn fans are running more to keep the animals comfortable indoors. Conversely, odours from barns tend to be less in the winter because barn fans are running less. Where the animals are housed outdoors, microbial decomposition of the manure slows due to the colder weather, generating less odour.

Odours from large, uncovered outdoor liquid manure storage facilities can be high, due to anaerobic decomposition of the manure, particularly during the summer. There may be negligible odour during the winter when the manure is frozen. Odours increase as the weather gets warmer, because anaerobic decomposition of the manure increases. As decomposition progresses, gases are generated, bubble to the surface and are slowly released to the atmosphere. Depending on the system used, transfer of the manure from the barn to the storage facility can increase the release of odourous gases.

Agitation of the manure in the storage prior to and during pump out, is necessary to suspend settled solids and homogenize the manure. Very high odour levels occur during agitation and pumping, as these operations greatly disturb the manure and accelerate the release of gases.

Land application of manure can also create intense and offensive odours. The strength of the odours is largely dependent on the type of manure and the method of application. Liquid manures and some poultry manures create more odour when applied to land than solid manures. These odours are best mitigated by using injection or incorporation immediately following application, because covering the manure with soil greatly reduces gaseous losses.

Planning and Managing to Reduce Odour Nuisance

The planning and management of livestock operations should include measures to reduce the intensity and frequency of odours that reach neighbours. There are opportunities to reduce odour nuisance by:

- siting the operation appropriately, including adhering to separation distances, considering wind and air drainage, and optimizing the use of naturally treed areas
- landscaping and planting shelterbelts
- designing and managing livestock housing to reduce odour nuisance
- managing manure storage facilities and piles to minimize odour nuisance
- applying manure to land using beneficial manure management practices and technologies

Siting the Operation

When deciding where to build a new livestock operation, it is ideal to locate the operation far enough from neighbours and other conflicting land uses to disperse and dilute odours as much as possible. Sites with as few neighbours as possible will also reduce conflicts due to odours.

Separation distances

Part 5 (Livestock Operations) of the Provincial Planning Regulation (81/2011) under The Planning Act includes reciprocal, minimum separation distances from new and expanding livestock operations to single residences and designated residential or recreation areas (Table 1). Due to the potential for odour nuisance, greater separation distances are required as the size of the operation increases. For the same reason, greater separation distances are required for earthen manure storages and feedlots than for other storage types and livestock housing systems.

Municipalities or planning districts must adopt separation distances in their zoning bylaws. Although the separation distances must be based on minimum requirements set out by the Manitoba government in the Provincial Planning Regulation, municipalities or planning districts can set them higher. These distances are meant to reduce the potential for conflict between livestock and non-farm uses, and should be applied mutually to both non-farm and livestock developments. The municipality should always be contacted to determine the required separation distances in the local zoning by-law. If the separation distance cannot be met, the operator can apply to council for a variance. There is a public hearing associated with the application for a variance and conditions may be attached if council chooses to approve it. Council's decision is final and there is no avenue for appeal.

SEPARATION DISTANCES

Separation distances are required distances between livestock facilities and residences or designated areas to reduce odour nuisance and other potential land use conflicts.

Photo credit: Google Earth

TABLE 1: Minimum separation distances for siting manure storage facilities, animal confinement facilities and feedlots

Size of Operation in Animal Units[1] (AU)	Minimum Distance (m)			
	From a Residence		From a Designated[2] Area	
	To Earthen Manure Storage Facility or Feedlot[3]	To Animal Confinement Facility[4] or Non-earthen Manure Storage	To Earthen Manure Storage Facility or Feedlot[3]	To Animal Confinement Facility[4] or Non-earthen Manure Storage
10 - 100	200	100	800	530
101 - 200	300	150	1200	800
201 - 300	400	200	1600	1070
301 - 400	450	225	1800	1200
401 - 800	500	250	2000	1330
801 - 1600	600	300	2400	1600
1601 - 3200	700	350	2800	1870
3201 - 6400	800	400	3200	2130
6401 - 12800	900	450	3600	2400
12801 and greater	1000	500	4000	2670

[1] The animal unit summary table is provided in Appendix A.

[2] Officially designated in a development plan and includes urban centres, settlement centres, rural residential areas, cottage areas, parks and recreational areas.

[3] Feedlot means an outdoor area that is fenced to confine livestock solely for the purpose of growing or finishing but does not include a grazing area or a seasonal feeding area.

[4] Animal confinement facility means a barn or an outdoor area where livestock are confined by fences or other structures, and includes a seasonal feeding area but does not include a feedlot or grazing area.

Wind and air drainage

Wind and air drainage can carry odours to neighbours. Prevailing winds, however, can vary between seasons. Since summer is the time when odours are more intense and neighbours are outdoors more often, the direction of the prevailing winds during the summer should be considered. Siting the operation so that summer prevailing winds are directed away from neighbours can minimize the number of times neighbours are exposed to odours.

AIR DRAINAGE

Air drainage is when air in contact with the ground is cooled and flows down slope, settling in low-lying areas.

Some landscapes can concentrate odours in an undesirable direction. During calm, summer evenings, the air near the ground will be cooled and drift down a slope. This is known as air drainage. In much of Manitoba, the land is fairly flat, so air drainage is not a major concern. However, if an operation is planned where a neighbour's residence is down slope, the potential for odour nuisance increases. As the air passes the livestock operation, it will pick up odours and carry them down slope. This phenomenon may occur frequently during calm summer evenings, at the same time when most people like to be outdoors.

