Windrow Composting End-of-Lay Hens

March 2010

Composting is one of the four approved poultry mortality disposal methods in Manitoba and is regulated under the Livestock Manure and Mortalities Management Regulation (LMMMR). It is a controlled process in which bacteria, fungi and other microorganisms convert the dead birds and organic material into a stable humus-like product through mostly aerobic decomposition.

Composting is an environmentally sound method of processing dead birds when done properly. Producers wanting to compost must file a Composting Plan with Manitoba Conservation (please contact the Environmental Services Branch at 204-945-8541).

Composting Recipe

The correct mix of carbon (C), nitrogen (N), water and oxygen is necessary to promote the biological activity required for proper composting.

C:N ratio: Ideally, a C:N ratio of 25:1 to 30:1 is targeted. If the C:N ratio is too low, there will be a surplus of nitrogen which can be converted to ammonia and lost by volatilization. On the other hand, if the C:N ratio is too high, not all of the carbon in the mixture will be used by the microorganisms and the decomposition of material will slow down and may be incomplete after the expected duration of the composting process.

Poultry carcasses are high in nitrogen so large amounts of carbon must be added to achieve the correct proportions. In Manitoba, straw is often used as the source of extra carbon. However, for straw based piles, a C:N ratio of less than 25:1 may be appropriate due to the wide variation in the C:N content of straw harvested from different fields.

Moisture: Microorganisms need water to survive. A moisture content of 45 to 60% is desired. If the moisture content is too high, conditions will become anaerobic and the compost pile will generate unwanted odours and may not heat. If the moisture content is too low the breakdown of material will slow down or stop completely. Moisture can be determined using the hand squeeze test.

Figure 1 - Hand squeeze test

Hand squeeze test

Pick up a handful of the compost material and squeeze for 10 seconds.

Too wet – liquid can be squeezed out of material

Too dry – material expands (does not hold shape) and no wetness on palm

Just right – material leaves wetness on palm and retains shape

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Porosity: Since composting is an aerobic process, microorganisms require oxygen (O_2) and release carbon dioxide (CO_2). In order to keep the process aerobic, the mixture should be porous enough to allow O_2 in and to allow CO_2 to escape. A compost mixture that is insufficiently porous will result in large volumes of material becoming anaerobic, decreasing the rate of decomposition and increasing the potential for unwanted odour production, whereas a pile that is too porous will cool and dry too quickly and will not be able to heat. In general, manure alone is not porous enough to keep the compost pile aerobic. The compost pile needs to be made with materials that will create a more open and porous structure. If straw is used as the carbon rich additive, it can provide enough porosity that additional bulking materials are not necessary. However, if material such as fine sawdust is used, additional bulking material will be required.

Based on Manitoba trials the following compost recipe using straw, manure and carcasses have worked well. This recipe does not include the additional straw required for the base and cap. A typical 15,000 carcass pile may require two extra round bales for the base and another two round bales for the top coat.

Table 1. Core recipe for using straw, manure and carcasses

	Straw	Manure	Carcasses
Ratio by weight	15%	15%	70%
Quantity	1000 lb	1000 lb	1250 birds

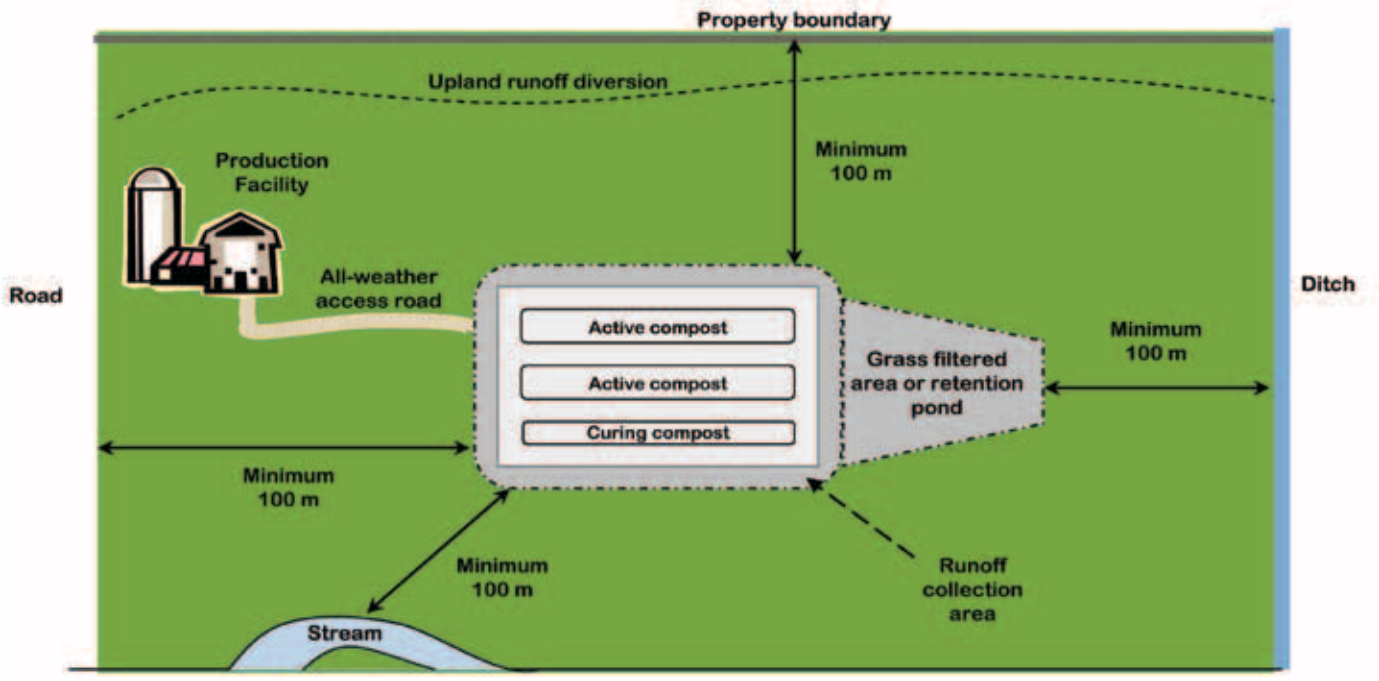
Note: The addition of more than 15% manure by weight will require the operation to file a permit application to construct a manure treatment facility with Manitoba Conservation.

