Composting Animal Manures

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Take Home Message

✓ Composting is one of the manure management techniques used by farmers. It involves the natural biological breakdown of the manure into a more stable 'humus-like' substance. It has some significant benefits and some drawbacks. Whatever the intention, it should be realized that composting is a major undertaking which will require the same commitment and management as other parts of a livestock operation in order to be successful.

Benefits

Benefits of composting animal manures include improved manure handling, improved land spreading, a lower potential risk of contamination of water, a significantly lower potential for nuisance complaints, destruction of most weed seeds and pathogens, the production of an excellent soil conditioning product, and improved soil tilth and disease suppression.

Improved manure handling

Composting reduces the weight and volume of the manure-bedding mix, primarily as a result of reducing its moisture content. This means that it can be hauled longer distances to spreading sites than 'raw' manure for the same transportation cost. It is also easier to handle than manure and stores well with reduced odours and fly problems. Compost, as a result, can be applied to fields at more convenient times of the year. This is especially important for farmers practising no till or reduced tillage farming.

Composting also provides improved flexibility in the management of manure in pens. This is achieved by allowing pens to be cleaned more often and at any time during the year or when the pen is vacant. This can reduce cattle stresses by not having to move them when pens are to be cleaned.

Improved land spreading

Compost is an easier product to land spread than manure. It has fewer clumps than manure and is easier to spread more uniformly and accurately. Some of the equipment currently used to spread manure may require slight modifications in order to achieve uniformity and accuracy of spreading compost versus manure. These modifications are however, generally minor in nature.

Reduced odour nuisance

While some odours are given off during the composting process, these are generally released during pile formation and initial turnings. Any odours produced are localized to the compost site (often near the feedlot) and can be minimized quickly with good compost management. The finished compost will normally have a non-offensive humus like smell. This can be a significant benefit to farmers, especially if the product is spread near houses or built up areas.

Soil conditioning and soil tilth

Both manure and compost are good soil conditioners with some crop nutrient value. Historically manure is spread onto the land directly from the feedlot, providing soil-conditioning properties similar to those of compost. Thus soil conditioning alone does not justify making compost from manure.

There are, however, other benefits to be gained by composting. These include the conversion of nitrogen in manure into more stable organic forms. Some nitrogen is lost in this process, however, the resulting product is less susceptible to leaching or volatilisation.

The heat generated during the composting process significantly reduces the number of viable weed seeds and pathogens remaining when compared to >raw= manure. This can have spin-off effects as far as reducing herbicide costs for farmers. Its nutrients will also reduce the requirement for inorganic fertilizer. The more complex organic forms of nutrients found in compost provide fertility characteristics such as the gradual availability of phosphorus and nitrogen that is beneficial to some crops.

Compost improves soil tilth and may improve the soil's ability to mineralize existing and added nutrients.

Disease suppression

Research and field trials are suggesting that an improvement in the soil environment, such as the use of compost, has resulted in some of the more common plant diseases being suppressed. This has been attributed to an increase in the number of beneficial microbes in the soil. These microbes occur naturally in compost. This will obviously have a positive impact in reducing the amount and thus cost of pesticides used on these fields.

Drawbacks

Drawbacks to composting include cost, management and time commitments, potential odour, site requirements, additional handling of product, potential loss of nitrogen, and the slow release of nutrients from the composted material.

Cost, management and time

Like any other processing operation composting requires equipment, labour, management and a suitable location. The initial cost of setting up a composting operation can be reduced if a suitable composting site and existing farm machinery and facilities can be used. This type of approach is generally used if small volumes of manure are composted, however, costs escalate when the volume of manure to be composted requires the purchase of specialized equipment and / or the development of a suitable composting site. The actual costs incurred vary depending on the type and quantity of equipment needed as well as the amount of work required to develop a suitable site.

Similarly the amount of management and time required to adequately monitor and control the process will be dependent on the amount of manure to be composted and the type of equipment used.

In Southern Alberta, one of the main drawbacks is the loss of moisture from the compost windrows during windy summer conditions. This is especially the case if the windrows are turned too often. If the composting material is allowed to dry out the process will shut down by itself. Composting over winter will help to alleviate this problem, as evaporation rates are significantly lower. In situations with smaller volumes of manure being composted, hauling and spraying water on the windrows may be feasible.

