CULTIVATING SUCCESS™
sustainable small farms education

Composting for small livestock producers

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University of Idaho Extension

Food Systems
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Today's Presenter(s)

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Extension Educator, Gooding County
University of Idaho

Colette DePhelps, facilitator
Area Educator, Community Food Systems
University of Idaho Extension, Northern District

Webinar Tips

Close all other programs running on your computer

Check your sound – problems with clarity, speed, etc. switch to the phone

Call-in number provided in the welcome email

Mute computer sound when using phone

Type in questions for speakers (or for help with viewing & sound) into question box

Handouts are available to download on your computer

Today' Webinar Topics

- Manure and nutrient management
- Manure production
- Composting theory
- Management parameters
- Composting methods
- Screening compost
- Troubleshooting

Nutrient and manure management in small to medium size livestock operations

- Lot of different situations/ approaches
- From small backyard type operations to considerable big dairies with thousands of animals

- Multi-species or single specie?
- Variable soil conditions
- Variable crop types and conditions
- Can someone else use your manure or compost?
- Learn to use your resources to your advantage

Good manure management

- Keeps livestock healthy
- Returns nutrients to the soil and improves soil condition
- Improves pastures and gardens
- Relatively inexpensive
- Protects the environment

Poor manure management

- Source of problems = liability
- Livestock can get sick
- Unsanitary conditions
- Run off risk
- Pollution of air and water
- Complaints from neighbors
- Increased insect and parasite populations
- Loss of nutrient value
- Harms the environment

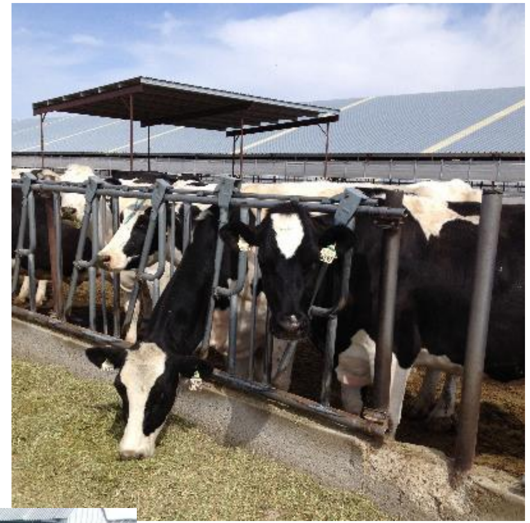
Manure Production

What is an animal unit?

- **An animal unit is 1,000 (one thousand) pounds of any type of animal**
  - 1- 1,400 Lb dairy cow: 1.4 AU
  - **1 – 130 Lb goat or sheep: 0.13 AU**
  - 1- 7 Lb chicken: 0.07 AU

- Calculation AU=

$$\frac{\text{\# of animals * animal weight}}{1{,}000}$$



Nutrient value of manures

Lab analysis vs book values

Table 1.b – Section 3 – All other livestock and poultry. Diet based numbers are in BOLD. See footnotes 2 and 3 for source of non-bold values.

Animal Type and Production Grouping	Total solids[3]	Volatile solids[3]	COD[3,4]	BOD[3,4]	Nitrogen	P	K	Ca	Mg	Total Manure[5]		Moisture[6]
	kg / day-animal (d-a)									kg / (d-a)	liter / d-a.	% w.b.
Beef - Cow (confinement)[7,10]	**6.6**	**5.9**	6.2	1.4	**0.19**	**0.044**	0.14	**0.089**		-	-	88
Beef - Growing Calf (confinement)	**2.7**	**2.3**	2.3	0.52	**0.13**	**0.025**	0.085	**0.040**		22	22	88
Dairy - Lactating cow	**8.9**	7.5	8.1	1.30	**0.45**	**0.078**	**0.103**			68	68	87
Dairy - Dry cow	**4.9**	4.2	4.4	0.626	**0.23**	0.03	0.148			38	3	87
Dairy - Milk fed calves					0.0079							
Dairy - Calf-150 kg	1.4				0.063					8.5	8.5	83
Dairy - Heifer-440 kg	3.7	3.2	3.4	0.54	**0.12**	**0.020**				22	22	83
Dairy - Veal-118 kg	0.12				0.015	0.0045	0.0199			3.5	3.5	96
Horse - Sedentary-500 kg[8]	**3.8**	3.0		0.48	**0.089**	**0.013**	**0.027**	**0.023**	**0.009**	25	25	85
Horse - Intense exercise -500 kg[8]	**3.9**	3.1		0.49	**0.15**	**0.033**	**0.095**	**0.069**	**0.018**	26	26	85
Layer	**0.022**	0.016	0.018	0.0050	**0.0016**	**0.00048**	0.00058	**0.0022**		0.088	0.088	75
Swine - Gestating sow-200 kg	0.50	0.45	0.47	0.17	**0.032**	**0.009**	0.022			5.0	5.0	90
Swine - Lactating sow[9] -192 kg	1.2	1.0	1.1	0.38	**0.085**	**0.025**	.053			12	12	90
Swine - Boar-200 kg	0.38	0.34	0.27	0.13	0.028	0.0097	.0176			3.8	3.8	90
	lb / day-animal (d-a)									lb / d-a.	ft³ / d-a.	% w.b.
Beef - Cow (confinement)[7,10]	**15**	**13**	14	3.0	**0.42**	**0.097**	0.30	**0.20**		-	-	88
Beef - Growing Calf (confinement)	**6.0**	**5.0**	5.2	1.1	**0.29**	**0.055**	0.19	**0.088**		50	0.81	88
Dairy - Lactating cow	**20**	17	18	2.9	**0.99**	**0.17**	**0.23**			150	2.4	87
Dairy - Dry cow	**11**	9.2	9.7	1.4	**0.50**	**0.066**	0.33			83	1.3	87
Dairy - Milk fed calves					0.017							
Dairy - Calf-330lb	3.2				0.14					19	0.30	83
Dairy - Heifer-970 lb	8.2	7.1	7.5	1.2	**0.26**	**0.044**				48	0.78	83
Dairy - Veal-260 lb	0.27				0.033	0.0099	0.044			7.8	0.12	96
Horse - Sedentary-1,100 lb[8]	**8.4**	6.6		1.1	**0.20**	**0.029**	**0.060**	**0.051**	**0.020**	56	0.90	85
Horse - Intense exercise -1,100 lb[8]	**8.6**	6.8		1.1	**0.34**	**0.073**	**0.21**	**0.15**	**0.040**	57	0.92	85
Layer	**0.049**	0.036	0.039	0.011	**0.0035**	**0.0011**	0.0013	0.0048		0.19	0.0031	75
Swine - Gestating sow-440 lb	1.1	0.99	1.0	0.37	**0.071**	**0.020**	0.048			11	0.18	90
Swine - Lactating sow[9] 423 lb	2.5	2.3	2.4	0.84	**0.19**	**0.055**	0.12			25	0.41	90
Swine - Boar-440 lb	0.84	0.75	0.60	0.29	0.061	0.021	0.039			8.4	0.13	90

ASAE D384.2 MAR2005 – Manure Production and Characteristics

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Table 6. Daily manure production and characteristics, as-excreted.

Values are as-produced estimations and do not reflect any treatment. Values do not include bedding. The actual characteristics of manure can vary ± 30% from table values. Increase solids and nutrients by 4% for each 1% feed wasted above 5%.

