

Composting to recycle animal tissue nutrients

On-farm mortality management
Small business animal tissue
disposal

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Winter 2007

Animal tissue

- Animal production operation
 - Normal on-farm mortality
 - Dairy – 2 to 9%
 - Swine – 0.5 to 15%
 - Poultry – 5 to 14%
 - Sheep and goats – 2 to 12%
 - Horse – 1 to 4%
 - Beef – 1 to 3%



Animal tissue

- ❑ Animal process operation
 - Butcher shop
 - Slaughter facility
 - Taxidermist
 - Road commission
 - Veterinary clinic
 - Market collection point



Bodies of Dead Animals Act



Previously amended:

1982 PA 239 (burial, incineration, landfill, rendering)

1993 PA 228 (to include poultry bin composting)

1998 PA 229 (to include livestock bin composting)

Amended July 7, 2005 Senate Bill No. 2 - Jelinek:

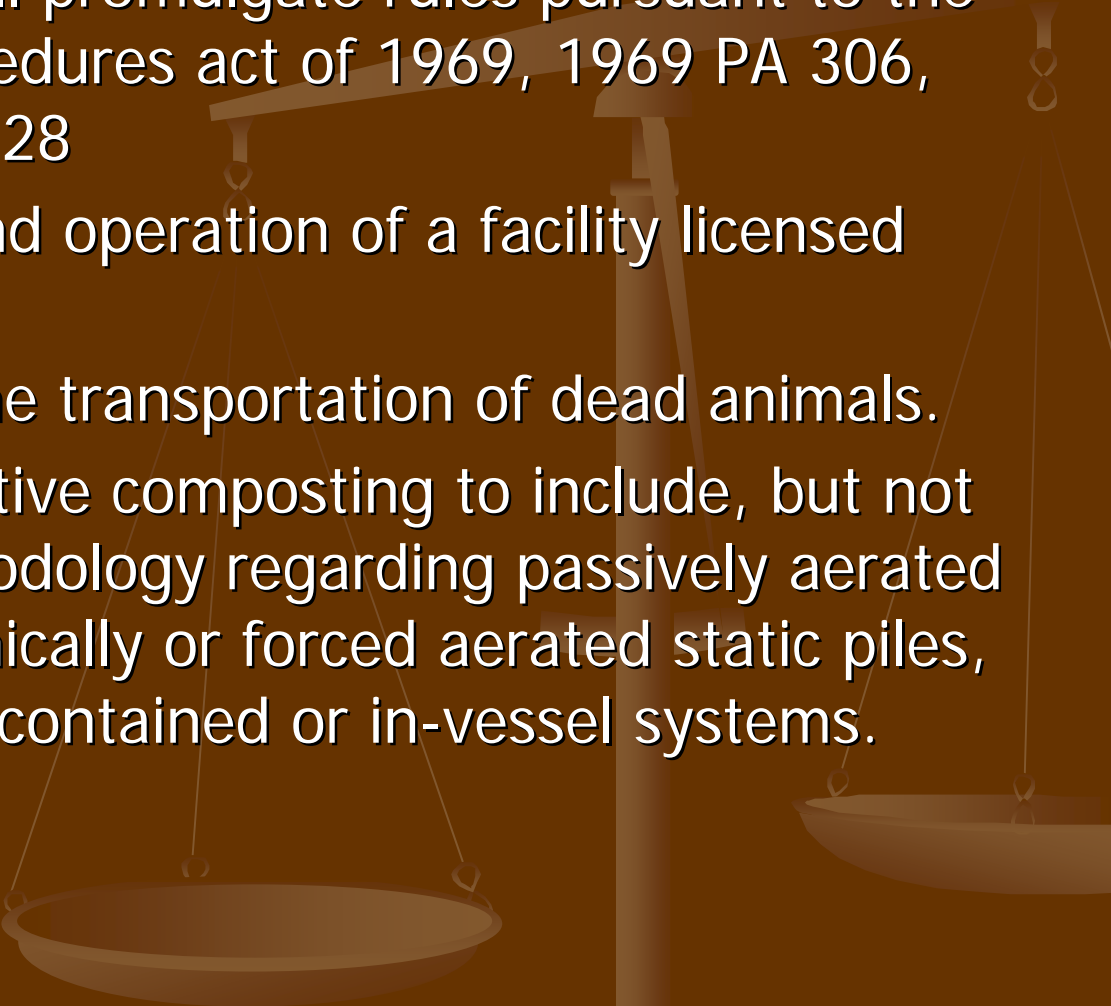
2005 PA 66 (added open pile, windrow, in-vessel and other methods as approved by the director)

Intent of law

- ❑ Protect human and animal health
 - Reduce risk of disease transmission.
 - Control flies, vermin, and scavenging animal problems.
- ❑ Protect environment
 - Ground and surface water
 - Air quality

Compliance is necessary for Right-to-Farm protection, NPDES General Permit coverage, and MAEAP verification

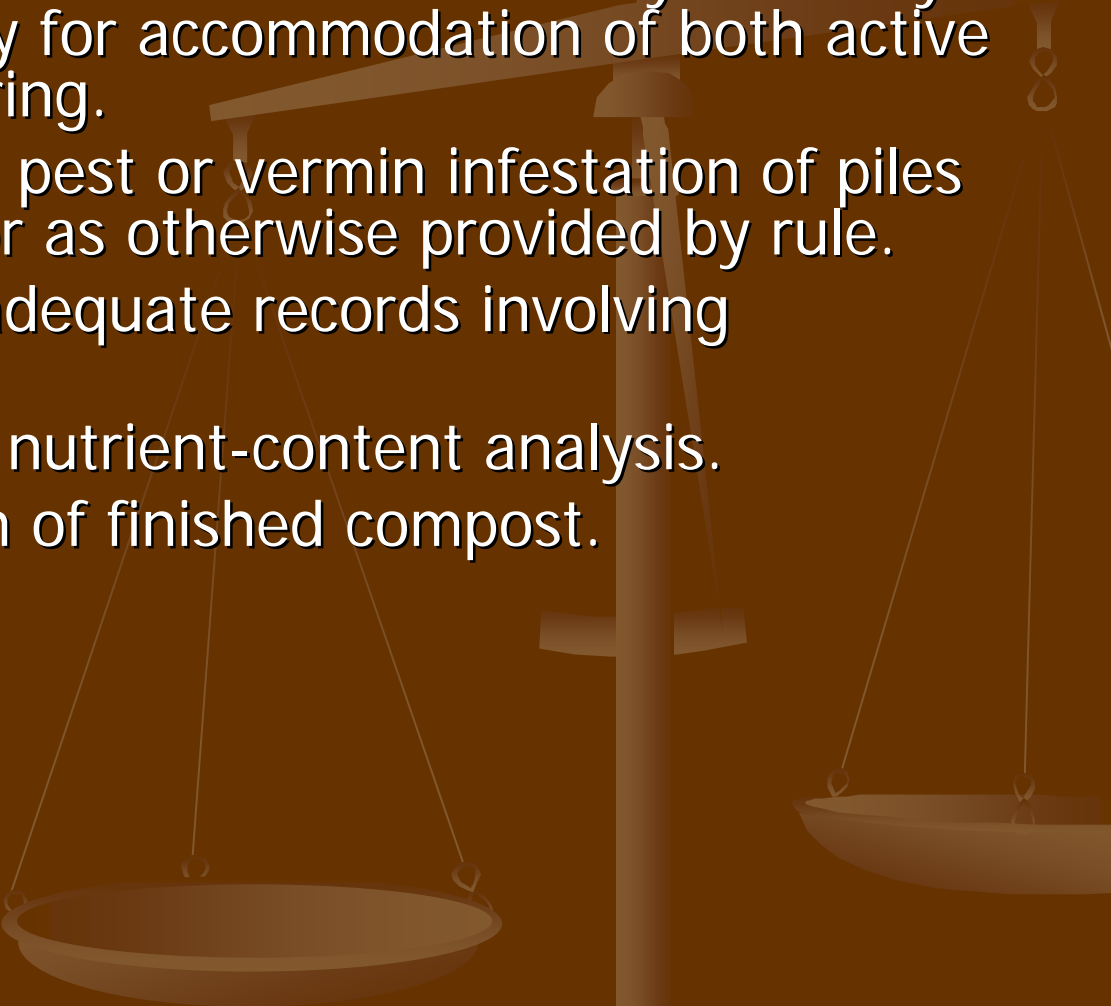
The law states in Sec. 15. that

- . . . the department shall promulgate rules pursuant to the administrative procedures act of 1969, 1969 PA 306, MCL 24.201 to 24.328
 - a) The construction and operation of a facility licensed under this act.
 - b) Vehicles used for the transportation of dead animals.
 - c) Methodology for active composting to include, but not be limited to, methodology regarding passively aerated static piles, mechanically or forced aerated static piles, windrow piles, and contained or in-vessel systems.
- 

continuing . . .

- d) Conditions for active composting to include, but not be limited to, recommended conditions regarding moisture content, carbon-to-nitrogen ratio, bulking agent particle size, animal tissue density, composting density, temperature ranges, and pH ranges.
- e) Parameters regarding grinding, including, but not limited to, pile form and shape, pile slumping, and the presence of large intact bones after composting.
- f) Methods for effluent containment and prevention of its movement into groundwater and surface water.

continuing . . .