Odour

While the end products of the composting process are virtually free of odour, the composting process itself does generate odours, some of which may be offensive to neighbours. Mismanagement of the process can also sometimes result in odours being generated. If managed properly, the composting process will tend to generate more odours when the process is being initiated and also when windrows are being turned. Careful consideration should, therefore, be given when siting a composting operation.

If the composting is carried out at the feedlot site, it is very difficult to distinguish the compost odour from that of the feedlot itself.

Site requirements (**Figure 1**)

A composting site should provide enough space for storage of manure and bedding, the compost piles or windrows, as well as for storage of the finished product. Alberta's Environmental Protection Department has of Code of Practice for Composting Sites, which provides details as to the physical and operational requirements of a site. These requirements include a well-drained composting pad having specific permeability restrictions, run-on and runoff water control structures and the provision of a runoff storage structure.

Additional handling requirements

Composting requires extra handling of manure compared to the direct application of manure to fields. This handling includes the placement of the manure and bedding material into composting piles / windrows, a method of aeration such as turning or static / forced aeration, and finally the loading of the material for transportation for use.

Potential loss of nitrogen

Composted manure generally contains at least 50% and up to 90% of the nitrogen found in fresh manure. A good manure handling system will generally conserve most of the nitrogen found in the manure, so composting manure poses a potential nitrogen loss. However, if manure is not incorporated quickly into the soil when spread, nitrogen is rapidly lost to the atmosphere. This could result in less nitrogen being available for crop use from fresh manure than from compost.

Slow release of nutrients

Nutrients in compost are generally in an organic form, which needs to be mineralized in the soil prior to becoming available to plants. This process takes time and, therefore, not all of the nutrient may be available to plants in the first growing season. Fertilization levels as well as application rates must be adjusted accordingly.

Site Location For Composting: Environmental Considerations

The siting and location of a composting facility is fundamental to the viability of the operation. There are several key items that should be considered when siting a composting facility. The proximity of the site to both the livestock operation as well as neighbours needs to be considered. Separation distances should be applied to a compost facility and should be the same as those for a manure stockpile.

The layout of the site is also important (**Figure 1**). The Alberta Environmental Protection Code of Practice for Compost Facilities details specific site requirements for compost facilities.

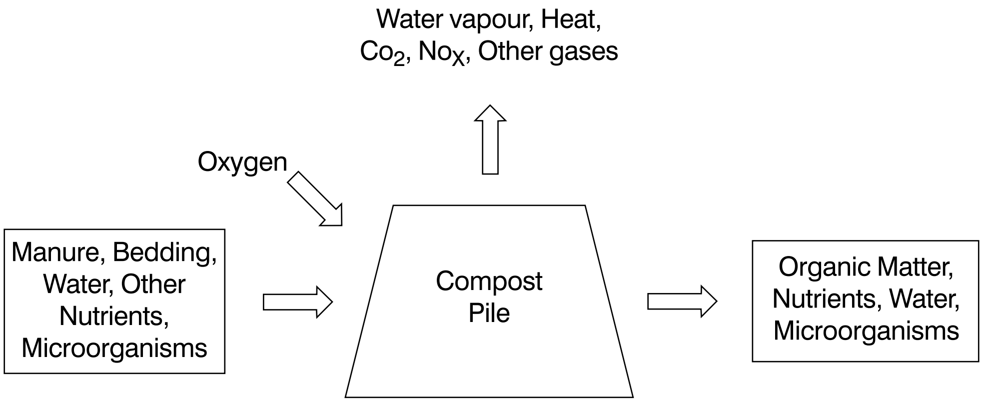
These include:

- The construction of a composting pad comprising a minimum of 0.5 m of clay-type material having a permeability of less than 5×10^{-8} m/sec (or alternate material that provides equivalent protection);
- Constructed with a minimum slope of 2% so that the pad does not collect water or leachate;
- The provision of a run-on control system to prevent the flow of surface water onto the storage, processing and curing areas;
- The provision of a runoff control and management system that provides protection of surface water quality;
- In addition, a groundwater monitoring system may be required.

