Growing Food Scrap Composting Capacity

Compost Site Operational Best Management Practices

James McSweeney

2022

Photo: Compost Now

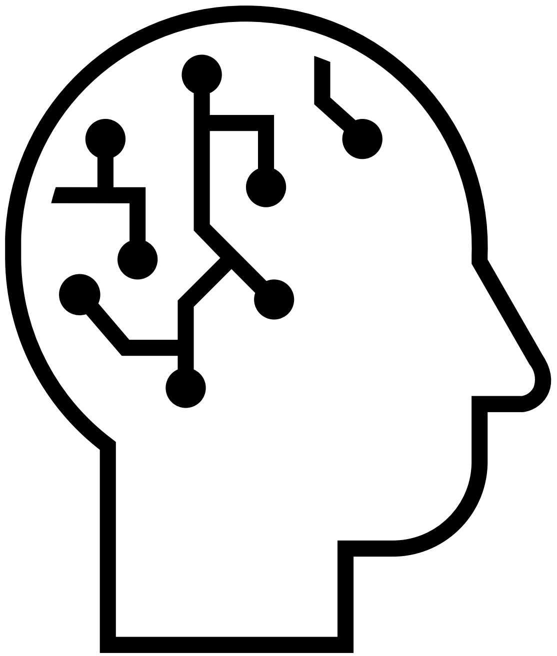
Key Topics

- Compost Basics & Best Management Practices
- Adding Food Scraps as a Feedstock
- Scaling Up Food Scrap Composting Capacity

Considerations for Adding Food Scraps

Define motivations:

- ✓ Compost quality
- ✓ Environmental
- ✓ Public demand
- ✓ Policy
- ✓ Financial



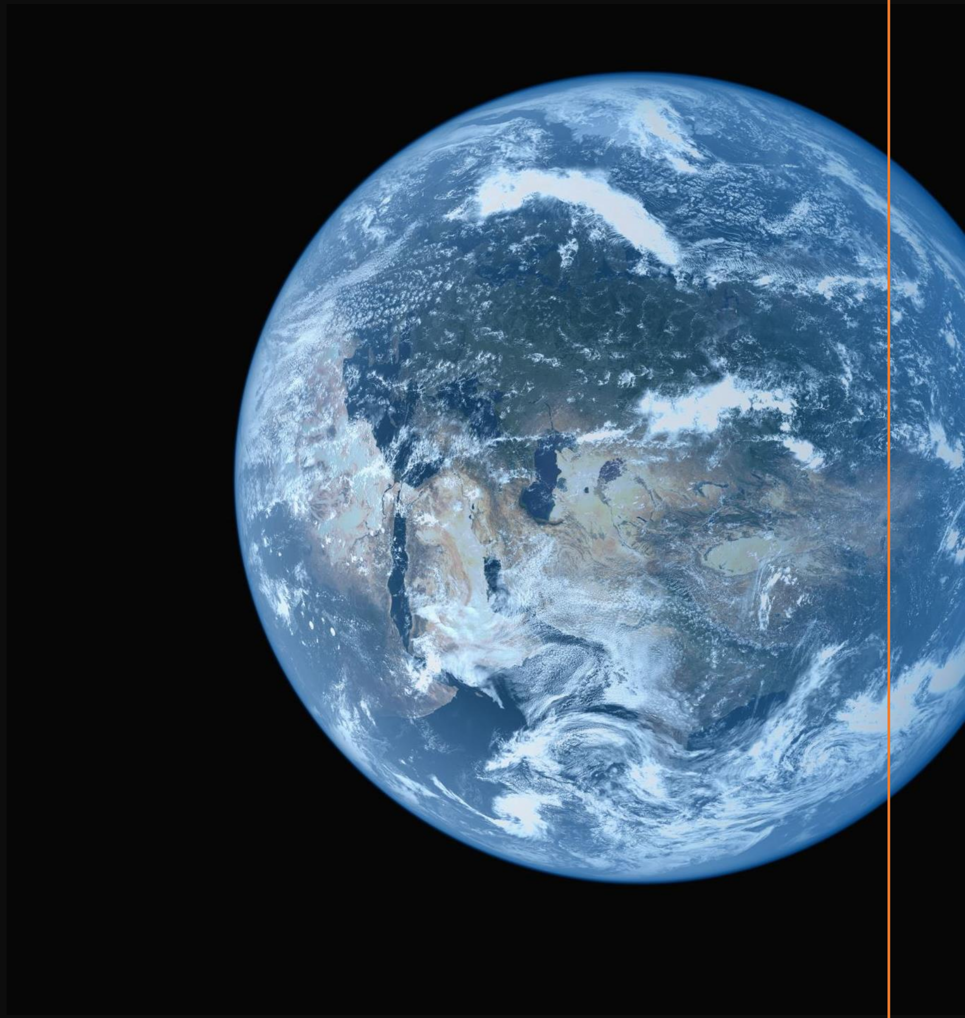
- ~ 2 Million Tons Food Scraps Composted In US in 2014 (EPA, 2014)
- Massachusetts 5th highest number of composting facilities in US at 262 (BioCycle, October 2017) and the 6th highest number accepting food scraps (BioCycle, January 2019)

Think Big. Start Small.

Behavior change through education: Convergence of environmental and social justice concerns

- People don’t understand that the impacts of their waste has dramatically unequitable impacts

- Environmental justice – both local and global



Local Zero Waste Goals

Provide support and leverage

Why Compost?

The Compost Handbook (Rynk, 2022)

Table 1.1 Summary of the benefits and drawbacks of on-farm composting.

Economic benefits of composting and compost	Environmental benefits of composting and compost	Drawbacks
Revenue from processing or "gate" fees	Improved soil health and plant vigor	Upfront and sustained investments in time and money
Revenue from compost sales	Retention of soil nutrients	Land requirement (and possibly building space)
Production of a useable product; reduced costs of substitute inputs	Water conservation	Odor and other nuisance complaints
Increase in crop yields and plant production and quality	Plant disease suppression; reduction in pesticide use.	Management in unfavorable weather
Generation of an animal bedding substitute	Erosion control	Diversion of manure and crop residues from crops if compost is sold off-farm
Destruction of weed seeds; reduce herbicide costs	Destruction of human, animal, and plant pathogens	Potential loss of nitrogen and generation of methane under anaerobic conditions
Reduction in waste disposal costs	Decomposition of hormones, antibiotics, and pesticides	Slow release of plant nutrients in finished product
Reduction in handling costs	Treatment of animal mortalities	Variable levels of plant-available nitrogen
Expansion of outlets for organic residuals	Lower environmental impacts from compost versus raw feedstocks	Zoning risk of being considered a commercial enterprise (rather than a farm)
	Reduction of greenhouse gas emissions	Need for environmental permits and adherence to regulations

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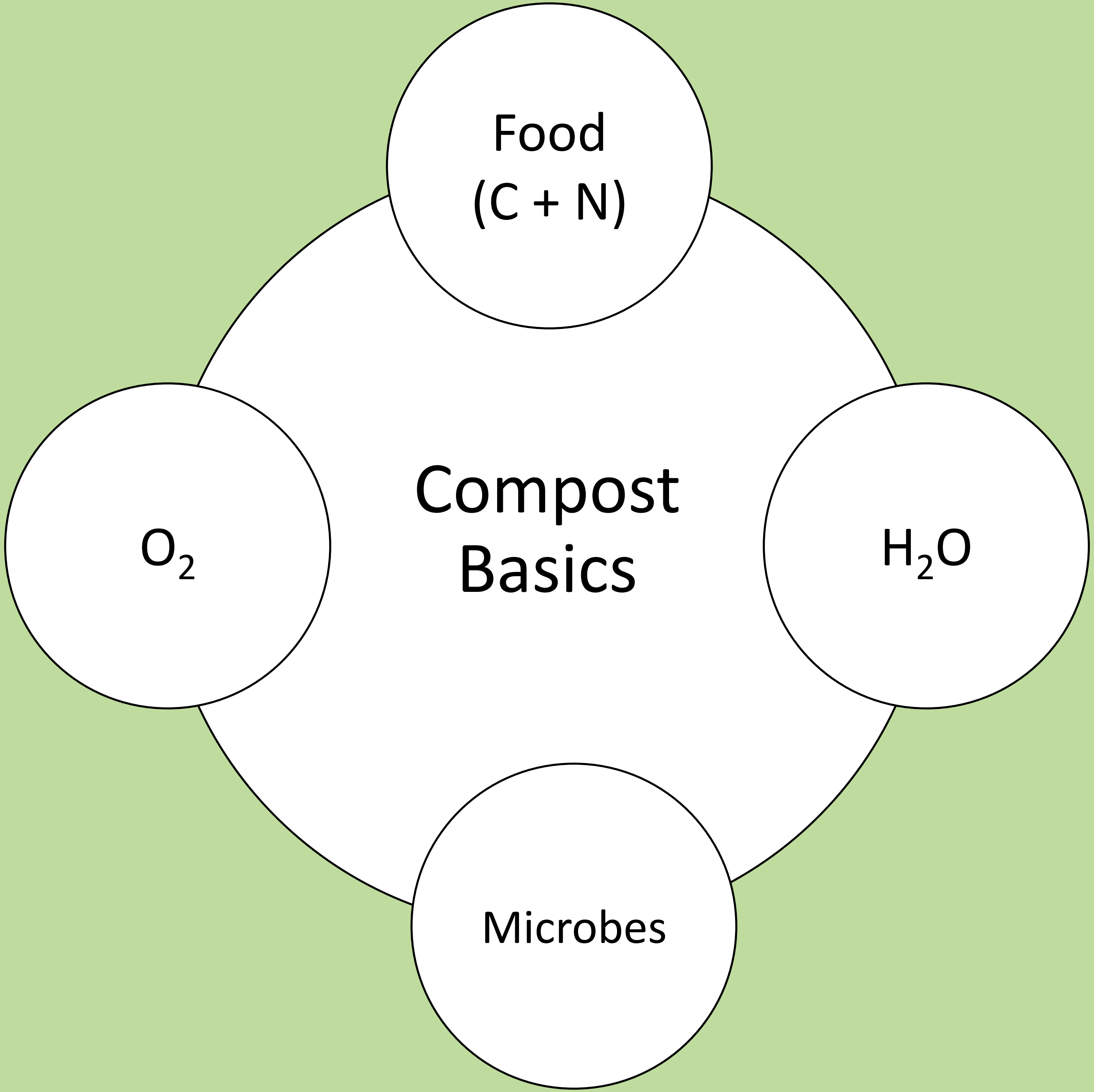
Considerations for Adding Food Scraps

