



# Cornell Waste Management Institute

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## The Space It Takes

### Footprint Calculator for Composting Butcher Waste

#### Butcher Residuals - Current Situation

In many communities, the custom butcher business is important to the survival of farm operations that raise livestock. These businesses provide a critical service by processing farm-raised animals into table-ready meat. Most small livestock farms sell their products directly to consumers. Without alternatives to rendering, total cost to the custom butcher industry for beef slaughter residuals alone would be approximately \$10 million, which would be passed on to the consumer.

The livestock and custom butcher industries need a convenient, socially and environmentally acceptable, biosecure way to dispose of carcasses and butcher residuals. Landfills generally will not accept residuals or carcasses. The livestock



Butcher waste.

farmers and custom butchers find themselves, in many cases, without disposal services or facing high disposal fees. Many people do not realize that composting is a legal and acceptable way of managing these materials in most states; however, regulation varies from state to state. Composting can be accomplished in compliance with environmental regulations in many states, but check regulations and composting rules to see if meat waste composting is allowed; if it is, adhere to best management practices. (To check the laws and regulations in your state, visit: <http://compost.css.cornell.edu/mapsdisposal.html>.) Many butchers also process other species, including ostrich, deer, goats, sheep and hogs. Many of these residuals must also be disposed of and may not be accepted for rendering.

Composting provides an inexpensive alternative for managing dead animals, butcher waste and other biological residuals. The temperatures achieved during composting will kill or greatly reduce most pathogens, reducing the spread of disease.

*Historically, renderers purchased meat by-products and recycled these materials into animal feed supplements, fertilizer, soaps, gelatins, pharmaceuticals and lotions. In 1997, the Food and Drug Administration (FDA) imposed a ban on feeding most mammalian proteins to cattle and other ruminants to safeguard against the risk of bovine spongiform encephalopathy (BSE or mad cow disease). In 2008, the 1997 rule was strengthened by prohibiting the tissues that have the highest risk for carrying the agent thought to cause BSE in animal feed and thus removing them from the animal feed chain. These regulatory actions have caused significant changes in renderers' business practices, the value of their products, and consequently, the question of what to do with the by-products from the meat processing industry.*



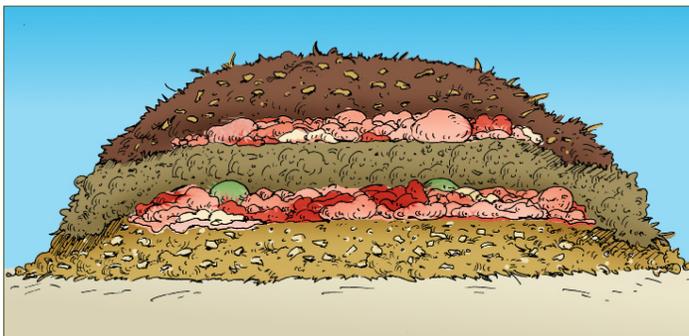
Properly composted material is environmentally safe and a valuable soil amendment for growing certain crops.

## Composting – An Economic Solution

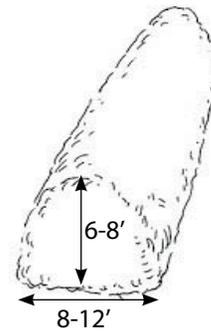
Static pile composting of meat processing by-products is a practice that can fit into the management of many butcher operations. In static pile composting, the by-products and carbon material (i.e. wood chips) are layered and no mixing is done until after the active phase of composting has occurred and the residuals are fully decomposed. The most common and efficient method is in windrows, but it can also be done in piles or in bins for small amounts. It is a good idea to check the laws in your state about composting butcher by-products when deciding which type of system to use. For example, some states may require that composting be done on a concrete pad, whereas others may allow for composting on bare soil.

### Windrows

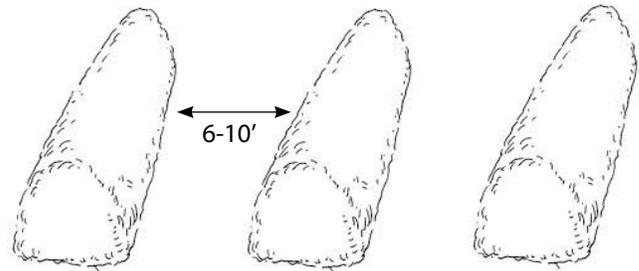
Windrows are simply elongated piles that can vary in size and spacing. A typical windrow will be 8-12 feet wide by 6-8 feet high by as long space allows. Space between the windrows can vary between inches and feet. Before calculating the footprint, think about spacing. Windrows can be positioned in many ways and will be dependent on space available, equipment and types of containment. If space is very limited, windrows can be located close together; the bottom edges can be an inch apart. Turning is not recommended in early stages of the composting process as it would liberate odors. In some states, however,