Site Selection

Careful consideration must be taken when choosing a composting site. Having a properly designed compost site is the first step to any successful compost operation.

- The site should have an impervious base. Depending on the site and the facility design and operation, the base of the compost operating area must be adequately lined with concrete, asphalt, specification-compacted clay, or an artificial liner to control or restrict downward migration of leachate. The liner or pad must be durable and large enough to allow the equipment to maneuver. The required liner thickness may be reduced at sites that are underlain by thick deposits of clay-rich soil and a relatively deep water table if moisture can be carefully controlled.
- The site should be slightly sloped (1-3% slope) to prevent ponding of runoff and leacheate in low spots or between windrows. Windrows should be placed up and down the slope. Berms or curbs may be constructed to divert upslope runoff.
- The composting site must be 100 m from any surface watercourse, sinkhole, spring or well and the operation's boundary.
- Proximity to other farm operations for easy access to hauling and storage of finished compost should be considered.
- The site area must be sized properly for the volume of material to be handled. Also, future expansions should be taken into account.
- The pile must be sized to accommodate equipment. Windrows that are too tall or too wide will not be turned effectively. Furthermore, adequate space for turning and maneuvering the equipment must be available.
- Some compost piles might be too dry and may require additional moisture. Locating the compost pile where water is easily accessible is ideal.
- For permanent composting sites contact Manitoba Conservation prior to construction to ensure all required approvals are obtained in accordance with requirements set out by the LMMMR.

Figure 2. Example of windrow composting site



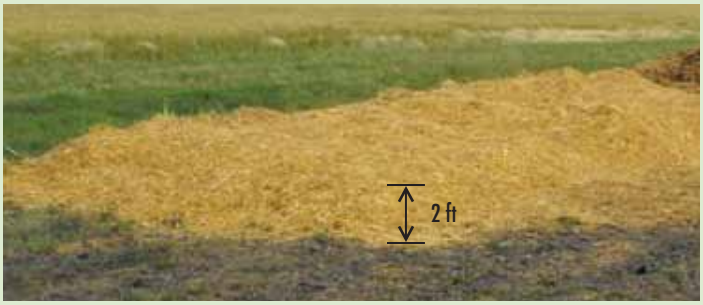
Windrow Construction

Generally, the size and shape of a windrow compost pile is based on the equipment used to turn the windrow effectively. Usually, windrows are no higher than 7 ft and no wider than 16 ft. Over-sized compost windrows will inhibit airflow resulting in anaerobic conditions and unwanted odours. Compost piles that require less water should be a triangular shape to shed water, whereas compost piles that require additional water should be concave to trap more water.

Although laying hens can be composted by layering whole carcasses with the carbon-rich and/or bulking material, it is preferable to use the blend and build method of composting especially when dealing with over 5000 carcasses. Using whole carcasses and building compost piles in layers is very labour intensive compared to pre-blending the material using a tub mixer (Figure 3). The tub mixer substantially decreases the labour required to set up the compost pile. It is also more difficult to get the compost pile to begin composting when whole carcasses are used because the composting microorganisms do not have the same intimate contact with the carcasses, carbon materials, air and water as they do when everything is blended together. Blending creates a more uniform initial compost mix and superior conditions for the composting microorganisms. It also decreases the volume of the initial mix which will reduce the land area required for the composting site.