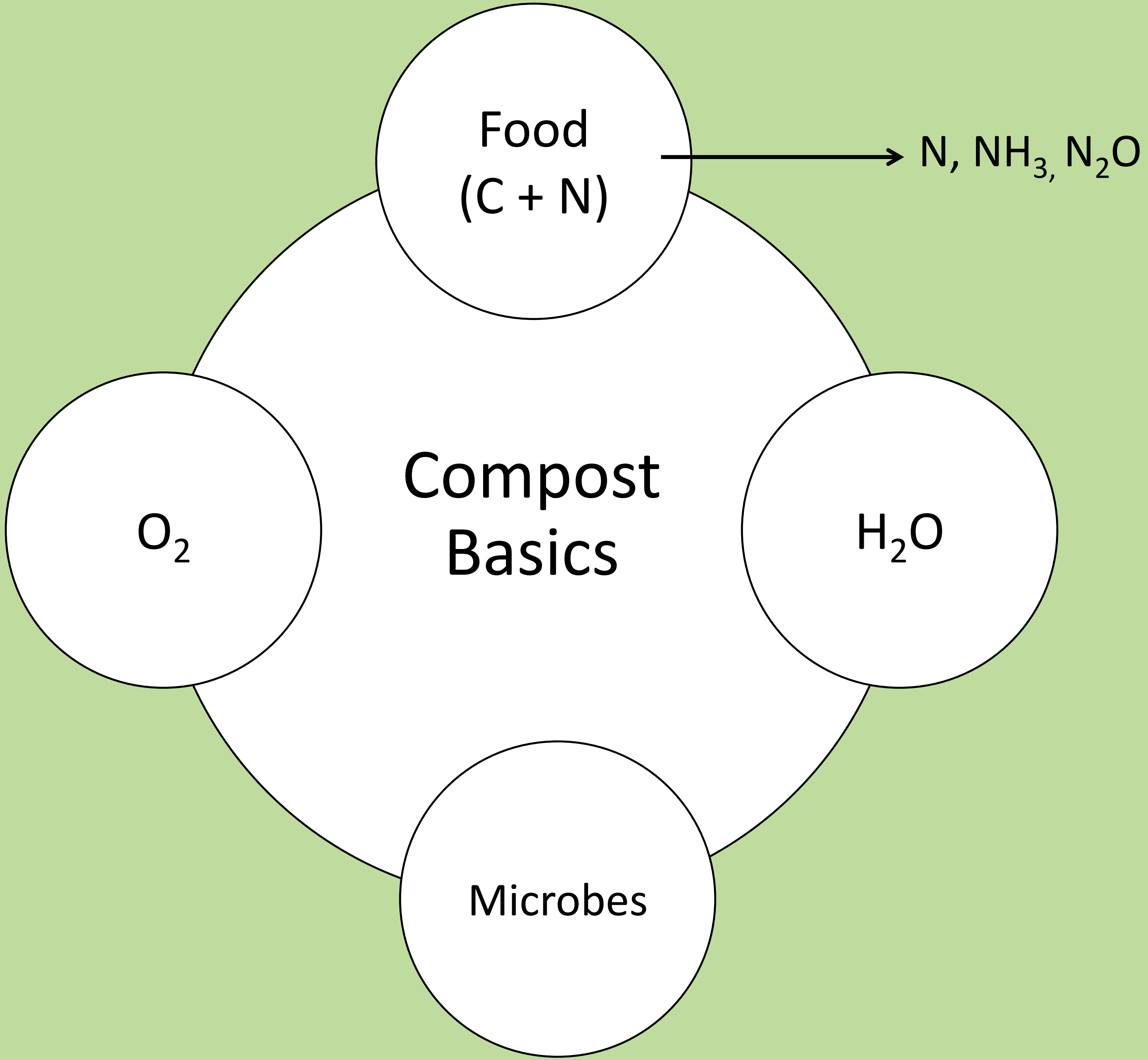
Identify and address risks right off the bat:

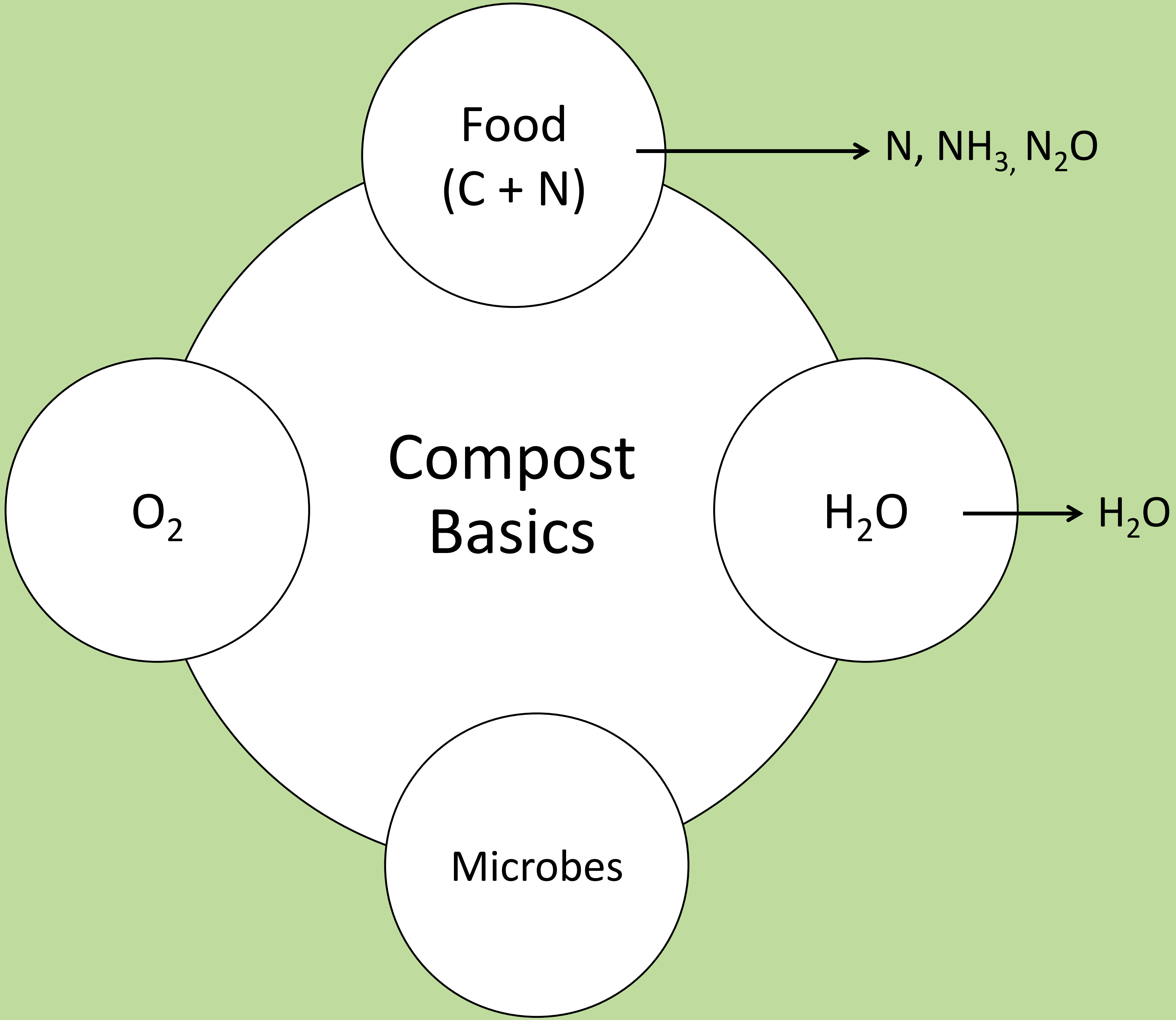
- ✓ Odors
- ✓ Vectors
- ✓ Contamination
- ✓ Different economics
- ✓ Neighbor concerns
- ✓ MSW contract preclusions

Need Training and Education in Best Management Practices (BMPs)