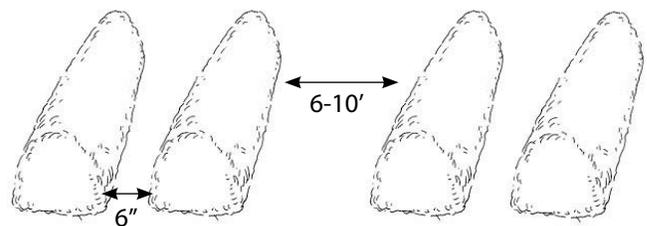
Cross section of butcher waste layered in a windrow.



Typical windrow dimensions, 8-12 feet wide and 6-8 feet high.



Windrows placed 6-10 feet apart for turning access.



Pairs of windrows close together (6 inches) with 6-10 feet between pairs.

aeration is required for management of pathogens. For example, in Michigan, in order to facilitate 3 temperature cycles, all peaking at greater than 130°F, it is recommended to turn the pile when the temperature of the windrow decreases to less than 100°F. Therefore, space is needed among the windrows to turn them. If turning is not required, windrows can be placed close together and can be removed or accessed from their ends. Piles can also be made taller (maximum 8 feet) to conserve space if available equipment can reach higher to construct the windrow. Be aware, that with taller windrows, compaction can occur, so it is imperative to use a chunky carbon source as the base to keep air flow coming in through the base, keeping the windrows aerobic.



Dumping butcher waste using a retro fitted dump trailer.

### Piles

Piles are similar to windrows, but are not elongated. Piles may vary in size, depending on the rate at which you are generating by-products. Piles would work well for residuals from smaller animals where there is less waste than from a full size steer as each “batch” could be managed separately. They may be located next to one another, with the bases of the piles being in contact with one another or with space in between. Piles are typically sized the same as windrows, that is, 8-12 feet wide by 6-8 feet high with a length as long as the batch requires.

### Bins

A bin is a structure designed to contain compost and withstand the force of equipment used for compost movement. One wall should be reinforced to confine compost when turning. The size of bins and number of sections



Bin made from concrete block highway dividers.

can vary and will depend on the size of the equipment, e.g. if you have a turning bucket 6 feet long, size the bin for ease of equipment use. The width of the bin is typically 6-12 feet wide. The height of the bin is typically 5-8 feet deep. Greater depths result in less air in the compost and slower decomposition. Bins work especially well for small animal processing such as poultry and small volumes of butcher waste.



Three bin system.



Chunky carbon base laid out waiting for butcher residual.

Composting requires space to construct the compost piles and takes from two to six months for the animal tissue to decompose. Bones take longer and may need a few cycles in subsequent piles where they will add to the pore space and air flow. It requires space for storage of carbon material, and if a finished product is desired, for curing and storage of that product. How much space is required for your butcher operation to compost effectively and efficiently?

## Calculating Space

### Calculators

There are three calculators available for determining how much space is needed to compost animal tissue.

- **Procedures and Equations for Sizing of Structures and Windrows for Composting Animal Mortalities** (Ohio State) was developed in 2000 by Keener and Elwell at the Ohio Agricultural Research and Development Center, Ohio State University, Wooster, OH and Monnin at USDA-NRCS, Columbus, OH. This paper presents equations for animal decomposition times and sizing of the composting system for animal mortalities that occur on a farm. It is applicable for any species from 2 to 650 kg (4.4 to 1,433 lbs). It calculates the space required for storage and composting of animal mortalities. It was not designed specifically for meat processing residuals. *Applied Engineering in Agriculture* 16(6):681-692.

- **Co-Composter Model** was developed by Cornell University's Department of Biological and Environmental Engineering and Cornell Waste Management Institute in 2001. Co-Composter is an excel spreadsheet that provides mass and volume balances, area estimations for storage, active composting and curing, and a cost analysis of alternate composting systems based on inputs entered by the user. This model was designed for different compost feedstocks that may be combined with manure. *When calculating for butcher residuals start with question #8 on the user input page: <http://compost.css.cornell.edu/CoComposter.xls>.*

- **Spartan Animal Tissue Composting (ATC) System Planner** was developed by Rozeboom, Person and Kriegel at Michigan State University in 2009. Spartan ATC is an excel application that assists in designing a composting system using a static approach and gives the option of using either bin, windrows, piles or overlapping piles. This model calculates the amount of space needed for composting only. It does not take into

account curing or storage of raw materials. This spreadsheet was specifically designed for composting animal tissue accumulated as whole carcasses or as animal tissue by-products from animal processing operations. [http://msue.anr.msu.edu/program/managing\\_animal\\_mortalities/composting\\_tools](http://msue.anr.msu.edu/program/managing_animal_mortalities/composting_tools).