Animal	Size [a] (lbs)	Total manure (lb/day)	(ft³/day)	(gal/day)	Water (%)	Density (lb/ft³)	Total Solids (lb/day)	Volatile Solids (lb/day)	BOD_5 (lb/day)	Nutrient content (lb/day) (N)	(P_2O_5)	(K_2O)
Dairy cattle	150	13	0.20	1.5	88	65	1.4	1.2	0.20	0.05	0.01	0.04
	250	21	0.32	2.4	88	65	2.3	1.9	0.33	0.08	0.02	0.07
Heifer	750	65	1.0	7.8	88	65	6.8	5.8	1.0	0.23	0.07	0.22
Lactating cow	1,000	106	1.7	12.7	88	62	10.0	8.5	1.60	0.58	0.30	0.31
	1,400	148	2.4	17.7	88	62	14.0	11.9	2.24	0.82	0.42	0.48
Dry cow	1,000	82	1.30	9.7	88	62	9.5	8.1	1.20	0.36	0.11	0.28
	1,400	115	1.82	13.6	88	62	13.3	11.3	1.70	0.50	0.20	0.40
Veal	250	9	0.14	1.1	96	62	0.32	0.14	0.22	0.04	0.03	0.06
Beef cattle												
Calf	450	26	0.42	3.1	92	63	3.40	2.88	0.58	0.14	0.10	0.11
High forage	750	62	1.0	7.5	92	62	5.8	5.2	1.05	0.41	0.14	0.25
High forage	1,100	92	1.4	11.0	92	62	8.5	7.6	1.50	0.61	0.21	0.36
High energy	750	54	0.87	6.5	92	62	4.2	3.9	1.0	0.38	0.14	0.22
High energy	1,100	80	1.26	9.5	92	62	6.2	5.7	1.50	0.54	0.21	0.32
Cow	1,000	63	1.00	7.5	88	63	7.70	6.00	1.40	0.31	0.19	0.26
Swine												
Nursery	25	2.7	0.04	0.3	89	62	0.27	0.22	0.09	0.02	0.01	0.01
Grow-Finish	150	9.5	0.15	1.2	89	62	1.0	0.80	0.30	0.08	0.05	0.04
Gestating	275	7.5	0.12	0.9	91	62	0.69	0.59	0.23	0.05	0.04	0.04
Lactating	375	22.5	0.36	2.7	90	63	2.25	2.03	0.75	0.18	0.13	0.14
Boar	350	7.2	0.12	0.9	91	62	0.66	0.59	0.23	0.05	0.04	0.04
Sheep	100	4.0	0.06	0.4	75	63	1.10	0.91	0.10	0.04	0.02	0.04
Poultry												
Layer	4	0.26	0.004	0.031	75	65	0.065	0.049	0.015	0.0035	0.0027	0.0016
Broiler	2	0.18	0.003	0.021	74	63	0.047	0.034	0.010	0.0023	0.0014	0.0011
Turkey	20	0.90	0.014	0.108	75	63	0.225	0.171	0.066	0.0126	0.0108	0.0054
Duck	6	0.33	0.005	0.040	73	62	0.089	0.053	0.012	0.0046	0.0038	0.0028
Horse	1,000	50	0.80	5.98	78	63	11.00	9.35	1.40	0.28	0.11	0.23

[a] Weights represent the average size of the animal during the stage of production.

(Manure Characteristics – MWPS 18-1)

How much manure do animals produce?

- **Example:**

How much manure will be produced by 100 sheep (or goats) confined year long in a corral?

Sheep and goat manure production example

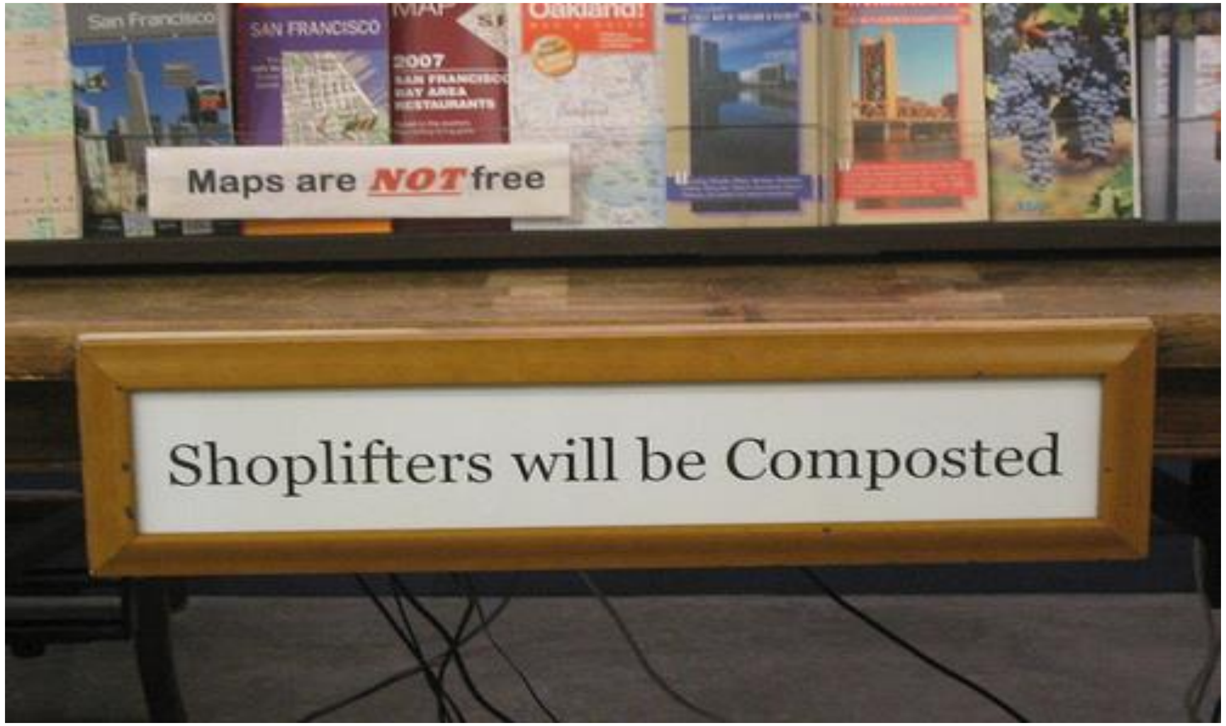
- 100 sheep (or goat), 100 pounds BW each
  - Manure WEIGHT: 4 lbs/day x 100 animals = **400 Lb/day**
  - Manure VOLUME: 0.06 cubic feet/day x 100= **6 cuFt/day**

- Manure WEIGHT: 400 lbs/day x 30 days/month x 12 months = **144,000 Lb (72 ton) of manure/yr**

- VOLUME: 6 cu ft/day x 30 days/month x 12 months = **2,160 ft^3 (80 Yr^3) of manure/yr**

- **This doesn't include bedding!!!**

Composting as manure treatment option



What is Composting?

- *Control of the natural breakdown of organic material that produces a stable humus-rich material*
- Aerobic process
- Biologically controlled
  - Bacteria
  - Fungi
  - Actinomycetes
- Macro-organisms are present too

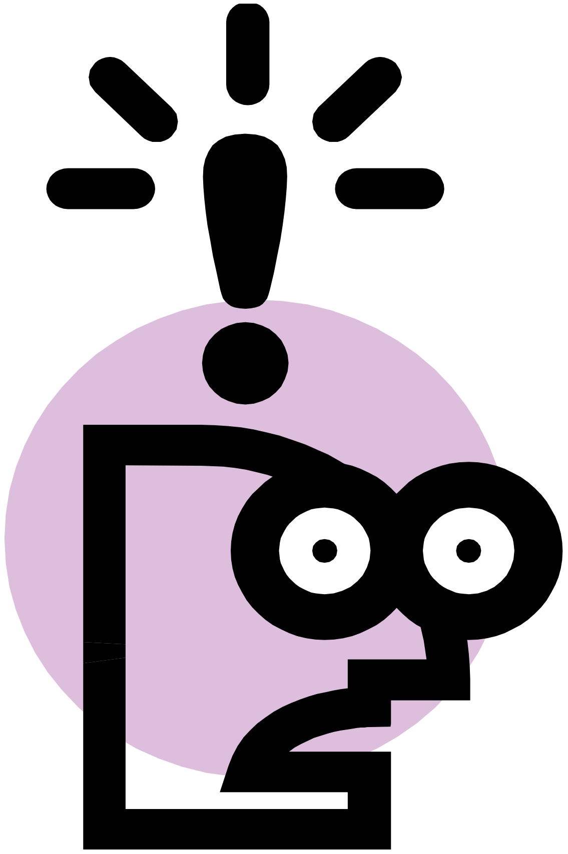
  Insects, earthworms, sow bugs, millipedes