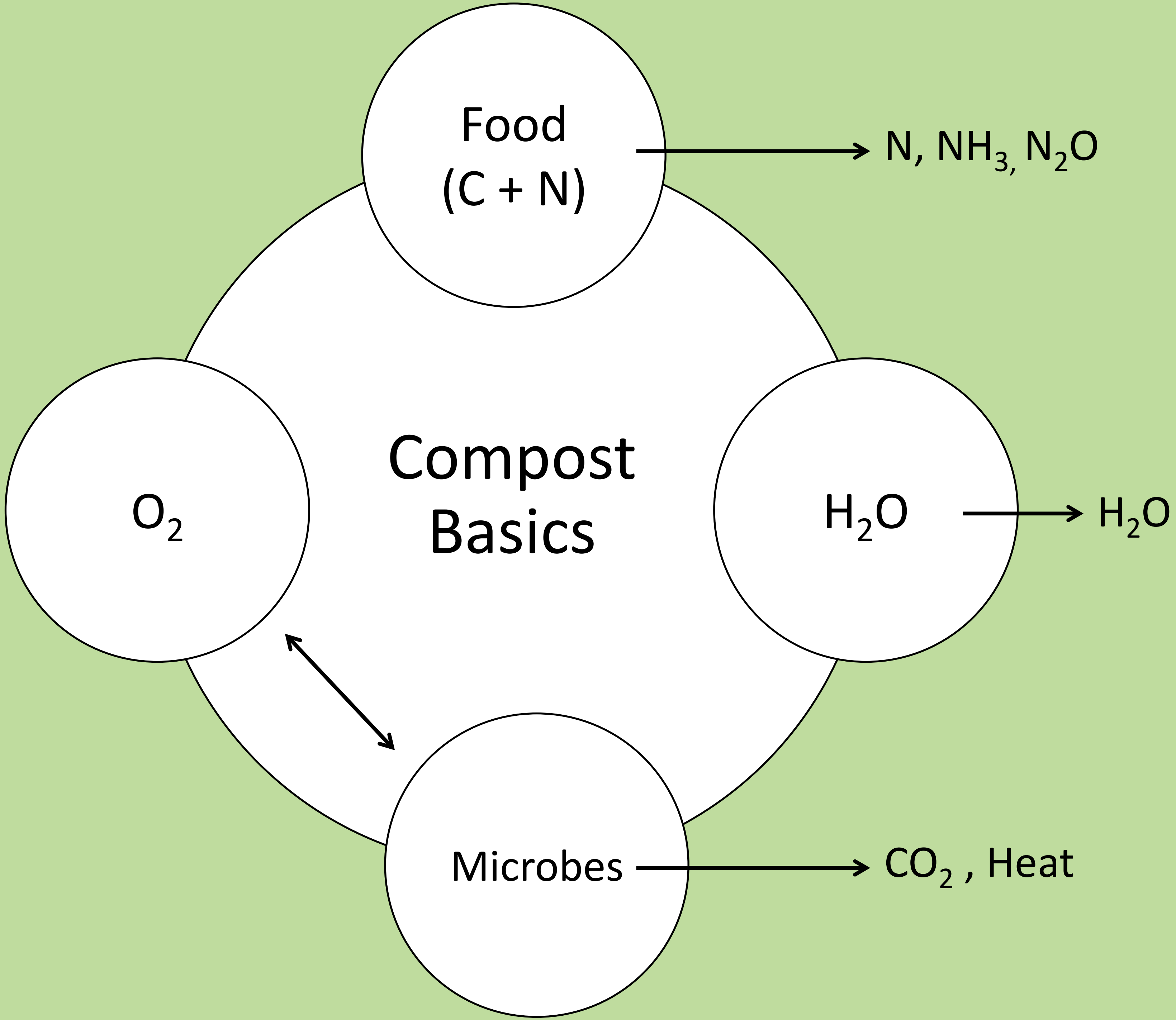
- RecyclingWorks MA Compost Site Technical Assistance
- Facility Management Plans
- Intensive trainings
  - Maine Compost School (1 Week)
  - US Compost Council Composter Training Programs
  - The 131° School of Composting
  - Neighborhood Soil Rebuilders (ILSR)