### Information Needed

In order to use any of these calculators, certain things need to be known:

1. **The weight and/or volume of by-products generated.** Table 1 shows the typical yield of retail cuts and by-products from cows, pigs and lambs. These percentages can be used or an average of actual weights or volumes from your operation can be used.

2. **The amount of carbon needed to be able to compost properly.** This can be calculated based on the weight of by-product to be composted. To facilitate effective composting, the right combination of feedstock, butcher residual and bulking material are required. Successful animal tissue composting has been accomplished using a target animal tissue density ranging from 0.5–15 lb/ft<sup>3</sup>. That is, 1 ft<sup>3</sup> of bulking material will be needed for every one-half to 15 lbs of tissue. However, when animal tissue density is greater than 10 lb/ft<sup>3</sup>, intensive management of aeration and moisture is necessary. This is because the by-product is mostly fat trim (about 70% lipids) which will melt in the pile causing it to “slump” or lose its shape. Therefore, for by-product composting, an animal tissue density of between 4 and 6 lb/ft<sup>3</sup> will probably work best.

3. **The type of composting system you plan to use** – windrows, piles or bins, and the approximate dimensions of the system.

4. **The length of time during which composting will occur.** This can typically take between 2 and 6 months for the decomposition of soft tissues. For thorough decomposition and pathogen kill, thermophilic temperatures of 104°F–140°F (40°C–60°C) should be reached

and maintained. The amount of time those temperatures should remain will depend on the amount/weight of residual being composted, as well as any state regulations that may be in place. After this active, hot phase, the compost should also go through a mesophilic stage of 77°F–104°F (25°C–40°C) to finish the composting process. Bone degradation takes longer, especially when processing cull cows over 24 months of age. It may take several compost cycles depending on compost management and duration. However, piles with bones can be used as the base for more piles as the bones add structure. Piles in which the bones have decomposed can be moved for curing or can be land spread.

### How Much Space is Needed?

#### One example

Any one of the calculators can be used to calculate the amount of space you will need to compost residual from your particular operation, and it is a good idea to use one to get a precise calculation. However, to get a general idea of how much space will be needed for any butcher operation, we have calculated the square footage required to compost the residual from one cow, one pig, or one lamb. If the business butchers a variety of animals, the amount of space should be calculated on the largest animal butchered. This information can be used in the planning stages of your operation and can

#### Information Needed for all Models:

- *Weight and/or volume of by-products generated.*
- *Weight and/or volume of carbon needed.*
- *Type of composting system to be used.*
- *Length of time needed for decomposition of soft tissues.*

#### Additional Information Needed for Co-Composter:

- *Density of flesh waste.*
- *Moisture content of flesh waste.*
- *Nitrogen content of flesh waste.*
- *Carbon to Nitrogen ratio (C:N) of flesh waste.*

#### Additional Information Needed for Spartan ATC Planner:

- *An estimate of the number of months that will be required to start and complete the creation of a new batch (period over which animal tissue will be added.)*
- *The length, width and height of the windrow, pile or bin.*

then be fine tuned in production. The following information was used in the calculations:

#### Information for all Models

1. Pounds of by-product generated using information from Table 1: The hide, edible fats, variety meats, and 1/2 of the bones (steers only)

Table 1. Yield of retail cuts and by-products from cows, pigs and lambs.

Animal	Cow/Steer		Pig		Lamb	
	lb	% of live wt	lb	% of live wt	lb	% of live wt
Live weight (wt)	1000		220		99	
Retail cuts	420	42.0	123	56.0	35.2	35.6
By-products						
Hide	80	8.0			15.6	15.6
Edible fats	110	11.0	35	16.0	8.9	8.9
Variety meats	40	4.0	9	4.0	2.2	2.2
Blood	40	4.0	9	4.0	4.4	4.4
Inedible fats & meat scraps	45	4.5	17	8.0	22	22.2
Bones	135	13.5				
Other (stomach contents, shrink, etc.)	140	14.0	26	12.0	11.1	11.1

will not be composted. The stomach and contents of the animal will be composted, but approximately 3% of “other” is shrink/empty space, so, total pounds to be composted per animal is calculated as:

$$\text{Total pounds to be composted} = \text{Live weight} - \text{Retail cuts} - \text{Hide} - \text{Edible fats} - \text{Variety meats} - 1/2 (\text{Bones}) - 3\% (\text{Other}).$$

Animal	Cow/Steer	Pig	Lamb
lbs of by-product	278	52	37

2. Amount of carbon: The carbon requirement for the residual from each animal was calculated using target tissue densities of 4, 5 and 6 lbs/ft<sup>3</sup> as shown below.