The Composting Process

Composting is the aerobic decomposition of organic materials by microorganisms under controlled conditions. During the composting process the microorganisms feed on organic matter while using oxygen. This active composting process generates a lot of heat and releases a large quantity of water vapour as well as carbon dioxide, nitrous oxides and other gases (**Figure 2**). These losses can amount to as much

Figure 2. The Composting Process.



as one half of the weight of the initial materials. Composting reduces both the mass and volume of the initial materials whilst transforming them into a valuable soil conditioning material.

The composting process is most rapid when the optimum growth conditions for the microorganisms are maintained. These optimum conditions include the following:

A Carbon to Nitrogen ratio of	20:1 – 40:1 (it will work as low as 10 - 15:1)
Moisture content	40% – 65%
Oxygen Concentrations	greater than 5%
pH	6.5 – 8.0
Compost Pile Temperature	40°C – 40°C

The process will start as soon as appropriate materials are mixed together. With the process starting, the microorganisms will start to consume the oxygen present. In a very short time, most of the oxygen will have been consumed and the process slowed or even stopped until the oxygen supply can be replenished. It is thus critical to ensure that the composting material is supplied with a continuous source of oxygen. This can be accomplished in a number of ways which include; forcing air into the pile, turning the pile frequently, or by providing a passive air exchange. Generally, farmers will utilize a combination of turning and passive air exchange to manage the process.

Since heat is a direct byproduct of the process, it becomes a good process indicator. Temperature increases or decreases occur within a short period of a change in microbial activity. Typically in a composting process the temperatures will rise rapidly initially and be maintained for several weeks before tailing off and finally dropping to the ambient air temperature.

Decreases in temperature during the initial weeks of the composting process are easily identified and, in most cases, can be attributed to a decrease in the amount of available oxygen in the pile or a decrease in the moisture content.

Once the active process is completed, a curing period is usually entered. While curing, the composting action continues; but, at a much slower pace and will generally not require any further turning or forced aeration. The composting process has no defined completion point, however, compost is generally deemed to be 'done' by considering characteristics relating to its odour, temperature, C:N ratio and oxygen demand.

Raw Materials

The primary raw materials required from a feedlot operation for composting are manure and bedding material. The manure contains the nitrogen, moisture and microorganisms, while the bedding material provides most of the carbon required for the process as well as being a bulking agent adding structure, porosity and texture. The key to getting the process underway is to reach the desired C:N ratio, have the right moisture content, and have the bedding and manure well mixed.

The coarser the bedding material the easier it becomes to provide a passive method to aerate the compost pile. However, the longer it will take to properly compost the larger pieces of material. It should be noted that coarse bedding such as wood chips are excellent bulking agents, but do not allow all of their carbon to become available to microorganisms during the composting process.

Composting Methods

There are three more common types of composting systems. These are categorized with reference to the type of aeration system used.

Active Aeration

This is generally where piles or windrows are aerated by frequent turnings which reform the pile structure allowing new air exchange passages. This is a system commonly associated with large operations like those found on some feedlots. The composting material is generally set out in windrows (**Figure 3**) and some form of mechanical turning equipment used to turn the windrow (**Figure 4**). Active aeration windrow composting is more labour intensive than static-pile passive-aeration systems because of the management and methods used to aerate the compost.

Static pile / passive aeration

This is where the piles or windrows are not turned and usually rely upon natural air systems to supply sufficient aeration (**Figure 5**). This system is more common on smaller composting operations. The process usually takes significantly longer than active aeration and the product produced is generally less consistent. Other problems associated with passive aeration are due to the uneven temperature distribution in the pile or windrow. This results in not all of the weed seeds or pathogens being killed during the process. The most important management parameter is to ensure that enough air is entering the pile and that it is evenly distributed. This can be achieved in a number of different ways, each requiring some form of management. This system of composting has a lower overall labour requirement when compared to active aeration systems, although the labour requirement has peaks when the piles are constructed and removed.