- d) The accommodation of normal natural daily mortality and system capacity for accommodation of both active composting and curing.
 - e) Control of odor and pest or vermin infestation of piles with biofilter caps or as otherwise provided by rule.
 - f) The generation of adequate records involving composting.
 - g) A system of annual nutrient-content analysis.
 - h) The final disposition of finished compost.
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Animal Compost Rule Making Committee

- 
- Kevin Kirk, Michigan Department of Agriculture
 - Jennifer Pickworth, Michigan Department of Agriculture
 - Brian Culham, Michigan Department of Environmental Quality
 - Anne Woiwode, Sierra Club
 - Lynn Henning, Sierra Club
 - Duane Roskoskey, Michigan Department of Environmental Quality
 - Suzanne Reamer, Natural Resources Conservation Services
 - Ernie Birchmeier, Michigan Farm Bureau
 - Tonia Ritter, Michigan Farm Bureau
 - Gary Trimner, Michigan Milk Producers Association
 - Steve Mahoney, Michigan Department of Agriculture
 - Dr. Dale Rozeboom, Michigan State University
 - Jerrod Sanders, Michigan Department of Environmental Quality
 - Rhonda Wuycheck, Michigan Department of Environmental Quality
 - Matt Flechter, Michigan Department of Environmental Quality
 - Brad Deacon, Michigan Department of Agriculture

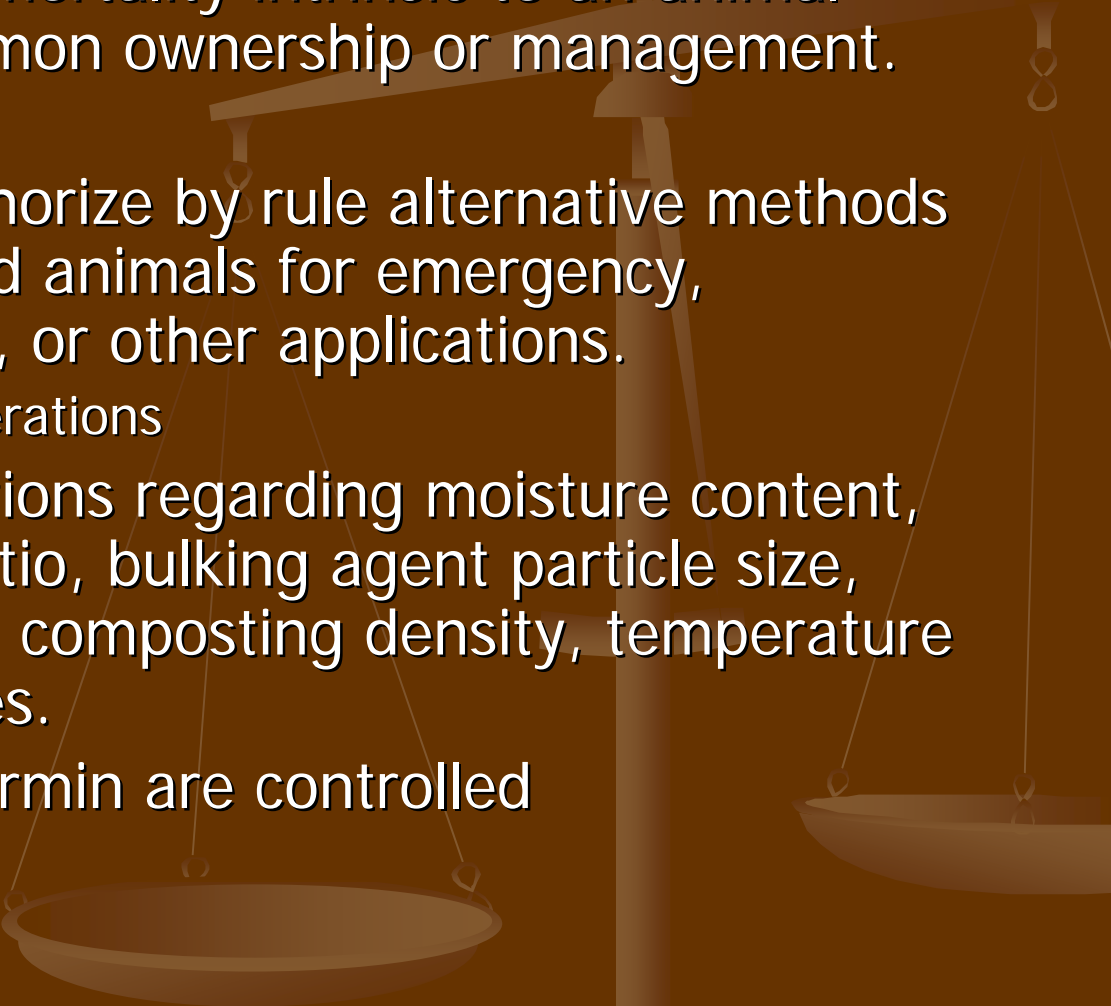
**MICHIGAN DEPARTMENT OF AGRICULTURE
ANIMAL INDUSTRY DIVISION
P.O. Box 30017, Lansing, Michigan 48909**

**REGULATIONS FOR
ACT 239, P.A. 1982, as amended
BODIES OF DEAD ANIMALS**

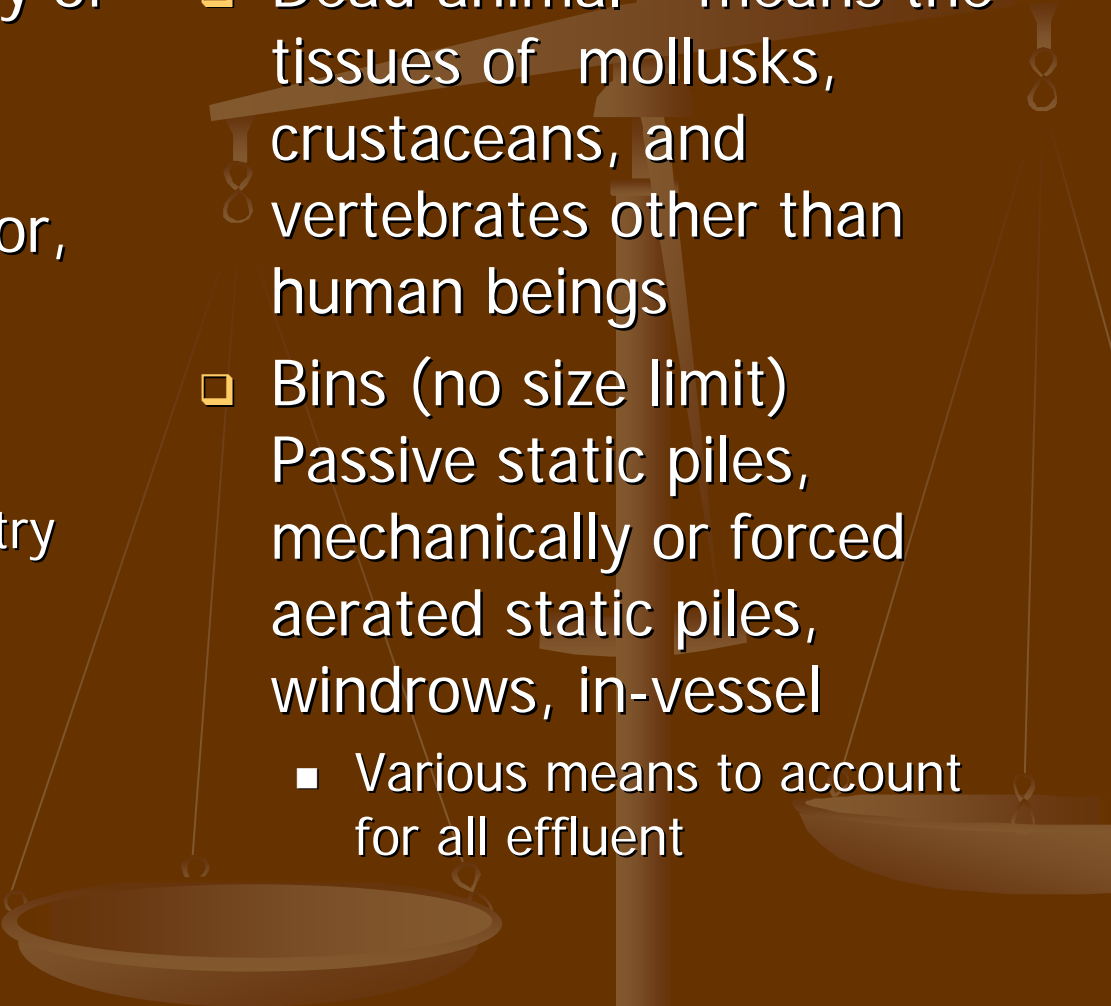
Effective September 2, 1988

AUTHORITY: Act 239 of 1982, as amended
TOTAL NUMBER OF COPIES PRINTED: 690
TOTAL COST: \$227.45
COST PER COPY: \$0.46

Rules: Old and Proposed New

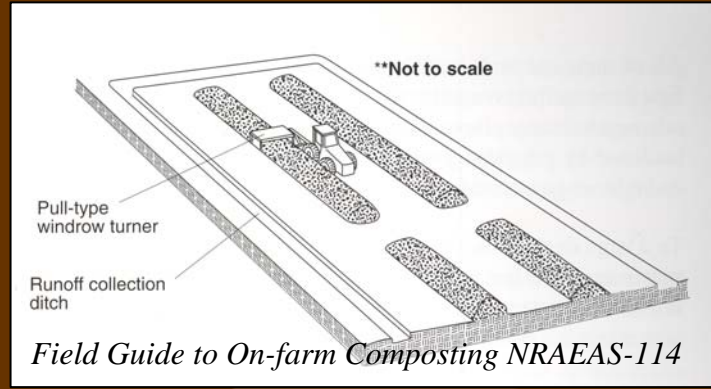
- ❑ Normal natural daily mortality intrinsic to an animal operation under common ownership or management.
 - Multiple site farms
 - ❑ The director may authorize by rule alternative methods of composting of dead animals for emergency, commercial, research, or other applications.
 - Animal processing operations
 - ❑ Recommended conditions regarding moisture content, carbon-to-nitrogen ratio, bulking agent particle size, animal tissue density, composting density, temperature ranges, and pH ranges.
 - ❑ Flies, rodents, and vermin are controlled
- 