Benefits of Composting

- Reduced volume of organic wastes (35 to 50+%)
- Soil conditioning and fertilizer
- Improved manure/wastes handling
  - Easier to transport and apply
  - Stable product for storing
- Pathogen destruction/reduction
- Much less problematic than manure/wastes
- Nutrient's export
- Saleable product

Challenges of Composting

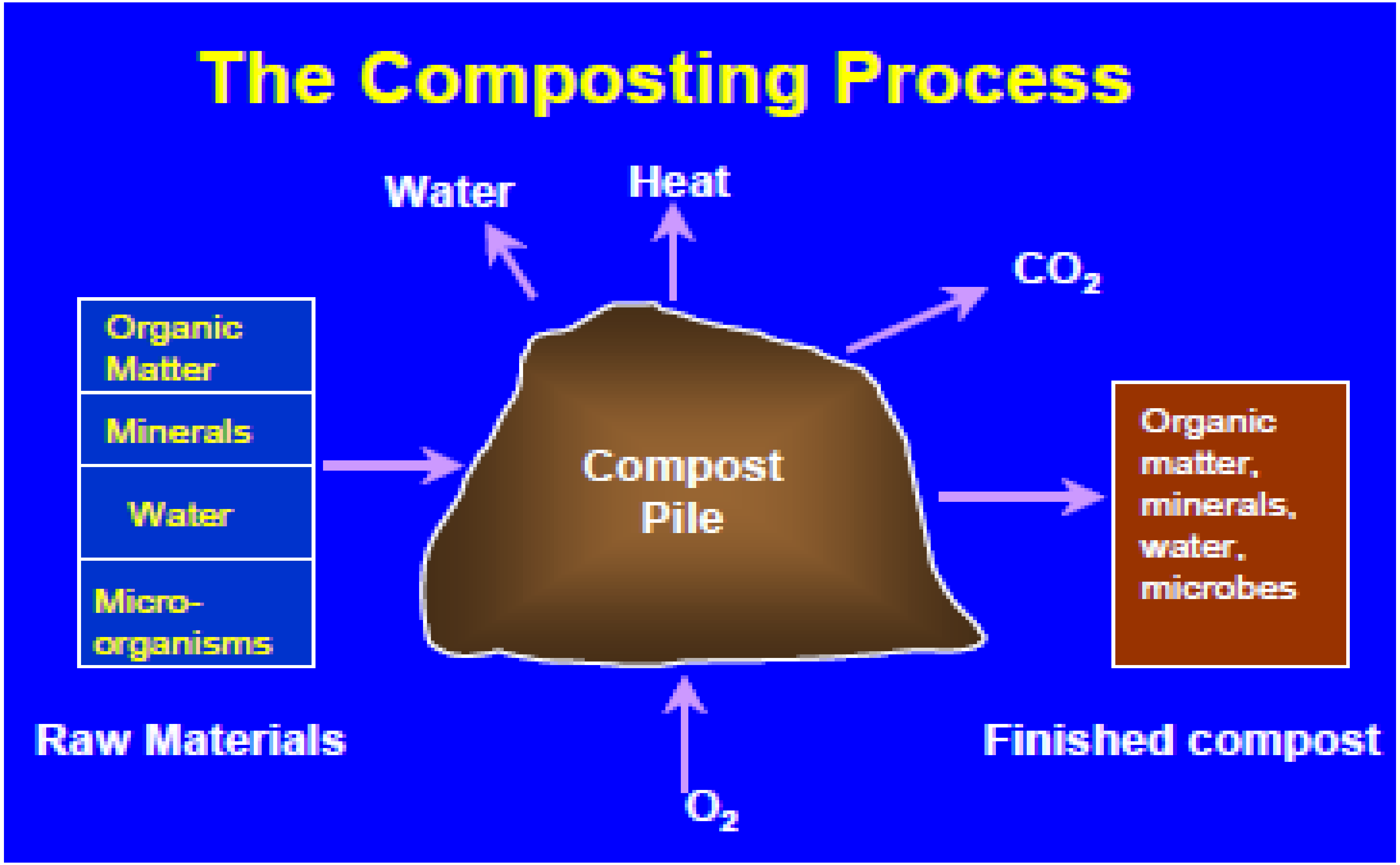
- Requires management
- Requires time
- Financial investment
- Odors, if mismanaged
- Weather
- Concentrate certain nutrients (e.g. P, K)
- Marketing of product



What do I need to make compost?

- **Organic matter**
- **Oxygen**
- **Moisture** (50 - 60%)
- **Correct carbon to nitrogen ratio** (~30:1)
- **Temperature** (120-160 ºF) (49 – 71 ºC)
- **pH** (6.5 – 8.5)
- Bulk density: 40 lb/ft^3

Schematics of Composting



Adapted from Rynk, 1992

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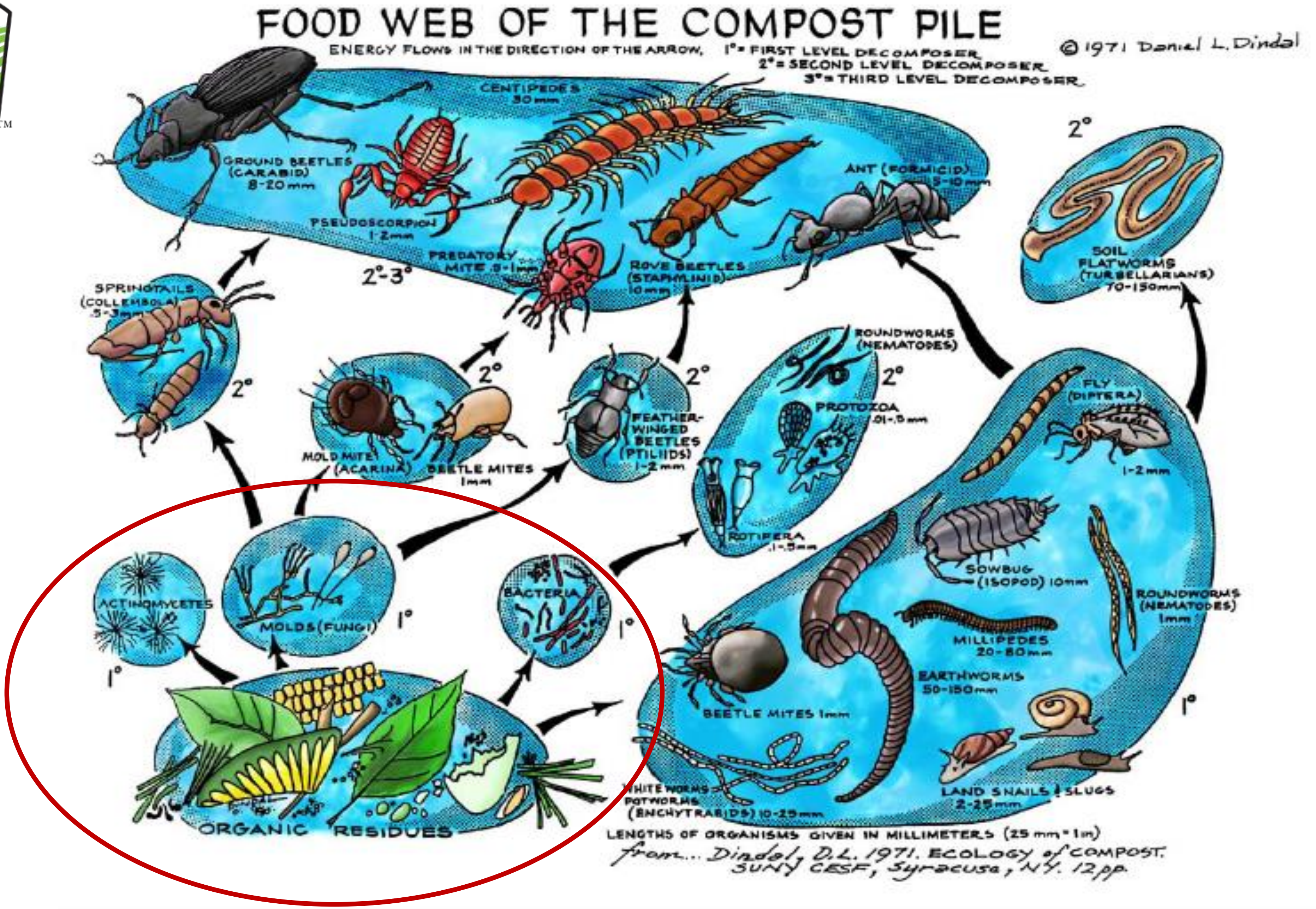