In vessel aeration

This is where compost is made in large containers, silos or channels (**Figure 6**). These systems are invariably aided by forced aeration systems and / or constant or periodic mechanical agitation. This process is one of the more costly to set up and is not necessarily well suited to feedlot operations. Most in-vessel systems have automated or semi-automated equipment controlling different aspects of the process.

Composting Operations

The composting process itself is only one of many steps needed to produce compost. Once the composting process requirements have been satisfactorily addressed, the production of compost becomes largely a matter of materials handling. While aeration, and other aspects are critical to the process and should not be overlooked, most of the labour and equipment involved in a composting system are used to move and mix materials. It can be just as important to choose the correct equipment as the method of composting.

Feedlot composting operations seldom involve more than the storage and mixing of raw materials, pile or windrow formation, curing and storage of compost. In some instances, depending on the end use of the compost, secondary-handling equipment may be required. This is generally the case if the compost is to be bagged or prepared for specific markets.

Careful planning should go into the flow of operations from raw materials to finished compost when developing a composting site. Some Alberta site considerations include the orientation of windrows. Generally, it is preferred to have a N – S orientation because of the position of the sun, however, consideration to orientating windrows perpendicular to prevailing strong winds is also recommended. The type of equipment used to handle the materials will play a role in the layout of a site, as will temperature and other climatic constraints.

It is possible to utilize contractors to carry out the composting operation for a feedlot. Generally agreements are reached, where feedlots provide a suitable site for the operation to be carried out as well as providing a source of raw materials to that site. The contractor then generally processes and markets the compost on mutually agreed terms. This can provide both a possible source of income as well as a simplified manure handling operation to a feedlot, at the same time producing a relatively odourless product acceptable to most communities.

Using compost

The use of compost is widespread in our society, however, marketing compost from a feedlot may require special approvals be obtained from Alberta Environmental Protection and possibly other federal agencies. This is especially the case if it is proposed to market the compost for use off of the farm, such as to the urban market.

By far the biggest market for compost is supplying it to farms for spreading on agricultural land. Farmers throughout the province are quickly realizing the benefits of utilizing compost as a soil conditioner and nutrient source and are becoming more receptive to considering its value in monetary terms. This together with the fact that compost is becoming more readily available in many areas all act to enhance the value of the product. Fertilizer-type centrifugal broadcasters, special compost spreaders or modified manure spreaders are better able to spread compost because it has a smaller particle size and less coherence than manure. These systems may also be adapted to allow for inorganic fertilizers to be mixed in with the compost at the time of application to meet crop nutrient requirements.

Summary

While composting may not be applicable to all feedlots, there are benefits associated with the extra processes required for its production. In some cases, these benefits are seen to be very valuable to the feedlot operation and may justify the development of a composting operation at that site. Research and development continues into the production and utilization of compost within the agricultural sector. This continues to identify potential improvements to existing composting systems as well as the methods and areas of compost usage.

To date, the number of feedlots with composting operations in Alberta is limited. However, as demand for the product and need to better manage manure nutrients increase more feedlots are looking at the process.

References

1. On-Farm Composting Handbook. Natural Resource, Agriculture, and Engineering Service, USA
2. Code of Practice for Compost Facilities. Alberta Environmental Protection.

Figure 1. Composting Site Design.