Rules: Old vs. Proposed New

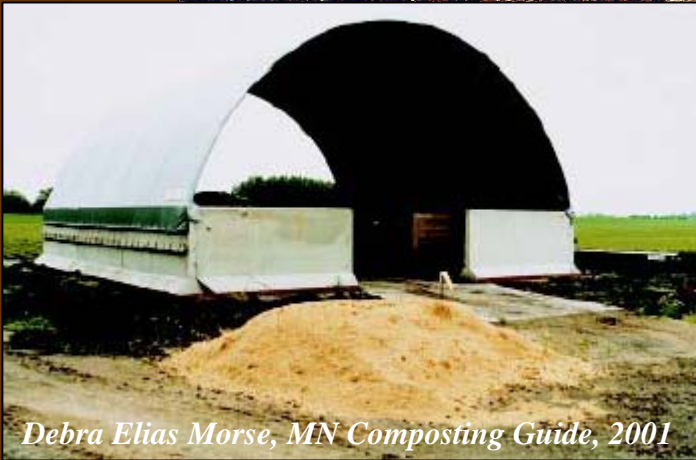
- 
- Only on-farm mortality of poultry and certain livestock
 - Structure – bin w/ floor, walls, roof
 - Structure prevented effluent from leaving
 - Bin size limits for poultry
 - Dead animal – means the tissues of mollusks, crustaceans, and vertebrates other than human beings
 - Bins (no size limit)
Passive static piles, mechanically or forced aerated static piles, windrows, in-vessel
 - Various means to account for all effluent



Steve Boyles, Ohio State University



Field Guide to On-farm Composting NRAEAS-114



Debra Elias Morse, MN Composting Guide, 2001



Iowa State University

Rules: Old vs. Proposed New

- For an animal production operation accumulating more than 20,000 pounds of mortality annually or any animal process operation, regardless of composting method, composting shall be done in compliance with the following:
 - All active, finished, curing, and cured compost at the site shall be located in or on, one or both of the following:
 - On an improved surface as defined by NRCS 313 Waste Storage Facility Conservation Practice Standard, November 2005 (see section on “Liners”) and designed to withstand anticipated loads from the equipment used for placement, aeration and movement of compost.
 - In an in-vessel system.
 - Other methods as approved by the director

Rules: Old vs. Proposed New

- All effluent generated and runoff events during active composting and curing, not retained in the compost, shall be managed in a manner consistent with all applicable federal, state, and local laws and with at least one of the following:
 - Reintroduced into compost piles
 - Collected and stored in a storage facility with a liner meeting the criteria defined in NRCS 313 Waste Storage Facility Conservation Practice Standard, Dated 11/05, and utilized for crop production in accordance with the recommendations in GAAMP's.
 - Diverted to a treatment system meeting the criteria in NRCS 635 Wastewater Treatment Strip Conservation Practice Standard, Date 9/06.
 - Disposed of in accordance with Act No. 136 of the Public Acts of 1969, being S323.271 et sep. of the Michigan Compiled Laws.
 - Other methods as approved by the director

Rules: Old vs. Proposed New

- For an animal production operation accumulating less than 20,000 pounds of mortality annually, composting may be done without a structure or vessel provided the following conditions are met:
 - A new composting site shall be selected for use annually.
 - Use of the current year's site may continue until the compost is finished, but not more than 2 years from the time of the first dead animal addition, at which time the finished compost must be disposed of in accordance with Rule 5(10).
 - No new tissue shall be added to a site after one year from the first dead animal addition.
 - May be immediately adjacent to a previous site.
 - A previous site shall not be revisited within a 10-year period of time.
 - Shall be on land used in crop production.
 - Shall not be directly above subsurface drains (tile).

Rules: Old vs. Proposed New

■ Limited list of bulking agents

- Sawdust
- Chopped straw
- Spelt hulls
- Bean pods
- Grass clippings
- Leaves
- Shredded cardboard or newspaper
- Chopped cornstalks
- Finished compost



■ More bulking agents, also

- Fresh manure
- Manure with bedding
- Wasted feed (ground corn, silage, haylage)
- Legumes (peas, beans, soybeans)
- Hay
- Fresh horse manure
- Horse manure with bedding
- Shrub and tree trimmings
- Cornhusks, cobs
- Wood chips