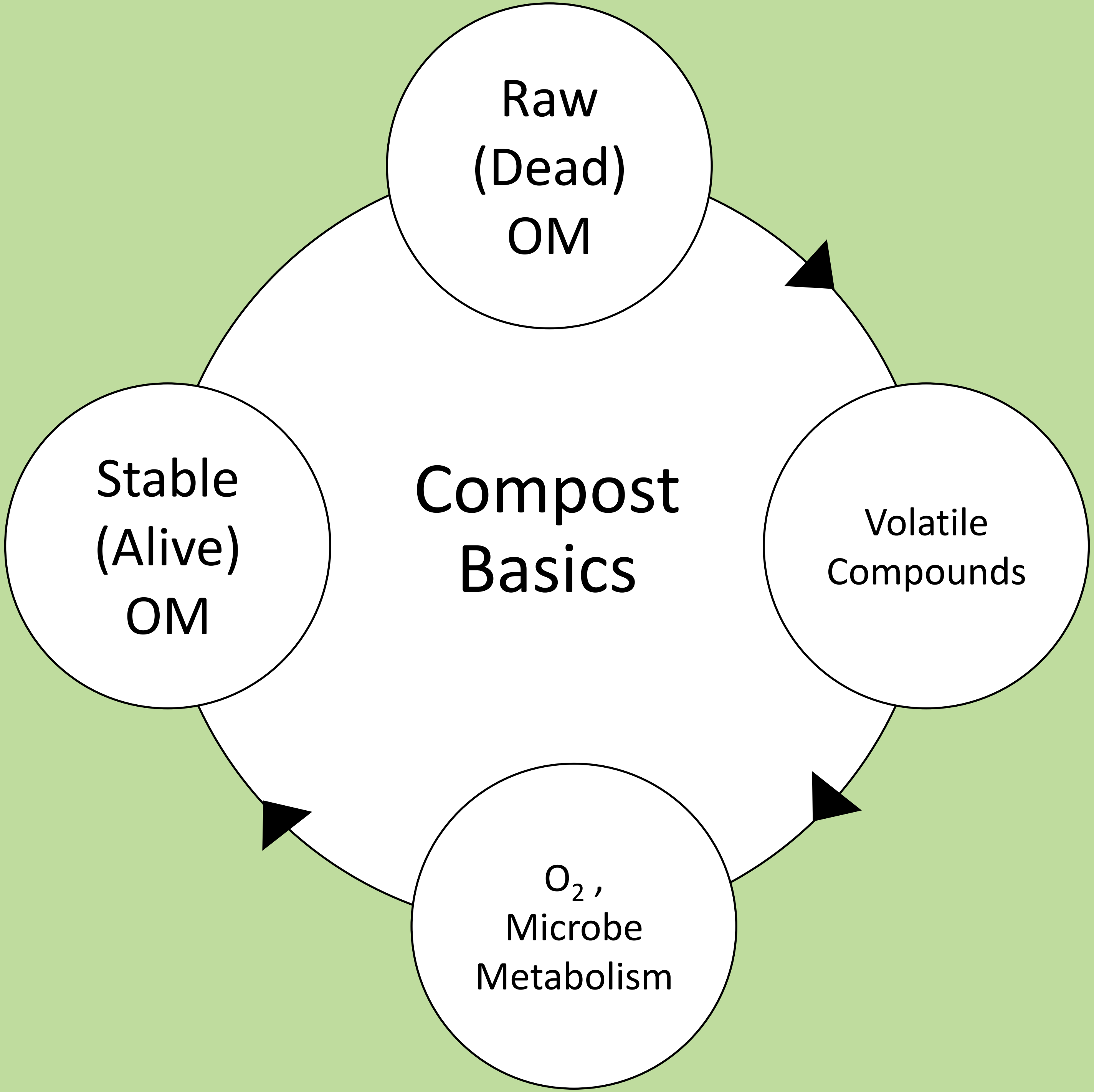

Food
(C + N)
O_2
Compost
Basics
H_2O
Microbes

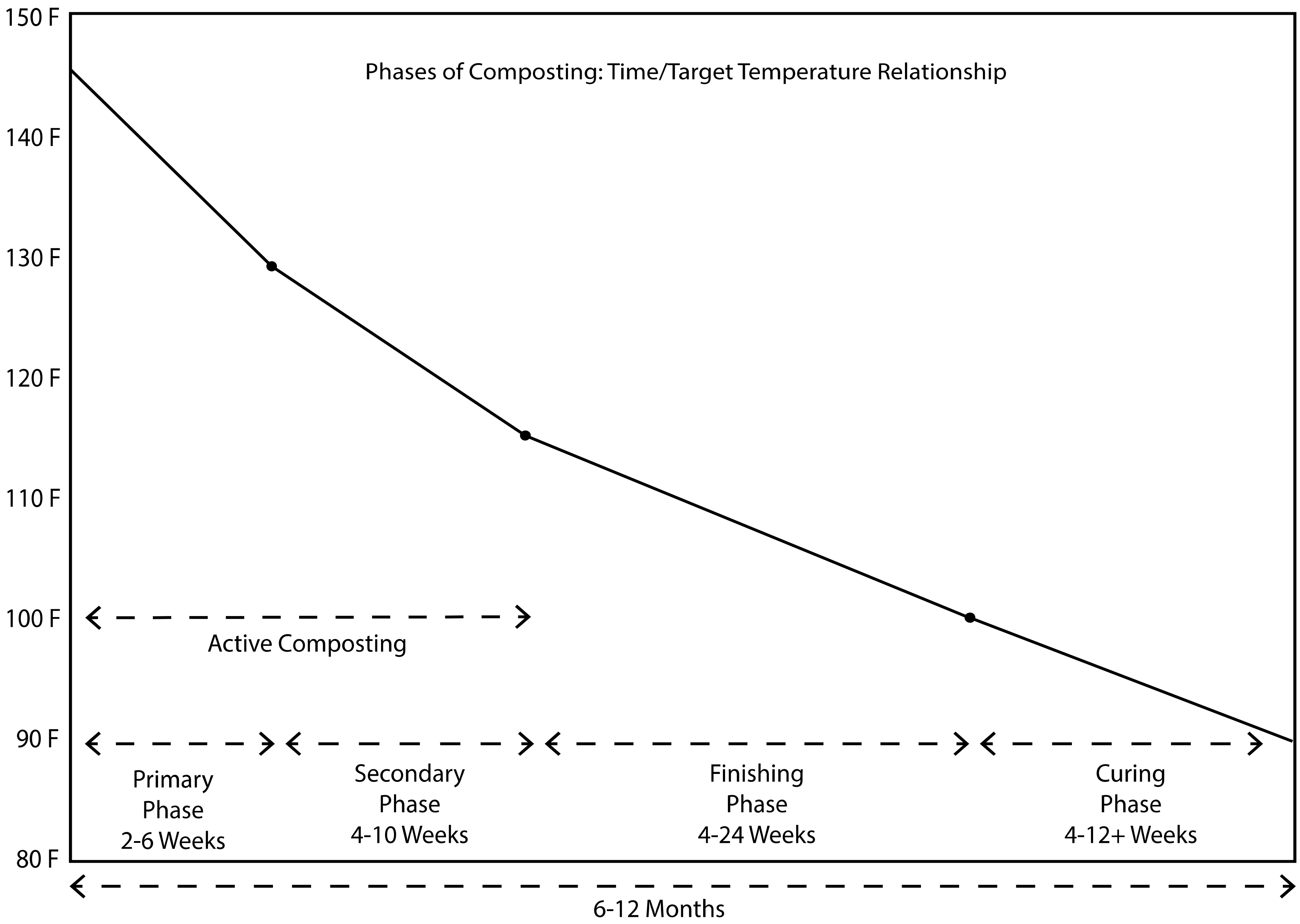

Food
(C + N)
N, NH_3, N_2O
Compost
Basics
O_2
H_2O
Microbes



Food
(C + N)
N, NH3, N2O
Compost
Basics
O2
H2O
H2O
Microbes


Food
(C + N)
N, NH3, N2O
Compost
Basics
O2
H2O
H2O
Microbes
CO2 , Heat


Raw (Dead) OM
Volatile Compounds
O_2 , Microbe Metabolism
Stable (Alive) OM
Compost Basics



(McSweeney, *Community-Scaled Composting Systems*, 2019 *forthcoming*)

Compost BMPs: Compost Recipe

Balance: → Effective blending

- Protein w/ Carbon (C:N Ratio)
- Moisture w/ dry matter (Moisture Content)
- Dense material w/ bulking agent (Bulk Density)
- Analytically developed

1 Part
High Nitrogen
(Green)

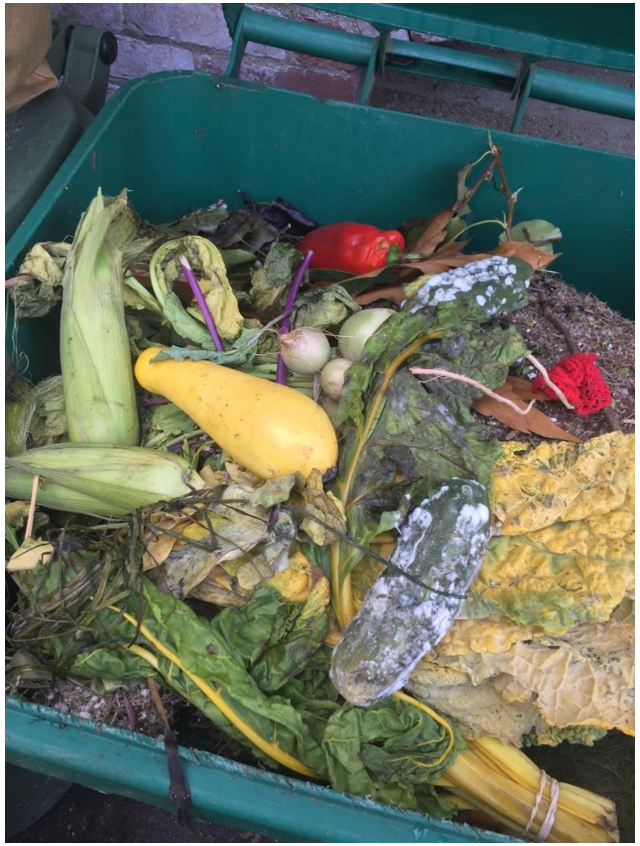
1-2 Parts
High Carbon
(Brown)

1-2 Parts
Neutral
(Balanced C:N)

½-1 Part
Bulking Agent
(Porous)

Nitrogenous (<25:1 C:N) or Group II

Food scraps and grass have very similar C:N, moisture, and density



Recipe Neutral Materials (C:N 25-40:1)

- Ground mixed yard trimmings
- Leaves

Carbonaceous (C:N >40) & Porous (≥50% Voids)

- Clean overs (screenings, mostly woody)
- Chipped Christmas trees

Compost BMPs: Temperature Treatment

- Monitoring
- Turning

Pathogen Reduction Mechanisms

- Thermal destruction
- Production of toxic byproducts such as gaseous ammonia
- Competition between indigenous microorganisms and pathogens
- Antagonistic relationships between organisms
- Antibiotics produced by certain fungi and actinomycetes
- natural die-off in the compost environment (which is non-ideal for enteric (gut) pathogens)
- Nutrient depletion

Kristine Wichuck and Dary Mccartney. A review of the effectiveness of current time-temperature regulations on pathogen inactivation during composting. (Journal of Environmental Engineering and Science · August 2007).

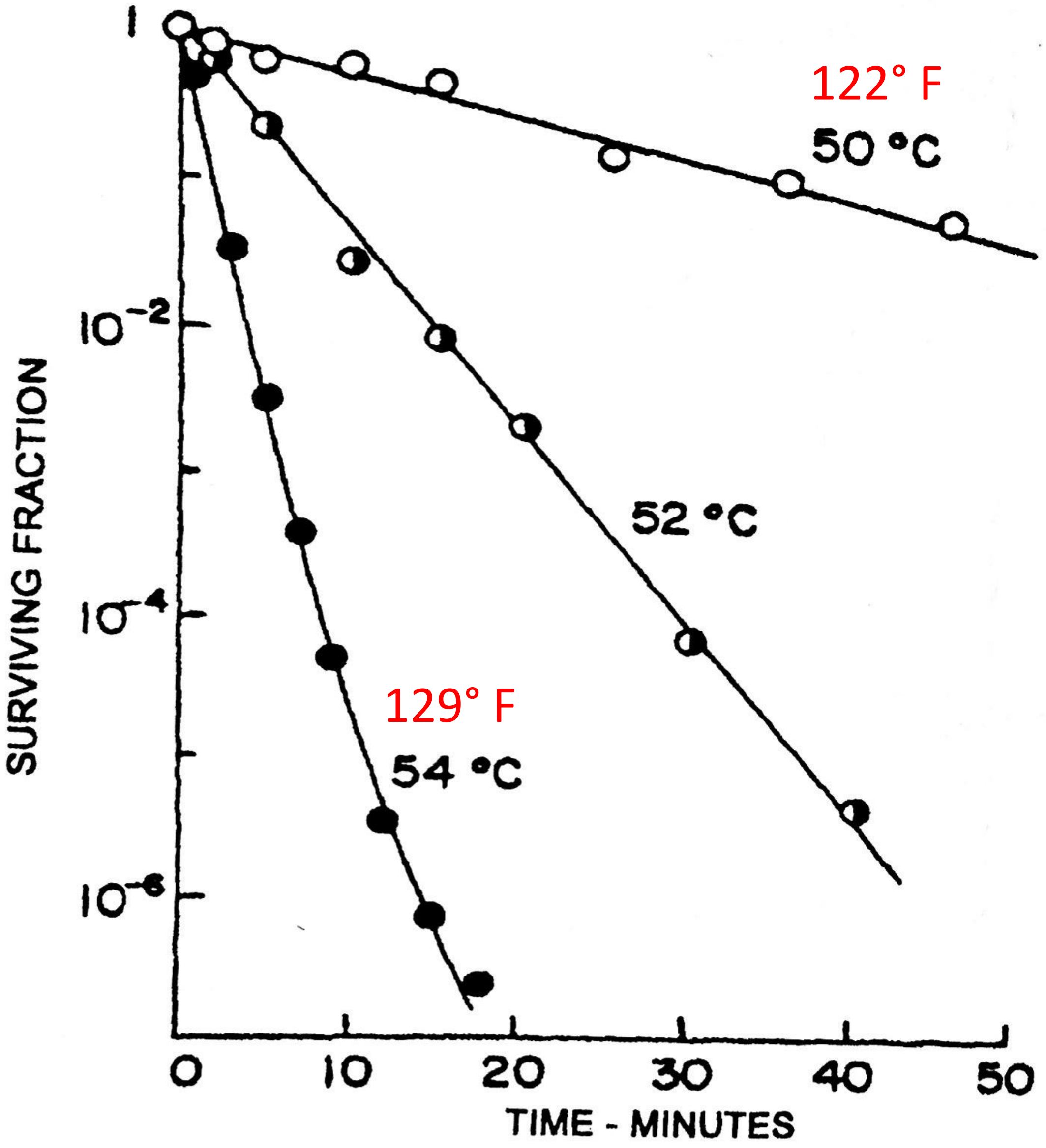


FIGURE 8.4. Heat inactivation of *Salmonella enteritidis* serotype Montivideo in composted biosolids. (Data from Ward and Brandon, 1977.)