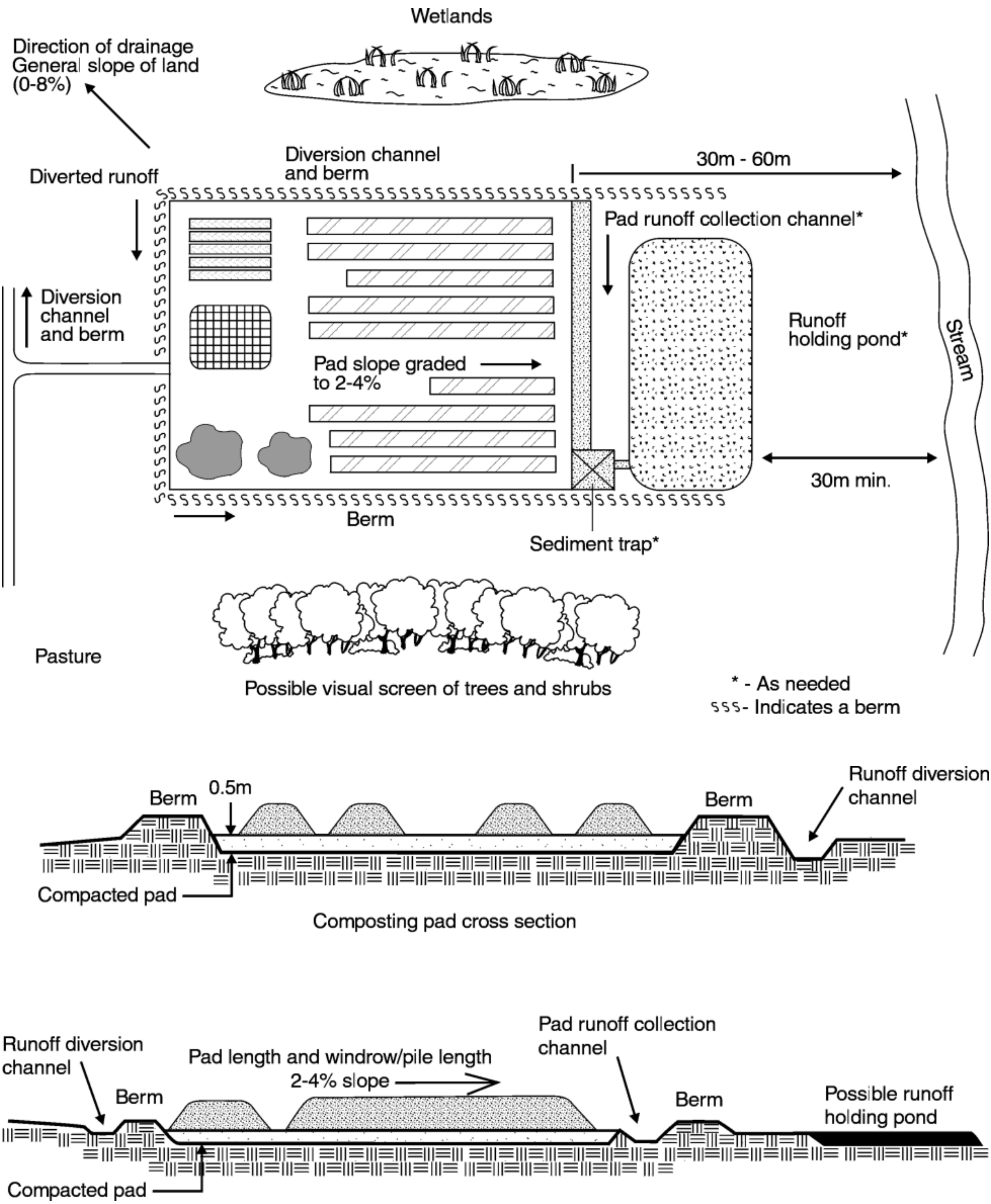


Figure 3. Windrow forming.