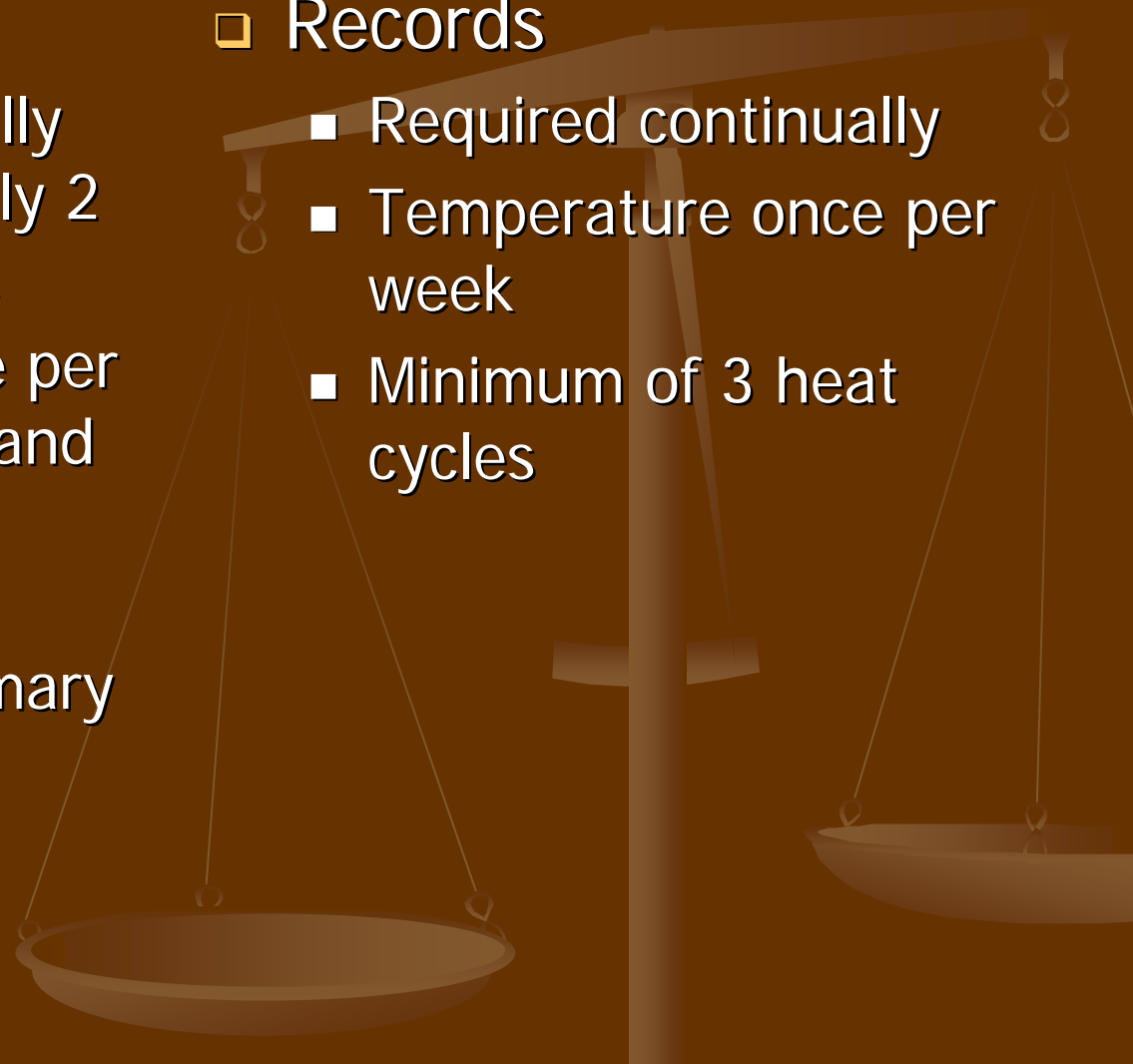
Rules: Old vs. Proposed New

□ Records

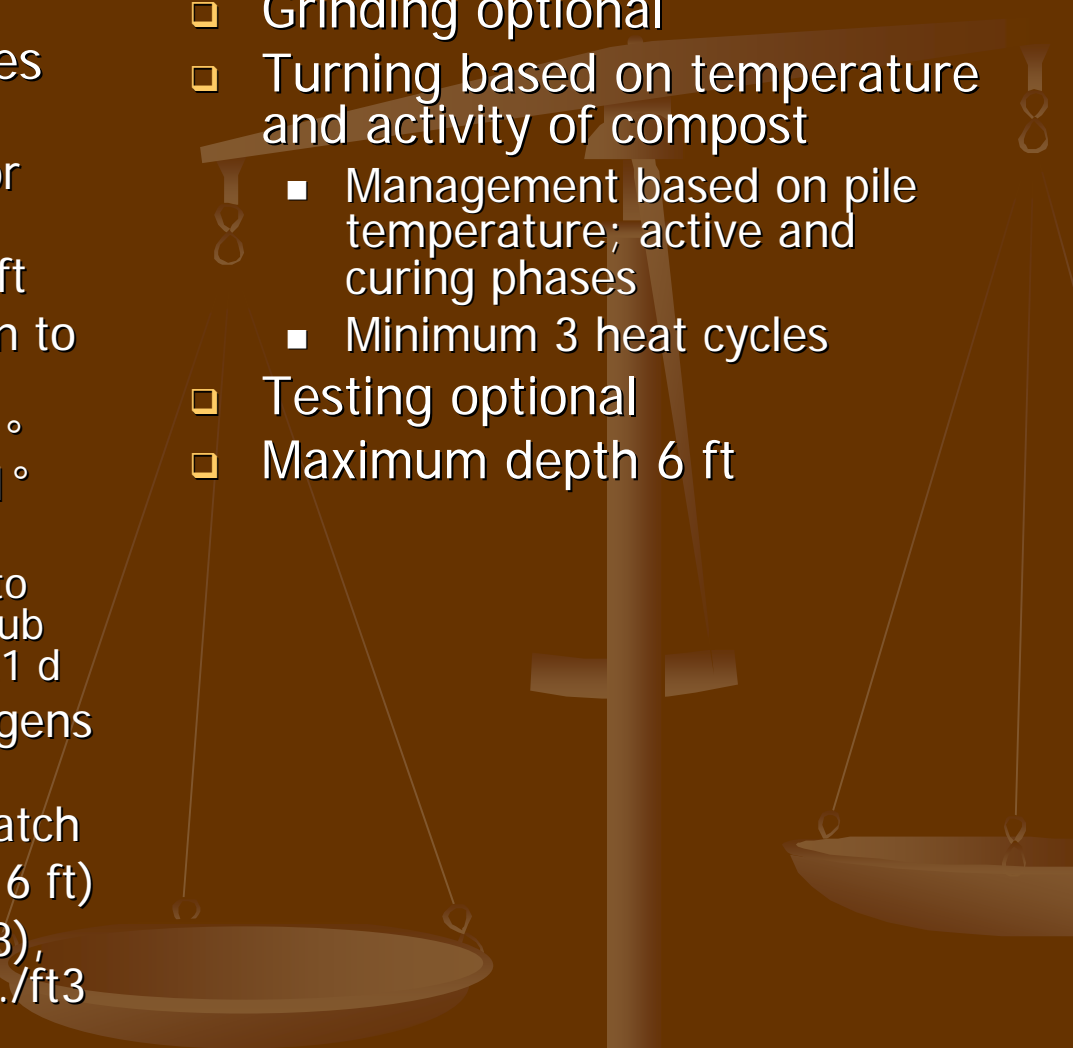
- Required continually for poultry and only 2 years for livestock
- Temperature once per phase for poultry and twice a week for livestock
- Two phases – primary and secondary

□ Records

- Required continually
- Temperature once per week
- Minimum of 3 heat cycles



Rules: Old vs. Proposed New

- 
- 43 sub rules for poultry - specific, limiting, sometimes conflicting
 - If carcass >30 lb. grind or chop required
 - Max bin width/length 12 ft
 - Written management plan to director before starting
 - Times (e.g. 2 to 7 d for 1° poultry bins, ≥ 60 d for 1° and 2° livestock bins)
 - Sub rule 27 says move to secondary pile by d 7, sub rule 29 says minimum 21 d
 - Testing for poultry pathogens yearly
 - Nutrient analysis every batch
 - Max depth 5 ft (livestock 6 ft)
 - Max 4 lb./ft³ (Sub rule 18), but sub rule 2 states 2 lb./ft³
 - Grinding optional
 - Turning based on temperature and activity of compost
 - Management based on pile temperature; active and curing phases
 - Minimum 3 heat cycles
 - Testing optional
 - Maximum depth 6 ft

Composting

The controlled
biological
decomposition of
organic material
under (aerobic and
anaerobic) conditions
...



Not just “above ground burial”

Composting

- . . . so that storage, handling and land application of compost can be done without adversely affecting the environment or people, and
- . . . to recycle nutrients.



Composting microorganisms

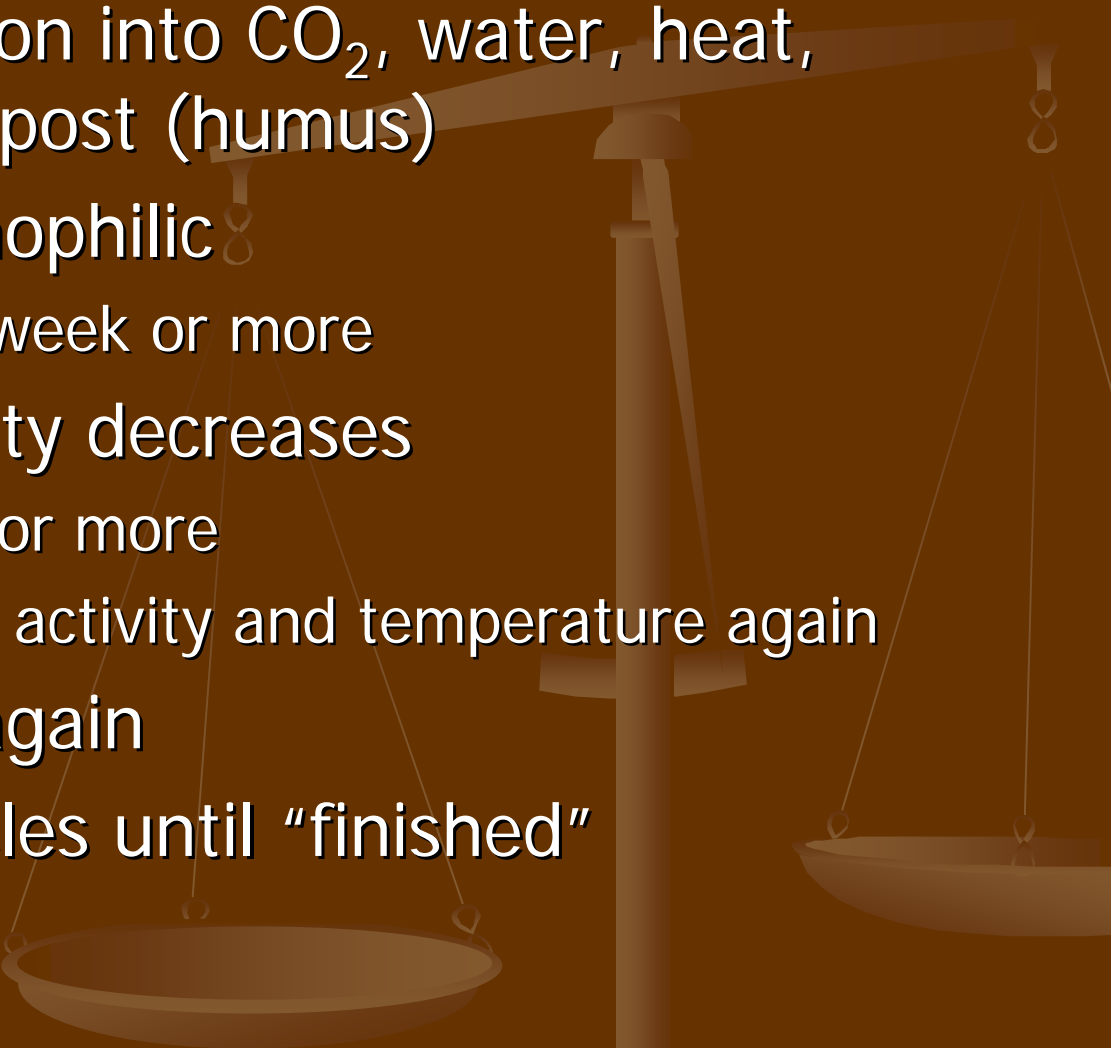
□ Bacteria

- Consume organic material - activity
 - Decompose sugars, starches, proteins, fat and some cellulose
- Both anaerobic (without air) and aerobic (with air)
 - *Actinomyces* spp. - earthy odor