Tissue Density (lbs/ft <sup>3</sup> )	4	5	6
Cow/Steer	70 ft <sup>3</sup>	56 ft <sup>3</sup>	46 ft <sup>3</sup>
Pig	13 ft <sup>3</sup>	10 ft <sup>3</sup>	9 ft <sup>3</sup>
Lamb	9 ft <sup>3</sup>	7 ft <sup>3</sup>	6 ft <sup>3</sup>

3. The type of composting system used was passively aerated windrows.

4. Composting time used was 180 days for steers, 72 days for pigs and 60 days for lambs.

**Additional Information for Co-Composter**

1. The density, moisture content, nitrogen and carbon to nitrogen (C:N) ratio of butcher residual waste was assumed to be 66 lbs/ft<sup>3</sup>, 65%, 3% and 6:1, respectively.

Parameter	Flesh Waste
Density (lbs/ft <sup>3</sup> )	66
Moisture (%)	65
Nitrogen (%)	3
Carbon : Nitrogen ratio	6:1

2. Wood chips are the carbon source.

**Additional Information for Spartan ATC**

1. The time required to form a batch varied depending on the amount of residual and target tissue density of the mix.

2. The dimensions of the windrows used were 6 ft high, 12 ft wide and 50–100 ft long.

3. The equipment working space/vehicle access used was 6 ft.

**Space Required for Primary Composting**

A comparison of the pad size, including working space needed for composting the butcher residual from processing one cow, one pig and one lamb is shown in Table 2.

An average of 14.3 square feet is required to compost the residual from one cow at a target tissue density of 5 lbs/ft<sup>3</sup>, so if the operation is processing 20 cows per week (1,040 cows per year), primary composting will require approximately 14,872 square feet of space (0.3 acres) per year.

$$20 \text{ cows/week} \times 52 \text{ weeks/year} \times 14.3 \text{ square feet} = 14,872 \text{ square feet/year.}$$

Similarly, the processing of 20 pigs or 20 lambs per week at a target tissue density of 5 lbs/ft<sup>3</sup> will require approximately 1,664 or 1,144 square feet per year, respectively.

$$20 \text{ pigs/week} \times 52 \text{ weeks/year} \times 1.6 \text{ square feet} = 1,664 \text{ square feet/year.}$$

$$20 \text{ lambs/week} \times 52 \text{ weeks/year} \times 1.1 \text{ square feet} = 1,144 \text{ square feet/year.}$$

**Total Space Required for the Composting Operation**

The amount of space required for storage of raw materials, composting, and curing (i.e. total area for a composting operation) is only estimated in the Co-Composter model. The other calculators do not include an estimate of the space needed for the curing phase. The total amount of space required by the Co-Composter model was between 1.5 and 2.5 times the area required just for composting. Curing is not required in all states, so the estimation of space provided by all three of these tools should be satisfactory in those states. When calculating total space needed for the entire

composting operation in states requiring curing, add the calculation to accommodate that time and space.

### Which Calculator Should I Use?

One tool is not better or more accurate than the other. They generate different numbers because they are simply a “product of math” or a “play” on numbers (see text boxes on page 5). All three are easy to use. All three require you to have some knowledge of the amount of by-products you will generate, as well as how much carbon you intend to use. Take some time to check each one out and use the one with which you are most comfortable.

*Approximately how much space is needed for primary composting?*

*The residual from:*

*1 Cow = 14.3 square feet*

*1 Pig = 1.6 square feet*

*1 Lamb = 1.1 square feet*

US Butcher Waste & Mortality Disposal Laws  
<http://compost.css.cornell.edu/mapsdisposal.html>

Table 2: Square feet of space required for primary composting per cow, pig or lamb butchered at three different target tissue densities calculated by 3 models.

Target Density (lbs/ft <sup>3</sup> )	Cows			Pigs			Lamb		
	4	5	6	4	5	6	4	5	6
Ohio State (ft <sup>2</sup> )	20.6	16.5	13.8	1.7	1.4	1.25	1.0	0.8	0.7
Co-Composter (ft <sup>2</sup> )	13.4	11.3	9.6	1.7	1.6	1.5	1.3	1.0	1.0
Spartan ATC (ft <sup>2</sup> )	18.9	15.1	13.0	2.3	1.9	1.9	1.6	1.4	1.3
Average (ft <sup>2</sup> )	17.6	14.3	12.1	1.9	1.6	1.5	1.3	1.1	1.0



Covering butcher waste.



Butcher waste compost in a bin system.

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