Desired Characteristics of Raw Materials Mixes

Characteristic	Reasonable Range	Desired Range
C:N	20:1 – 40:1	25:1 – 30:1
Moisture Content	40 – 60%	50-60%
pH	5.5 – 9.0	6.5 – 8.5
Bulk Density	Less than 40 lb/cu.ft. (1,100 lb/cu yr)	-

Source: NRAES-54

Sheep/goat manure C:N 13-20 65-70% moisture

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Calculate C/N Ratio For Three Materials

This calculation solves for the carbon to nitrogen ratio of up to three materials. Enter the mass of each material (wet weight), percentage of carbon, percentage of nitrogen, and percentage of moisture, then click on the calculate button. If you have less than three materials be sure to enter zeroes in the fields for the missing materials.

Note - Use whole numbers

Ingredient	% H20	Weight	% Carbon	% Nitrogen	C/N Ratio
				Result:	

Calculate Reset

http://compost.css.cornell.edu/calc/2.html

Cornell Waste Management Institute © 1996
Dept of Crop and Soil Sciences
Bradfield, Cornell University
Ithaca, NY 14853
607-255-1187
cwmi@cornell.edu

Compost management parameters

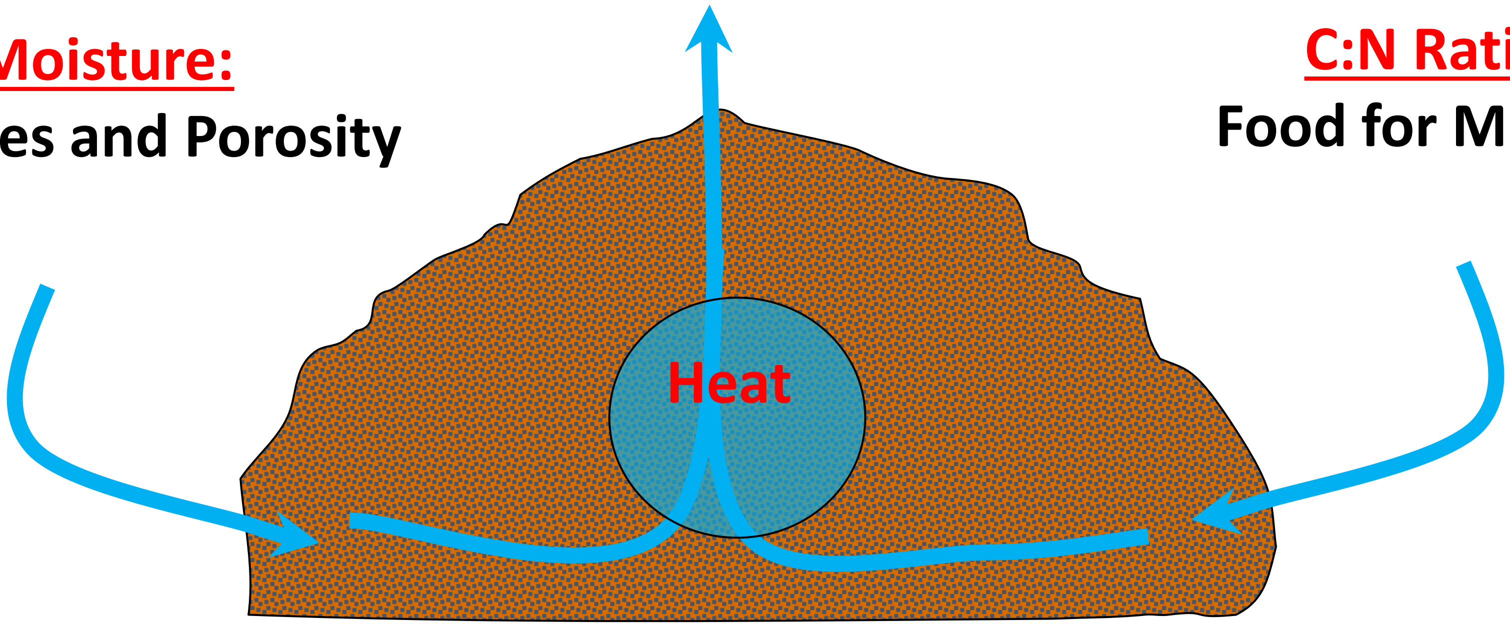
- Temperature
- Warm= Fast action – Cool= Slow action
- Temp is a good management tool + thermometer
- Aeration
- Replenishes necessary oxygen
- Removes heat, water vapor, CO_2, and other gases
- Moisture
- Necessary for microbial activity
- Too dry = no action - Too wet = no air
- "Squeeze" test

Compost Pile Dynamics

Porosity: 1. Air Movement (convection)
2. Pile Height (~ 3')

Moisture:
Microbes and Porosity

C:N Ratios:
Food for Microbes



Temperature:
1. Controls Microbe Community
2. Pile Height, C:N Ratios

Monitoring Temperature/Activity

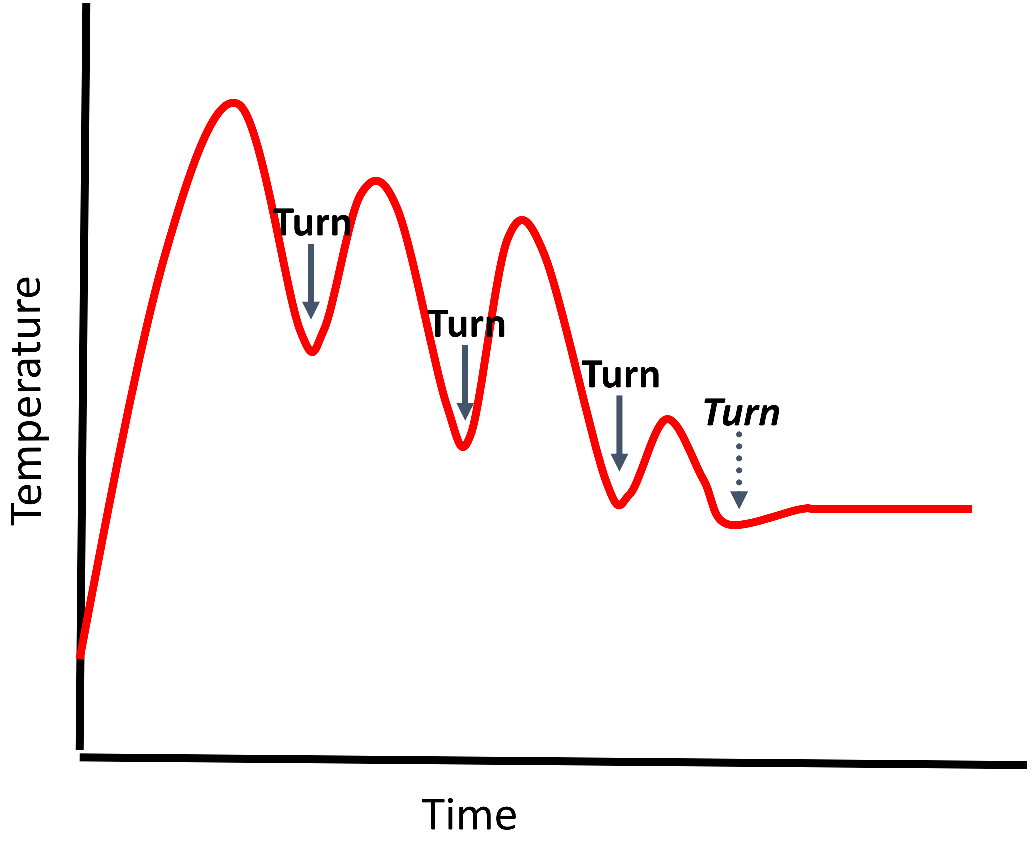
- Magic number to remember = **131 °F (55 °C)**
- That is the USEPA **Processes to Further Reduce Pathogens (PFRP)**
- It also has a time component, PFRP must be maintained for certain time and achieved on repeated occasions depending on the technique considered
- Home compost systems very seldom reach and sustain PRFP temperatures