□ Fungi

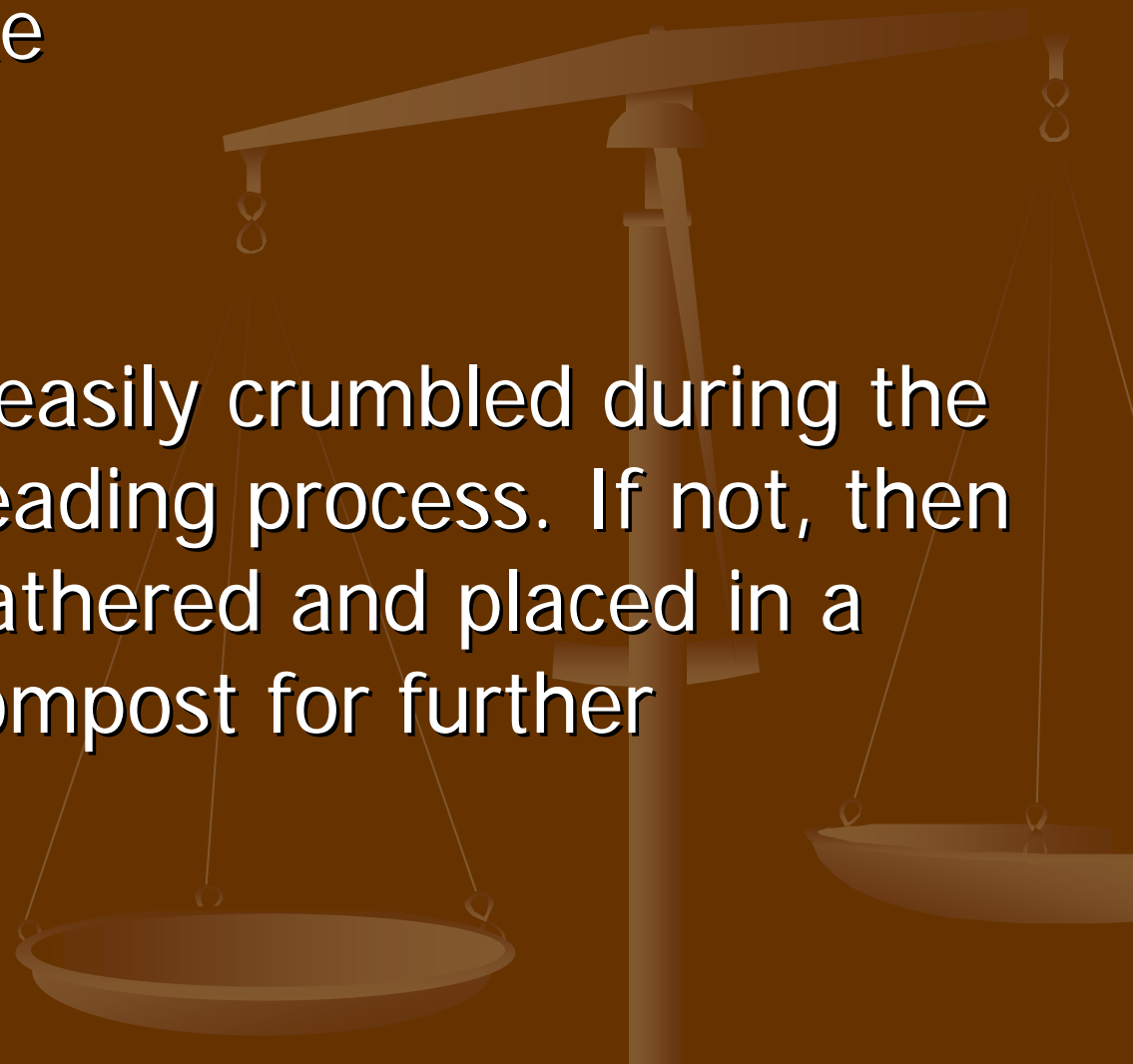
- More cellulose decomposition

Composting activity

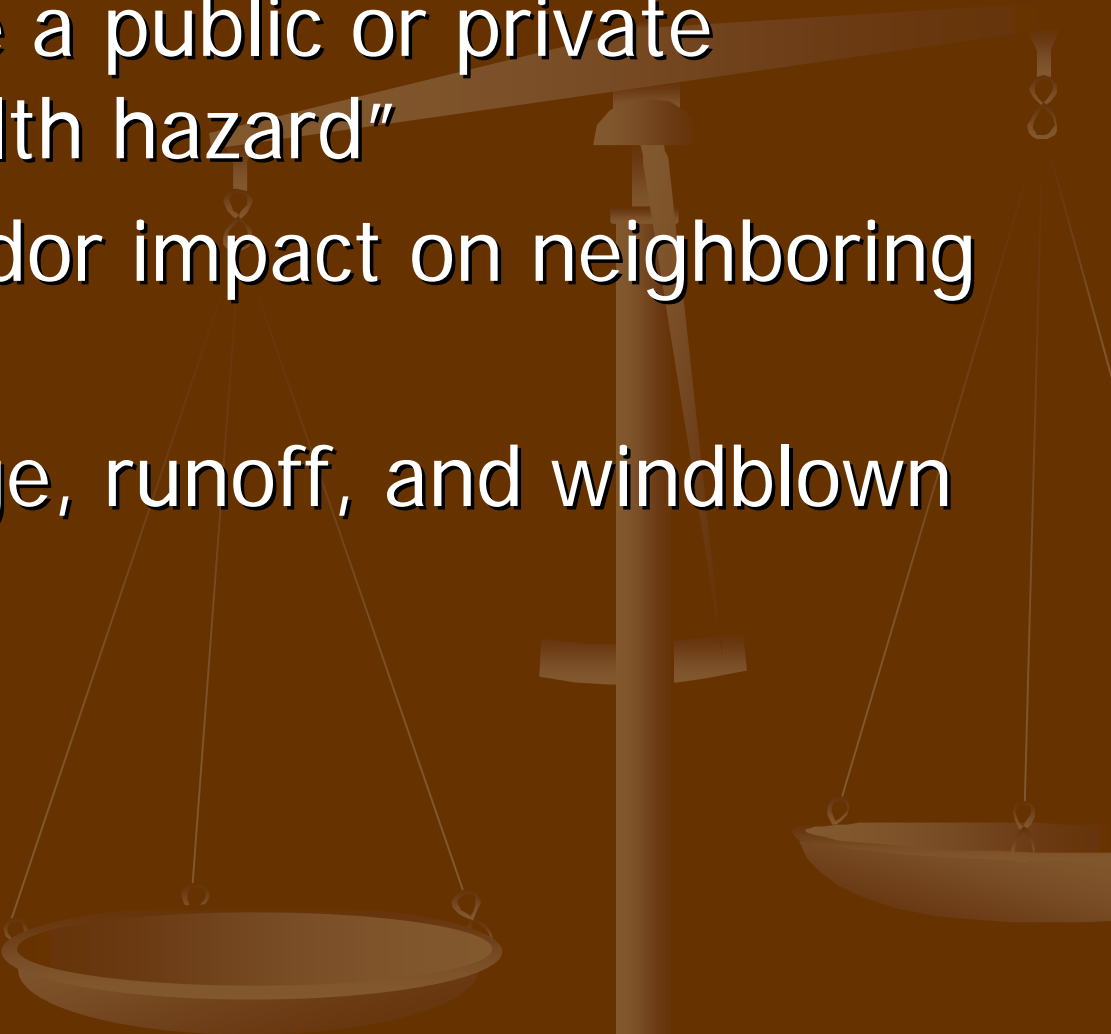
- ❑ Rapid decomposition into CO₂, water, heat, minerals, and compost (humus)
 - ❑ Aerobes are thermophilic
 - 120 to 150° F for week or more
 - ❑ Aerate when activity decreases
 - <100° F for week or more
 - Increasing aerobic activity and temperature again
 - ❑ Both will subside again
 - ❑ Repeated heat cycles until “finished”
- 

“Finished” compost

- ❑ Dark, humus-like
- ❑ No soft tissues
- ❑ Little odor
- ❑ Bones must be easily crumbled during the mechanical spreading process. If not, then they must be gathered and placed in a new batch of compost for further decomposition.



BODA states

- ❑ “shall not create a public or private nuisance or health hazard”
 - ❑ “minimize the odor impact on neighboring premise”
 - ❑ “prevent seepage, runoff, and windblown movement
- 

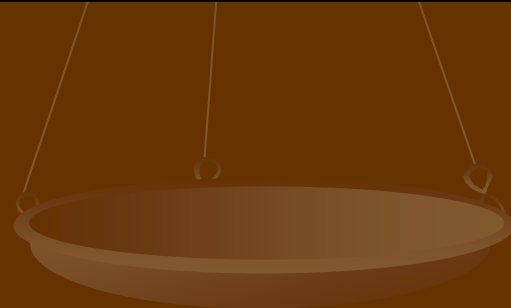
Curing

- ❑ After active composting, further decomposition at slow rate
- ❑ Less heat and lower temperatures (range 60 to 100° F).
- ❑ Several weeks to as long as a year or more
 - Bones decomposed
- ❑ Is not required by law (BODA)

Curing

- Amount of curing (desired mature or stability) depends on intended use of compost
 - Soil amendment
 - Finished or partially cured
 - Monitor temperature
 - Decomposition may not have ceased entirely
 - Plant medium
 - Fully cured
 - Laboratory test

More process management



Best conditions for active composting

- ❑ Carbon-to-nitrogen ratio (C:N; on weight basis) between 15:1 to 40:1.
- ❑ Moisture content, range of 40 to 60 %.
- ❑ Oxygen concentration of greater than 5%
 - Compost density (lbs./yd³), range of 800 to 1200.
- ❑ pH, range of 5.5 to 9.0.
- ❑ Temperature (degrees Fahrenheit), range of 100 to 150.

Worksheet to optimize conditions - C:N and moisture

January 29, 2007							
Materials in Compost Mix	Amount in Mix		Moisture %	Carbon % wet wt	Nitrogen % wet wt	Bulk Density lbs/yd ³	Cost \$
Poultry carcasses	1,000.00	lbs	65	4.20	0.84	800	\$ 0.01
Sawdust	468.80	lbs	39	43.92	0.15	410	\$ 45.74
Straw	-	lbs	12	49.28	0.62	227	\$ -
Laying hen litter	500.00	lbs	69	14.88	2.48	1479	\$ 25.00
Water	8.61	lbs	100	0.00	0.00	1686	\$ 0.51
Empty	-	lbs	0	0.00	0.00	0	\$ -
Empty	-	lbs	0	0.00	0.00	0	\$ -
Empty	-	lbs	0	0.00	0.00	0	\$ -
						Total Cost	\$ 71.25
Performance Summary							
Category	Constraints		Mix	Recommendations			
Percent Moisture	50 <= Percent Moisture <= 60		60.0	Percent Moisture OK			
Carbon : Nitrogen	15 <= C:N <= 40		15.0	C:N ratio OK			
Bulk Density (lbs/yd ³)	Bulk Density = 850		723	Increase bulk density			
Water : Carbon	No criteria set		4				
Materials Summary							
Material	Constraints		Units	Recommendations			
Poultry carcasses	Poultry carcasses = 1000		lbs	Amount OK			
Sawdust	0 <= Sawdust <= 20000		lbs	Amount OK			
Straw	0 <= Straw <= 2000		lbs	Amount OK			
Laying hen litter	0 <= Laying hen litter <= 500		lbs	Amount OK			
Water	0 <= Water <= 20000		lbs	Amount OK			
Empty			lbs				
Empty			lbs				
Empty			lbs				

Oxygen concentration

- Particle size
 - Varied
 - 0.1 to 2 inches
- Aeration
 - Moving
 - Turning
 - Mixing



Moisture content

- ❑ May have to add water
 - Depends on the moisture content of compost
 - Slowly
 - 1 to 2 gal per minute maximum
 - Fresh bulking agents stored uncovered
 - Quit if leaching
- ❑ Compost should leave your hand feeling moist, but not be able to squeeze water out of it. Silage like.