Figure 3. Tub mixer

Blend and Build Method

Step 1: Building the base	
Establish a 2 ft (60 cm) base layer of bulky, absorbent organic material such as chopped straw, sawdust, or wood chips. This 2 ft base acts as a sponge to absorb fluids.	
Step 2: Blending the compost mix	
• Place carbon bulking material into the mixer. Allow mixer to run long enough to break bale if using straw. • Add solid hen or pullet manure and allow mixer to stir materials together (skip this step if you are not including manure in your recipe). • Add carcasses to mixer and blend to desired moisture content. Pile the blended compost mixture in the centre of the base layer ensuring that the mixture remains 2 ft (60 cm) from the edge of the base.	
Step 3: ***Capping the pile***	
Cap the entire compost pile with at least 2 ft of bulky, absorbent organic material (uncovered parts may attract scavengers). The 2 ft cover will act as a biofilter to reduce any unwanted odours. The height for the compost pile including the base should be no more than 7 ft.	

For a typical 16 ft wide and 4-7 ft high pile, you will need 4-5 linear ft of windrow per 1,000 carcasses. A typical 15,000 carcass pile might be 16′ wide and 65′ long when whole carcasses are used. Piles with blended recipes may be shorter. Generally, the volume of the constructed pile will be approximately 0.25 ft^3 per carcass.

Layering Method

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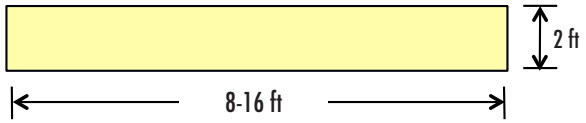


Step 2: *Layering the compost pile*

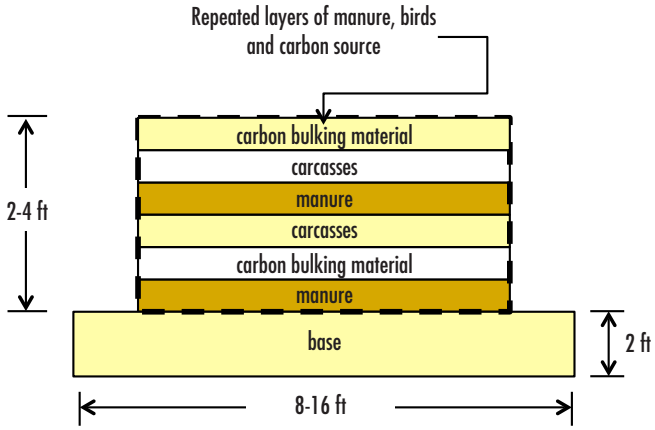
Add the following in layers:

a) 6-8 in. solid hen or pullet manure.

b) Layer of carcasses not more than 1 ft deep and none within 1-2 ft of the edge.

c) 6-12 in. of carbon bulking material.

Repeat steps a-c until pile is 5-7 ft high.



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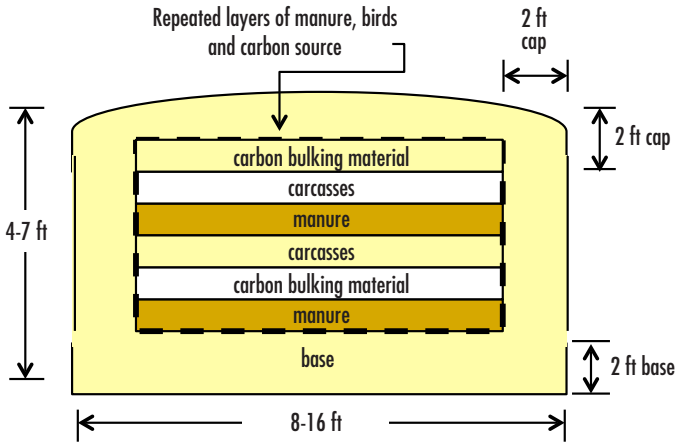

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Managing the Composting Windrow

To ensure that proper composting takes place, you must manage the pile. Compost management involves activities such as taking regular temperature measurements, frequent moisture checks, making on-site observations and turning and watering the pile as necessary. It is a good idea to keep a record of your information in a record book.

Once the compost pile is constructed, the temperatures inside the compost pile should increase to 40-65°C (104-149°F) within the first couple weeks. Temperatures can be determined throughout the compost pile using a 3 or 4 ft temperature probe (Figure 4). In a turned windrow, temperatures of 55°C throughout the pile for 15 days or longer will provide effective pathogen and weed seed kill. Refer to the Appendix A: Troubleshooting Guide if your compost piles are not heating up.