- **For on-farm composting methods this temperature is easily reached and maintained**

Temperature Cycles

Important temperatures:

- Maintain between 110 to 150 °F (43 to 60 °C)
- **131 °F (54.5 °C) = Regulatory Critical T° for destruction of human pathogens**
- 145 °F (63 °C) = destruction of most weed seeds
- > 160 °F (71 °C) = risk of auto-combustion



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Monitoring compost piles/ windrows

Maintain 131 F

3 days x 5 times when turning

3 days the rest

When Is Compost Done?

- Finished product will be:
  - Dark and crumbly
  - Original identity of materials mostly gone
- Finished compost will smell earthy
- Moist pile remains cool after turning
- Inhabited by earthworms and others
- Ready in as little as 3 months to as long as 1 year

On-farm Composting Methods

- **Windrows and piles**
  - Mechanically turned
  - Passive aeration
  - Forced aeration
- **Open bins composter**
- **In-vessel composting**
  - Forced Aeration - Bin
  - Rotatory vessels
  - Other in-vessel systems

Mechanically Turned Windrows

- Most used in southern Idaho
- Easy to construct
- Bucket loaders
  - 6-12' H, 10-20' W
- Truck loads
- Turning machines
  - 3-9' H, 9-20' W
- Can use loader or tractor for turning

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Windrow/pile can be turned by other means

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Windrow composting using a tractor or skidder