Naturally treed areas and landscape features

As much as possible, livestock facilities should be blended into the landscape and natural vegetative buffers should be preserved. Multiple benefits can be derived from the maintenance of natural landscape features, including treed areas. Depending on their size and location, treed buffers can block wind and improve the energy efficiency of the farm, reduce snow accumulation, trap dust, disperse odours, blend the operation with the surrounding features of the local landscape and provide a visual and sound barrier.

Landscaping and planting shelterbelts

Attractive landscaping and well-kept grounds convey the owner's pride in their operation. The image of a well landscaped and maintained livestock operation can reduce odour complaints from neighbours, because they perceive it to be a responsibly operated farm.

Shelterbelts are strategically planted rows of trees, often around the perimeter of the yard site or manure storage facility. Like treed buffers, shelterbelts can:

- improve the energy efficiency of the farm
- reduce snow accumulation
- trap dust
- disperse odours
- blend the operation with surrounding features of the local landscape
- provide a visual barrier

The porosity of the shelterbelt varies with changes in height and leaf density. Although shelterbelts can trap dust and disperse odours, there is no way to quantify these potential benefits. Consequently, there are no known design standards or recommendations specifically for odour control. Typically, a three to five row shelterbelt is used.

Historically, landowners have designed shelterbelts to meet their personal needs 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 B, it is important to recognize that the purpose of this document is to provide generic advice that can be adapted to suit individual requirements. It is not intended to be used as a regulatory template. The number of rows, width between rows or spacing between trees, is as unique as each site and the landowner's reasons for planting trees.

Livestock Housing Systems

Odours from livestock housing facilities occur frequently, have long duration, and in some circumstances, may be continuous. Operations that have manure covered floors and dirty animals will have more odour problems than clean facilities with clean animals. A clean facility is not only a product of good management. It is also a product of good housing system design.

In large part, the housing system determines whether the manure will be managed as a solid or a liquid. The type of equipment used to handle the manure depends, in part, on the solids content of the manure. Liquid manure systems typically produce much more odour than solid manure systems due to the anaerobic decomposition of the manure. Well-managed, well-aerated, solid manure systems with generous amounts of bedding, generate the least amount of odour.

Beef

A major portion of Manitoba's cattle production takes place on pasture. When cattle are primarily sustained by grazing, the density of the cattle is low, the manure is spread naturally over large areas and the odours are negligible.

Seasonal feeding areas are temporary, outdoor animal confinement facilities, where the cattle are provided additional or all of their feed requirements on a seasonal basis, typically from fall to spring. The density of cattle in these areas is higher than pasture, but lower than feedlots. Calving areas can be either in barns or outdoors. They are also temporary animal confinement facilities. Cattle are moved out of seasonal feeding areas and calving areas for the summer when the pasture is ready.

Feedlots have much higher densities of livestock, resulting in solid manure accumulating in manure packs. In some cases, significant amounts of bedding is provided, which adds to the total volume of the manure pack. Wet manure packs are more odorous than dry manure packs. The feedlot should be designed, constructed and managed to keep the manure packs as dry as possible.

Rainwater should be diverted away from the pens and the pens should be sloped to allow precipitation to drain effectively. Any runoff that is contaminated with manure must be managed so it does not enter surface water. Continuous odours can be reduced with frequent removal of manure, although the cleanout itself may release pockets of trapped gas and cause odour intensity to increase temporarily.

Dairy

There are three main types of housing for dairy cattle: freestall, tie stall and loose housing. All use some amount of bedding. In tie stall and freestall barns, the bedding is provided in the stalls. Loose housing systems use much more bedding in a larger lying area, sometimes called a bedding pack.

Freestall housing allows the animals to move freely between the stall rows and the feed face, using alleyways. These alleyways are either solid or slatted concrete. The slatted alleyways have an under-floor pit that collects the manure. Manure is deposited into the pit directly by the cow or through the use of skid steers, scraper systems or robotic units. The pits are most often shallow, providing temporary storage, typically for about a month, although longer-term, deep under-barn pits are possible. Manure is transferred from the shallow pit to a permanent outdoor storage, using conveyors, gravity or pumps. Solid flooring is cleaned with automatic scraper systems, skid steers or a robot manure handler that can push or vacuum manure off alleyways and transfer it into the storage systems.

Tie stall facilities tether dairy cows into the stall space where they spend the majority of the time. There is a shallow gutter behind the stall into which manure and urine falls. Manure is removed via a simple chain driven scraper system to a temporary pit at the end of the barn. The temporary pit is typically pumped out daily to a larger outdoor manure storage.

Loose housing systems have both solid and semi-solid, or liquid manure. In addition to a concrete area where feed is provided, they have a large open-bedded area. Bedding such as straw is added on a regular, often daily, basis. Two to six months of bedding can accumulate before removal. In these systems, there is a solid floor feed alley and manure that falls in this area is removed, either with skid steers or automatic scrapers, to a liquid or semi-solid storage facility.

Layers

Most egg-laying hens and pullets in Manitoba are housed in conventional or enriched cage systems. Most of these systems have solid or semi-solid manure collection systems. Belts run below the cages, collect manure and transfer it to an above ground storage or field storage. In-barn dryers have been incorporated in a limited number of these systems, to reduce the moisture content of the manure and make it more stackable.

Some layer and pullet operations add water to the manure to manage it as a liquid. In caged systems with belts, the manure is transferred to a covered concrete pit via the belts, and water is added in the pit. In caged systems with no belts, the manure is collected underneath the cages, in shallow pits or gutters. Water is added to the gutters, so the manure can be scraped into the covered concrete pit. Some of these operations periodically transfer the manure from the pit to a larger outdoor manure storage facility, via pipeline.