Process to Further Reduce Pathogens (*PFRP)* & National Organic Program (NOP) Standards

Turned Windrows

- **PFRP standard** *is to turn pile at least five times while maintaining ≥131 Degrees F for at least 15 days*

Aerated Static Pile or In-Vessel

- **PFRP requirement** *is that the material reaches 131 Degrees F or greater for a minimum of 3 days*

Key Factors to Ensure Pathogen Inactivation

- Institutionalize BMPs
- Track batches
- Consistent temperature monitoring
- (1’ and 3’, multiple points)
- Adopt maturity standard
- Prevent reintroduction of pathogens (keep high and dry)
- Maintain aerobicity (small pile sizes)
- Periodic testing

Compost BMPs: Moisture Management

- Improved pad surfaces
- Graded
- Level
- Clean water diversion
- Clean pad
- Recipe

Compost BMPs: Vector Controls

- Immediate incorporation of food sources
- Cover piles (w/ compost & covers)
- Avoid odors
- Hit temps

Signs That There's A Problem

- Pile not heating
- Pile overheating
- Materials not breaking down
- Leachate
- Strong smells
- Increasing animal, bird, and insect populations
- Complaints
- Angry mobs on social media

Management Response

- Acknowledging issue
- Identifying root causes
  - Use monitoring
  - Review process (recipe, management, site conditions, etc)
  - Cross-check against other observations
- Evaluate response strategies
  - Varying degrees depending upon urgency and conditions
- A yard of prevention is worth a truckload of cure

Issues Compound:

Dealing with root causes is key to successful remediation

Example:

Wet pile conditions can create odors, which can attracts vectors

Management Response

Communicate *with affected parties, neighbors, town, state*

- *Proactive communication*
- *Have strategy (written, i.e. Odor management plan)*
- *Be transparent*
- *Documentation*

Monitoring Odor

What is Odor?

Unpleasant fragrance caused by volatilized chemical compounds:

- *Volatile Organic Acids (Rotten, acrid, garbage)*
- *Ammonia (Chemical, eyes water)*
- *Sulfur Dioxide (Vomit smell)*
- *Mercaptans (Bad breath, rotten cabbage)*

Monitoring Odor

What is Odor?

- Think of odor as food for microbes
- Contain odor and create conditions where aerobic microbes thrive
- Odors are typically high N (ammonia and organic acids), and therefore have valuable nutrient value

5.0 Problem Odor - Anaerobic Conditions, Leachate

Identified Issue	Cross-Check	Root Causes	Remediation Actions	Preventative Actions
Problem Odor	Anaerobic pile conditions?	High moisture content (Lack of moisture in original recipe)	Blend in dry matter	Adjust recipe to lower moisture content Construct smaller piles
			Decrease pile size	
			Turn pile to dry	
		Dense pile conditions (Lack of large structural particles in original recipe and/or Infrequent turning/mixing)	Blend in porous bulking agents (wood chips, grindings)	Adjust recipe to add porosity (5-15% woody chip/grindings by volume)
			Turn pile to loosen and aerate	Ensure thorough blending
				Turn more frequently
		Large piles inhibiting passive aeration.	Decrease pile size	Construct smaller piles
	Leachate from pile?	High moisture conditions	Absorb leachate with dry carbonaceous materials	Maintain pile moisture in target range.
				Ensure site infrastructure creates adequate drainage.

5.1 Problem Odor - Problem Feedstock

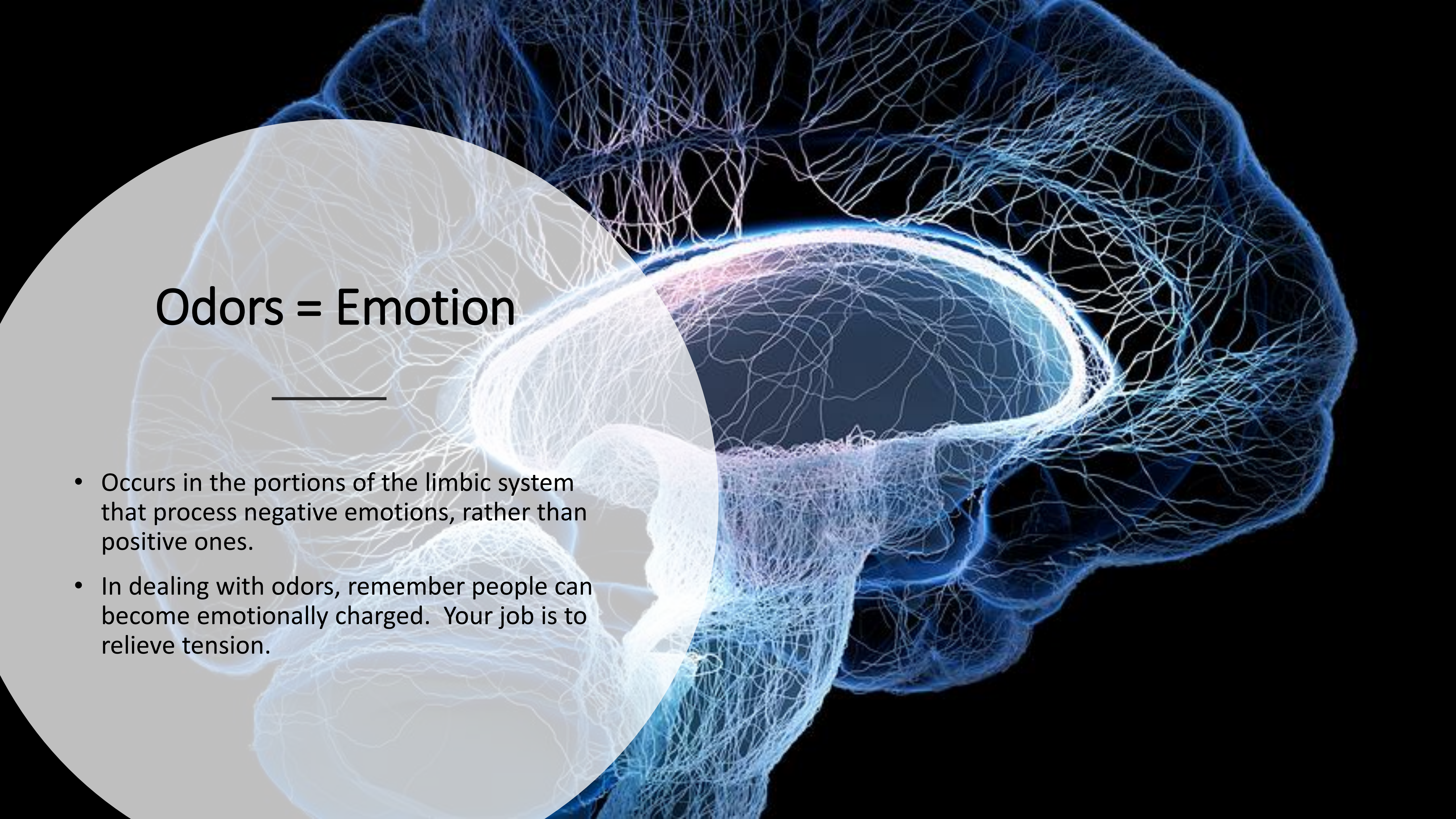
Identified Issue	Cross-Check	Root Causes	Remediation Actions	Preventative Actions
Problem Odor	Problem feedstock?	High protein	If odor is not controlled after capping, then remediate recipe with carbon materials and bulking agent.	Develop targeted recipe for problem feedstock. Significant sources of available carbon and porous bulking agents will be needed.
		High moisture	If odor is not controlled after capping, then remediate recipe with dry matter and bulking agent.	Develop targeted recipe for problem feedstock. Dry matter and porous bulking agents will be needed.
		Low or high pH	If odor is not controlled after capping, then remediate recipe moisture content and density, then leave unturned until pH is buffered by composting process.	Control carbon to nitrogen ratio and moisture content to minimize high protein (N), high moisture, and low pH conditions or high protein (N), low moisture, and high pH conditions.
		Specifically challenging compounds or feedstock	Find technical support if traditional odor management techniques fail.	Use lab testing of feedstocks to develop targeted recipe for problem feedstock.
				Trial feedstock on a small scale before introducing a large volume to the composting operation.

5.2 Problem Odor - Weather Factors

Identified Issue	Cross-Check	Root Causes	Remediation Actions	Preventative Actions
Problem Odor	Wind direction?	Strong odors escaping piles are likely to travel off-site.	Use cross-checks to implement immediate odor remediation to piles (Tables 1.0-1.1)	Observe wind and odor generation patterns to minimize turning and avoid odor release coinciding with wind transport in directions of receptors.
				Install a weather station or windsock to monitor wind direction.
	Air inversion?	Normal air movement patterns are stagnant, trapping odors low to the ground, and magnifying nuisance potential.	Use cross-checks to implement immediate odor remediation to piles (Tables 1.0-1.1)	Minimize turning in morning and evening when ground level inversions are common.
				Observe weather and odor generation patterns to minimize turning and avoid odor release coinciding with inversion conditions.
				Understand topological factors such as air drainages that can move and trap odors.

Odors = Emotion

- Brain processes smell in the limbic system where it also processes emotion
- Neuro-science has found processing of olfactory information to be highly emotional



Odors = Emotion

- Occurs in the portions of the limbic system that process negative emotions, rather than positive ones.
- In dealing with odors, remember people can become emotionally charged. Your job is to relieve tension.

Public Education Around Contamination

Largest touchpoint for the creation of a culture composting

Compost BMPs: Housekeeping

- Aesthetics matter! People smell w/ their eyes
- Remove trash
- Organized space
- Minimally crowded

Compost BMPs: Compost Maturation

- Earthy smell
- Friable
- Temps below 100 F
- O_2 demand, CO_2 & N_2O production minimal (test)
- Alive!

Minimize Neighbor Issues

Many environmental/nuisance problems associated with composting facilities can be avoided with proper facility site identification, planning, and outreach.