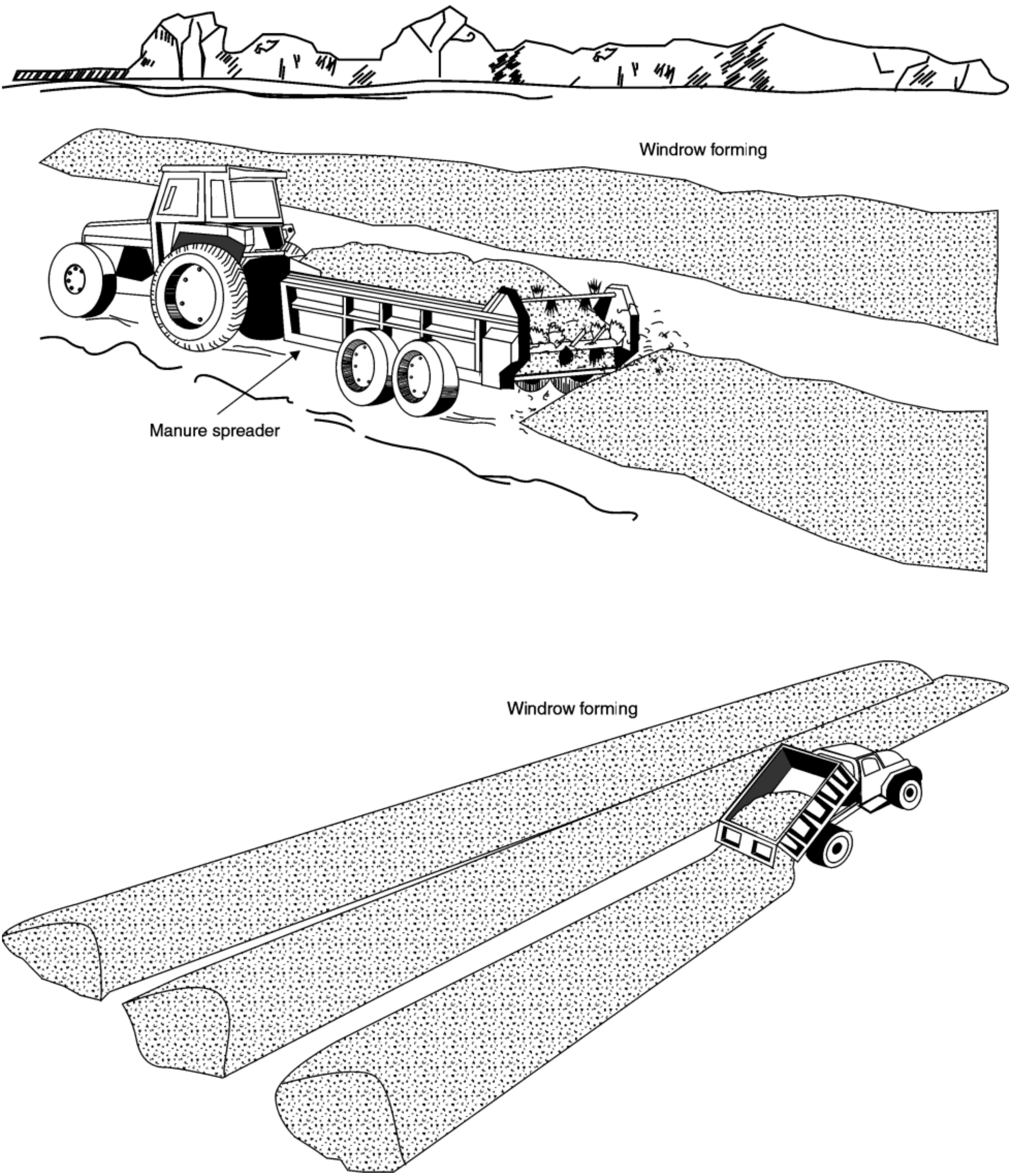


Figure 4. Windrow turning.