In free-run housing systems, manure is handled as a solid. Free-run layers are most often housed on a single-tier, removable slatted floor, with a shallow concrete pit beneath that collects the manure. At the end of the flock, the manure is transferred from the pit to field storage. Aviary systems for layers and pullets are free-run systems with multi-tier surfaces. Manure in these systems is collected by belts under each of the tiers.

A small number of layer pullets are free-run indoors on solid floors using bedding. The solid manure is removed at the end of the flock cycle by front-end loaders or skid steers, then field stored. Free range operations provide access to both indoors and outdoors.

Broiler chickens and turkeys

Broiler chickens, turkeys and turkey breeders are free-run on the floor. These systems tend to use bedding or litter. The floors can be solid or have a combination solid and slatted floors. Typically, the pits and floors of free-run systems are cleaned out at the end of each flock, with front-end loaders or skid steers.

Broiler breeder operations use a free-run housing system with slats and shallow pits beneath. This system uses bedding in the scratch areas. The pits are inaccessible to the birds, but they collect the manure. The pits and floors of free-run systems are cleaned out at the end of each flock, with front-end loaders or skid steers.

Pigs

The vast majority of pigs produced in Manitoba are housed in barns with liquid manure handling systems. These systems are generally designed with shallow gutters or pits under slotted sections of the pens or stalls. Typically, each room in the barn has its own pit. The floors of the pits are sloped towards a plug and the pits are emptied by pulling the plugs. The manure then flows by gravity or is pumped to an outdoor manure storage facility.

There are a very small number of pig barns in Manitoba that have deep pits under the barn. Deep pits are emptied less frequently and there is much more opportunity for anaerobic decomposition

of the manure. To ensure acceptable air quality for the barn workers and livestock, these barns require a higher rate of ventilation. As a result, these barns may create more odour than barns with shallow gutters. However, they often do not require outdoor liquid manure storage facilities, which eliminates another major source of odours.

Hoop shelters are a housing alternative for grower-finisher pigs that results in solid manure. The simplicity of construction, natural ventilation, reduction of odours, and lower capital costs associated with hoop shelters, make them an attractive option for some producers. However, they can have added biosecurity risks. Most hoop shelters are quonset-shaped metal structures, covered with polyethylene tarps. The ends are left open for most of the year, but covered during the winter months. The floor of the shelter is covered with deep straw bedding. Hoop shelter systems are normally cleaned out after every batch of grower-finisher pigs.

Sheep

Manitoba has recently experienced an increase in large-scale sheep production, particularly breeding facilities. Housing systems for sheep typically use large quantities of straw bedding and solid manure handling systems. Sheep do not tolerate standing in wet conditions, therefore every effort is made to keep the bedding areas dry. Sheep are extremely efficient at re-absorbing water in the caecum, which produces very dry feces. If sufficient bedding is provided to soak up the urine, a dry solid manure will be produced that is typically low in odours.

Practices for Managing Odour from Livestock Housing Systems

In addition to maintaining separation distances between livestock housing and neighbours (Table 1), several approaches are available to help control odours from livestock barns, particularly pig and poultry barns.

Ventilation

Proper ventilation rates are required to remove heat and moisture from the barn and to prevent the formation of very unpleasant or dangerous pockets of gas in the building. In the winter, heating may be required in pig and poultry barns to keep the ventilation rates high enough to remove ammonia and other manure gases. The ventilation system should not draw foul air from the gutter or pit back into the housing. With a properly designed and operated ventilation system, pigs will develop relatively clean manuring habits. 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.

Frequency of manure removal

Odours in the barn can be reduced by removing the manure from the barn as frequently as possible. However, increasing the frequency of liquid manure removal from the barn may increase odours released from the manure storage facility, particularly if a top-loading manure transfer pipe is used. For operations with shallow gutter systems, care must be exercised not to affect the operational aspects of the gutter.

If emptying the pit relies on gravity flow, 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, or plugging issues.

In-barn dust reduction

Odour levels from pig barn exhaust may be reduced by reducing airborne dust. The misting of water or oil in the air, or the sprinkling of vegetable oil directly onto the floor, reduces the quantity of inhalable and respirable dust in the air. Airborne, respirable dust is very fine dust that is of particular concern for barn workers, as it can be inhaled deep into the respiratory tract. When applying vegetable oil to the floor, the application rate must not create slippery conditions for livestock and workers.

Biofilters

Biofilters that treat the air being exhausted from pig and poultry barns are promising technologies for reducing odours. Biofilters consist of a bed of very porous granular or fibrous material designed to allow rapid proliferation of aerobic bacteria. These bacteria thrive on the odorous compounds being exhausted from the barn, thereby neutralizing them.

Wood chips, straw, peat moss and compost are typical examples of the main component of a biofilter. For the air exhausted from the animal housing to pass through the biofilter, the ventilation system must be directly connected to it. Therefore, use of a biofilter is best considered during the design of the barn and ventilation system. There are currently no biofilters of this type on any commercial livestock operation in Manitoba.

Biofiliters that are located outside and exposed to Manitoba's climate, may only function in the warmer months. This is when odour reduction is needed the most, as barn ventilation rates are high and people tend to be outdoors. Biological activity within the biofilter may slow or stop during the winter months, unless the biofilter is protected from extremely cold temperatures or has sufficient warm air flow to remain active.

Ventilation rates are much lower in the winter to retain heat in the barn. If it is necessary to keep the biofilter active, ventilation rates may have to be increased. This will improve air quality in the barn, but may also increase heating costs to maintain favourable barn temperatures.