Considerations for Adding Food Scraps

Infrastructure to fit the realities:

- ✓ Composting method
- ✓ Manage process water
- ✓ Improved surfaces
- ✓ Access
- ✓ Covered areas

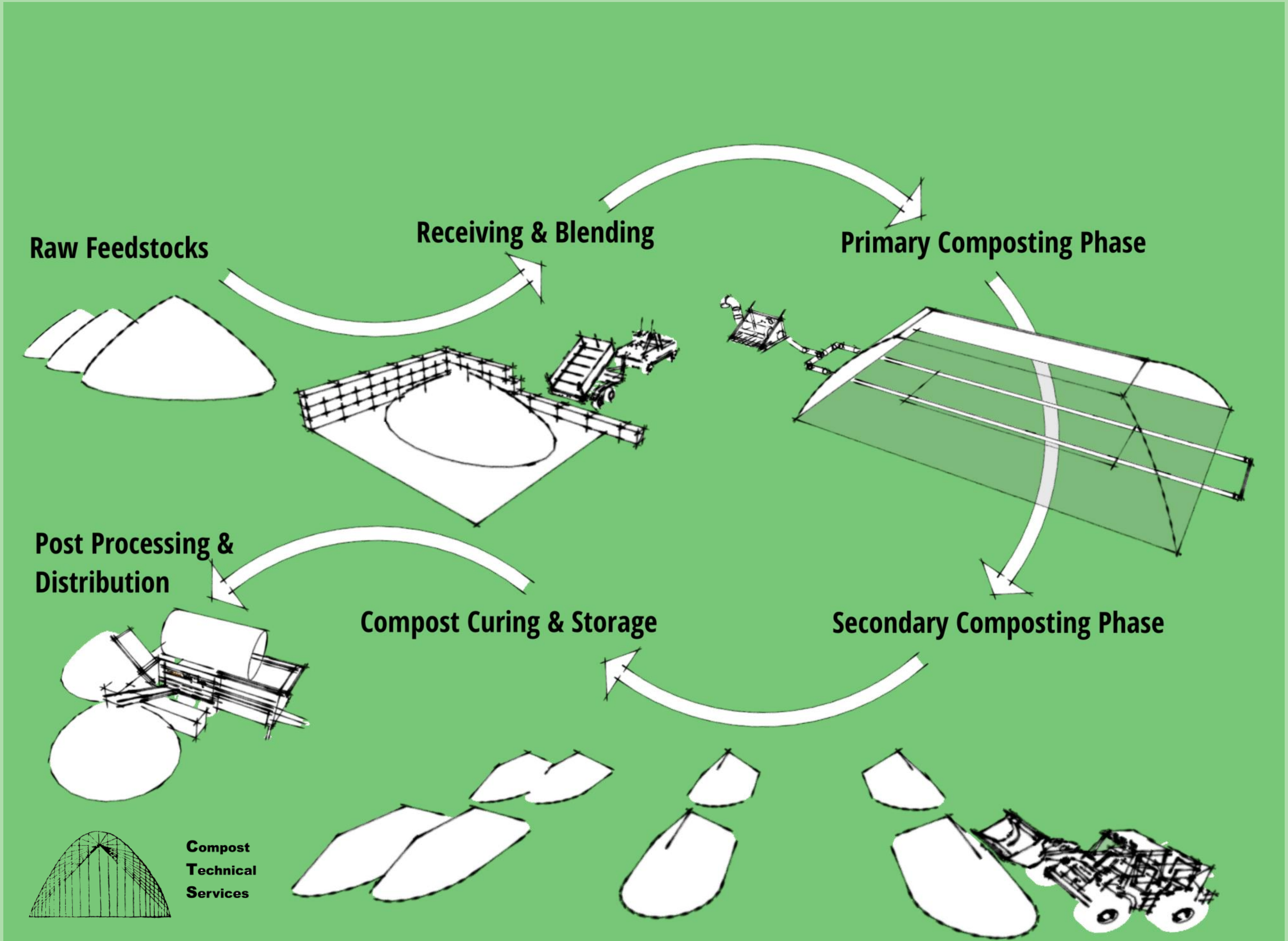
Common Composting Methods

Bins/Bays

Aerated Static Piles

Turned Windrows

In-Vessel



Raw Feedstocks
Receiving & Blending
Primary Composting Phase
Secondary Composting Phase
Compost Curing & Storage
Post Processing & Distribution
Compost Technical Services

Site Components: Feedstock Storage

In need of repair

New on-farm shed

Industrial site

Site Components: Receiving and Blending Areas

In need of repair

On-farm tipping dock
and blending area

Municipal site

Site Components: Primary Composting Area

Micro-scale

Blower & four channel
ASP manifold

Highest level of
process control

Site Components: Secondary, Finishing, Curing, and Storage

Secondary & finishing

Vegetated swale

Curing and storage

Site Components: Secondary, Finishing, Curing, Storage, and post processing

Covered blending and primary

Covered storage and screening

Protecting Water Resources

Maximize distance to surface waters, wetlands, wells, seasonally high groundwater and bedrock (minimum setbacks meet local and state regulations)

Site Components: Leachate and Process Water Catchment and Treatment

Pre-treatment
(compost sock)

Leachate and process
water to vegetative
treatment (organic hay)

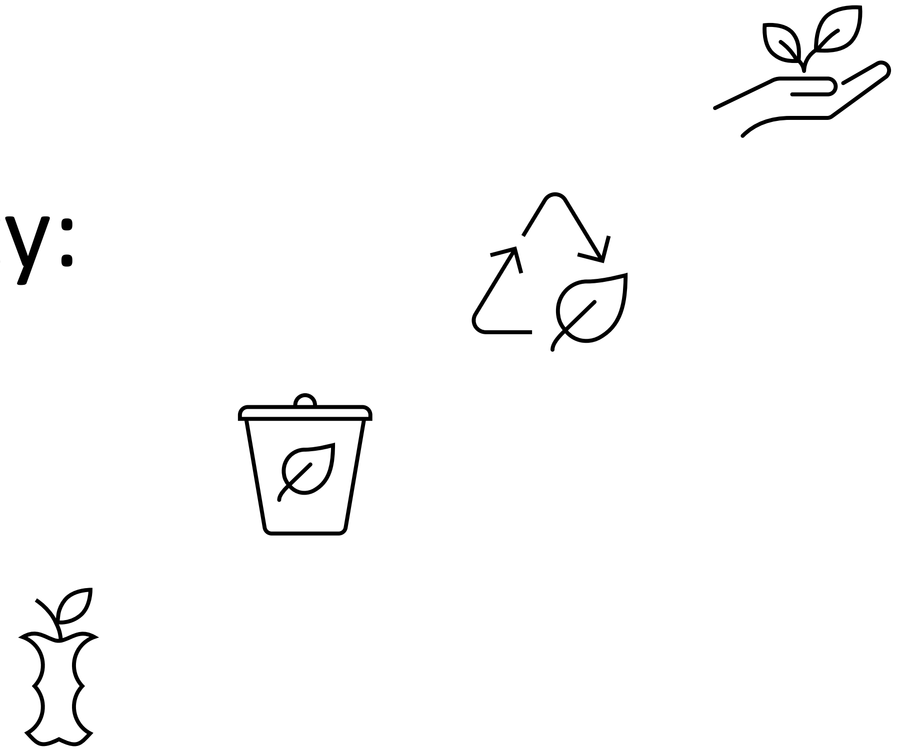
Process water
catchment pond
(large facility)

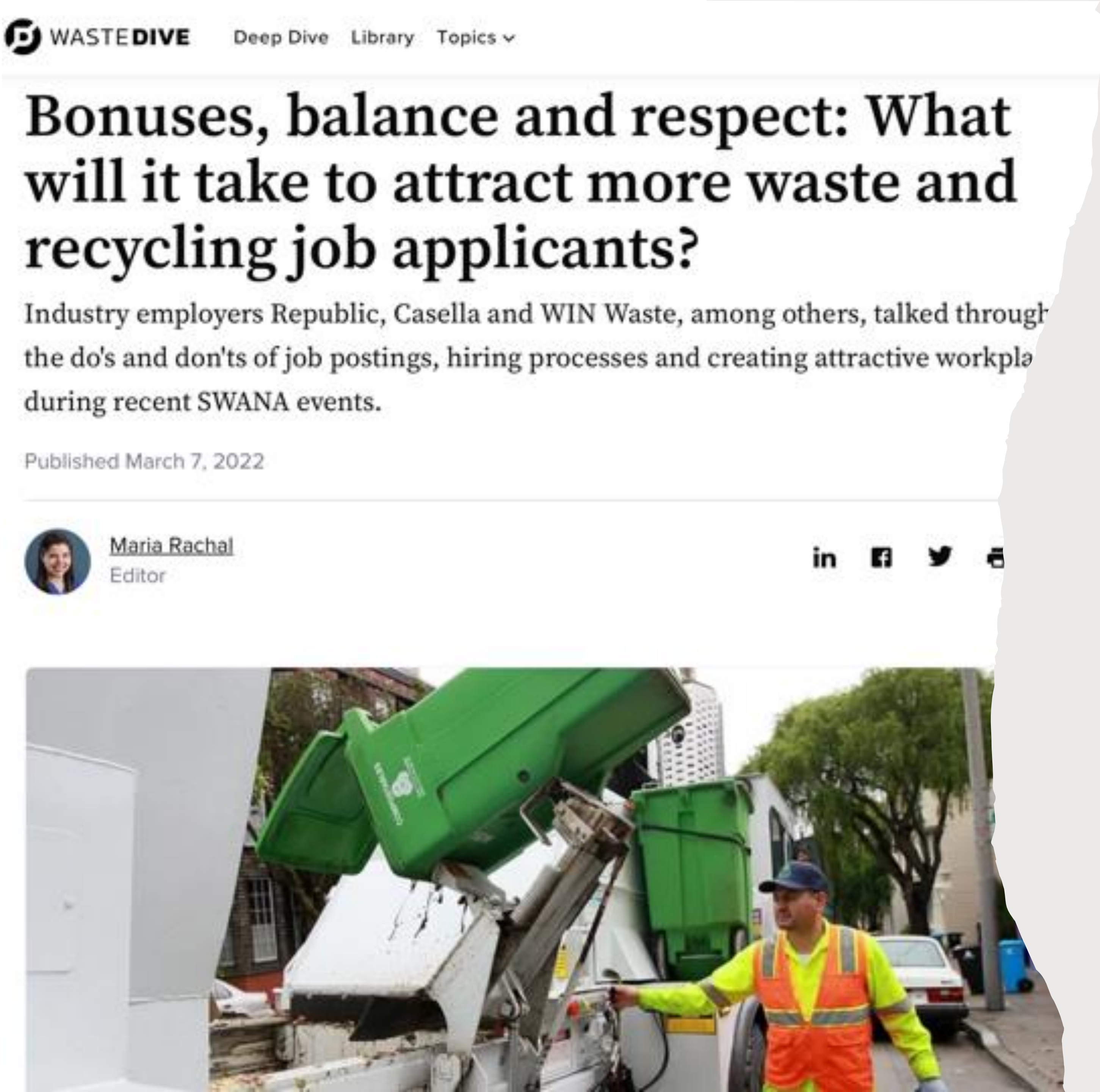
- Improved surfaces
  - Mixing areas
  - Compost pads
  - Access roads