Mixing the recipe

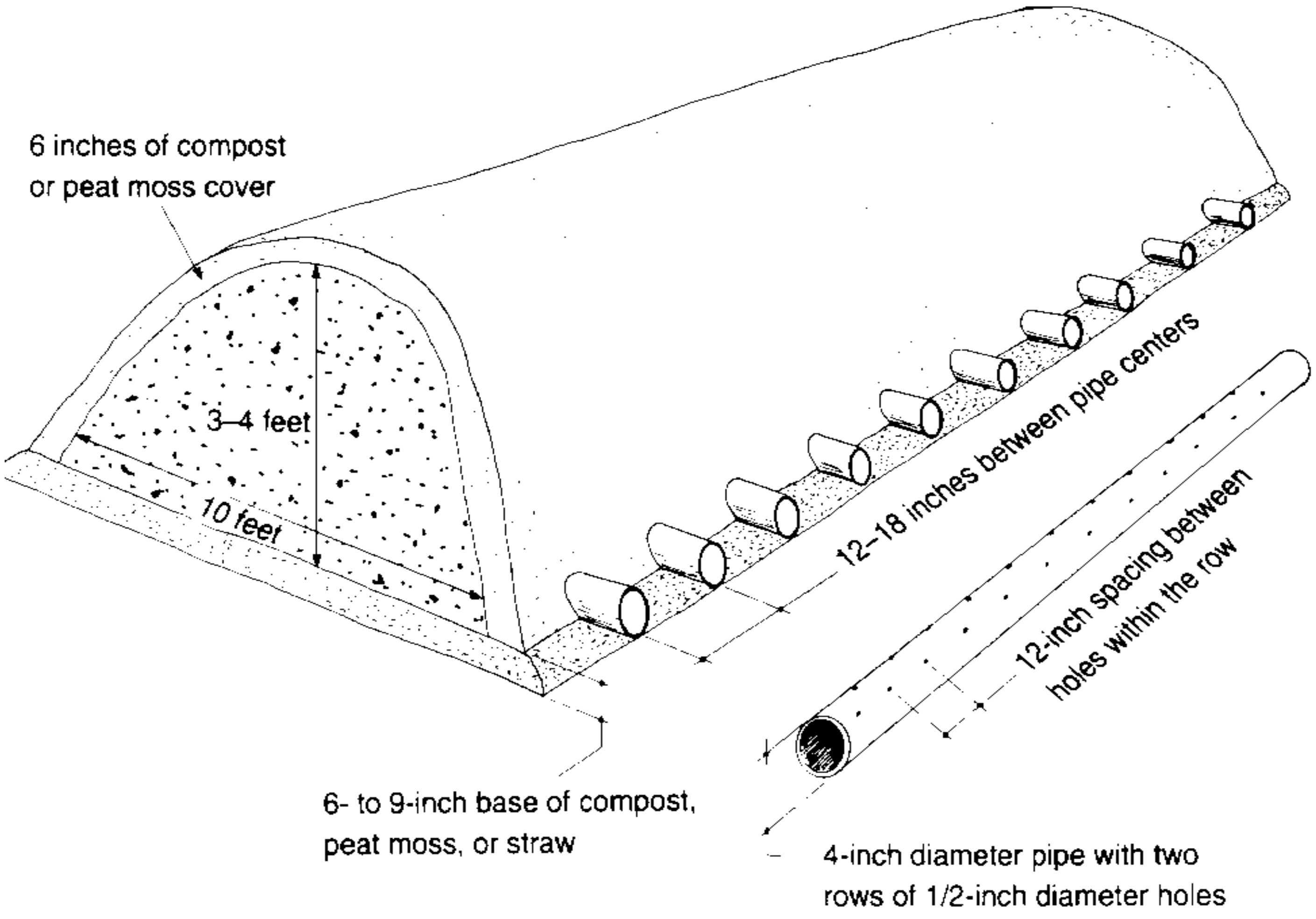

Building a windrow


Turning a windrow


Monitoring

Static Aerated Windrows

- 3 - 4’ H, 10’ W
- 6 - 9” of base compost
- Place pipes 12”-18” apart



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Building Aerated Windrows

1. Preparing the recipe

2. Plenum base

3. Plenum lay out

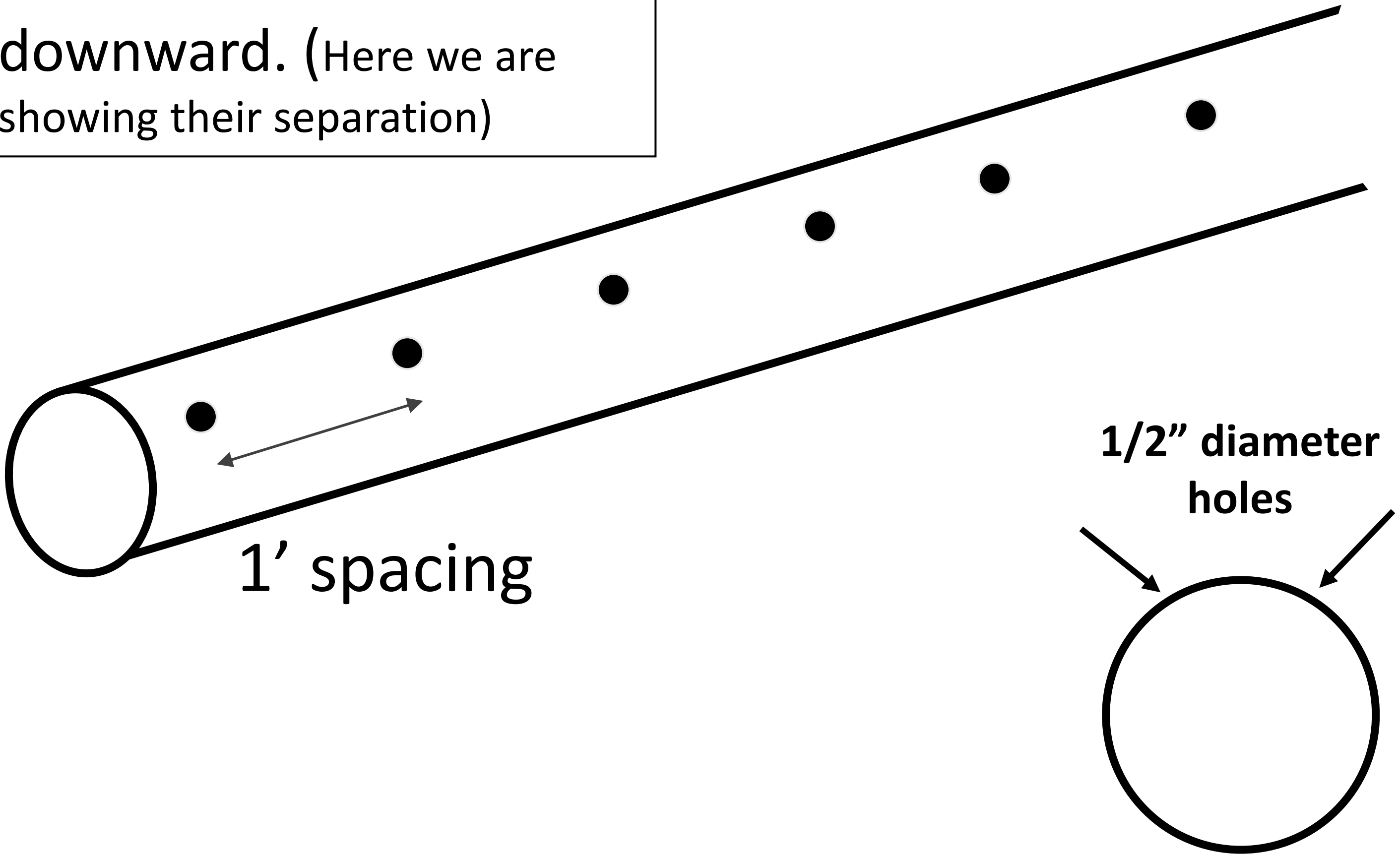
4. Building the windrow

5. Insulation cover

Forced aerated system

Pipes for Static Windrows

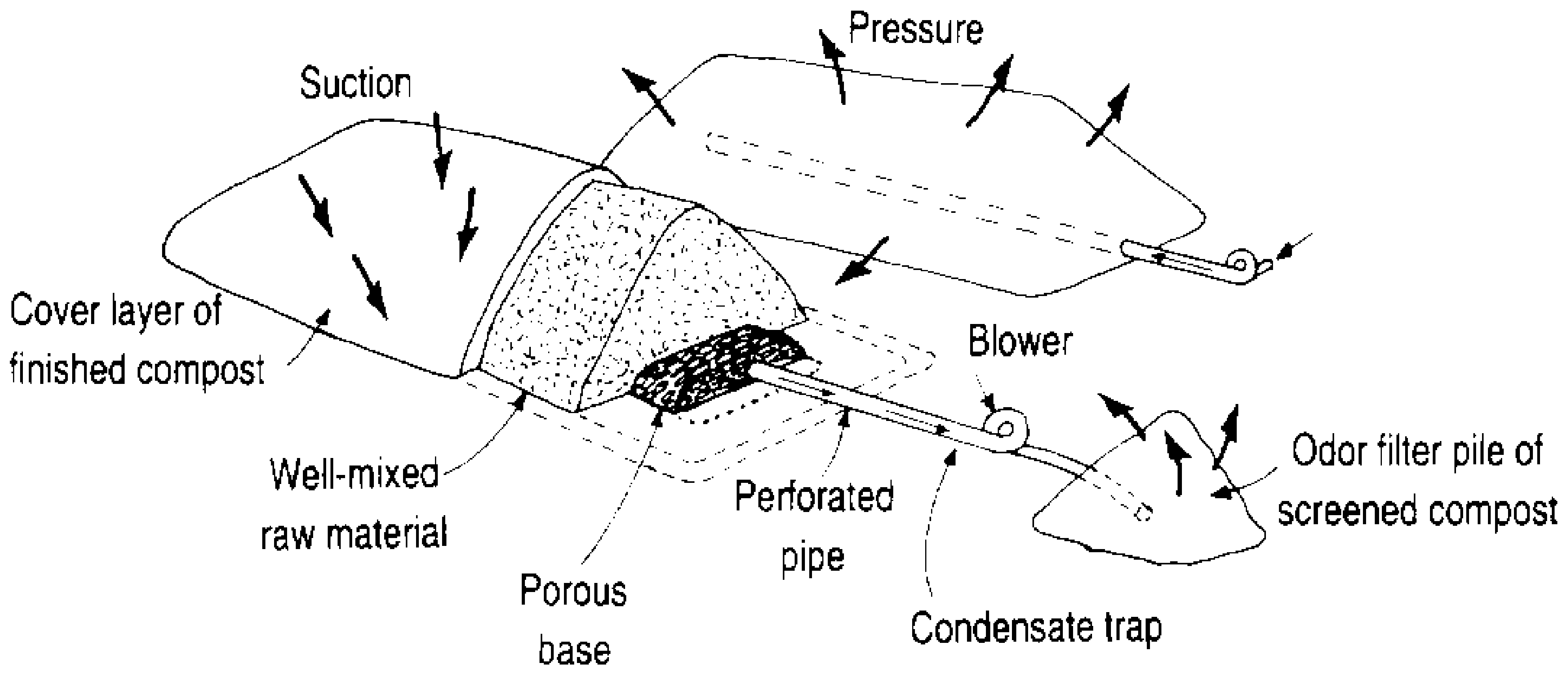
Holes must face downward. (Here we are showing their separation)



Forced Aeration composting

- No mechanical turning equipment
- Quickest method
- 5-8’ H, 10-16’ W
- 6” cover layer
- Air blower
  - timer
  - temperature sensor