Feeding practices

Proper balancing of livestock rations to meet the nutritional requirements of the animals can reduce the production and release of some odorous compounds. For example, excessive protein in livestock diets results in greater excretion of nitrogen and increased ammonia volatilization.

Odour and ammonia volatilization have been shown to decrease when crude protein levels in a ration are lowered and the fermentable carbohydrate in a ration is increased. Crude protein may be reduced by formulating rations to match the requirements of the animals, using ingredients with high protein digestibilities, amino acids and phase feeding. Decreasing the crude protein, increasing amino acids and using organic acids in feed can also decrease the pH of the manure, which results in lower ammonia volatilization rates.

Manure and feed additives

A wide variety of chemical and biological products are marketed as a means to mitigate odours for the benefit of farm workers and the operation's neighbours. Research centres in Canada and the United States report very disappointing results with manure additives, due to the low and unpredictable efficacy of the product, or the high costs. However, some of these additives may prove helpful in reducing 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 merit for specific applications. Conclusive proof from scientifically-sound experiments, conducted by a reputable research organization, should be obtained prior to investing in these kinds of products.

Recent research has shown promising results for some feed additives in either improving feed digestibility by livestock, implying less excretion of odour-forming compounds, 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 facility. Nevertheless, the improvement of feed digestibility, along with potentially lower odour levels in livestock housing, may justify their use. Before being commercially available, feed additives must be registered under the federal Feeds Act and regulations.

Manure Storage Facility Design and Management

The most common types of liquid manure storage structures are earthen manure storage facilities and steel and concrete tanks. These structures are used by the pig, dairy and sometimes layer industries. The dairy industry also uses molehill storages, which results in solid, liquid and semi-solid manures.

There are also some in-ground, covered concrete manure storage structures for liquid layer and dairy manure. Water must be added to layer manure in order for it to be managed as a liquid. Most layer operations in Manitoba store manure as a solid in a permitted building.

Earthen manure storage structures have larger surface areas than circular, steel and concrete tanks that hold the same volume of manure. When open to the atmosphere, the larger surface areas of the earthen storages release more odorous gases.

Agitation of the manure when emptying the manure storage releases intense odours. Therefore, reducing the number of times the manure is agitated and land-applied will decrease the frequency that neighbours experience intense odours. A significant advantage of earthen manure storage structures is that they are often designed with sufficient volume to require emptying for land application only once per year. The more expensive steel and concrete structures are often built with a smaller storage volume, requiring them to be emptied in both spring and fall.

In addition to maintaining separation distances between open storage structures and neighbours (Table 1), several approaches are available to help control odours from open storage facilities.

Maintaining a crust on liquid dairy manure

The natural crust that forms on liquid dairy manure due to undigested forages and other solid particles, decreases the release of odorous gases to the atmosphere by reducing airflow over the manure. The crust can also act like a biofilter, neutralizing odour before it is released. The solids in pig manure sink and do not form a crust on the surface of the manure.

Covered liquid manure storage structures

The odours from covered liquid manure storage structures are much lower than from uncovered structures. Liquid manure storage covers effectively reduce odour from the storage structure by creating a physical barrier between the manure surface and the air, thus reducing gas and odour emissions. The use of straw and synthetic covers on earthen manure storage facilities has generally been limited to pig operations that are required to use them by the rural municipality as part of a conditional use approval, or by the Manitoba Farm Industry Board in response to an odour complaint.

There are many types of covers available, including:

- positively pressurized synthetic covers

- negatively pressurized floating synthetic covers
- non-pressurized floating synthetic covers
- geotextile woven covers
- straw

When choosing a cover, cost, odour reduction, durability, ease of installation and emptying of the storage should be considered.

Applying a straw cover – Due to the expense of synthetic covers, the most commonly required covers in Manitoba are straw. They have typically been applied to earthen manure storage facilities.

The capacity of the manure storage facility and the design of the manure transfer system should be considered before applying a straw cover. Operations that only apply manure in the fall and have a manure transfer system that delivers the manure below the surface are best suited to straw covers. For these operations, if odour from the storage facility is causing nuisance, a straw cover could be applied in the spring and maintained over the summer months when neighbours spend more time outdoors. Straw covers may not be appropriate for storage facilities that are emptied in the spring or early summer, or if the manure is top-loaded and would bury the cover.

A straw cover involves applying straw uniformly (typically 20 to 25 centimetres thick) with a special blower. A good quality 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, sink or is blown to one end of the storage facility, additional straw should be applied. Historically, barley straw has been used, because it is more buoyant and lasts longer than other straws.

Removal of the straw at pump-out is critical to maintaining the capacity of the storage facility for the long term. Complete removal of the straw requires a higher level of management and may require specialized equipment for chopping the straw during agitation. Sufficient chopping and agitation is required to minimize the plugging of pumps, hoses or outlet nozzles. 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.

Using a synthetic cover – Synthetic covers are much less common than straw. The high capital cost and the challenges with agitation and pump out have made synthetic covers unpopular with livestock producers. Synthetic covers are typically made of high-density polyethylene (HDPE) that floats on top of the storage facility.

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. Removal of the cover is challenging and may result in costly damage to the cover. If the cover cannot be repaired, large volumes of plastic may require disposal.

It may be most appropriate to only install synthetic covers on the secondary and tertiary cells of multi-celled storage facilities, where removal of the cover for cleanout is not necessary and risk of damage is minimized. The primary cell could then be covered using straw.

Bottom loading of the manure storage

Delivering the manure 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 via gravity requires the transfer pipe to be sized and sloped properly. If the conditions do not allow for gravity flow, proper design of a pump transfer system is necessary.