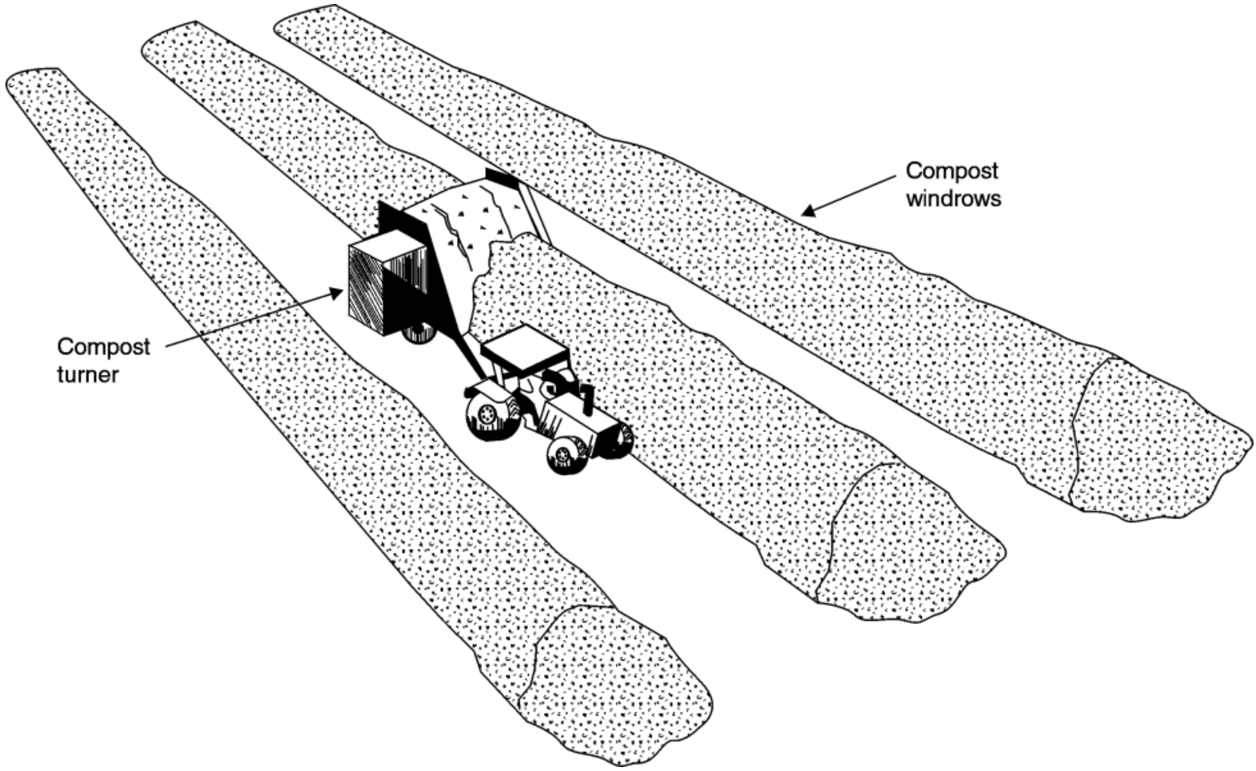


Figure 5. Static pile - passive aeration.

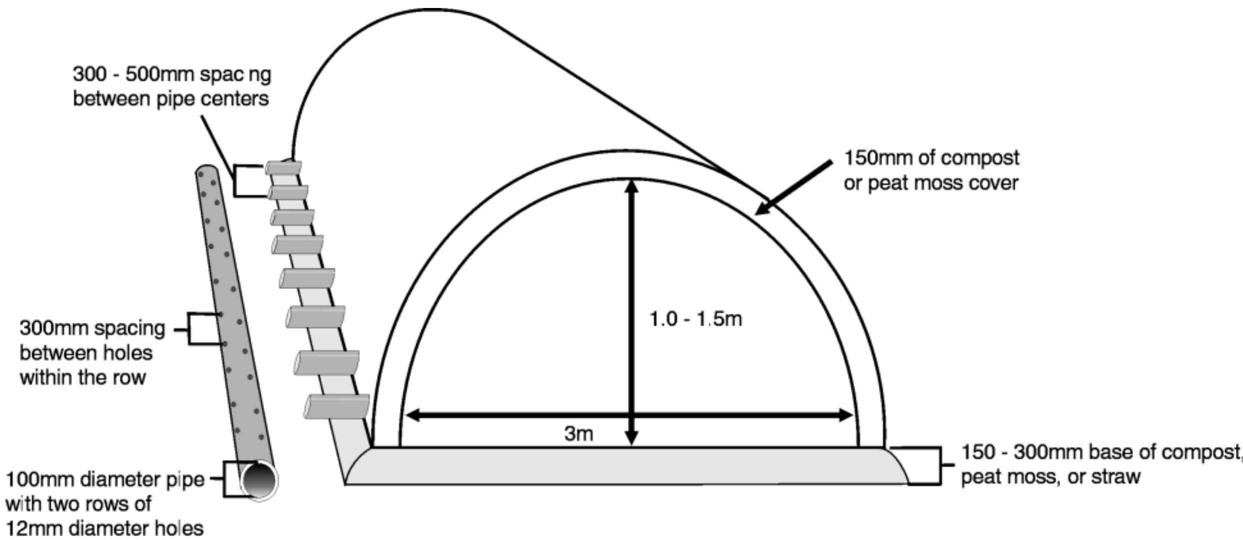


Figure 6. In Vessel Aeration.