Batch

- ❑ Initial additions, or loading, of new dead animals and bulking agent limited to a planned time period
 - Rate of mortality
 - An appropriately sized composting facility.
- ❑ Batches provide for appropriately timed temperature monitoring, aerating, and utilization

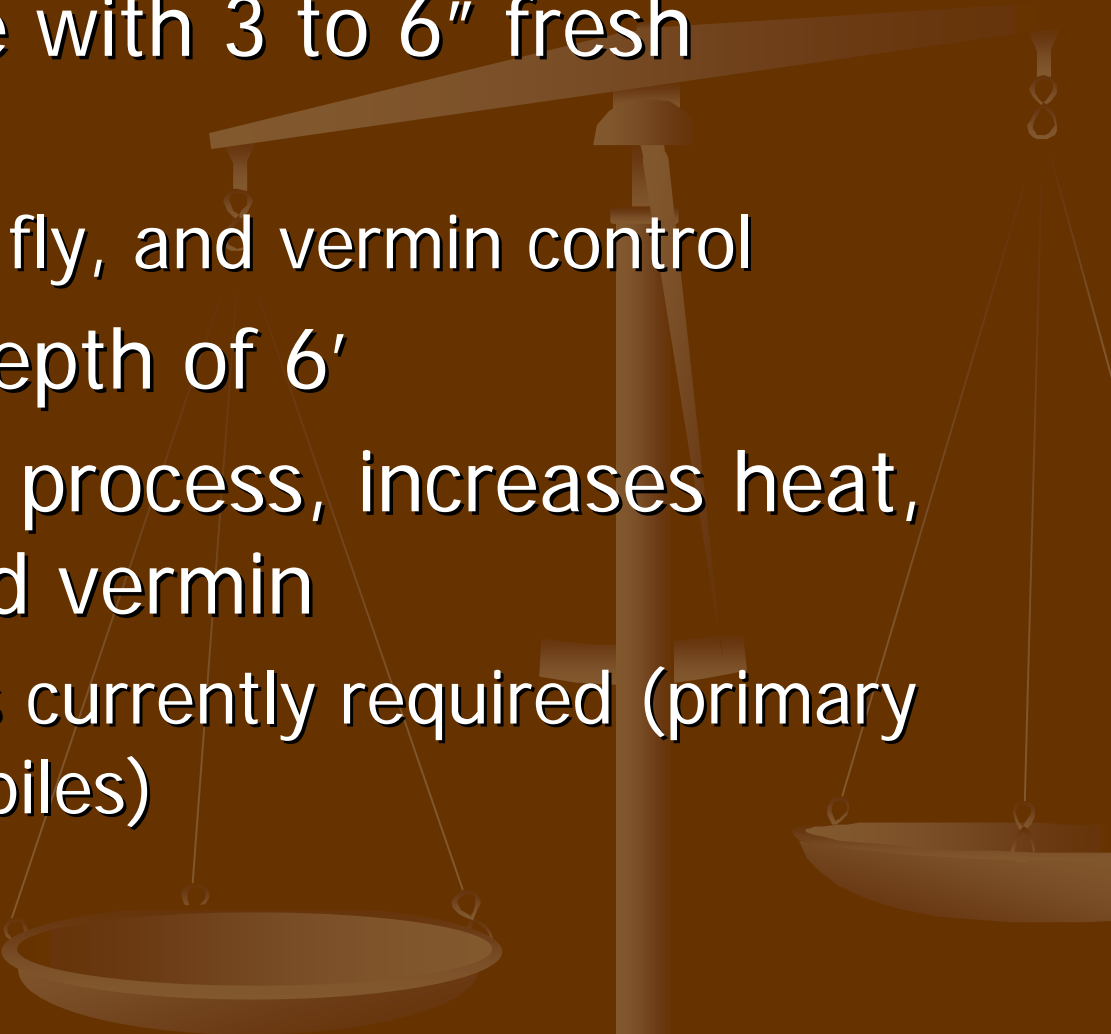
How to compost a dead animal?

- ❑ Carcass preparation
 - Chilling or freezing before composting slows or prevents activity
 - Carcasses left whole - necropsy cut speeds composting process
 - ❑ May compost carcasses of different livestock species together
 - Under common ownership
- 

How to compost a dead animal?

- ❑ Base of pile 1 to 2 feet of unused amendment
- ❑ Dead animal placed 6" or further from edge of pile
- ❑ Layers with minimum of 6" amendment
More for carcasses >500 lbs.
- ❑ Surround carcass with finished compost 6 to 12 inches on top of carcass
 - 1 to 1 mix with fresh bulking agent

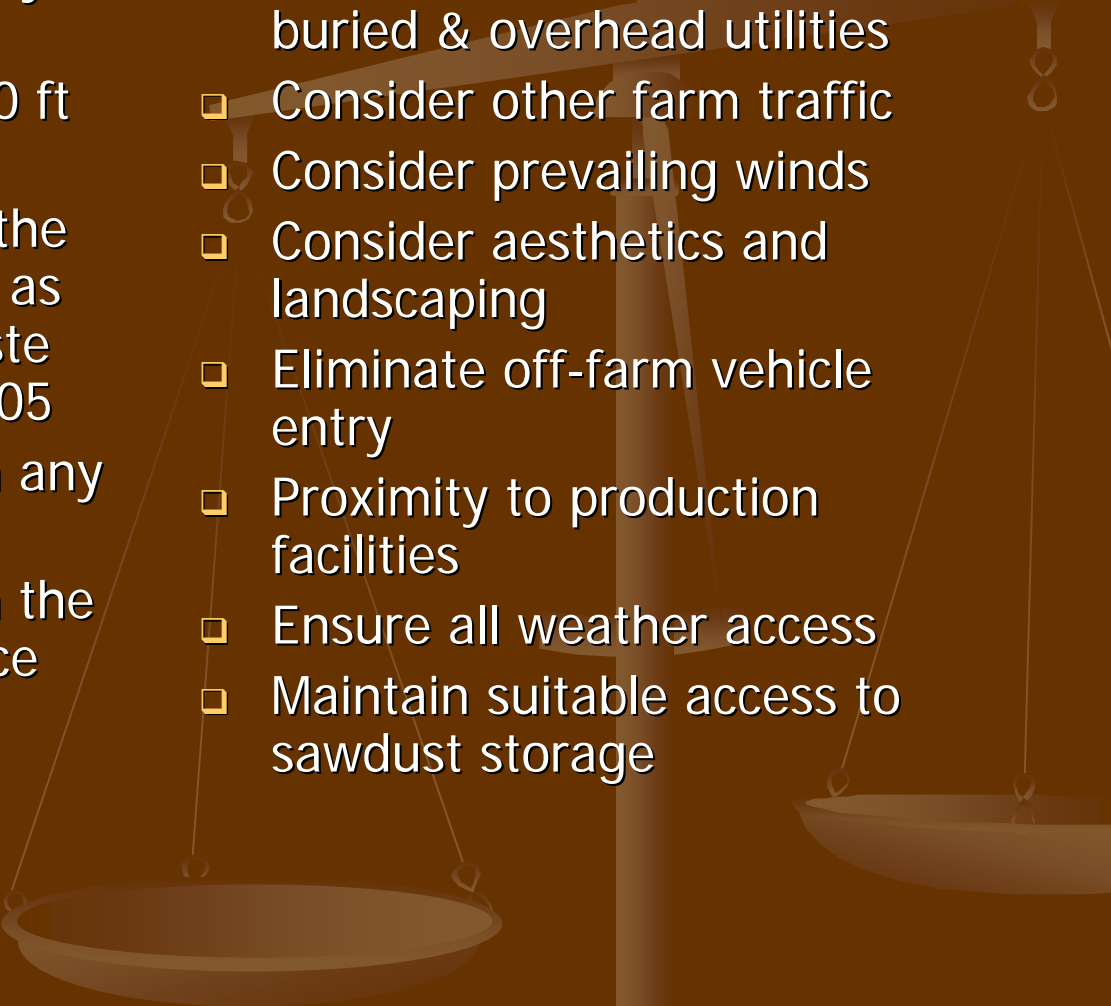
How to compost a dead animal?