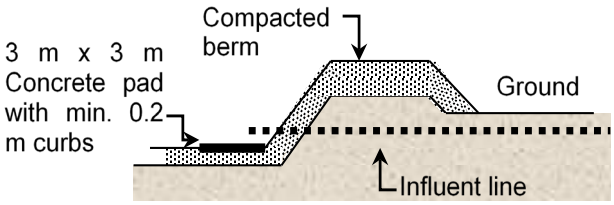

Figure 1. Representation of a bottom loading inlet to transfer liquid manure from the housing to the storage

Submerging a top-loading transfer pipe

If the manure is transferred to the storage via a top-loading pipe, extending the pipe into the storage beneath the surface of the manure will reduce turbulence and odour during transfer, similar to a bottom-loading pipe.

Field Storage of Solid Manure

Temporary field storage of solid manure is acceptable, provided it does not pollute surface or groundwater. The field storage site should take into consideration the potential for odour nuisance and the location of any neighbouring residences.

Well-managed, solid-manure piles with significant quantities of bedding, such as those generated by the beef, sheep and dairy industries, tend to generate the least amount of odour. Large quantities of straw or wood shavings create air pockets and channels throughout the manure pile, which facilitates aerobic decomposition with little or no offensive odour. Compacted manure piles, wet piles or piles with little or no bedding will produce more odours due to anaerobic decomposition.

Composting of Solid Manure

Composting is a controlled process in which microorganisms convert organic material into a stable, humus-like product, primarily through aerobic decomposition. Proper composting of solid manure should create little or no offensive odours. A permanent site for composting manure must be located at least 100 metres from the operation boundary.

Burning of Solid Manure

Burning solid manure piles creates unnecessary odour and smoke and is not permitted in Manitoba.

Land Application Practices and Technologies

The timing and location of manure application is dictated by the capacity of the manure storage facility, field availability, weather, soil moisture levels, soil nutrient status, crop requirements and regulations. The capacity of the manure storage facility will determine how many times a year manure must be applied. The facility must be large enough to eliminate winter application of manure and should allow some flexibility in timing spring or fall applications, to avoid unsuitable weather and poor field conditions.

The amount of odour released during manure application depends on the type of manure and exposure of the manure to the atmosphere. Spreading of solid manure typically results in less odour than liquid manure. Drier solid manures that contain significant quantities of bedding will create the least amount of odour. Wetter, solid manures have pockets of odour that will be released when applied on land. Land application of liquid manure can be a source of intense, objectionable odours. The less the manure is exposed to the air, the fewer odours are emitted.

Equipment selection

The application and incorporation equipment used to apply manure on land will influence the odours released. Injection and incorporation of manure on the same day as application, are the best management practices for reducing odours from land application. When manure is

injected or incorporated into the soil very soon after application, odours, ammonia volatilization and the risk of nutrients being lost in runoff are minimized and nutrient retention for crop use is maximized. More careful timing and field selection are necessary when the method of application increases odours.

Solid Manure Application – Odours from surface application of solid manure can be reduced if the manure is incorporated into the soil as soon as possible after application. This is achieved with a separate tillage pass. Odours from some solid manures that are surface applied without incorporation may linger for days following application.

Liquid Manure Application – There are a number of equipment options for liquid manure application. Various tool bars can be attached to tankers or drag hoses, each with different levels of odour control. The use of drag hose systems has the added advantages of reducing soil compaction and eliminating the need to drive back and forth from the field to the storage facility to fill the tanker, which can result in significant wear and tear on the roads and longer application times.

Direct injection systems: Proper injection of liquid manure markedly reduces odours from land application. The type of injection system depends on the soil openers attached to the injection toolbar. They can be grouped into high disturbance and low disturbance systems.

High Disturbance injection systems – High disturbance injection systems have shank-type injectors using sweeps or knives. These systems have the potential for the greatest odour reduction. They create considerable soil and residue disturbance and are therefore particularly suited to annual cropping systems under conventional tillage.

Low disturbance injection systems – For some forage crops and direct seeding systems, low disturbance, disk-type injectors allow liquid manure to be injected with less plant, residue or soil disturbance. A narrow slice is made through the plant material into the soil and the manure is dropped into the furrow. The furrow may be left open or closed if the toolbar is equipped with trailing twin discs. These systems may produce more odour than the high disturbance injectors if manure remains on the soil surface for a longer period of time.

Aerway application: Another type of low disturbance applicator has a series of spikes mounted on an axle which poke the soil creating a soil aeration effect. Liquid manure is delivered through a drop hose, behind or in front of each knife set. The spike angle can be adjusted and made more aggressive, increasing the aeration effect. This low disturbance applicator is an effective tool for minimum till, zero till or forage fields, as it accelerates infiltration of the manure into the soil, significantly reducing the odour compared to surface application without aeration.

Low level drop hoses: Low-level drop hoses and dribble-bar systems that direct manure toward the ground, reduce odours during application by reducing the exposure of the manure to the air. When used on a growing crop, dribble bars deposit manure directly on the soil beneath the crop canopy. Considerably less odour is released following application with low level application systems, compared with high level broadcast applicators. Odour can be further reduced on tilled soils if the manure is incorporated as soon as possible after application.

Low level splash plates: Low-level splash plates distribute the manure slightly above the ground or crop canopy. They reduce odours compared to high-level broadcast applicators and splash plates, by reducing the exposure of the manure to the air. The duration of the odour can be reduced on tilled soils if the manure is incorporated as soon as possible after application.