Considerations for Adding Food Scraps

Human and physical capacity:

- ✓ Labor
- ✓ Sized system
- ✓ Pilots





Food waste is year round

- Continuous labor requirements vs seasonal fluctuation with yard trimmings
- Cons and also pros

Site Capacity

Potential Throughput > Available (Local) Capacity

The
Throughput vs Efficiency
Paradox

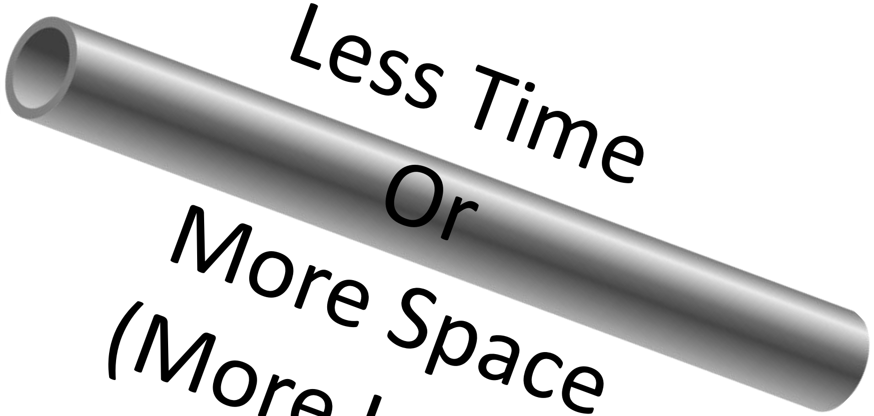
Raw Organics In

Stable Compost Out

Raw Organics In

Stable Compost Out

Raw Organics In



Less Time
Or
More Space
(More Labor)

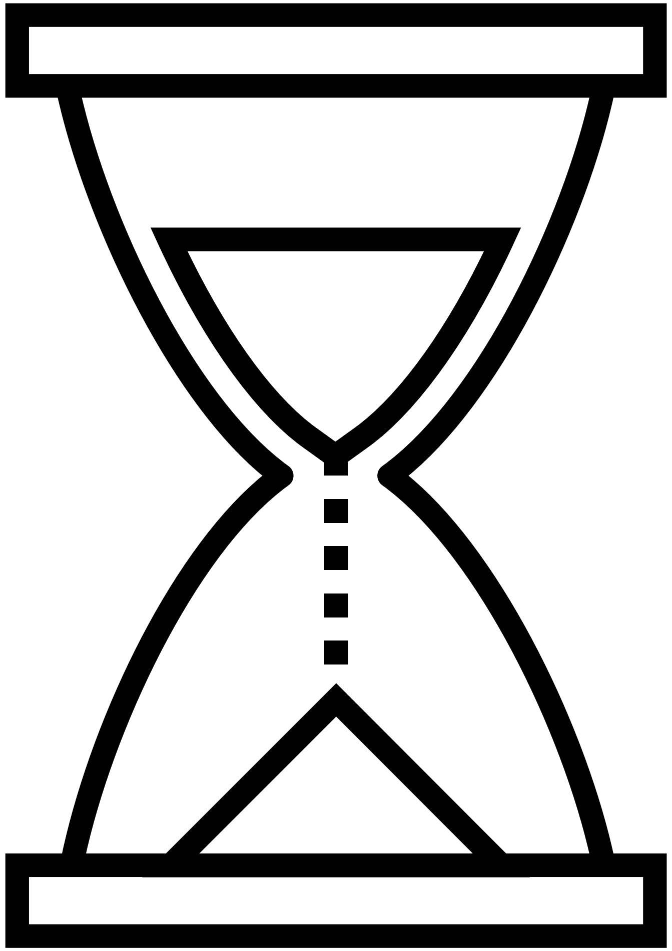
Stable Compost Out

Think Big. Start Small. (With Pilots).

Make small mistakes not big ones

Build community trust and support

Get to know what you don’t know you don’t know



Bottlenecks & Barriers to Expansion

- Compost Markets - Often under resourced/under prioritized
- Labor
- Capital for expansion
- Permitting and regulatory constraints
- Space (equal to processing time)

Where Operations Can Gain Efficiency: Pre- & Post-Processing

	Area of Efficiency Gain/Loss			
Technique/Strategy	**Spatial**	**Processing Time**	**Labor**	**Cost of Implementation**
Compost Drying	+	+	+	\$-\$\$\$\$
Physical Contaminant Prevention + Removal	+		+	\$-\$\$\$\$\$
Bokashi (Fermentation)	+	+	+/-	\$\$
Pre-Composting Feedstocks	+/-	+	+	\$\$
Moisture Reduction	+	+/-	+	\$\$\$\$
Particle Size Reduction	+	+	+/-	\$\$\$\$\$

+ = Increased Efficiency

+/- = It Depends or No Change

- = Decreased Efficiency

Where Operations Can Gain Efficiency: Compost Method

	Area of Efficiency Gain/Loss			
Technique/Strategy	**Spatial**	**Processing Time**	**Labor**	**Cost of Implementation**
Aerated Static Pile Composting	+	+	+	$-$$$
Vermicomposting	-	+	-	$-$$$$$
Windrow Turner	+	+	+	$$-$$$$
In-Vessel Composting	+	+	+	$$$$$

+ = Increased Efficiency

+/- = It Depends or No Change

- = Decreased Efficiency

Where Operations Can Gain Efficiency: Management Practices

Technique/Strategy	Area of Efficiency Gain/Loss: Spatial	Processing Time	Labor	Cost of Implementation	
Larger Piles	+	+/-	+/-	$	Adds Risk
Target C:N at 25:1	+	+	+	$	Adds Risk
Maximize Biologically Available Carbon (Low + Neutral C:N Feedstocks)	+	+	+	$	Adds Risk
Temperature Optimization (120-140° F)	+	+	+	$	
Reusing Compost as Feedstock	+	+/-	+/-	$	
Recycling Overs as Feedstock	+	+	+	$-$$$	
Increased Turning Frequency	+/-	+	+/-	$$	Adds Risk
Material Consolidation	+	+/-	-	$$	
Bays (vs Windrows)	+	+/-	+/-	$$$	

+ = Increased Efficiency

+/- = It Depends or No Change

- = Decreased Efficiency

Where Operations Can Gain Efficiency: Infrastructure

	Area of Efficiency Gain/Loss			
Technique/Strategy	**Spatial**	**Processing Time**	**Labor**	**Cost of Implementation**
Improved Pad Surfaces	+	+	+	$$-$$$$
Covered Structures	+	+/-	+	$$$$