- ❑ Cover entire pile with 3 to 6" fresh amendment
 - Biofilter – odor, fly, and vermin control
 - ❑ Maximum pile depth of 6'
 - ❑ Aerating speeds process, increases heat, controls flies and vermin
 - Two heat cycles currently required (primary and secondary piles)
- 

Reshape after collapse



Composting site selection

- ❑ Avoid wet areas; high & dry, well drained soils
 - ❑ A minimum setback of 200 ft from waters of the state.
 - ❑ A minimum of 2 ft above the seasonal high water table as defined by NRCS 313 Waste Storage Facility dated 11/05
 - ❑ A minimum of 200 ft from any well
 - ❑ A minimum of 200 ft from the nearest non-farm residence
 - ❑ Divert clean water
 - ❑ Locate safe distance from buried & overhead utilities
 - ❑ Consider other farm traffic
 - ❑ Consider prevailing winds
 - ❑ Consider aesthetics and landscaping
 - ❑ Eliminate off-farm vehicle entry
 - ❑ Proximity to production facilities
 - ❑ Ensure all weather access
 - ❑ Maintain suitable access to sawdust storage
- 

Bones

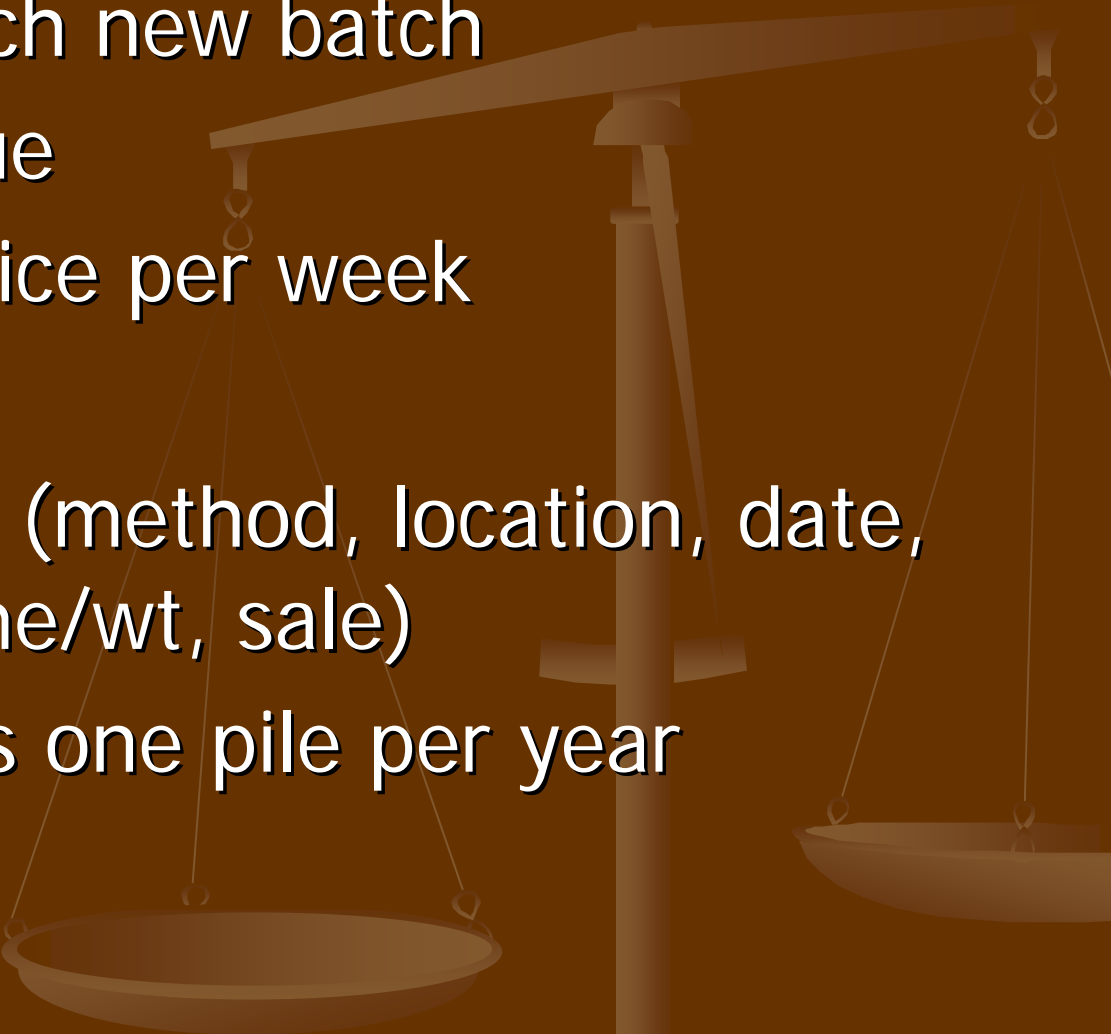


Practically, how long to compost?

Mortality Age (months)	<2	3-5	5-8	8-12	12-24	>24
Active decomposition (days)	45	90	120	180	270	365

Age more influential than size – maturity of bones and hide . . . remaining in cured compost shall be removed and added to an active compost pile or shall be disposed of under section 21 of Act No. 239 of the Public Acts of 1982

Records

- ❑ Start date of each new batch
 - ❑ Quantity of tissue
 - ❑ Temperature twice per week
 - ❑ Turning dates
 - ❑ Final disposition (method, location, date, estimated volume/wt, sale)
 - ❑ Nutrient analysis one pile per year
- 

Example record

Michigan Livestock Composting Record					
Name			Address		
City			County/Township		
Batch	Date	Pounds Added	Temp	Bin Turned	Disposition (include method, location, estimated volume or weight)
Michigan State University, Department of Animal Science, Swine Extension					

Risk of disease

- ❑ Nearly all potential bacterial and viral pathogens will be destroyed within 7 days of properly managed compost
 - Animal tissue placed completely in active portion of batch
 - Heat is lethal
 - Heat cycles must be achieved
 - Organic acids and pH of compost is lethal
 - Competition with other microbes is lethal
- ❑ Furthermore, most need a living animal as a host
- ❑ Prions will not be destroyed
 - BSE, Chronic wasting disease, scrapie

Biosecurity



- ❑ Vehicles and equipment
 - Maintain cleanliness between production unit and compost pile
 - Separate equipment
- ❑ Scavenging animals, birds and vermin
 - Maintain adequate cover over carcasses
 - Construct fencing if problems persist
 - Spread finished compost away from the site
- ❑ Personnel
 - Identify a manager for the pile

Summary: controllable composting variables

- ❑ Bulking agent
 - Percent recycled compost
- ❑ Moisture
- ❑ Particle Size
- ❑ Carbon/nitrogen ratio
- ❑ O_2
 - Porosity
 - Aeration Schedule
- ❑ Retention Time
 - Curing Time
- ❑ Pile shape and depth



Size of bin facility, pile, windrow, in-vessel unit

- ❑ Mortality rate
- ❑ Weight of mortality
- ❑ Animal density efficiency coefficient
 - 10 lb./ft³
- ❑ Size of equipment
- ❑ Composting activity/speed
 - Management intensity



Suggested number of months for well-managed active composting in static batches for the decomposition of all soft tissues

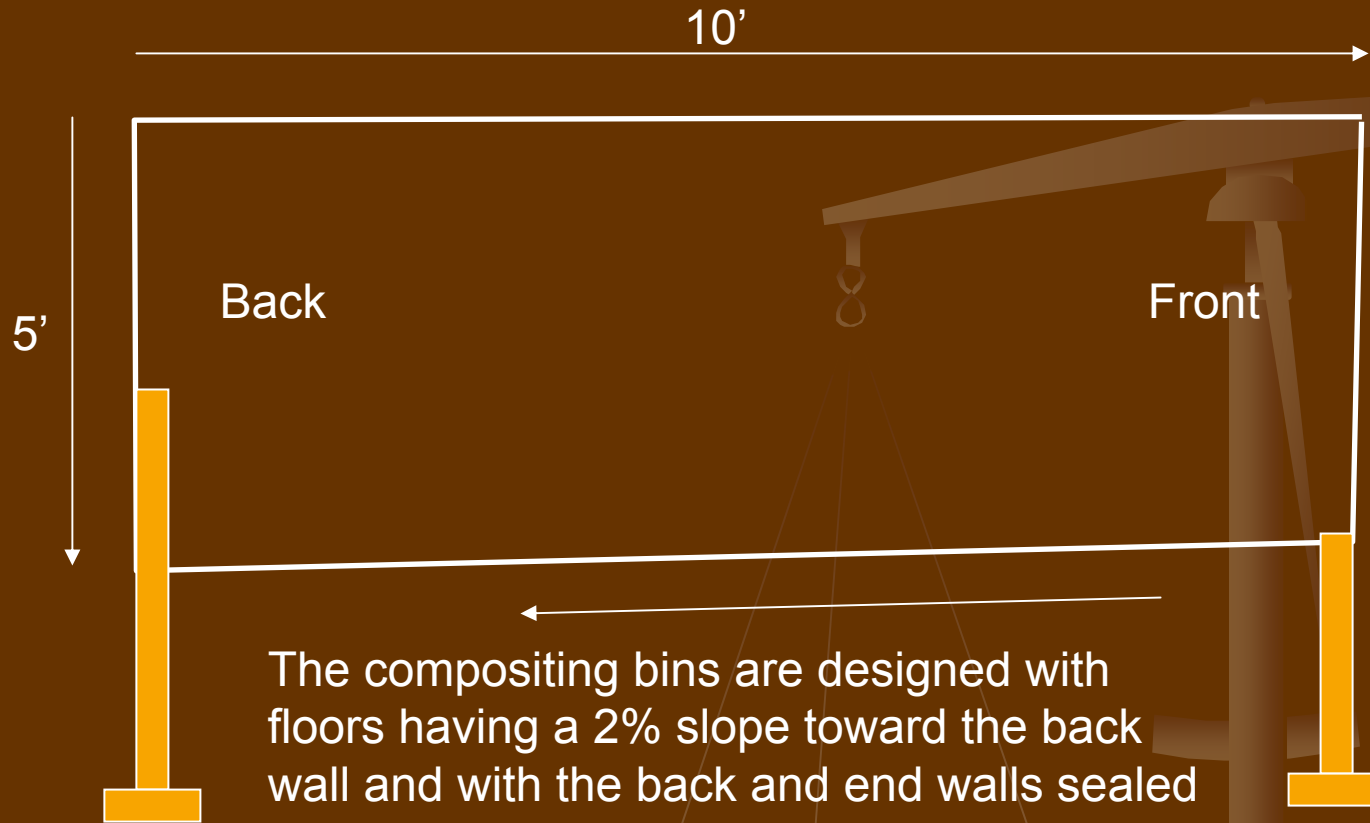
Carcass size, lbs.	Number of months
1 to 25	2
25 to 125	3
125 to 250	4
250 to 500	5
500 to 1000	6
1000 or more	8

Bin

- ❑ Constructed facility
 - Reinforced concrete floors
 - Two or more bins (rot-resistance, strong enough to resist mechanical forces of turning
 - Three sides
 - Roof
 - Pile
 - Static



Side view of bin



The composting bins are designed with floors having a 2% slope toward the back wall and with the back and end walls sealed at the floor-wall interface to retain leachate that may occur.