High level broadcast: Manure tankers are typically used for high level broadcasting of liquid manure to land. The potential for odours is greater with high-level broadcasting than with injection systems or low-level applicators, as the manure is discharged high into the air. Manure should be incorporated as soon as possible following application on tilled soils to reduce the duration of the odours from these systems.

Irrigation equipment (Big Gun): Stationary or traveling irrigation equipment can be used to apply liquid manure. Irrigation equipment saves a great deal of labour. However, it is not recommended in most circumstances, as it can result in very uneven application and it has the potential to create the greatest odour nuisance. As well, due to high nitrogen volatilization losses, higher manure application rates are required to reach the nitrogen requirement of the crop. This can create a greatly imbalanced fertilizer and over-application of phosphorus.

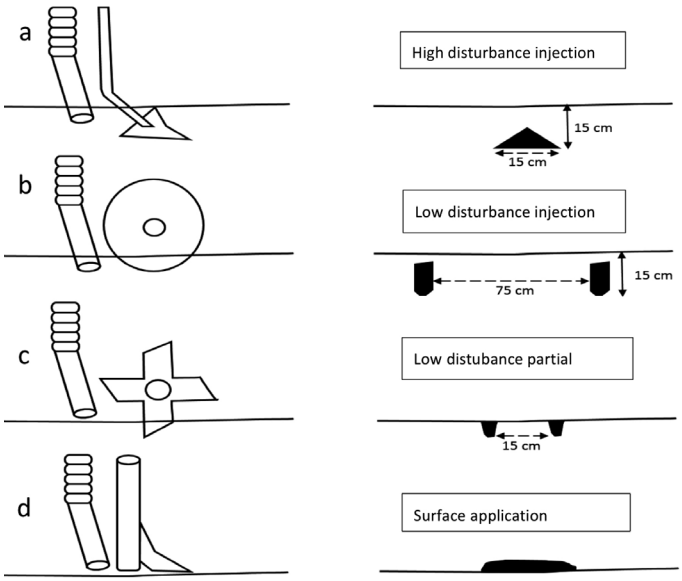

Figure 2: Application implements from high disturbance to surface application a) chisel injector b) disk opener c) aerway d) sleigh foot

Consideration of neighbours

Although manure is typically applied on fields only once or twice a year, it can cause intense odours that may persist for days. Producers should consider the following recommendations when planning their annual manure application activities:

- 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 summer weekends and holidays when neighbours are more likely to be outdoors.
- Incorporate manure as soon after surface application as possible on tilled lands.
- Consider injecting liquid manure for tilled fields near residences.
- Use low-level application equipment whenever possible.
- Maintain setbacks that are reasonable for the type of equipment used. Table 2 can be used as a guideline for manure application setback distances from residences.

Table 2: Odour potential and recommended setback distances from residences for land application of manure

Manure Type	Application method	Odour Potential[1]	Distance to Residence[2,3] (m)
Liquid manure	Big gun irrigation	Very high	Not recommended
Liquid manure and poultry manure with little or no bedding	Surface applied to conventionally tilled soils no incorporation	High	400
Solid manure with moderate to high bedding rates	Surface applied to conventionally tilled soils no incorporation	Moderate	150
All manures	Surface applied to forages, growing crop, minimum till or no-till land	Moderate	150
All manures	Surface applied and incorporated within 48 hours or surface applied using partial injection or incorporation tools that leave some manure on the soil surface	Low	75
Liquid manure	Direct injection with no manure on soil surface[4]	Very Low	15

[1] Odour potential refers to the intensity of the odour at the time of land application and/or the duration of the odour following application.

[2] Regardless of the setbacks for odour provided in Table 2, manure must not be applied within 15 metres of any residential well when the setback is vegetated, and 20 metres of any residential well when the setback is bare.

[3] Higher distances may be appropriate when applying manure near moderately to heavily populated areas.

[4] Excluding headlands.

Odours from Mortalities

Although most of the odours from livestock operations originate from the manure, livestock mortalities can also be a source of odour if not managed properly. Disposal of mortalities must be in accordance with Section 15 of the Livestock Manure and Mortalities Management Regulation (MR 42/98). Acceptable methods of disposal include delivery to a rendering plant, burial, composting and incineration. It is important that mortality disposal include effective steps to mitigate odour. Special precautions must also be taken when disposing of livestock mortalities that result from a reportable disease. Contact your veterinarian for guidance in this case.

Rendering

Rendering is an excellent option for disposing of non-specified risk material (non-SRM) mortalities, and many parts of Manitoba have regular pickup services. Rendering plants do not accept SRM, which are specific parts of older ruminant livestock that could contain the bovine spongiform encephalopathy (BSE) agent. These materials can be delivered to licensed landfills that accept SRM, such as the Brady Landfill in Winnipeg.

Burial

On-farm burial of routine mortalities is only permitted for operations under 300 AU. The burial location must be covered with at least one metre of soil. This soil cover should be sufficient to eliminate odours.

Composting

Mortality composting is a controlled process in which bacteria, fungi and other microorganisms convert the dead animals and organic material into a stable, humus-like product through both aerobic and anaerobic decomposition.

There are three phases with mortality composting. In the first phase, mortalities are placed on, and completely covered by, 18 to 24 inches of absorbent bulking material that is high in carbon, such as sawdust, straw or wood chips. During this phase, anaerobic microorganisms decompose the mortalities, releasing fluids and gases. These fluids and gases are extremely odorous. For this reason, it is essential that the mortalities be covered with at least 18 inches of bulking material at all times during the first phase. When the fluids and gases enter the bulking material, aerobic microorganisms break them down into relatively odour-free compounds.