“Push” or “Pull” Aeration



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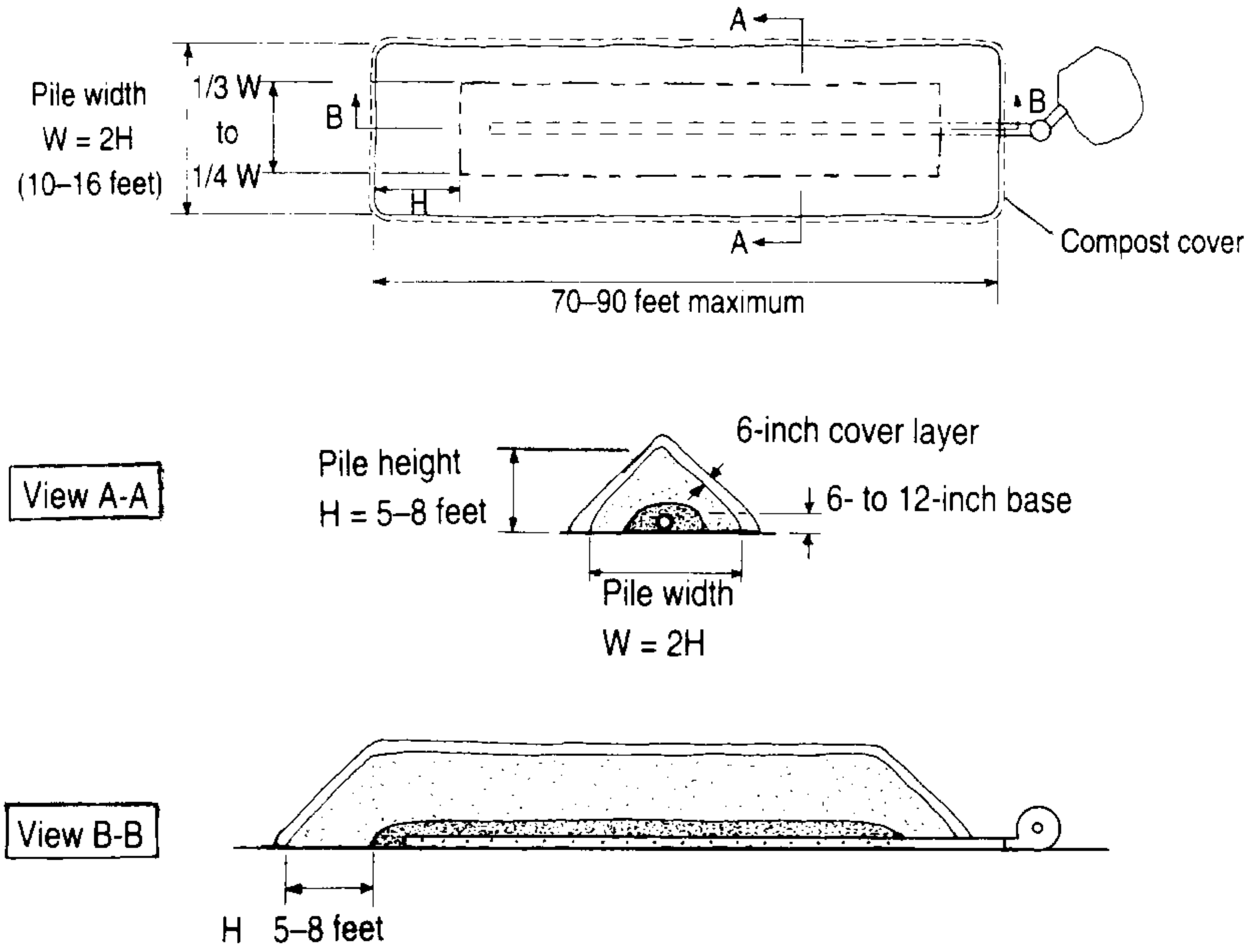
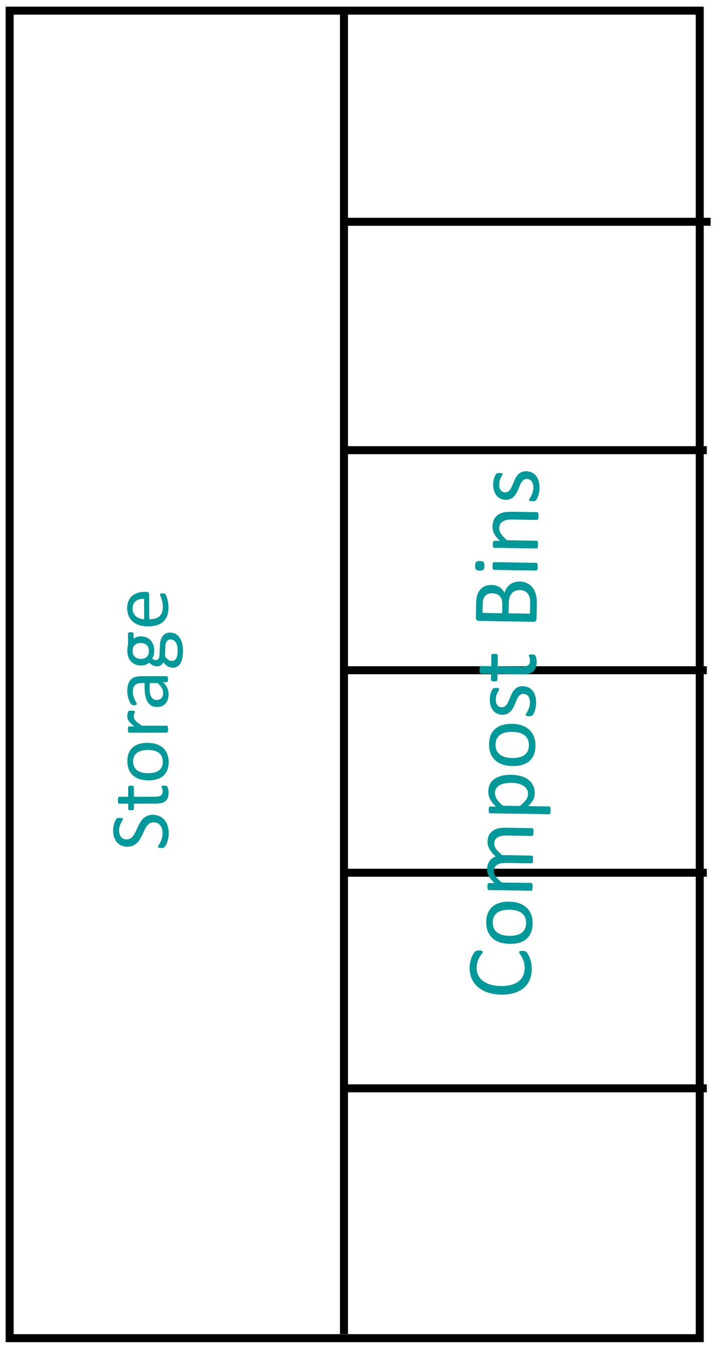


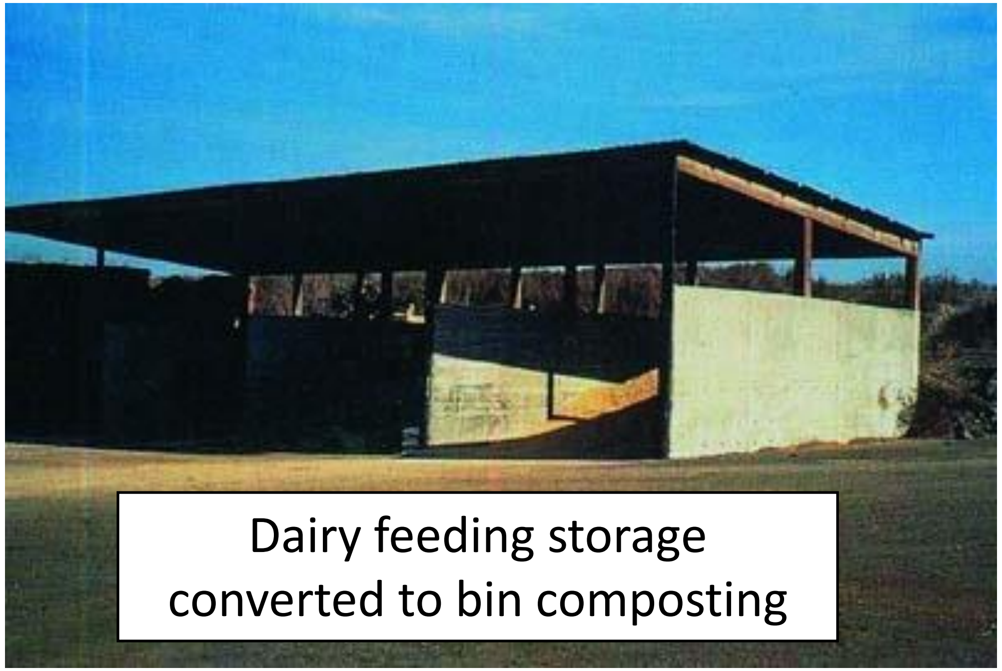
Open Bin Composting

- Modification of backyard bins or mortality composter
- Size for # of animals, average waste production, and storage time
- Allows for facilities to be built under roof
- Size it to your machinery and needs



On-farm Bin Composters

Horse manure (O2 Compost)