Top view



- 1 rows of 10' x 13' bins, 8" concrete walls suggested (If EQIP, then NRCS to specify)
- Need hard surface apron around bins as ground will thaw because of heat of composting in winter and loader movement will be more difficult. Dimensions dependent on turning radius of loader
- Roof alternative - possibly use a tarp that may be rolled back and forth to allow up to 2" of rainfall

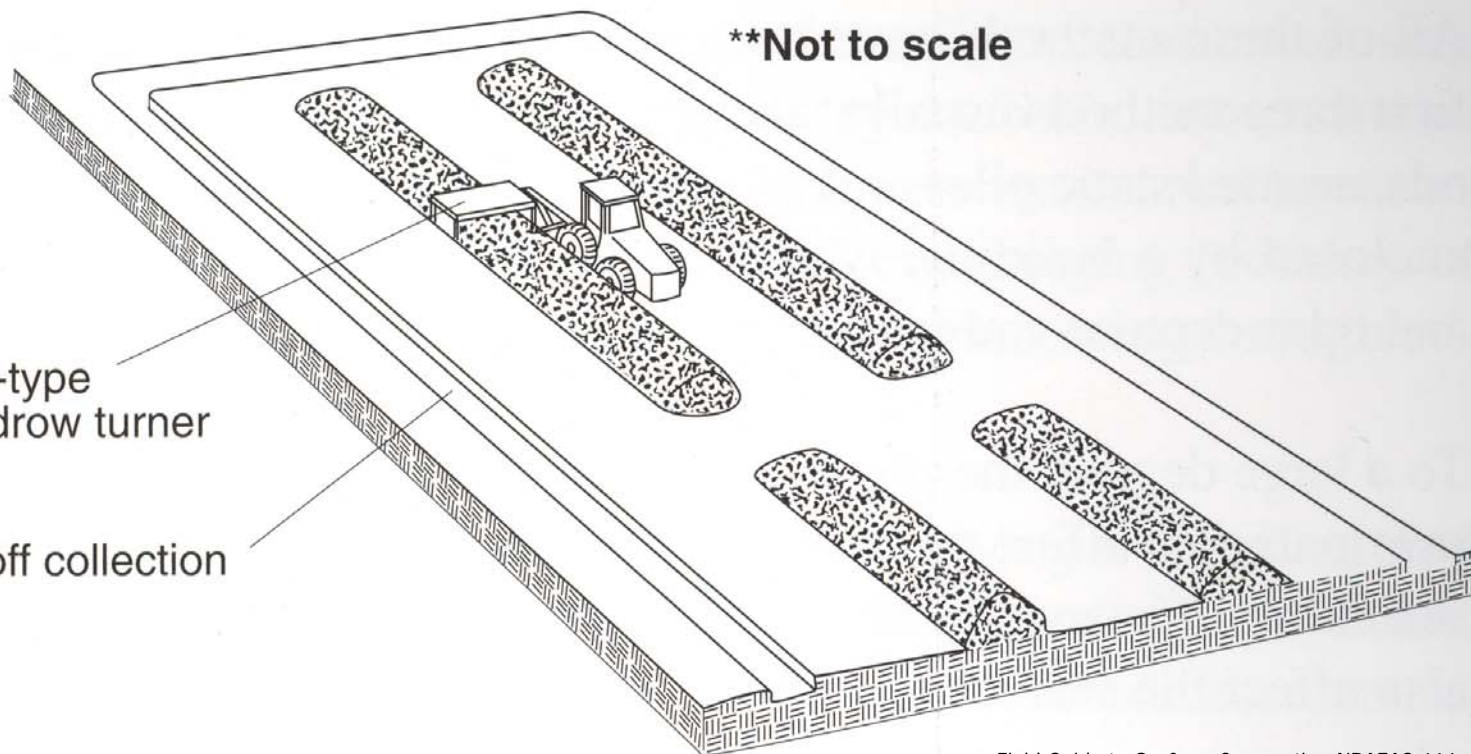
MSU Compost System Sizing Spreadsheet

Composting Worksheet for Bovine Mortalities in Bins				
Name:	Five-Hundred Cow Dairy	Phone:		
Address:	In, Michigan	Fax:		
	Animal Production Phase			
Item	Cows	Calves	Heifers	Feeder Cattle
Capacity	500	200	0	0
Days in this production phase	365	150	168	168
Number of animals per year	500	487	0	0
Percent mortality	0.05	0.12	0.02	0.02
Average weight of animals during phase, lb.	1400	110	600	600
Phase - calculated daily mortality (lb./day)	96	18	0	0
Total farm mortality daily (lb./day)	113			
Desired time to fill primary bin, number of months	1.5			
Total farm mortality per time (lb./day x number of months)	5107			
Desired animal tissue density, lb./ft ³	10			
Bin volume needed to fill bin in desired time, ft ³	511			
Length of bin, ft	10			
Width of bin, ft	12			
Height of compost material, ft	5			
Volume of bin, ft ³	513			
Number of months active compost occupies a bin	8			
Number of composting bins	6			
Number of bulking agent storage bins	1			
Total number of bins needed in compost facility	7			
Composting facility effective volume, ft ³	3762			
Composting facility area, ft ²	879			

****Not to scale**

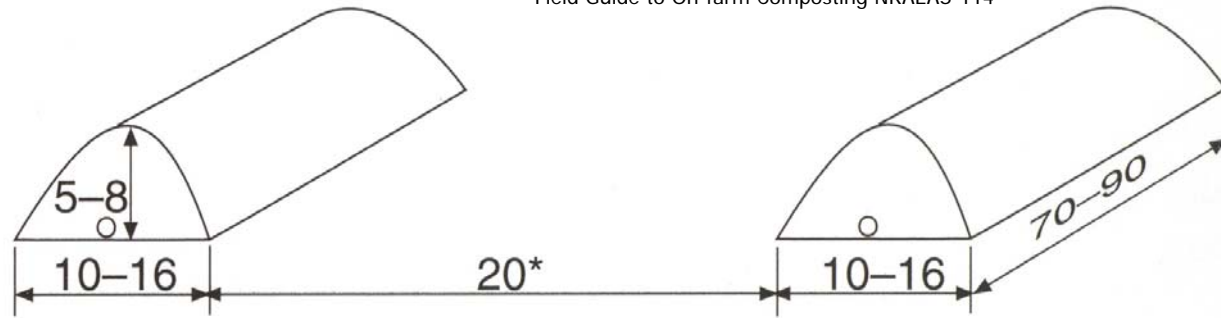
Pull-type
windrow turner

Runoff collection
ditch

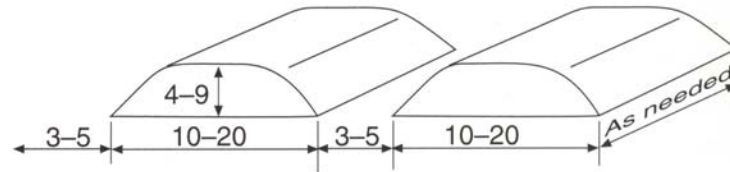


Field Guide to On-farm Composting NRAEAS-114

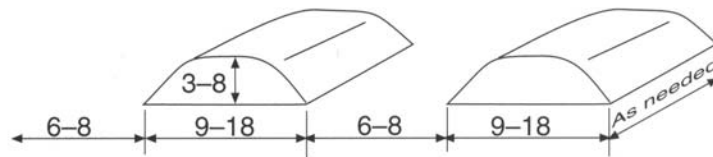
20,000 pounds or more



Individual aerated static piles



Self-propelled windrow turners



Tractor-assisted windrow turners (two-pass)

MSU Compost System Sizing Spreadsheet

Address:	In, Michigan
Phone:	
Fax:	
	Animal or Animal Tissue Accumulation
	Others
Capacity	500
Days per complete turn (all-in to all-in)	365
Total number of head per year	500
Percent mortality	0.055
Average weight of animals during phase, lb.	1400
Calculated daily mortality, lb./day	105
Desired time to fill windrow, number of months	2
Total farm mortality per time (lb./day x number of months)	6329
Desired animal tissue density, lb./ft ³	10
Windrow volume needed to fill windrow in desired time, ft ³	633
Length of windrow	18
Width of base of windrow	18
Height of compost material	8
Volume of windrow, ft ³	1737
Number of months compost occupies windrow	8
Total number of windrows needed in compost facility	4
Tractor and bucket working space, ft	20
Space needed to form and turn windrow	4014
Total volume of windrows used for composting, ft ³	7263
Size of pad for windrows, working space between, and around, ft ²	5369

$$\begin{aligned} \text{Bin} &= 879 + \\ &400 + 168 \text{ ft}^2 \\ &= 1447 \text{ ft}^2 \text{ of} \\ &\text{concrete} \end{aligned}$$