The second phase of the composting process begins when most of the animal has decomposed and the pile is turned for the first time. During this phase, the compost pile is turned regularly to introduce oxygen and increase aerobic microbial activity. Objectionable odours are still generated during this phase, so the pile must be covered again with bulking material immediately following turning. At the end of the secondary phase, there should be no flesh, and most bones should be brittle and easily crushed. Larger bones can be used as an inoculant for subsequent compost piles.

During the third or curing phase, the compost pile is left undisturbed for at least 21 days. The volume of the pile should be reduced and the original feedstocks and mortalities should be difficult to identify. The temperature inside the pile should be less than 8°C higher than ambient temperature. Properly finished compost should appear as a dark, granular material resembling humus or potting soil. It may have a slightly musty or earthy odour.

When locating the composting site, the farm residence and any neighbouring residences should be taken into consideration. Permanent composting sites that use manure must be located at least 100 metres from the operation boundary.

With the exception of turning the pile, proper composting should not result in offensive odours. However, the handling of mortalities and compost on a daily basis may be unpleasant for some neighbours. The following factors should be considered when selecting a mortalities composting site:

- traffic patterns required to move deadstock to the composting site
- accessibility for managing the pile and maintaining the bulking material cover
- preventing scavenging animals from accessing the site
- wind direction
- aesthetics

Incineration

Incineration is an acceptable method of mortality disposal if performed in accordance with the Incinerators Regulation (91/88 R). For mortalities to be burned without creating an odour problem, the temperature of the incinerator must be sufficiently high.

Storage, Refrigeration, Freezing and Transport

Livestock mortalities that are not immediately disposed of must be properly stored to minimize odours. The Livestock Manure and Mortalities Management Regulation (MR 42/98) specifies that mortalities must be kept in a secure storage room, covered container or secure location. This will prevent access by scavenger animals, such as coyotes, wolves, dogs or birds. As well, mortalities must be continually frozen or refrigerated if not disposed of within 48 hours after death, unless arrangements have been made to have them picked up for rendering within four days.

If disposal is occurring at an offsite location, additional care should be taken during transport to prevent odours and spillage. Commercial deadstock transporters use specialized equipment to contain odours and prevent spills. Producers that choose to transport their own mortalities should use vehicles or containers that do not allow spillage, are not overloaded, and are able to have the material completely covered.

Nuisance Complaint Resolution

The Farm Practices Protection Act

In Manitoba, nuisance complaints related to agricultural operations are governed under The Farm Practices Protection Act. When a dispute arises, the complete legal text of the act should be consulted. Unofficial copies of all Manitoba laws can be obtained from the Manitoba government website.

The Farm Practices Protection Act was proclaimed in January 1994. It protects farmers who carry on their farming operations using normal farm practices from unreasonable court action under the common law of nuisance. It also protects neighbours from nuisance (disturbance) caused by unacceptable farming practices.

The act is intended to provide for a quicker, less expensive and more effective way than lawsuits to resolve nuisance complaints about farm practices. It is meant to create an understanding of the nature and circumstances of an agricultural operation, and bring about changes to the mutual benefit of all concerned, without the confrontation and expense of the courts.

The Farm Practices Protection Act is administered by the Manitoba Farm Industry Board. The act establishes a process for reviewing and mediating nuisance disputes arising from the practices of legally-established agricultural operations.

The act states that a person who carries on an agricultural operation, and who:

- uses normal farm practices
- does not violate a land use control law, The Environment Act or regulations and orders, or
  The Public Health Act or regulations and orders

is not liable in nuisance to any person for any odour, noise, dust, smoke or other disturbance resulting from the agricultural operation, and shall not be prevented from carrying on the agricultural operation because it causes or creates an odour, noise, dust smoke or other disturbance. This protection from liability continues even if the land use bylaw of a municipality is amended, the ownership of the agricultural operation changes, or the use of land near the agricultural operation changes.

A normal farm practice is defined as a practice conducted in a manner consistent with proper and accepted customs and standards, as established and followed by similar agricultural operations under similar circumstances, including the use of innovative technology with advanced management practices, and in conformity with any standards set out in regulations.

A person who is disturbed by any odour, noise, dust, smoke or other disturbance resulting from an agricultural operation may make a complaint to the Manitoba Farm Industry Board. The complaint must be in writing and must state the nature of the disturbance, the name and address of the person making the application, and the name and address of the agricultural operation. The board will only consider nuisance complaints and will not deal with pollution, inhumane treatment of animals or other non-nuisance complaints. Complainants may not undertake nuisance action in court, unless they have applied to the board in writing, at least 90 days in advance, for a decision on whether the farm practice is normal.

When the board receives the nuisance complaint, it may investigate the disturbance, attempt to mediate the complaint, gather evidence, hold hearings and determine if the disturbance results from a normal farm practice. It may also refuse to consider the complaint if, in its opinion, the subject matter is trivial, frivolous, vexatious, or the complainant does not have a sufficient personal interest in the matter.

If the board is unable to resolve the dispute between the complainant and the owner or operator of the agricultural operation, the board will:

a) dismiss the complaint if the board believes that the disturbance results from a normal farm practice; or

b) order the agricultural operation to stop the farm practice that is causing the disturbance, if the board believes it is not a normal farm practice, or modify the practice in a manner set out in the order, to be consistent with normal farm practices

A decision of the board will be considered by the court in any subsequent nuisance action regarding that agricultural operation.