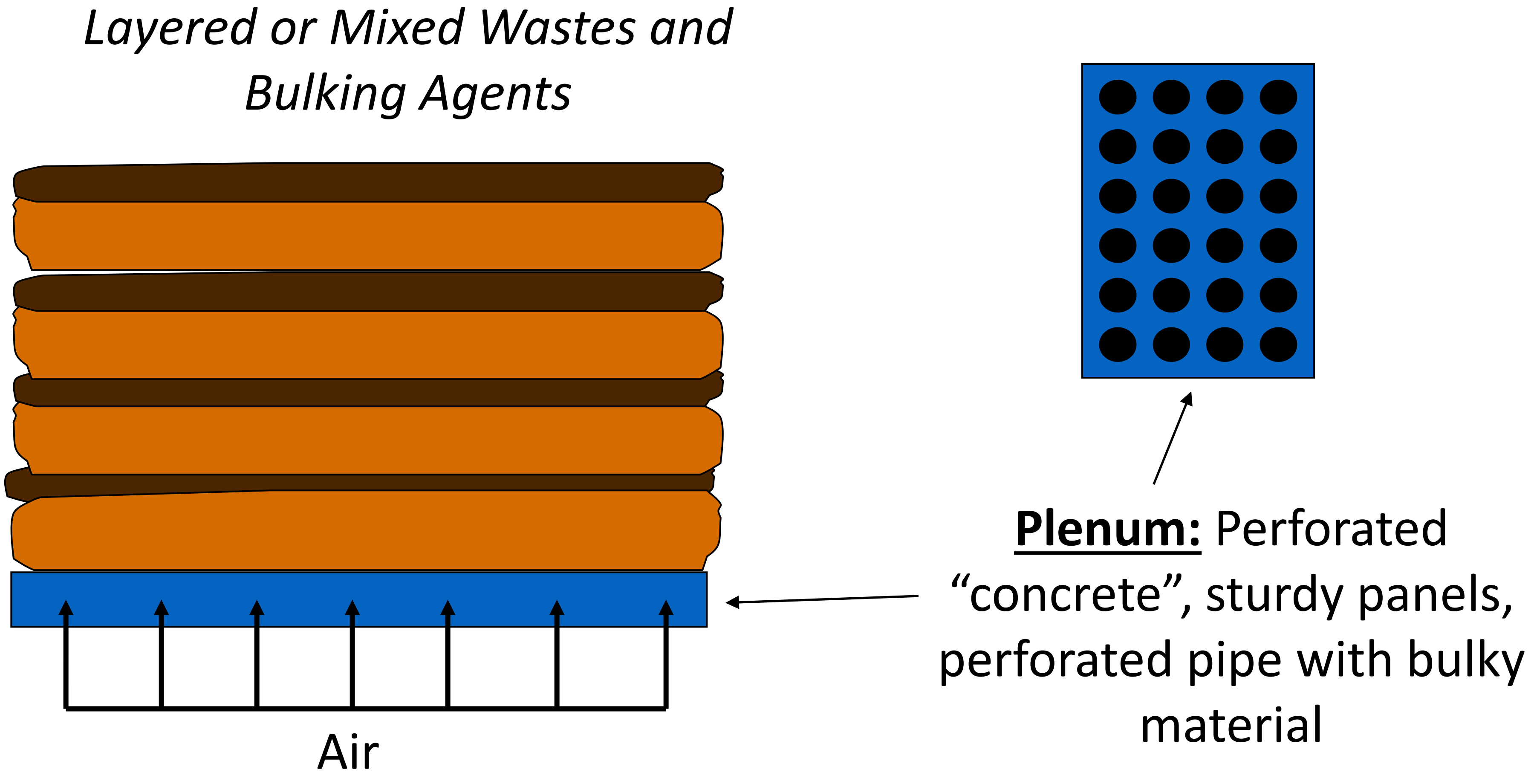
Dairy feeding storage converted to bin composting

Ontario, Canada

Mortality composting

In-vessel Composting

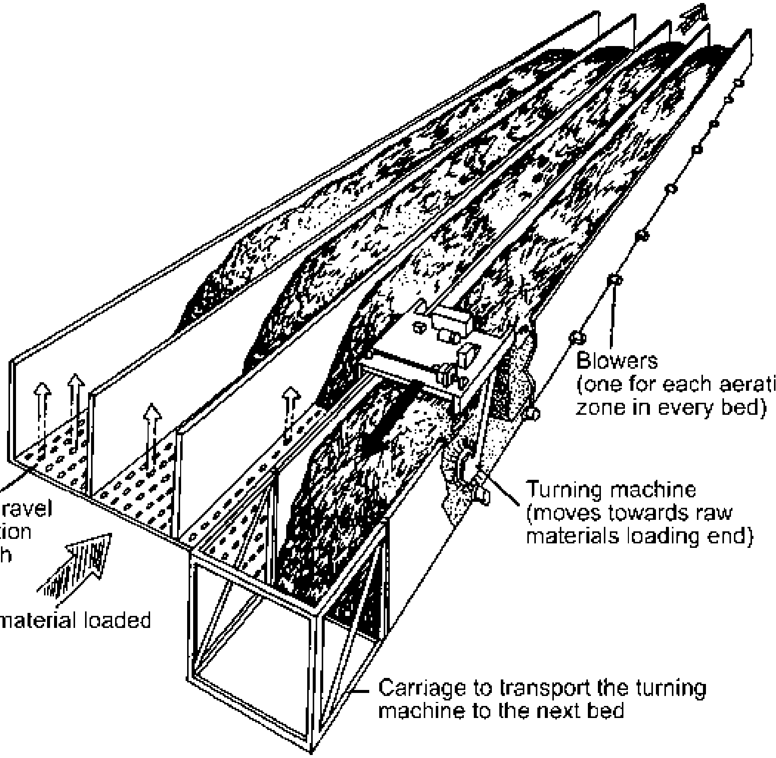
Forced Aeration: “Bin Blowers”



Forced Aeration bins

Forced Aeration Bins

In-Vessel Composting



In-vessel rotatory composters

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Screening Compost

Common Challenges

Problem	Cause	Solution
Odor	Not enough air	Turn; add coarser materials
Odor	Too wet	Turn; add dry materials; protect from rain
Odor	Too much nitrogen	Add carbon rich materials
Pile does not heat to desired temp	Not enough size	Make a larger pile
Pile does not heat to desired temp or no activity	Lack of nitrogen	Add more nitrogen rich materials and start over
Pile does not heat to desired temp or no activity	Lack of oxygen	Turn; add coarser materials

Common Challenges

Problem	Cause	Solution
Pile does not heat to desired temp or no activity	Too moist	Turn. If persist, add coarser dry materials
Pile does not heat to desired temp or no activity	Too dry	Turn and add water at the same time
Pile too hot risk of fire	Big size	Turn. If continue reduce pile size
Pile too hot risk of fire	High N coupled with chunky high C	Turn. If continue, reduce pile size and manage C:N ratios
Pile on fire!!	See above	Break pile in smaller ones or flatten it. DO NOT ADD WATER
Pets and wildlife scavenging in the pile	Scraps of meat, dairy, oils, etc.	Stop adding materials to pile. Encourage higher temp. Use an enclosed system

Rules and regulations

- In Idaho, the Idaho Department of Agriculture (ISDA) manages most of the issues
- http://www.agri.idaho.gov/AGRI/Categories/Animals/Dairy/dairyRules.php
- County regulations should be consulted since there are wide variations (Check P&Z)
- In the USA: City – County – State (Ag, Environmental) –USDA – USEPA.
- Check with your Extension Educator or Specialist first

Suggested Readings

On-Farm Composting Handbook. 1992. NRAES-54. Natural Resource, Agriculture, and Engineering Service. Cooperative Extension, PO Box 4557. Ithaca, New York.

ISBN 0-935817-19-0.

National Engineering Handbook Part 651**. Agricultural Waste Management Field Handbook (AWMFH).** Chapter 10. 1996. It could be downloaded at: http://www.wsi.nrcs.usda.gov/products/W2Q/AWM/handbk.htm

US Composting Council http://compostingcouncil.org

Composting at Home. R. Rynk and M. Colt. 1997. CIS 1066. University of Idaho, Cooperative Extension System.

Suggested Readings

University of Idaho Extension Publications

Dairy Compost Production and Use in Idaho Series. Extension Current Information Series (CIS):

The Composting Process - CIS 1179

On-Farm Composting Management - CIS 1190

http://www.cals.uidaho.edu/edComm/catalog.asp

(search for “composting”, you will find these and other publications)

Cornell Waste Management Institute

http://cwmi.css.cornell.edu/

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Thank you!

Questions?

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