Figure 4. Temperature measurement of an end-of-lay windrow compost pile in the winter using a 3 ft probe

Continue to take temperature measurements throughout the pile daily. Once the temperatures within the pile have dropped continuously for 10-14 days, it may be time to turn the pile. Windrows can be turned using specialized compost turning equipment (Figure 5) or basic front-end loaders. Turning the pile will re-establish the pile structure which should increase microbial activity and temperature. Piles should be turned regularly based on temperature measurements and moisture from this point on.

Figure 5. PTO-driven straddle windrow turner

When your compost appears dark and soil-like it may be finished the active composting phase. The pile should be turned once more and if the temperatures do not rise again it should be left to cure for a minimum of 21 days. Compost cured for longer than 21 days with temperatures less than 8°C above air temperature, and showing at least 50% reduction in weight, can be considered mature.

Mature compost can be used as a soil amendment or fertilizer. The nutrient content of the finished compost will vary (Table 2) depending on the compost recipe and method. Before applying compost to land, a nutrient analysis should be done to ensure that compost is not applied in excess of crop requirements. Mortality compost should not be spread on active grazing land.

Table 2. Nutrient content of sampled poultry mortality compost analyzed on an "as is" basis

	Manitoba Trial Values	Literature Values
N, %	1.5-2.0	1.2-1.9
P_2O_5, %	0.5-1.0	1.8-2.3
K_2O, %	0.5-0.7	1.3-1.6

Worker Health and Safety

It is essential that people take the necessary precautions when working with compost. Composting may contain pathogens if high temperatures are not achieved and may promote the growth of aspergillus fumigatus which can affect the lungs of compost workers. Other health problems can occur if the compost is not properly maintained. The risk of infection to healthy workers is relatively low, but people with asthmas, diabetes, or suppressed immune systems should not work at compost sites.

The following measures are appropriate:

- Protective clothing or coveralls should be worn and employees and contaminated clothing should not be worn home by employees.
- Workers must maintain high standards of hygiene such as washing hands before meals, breaks and before going home.
- During dry weather the composting area should be sprinkled with water to prevent dust.
- To reduce dust inhalation, workers should wear adequate dust respirators.
- Safety footwear and glasses should be worn where necessary.
- The compost facility should not be located near any residences, businesses, or public facilities.

For More Information

- Your local Manitoba Agriculture, Food and Rural Initiatives Growing Opportunities (GO) Centre or Office.
- Manitoba Agriculture, Food and Rural Initiatives website: **manitoba.ca/agriculture**

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Appendix A: Troubleshooting Guide

Symptom	Possible Cause	Remedy
Pile fails to heat	Material is too dry	Add moisture
	Material is too wet	Add dry material
	Not enough N	Add high N amendment
	Poor structure (slumping)	Add bulking agent
	Cold weather, small piles	Enlarge or combine piles
Temperature falls consistently and gradually over several days, but material is not fully decomposed	Low oxygen, need aeration	Turn or aerate pile
	Low moisture	Add water
Uneven temperatures in pile	Poorly mixed materials	Turn or re-mix pile
	Uneven airflow	Re-mix pile
	Materials at different stages of maturity	None required – do not mix materials at different stages of composting
Compost contains clumps of materials and large particles, texture is not uniform	Poor mixing of materials	Improve initial mixing
	Uneven airflow	Screen or shred compost
	Raw materials contain large particles, non-degradable, or slowly degrading materials	Screen compost, grind or sort raw materials
	Active composting not complete	Lengthen composting time
Pile overheating (temperature greater than 150°F)	Insufficient aeration for heat removal	Turn pile of increase aeration
	Moderate to low moisture	Add water and mix
	Pile is too large	Decrease pile size to less than 8 feet
	Spontaneous combustion	Decrease pile size, maintain proper moisture, combine with other piles
Ammonia odour coming from composting pile	High nitrogen levels	Add high carbon material
	High pH	Lower pH with acidic ingredients
	Slowly available carbon source	Use another carbon source amendment or increase carbon proportion
High temperatures or odours in curing or storage of pile	Compost is not stable	Manage pile for temperature and odour control, turn piles as necessary, limit pile size
	Piles are too large	Decrease pile size
Rotten egg or putrid odours coming from composting pile	Materials too wet	Add dry amendment
	Poor structure	Re-mix pile and add bulking agent if necessary
	Pile compacted	Turn pile to fluff
	Pile too large	Decrease pile size
	Airflow uneven or short	Re-mix pile, change recipe
Material is damp, has no unwanted odour, but fails to heat up	Lack of nitrogen	Mix high nitrogen materials like fresh manure or urea fertilizer
	Compost is finished	Transfer to curing area
Insect/flies or scavengers	Unattended piles	Maintain active turning and composting—heat and moisture discourage pests
	Uncovered raw material	Ensure there is adequate cover. Can cover with finished compost.