If the agricultural operation fails to comply with the order of the board, the board can file its order with the court and apply to the court to have the order enforced. This could subject the owner or operator of the agricultural operation to court-imposed enforcement and remedies.

CONTACT INFORMATION:

Manitoba Farm Industry Board
Policy Branch
Manitoba Agriculture and Resource Development
812-401 York Avenue
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Phone: 204-945-3856
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APPENDIX A: Animal Unit (AU) Summary Table

	AU PRODUCED BY ONE LIVESTOCK	LIVESTOCK PRODUCING ONE AU
Dairy		
Mature cows (lactating and dry), including associated livestock	2.000	0.5
Beef		
Beef cows, including associated livestock	1.250	0.8
Backgrounder	0.500	2
Summer pasture/replacement heifers	0.625	1.6
Feeder cattle	0.769	1.3
Pigs		
Sows, farrow to finish (110-115 kg)	1.250	0.8
Sows, farrow to weanling (up to 5 kg)	0.250	4
Sows, farrow to nursery (23 kg)	0.313	3.2
Weanlings (5-23 kg)	0.033	30
Growers/finishers (23-113 kg)	0.143	7
Boars (artificial insemination operations)	0.200	5
Chickens		
Broilers	0.0050	200
Roasters	0.0100	100
Layers	0.0083	120
Pullets	0.0033	300
Broiler breeder pullets	0.0033	300
Broiler breeder hens	0.0100	100
Horses		
Mares, including associated livestock	1.333	0.75
Sheep		
Ewes, including associated livestock	0.200	5
Feeder lambs	0.063	16

Other livestock or operation type - Please inquire with Manitoba Agriculture and Resource Development.

APPENDIX B: Shelterbelt Establishment

Adapted from Agriculture and Agri-Food Canada's Basic Shelterbelt Establishment Guidelines for Prairie Livestock Facilities.

Introduction

Properly-planned shelterbelts around a livestock facility provide many benefits. Shelterbelts reduce the expense of snow removal by trapping snow, and reduce heating and maintenance costs of buildings by reducing wind velocities. Protected livestock are generally healthier and require less feed. Shelterbelts have the potential to effectively control odor, particularly when used in combination with other methods. They also help blend the physical features of the facility with the landscape, and provide a more pleasant working environment.

Planning a Shelterbelt

Proper planning of a shelterbelt involves reviewing your present requirements, assessing your future needs, estimating the quality of existing shelterbelts, and planning new shelterbelts to achieve the benefits.

Most livestock facilities would have had some scale ground plans that provide the necessary measurements and locations of existing trees, sloughs, buildings, manure storage facilities, corrals, access roads and power lines. If not, it is recommended to measure and map the area, keeping in mind prevailing wind directions and areas where excessive snow accumulations can cause problems.

To eliminate problems with snow buildup, it is recommended that all shelterbelts be at least 30 metres (100 feet) from main buildings, manure storage facilities and access roads. Compliance with shelterbelt setback regulations, established by rural municipalities, is strongly recommended, in addition to regulations set by Canadian railroad and provincial highways and transportations departments, where applicable.

Shelterbelt Design

There is no single, ideal shelterbelt design, with a set number of rows, planting width or species for every livestock facility. Factors such as soil conditions, operational activities, and layout among buildings, lagoons and roads must be taken into consideration to ensure the success and usefulness of the shelterbelt over the long term.

For odour protection, a three-row shelterbelt is recommended where space is not limited, to obtain basic wind and snow protection (Figure B1). Up to five or six rows of trees can be planted on the sides of the property most subject to prevailing winds, or in areas where greater shelter is required to reduce wind or trap snow.

Shelterbelt Maintenance

Using plastic mulch greatly reduces the growth of weeds and grass within the rows and allows trees to thrive in the early years. Mowing or tilling between the rows is still required to help control weeds. Trees should be planted at least 30 metres away from manure storage facilities to allow access.

Figure B1: Three row shelterbelt.

The shelterbelt design should consist of a combination of dense shrubs, tall deciduous and coniferous material. Fast-growing trees can be planted to provide benefits sooner, but long-lived trees should also be considered for lasting effect. This can be accomplished by using a variety of species, each possessing at least one of the desired characteristics.

The outside row of a shelterbelt acts as a snow trap and starts to deflect the wind current upwards. This row should be a dense shrub, 15 to 30 metres (50 to 100 feet) from the inside tree rows. This row acts as a trip line, and reduces the size of snowdrifts that build up on the inside of the tree rows (Figure B2). The tree rows should consist of a fast to moderate-growing species and a long-lived species at a minimum. If space allows, additional tree rows closer to the site could be tall, dense and long-lived conifer species.

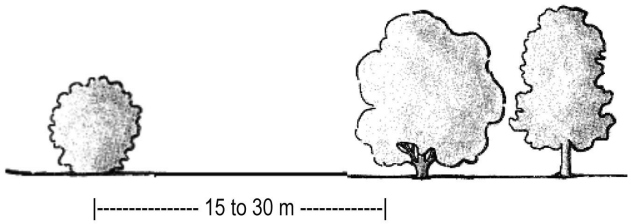

Figure B2: Shelterbelt spacing

Establishing an alley crop system, with distances up to 30 metres (100 feet) between tree rows would achieve the benefits of a traditional shelterbelt system, and allow for the production of crops or forage between the tree rows. This would allow for greater use of the land surrounding the livestock facility.

A proper shelterbelt design for a livestock facility should be developed separately for each site and circumstance. On-site consultation ensures that all soil and site conditions are assessed accordingly, and that no other activities surrounding livestock production are compromised with the establishment of a shelterbelt.