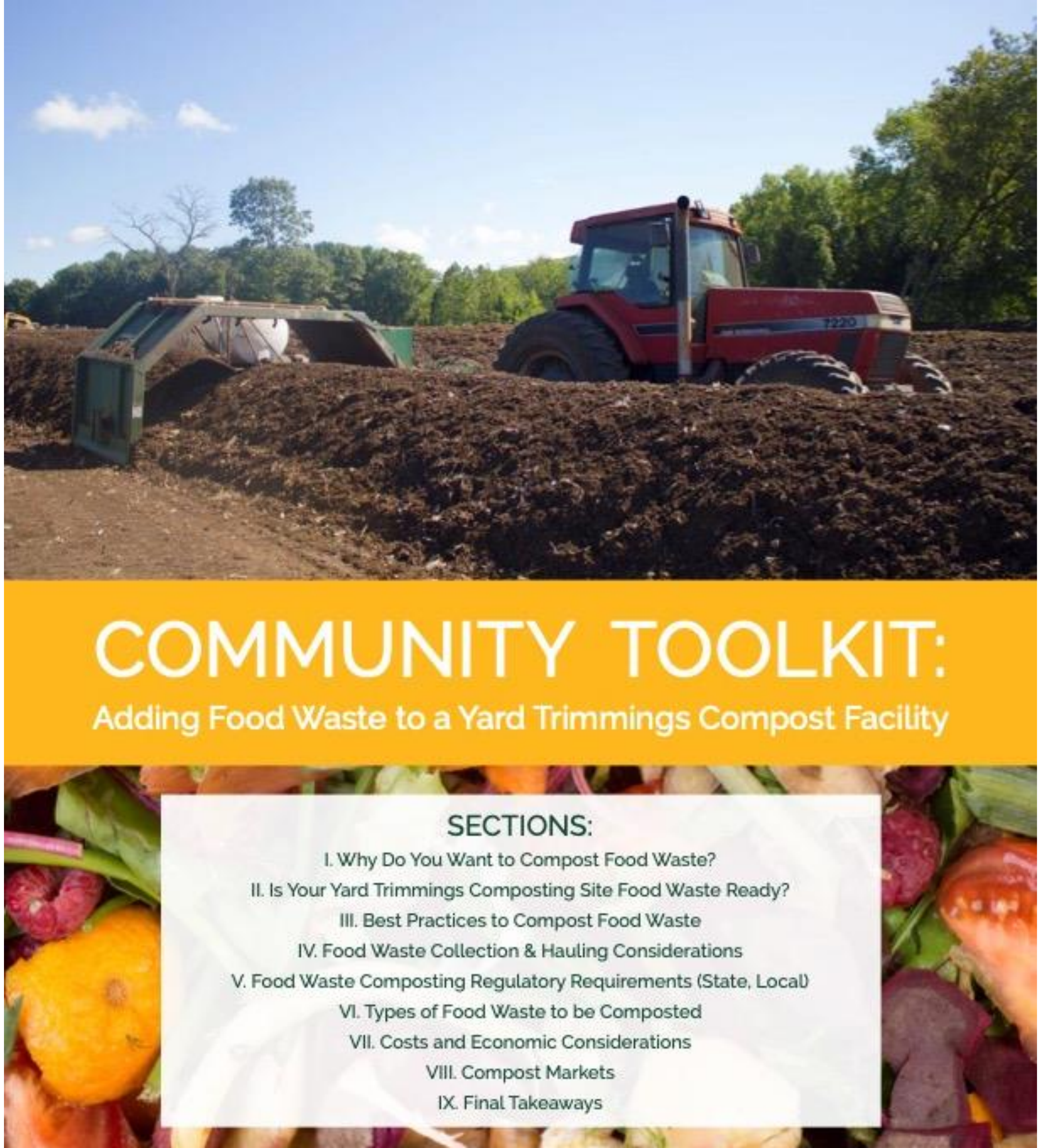
+ = Increased Efficiency

+/- = It Depends or No Change

- = Decreased Efficiency

For Yard Trimmings Facilities

https://wastedfood.cetonline.org/Community-Toolkit-Yard-Trimmings-Food-Scraps




BIOCYCLE CONNECT WEST 2020: Building Best-In-Class Organics Recycling Programs
MARCH 30 – APRIL 2, 2020 • SACRAMENTO, CA • BioCycleConnectWest.com

BioCycle.net
NOVEMBER/DECEMBER 2019

BioCycle®

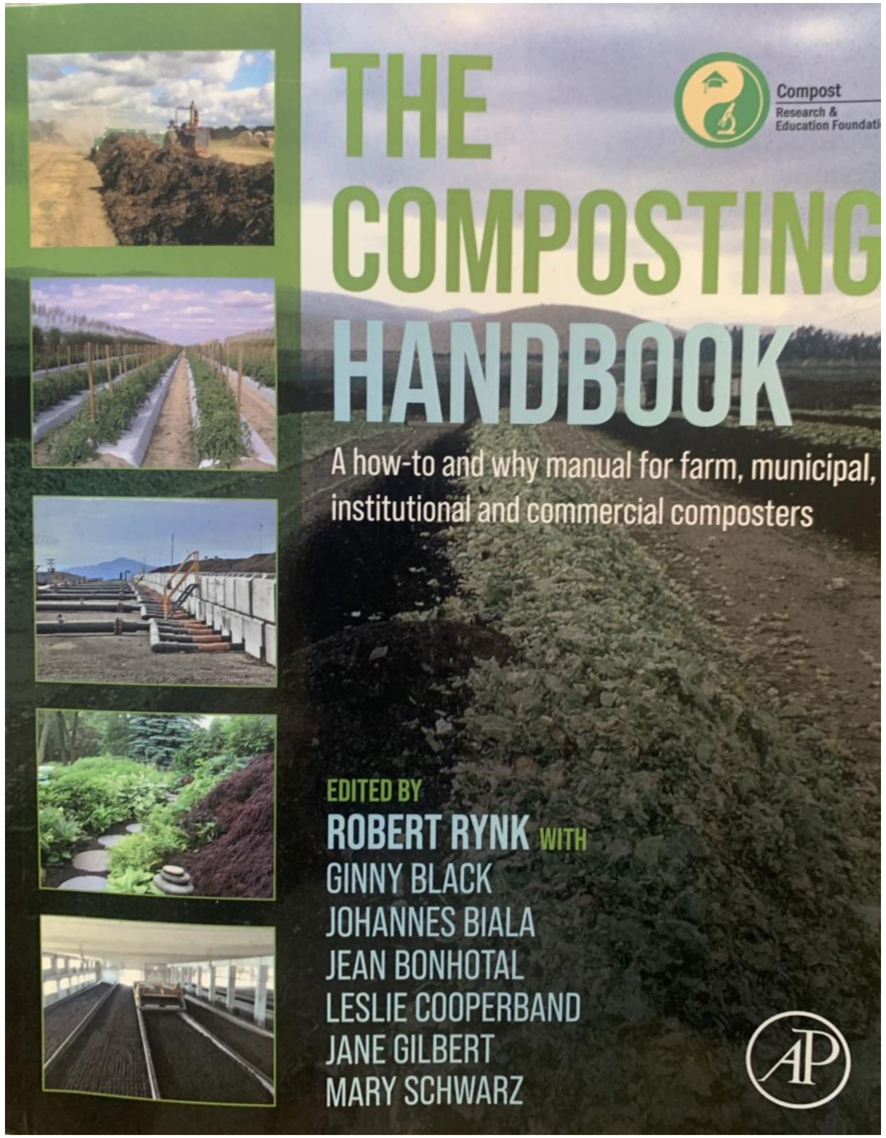
CELEBRATING 60 YEARS

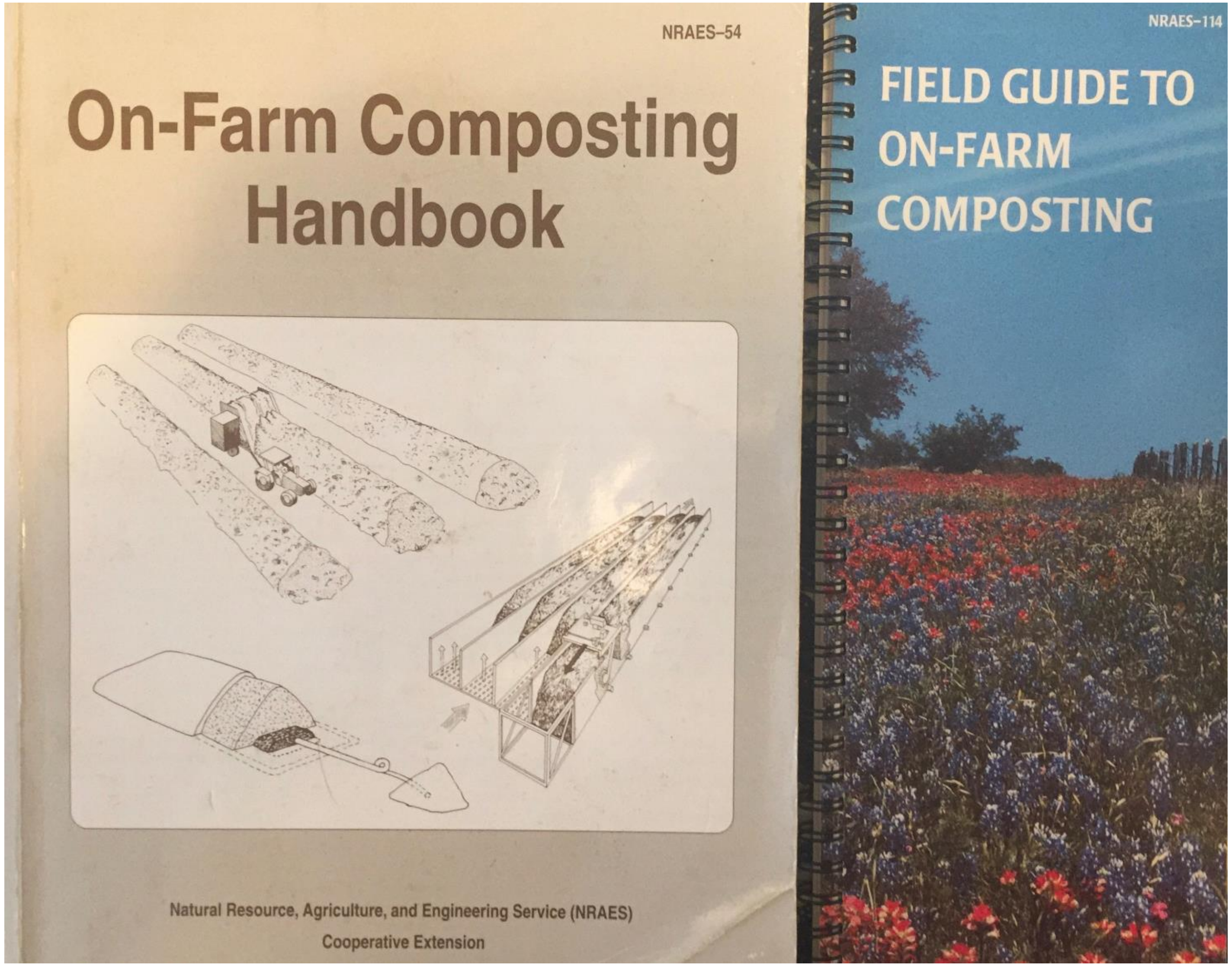
THE ORGANICS RECYCLING AUTHORITY

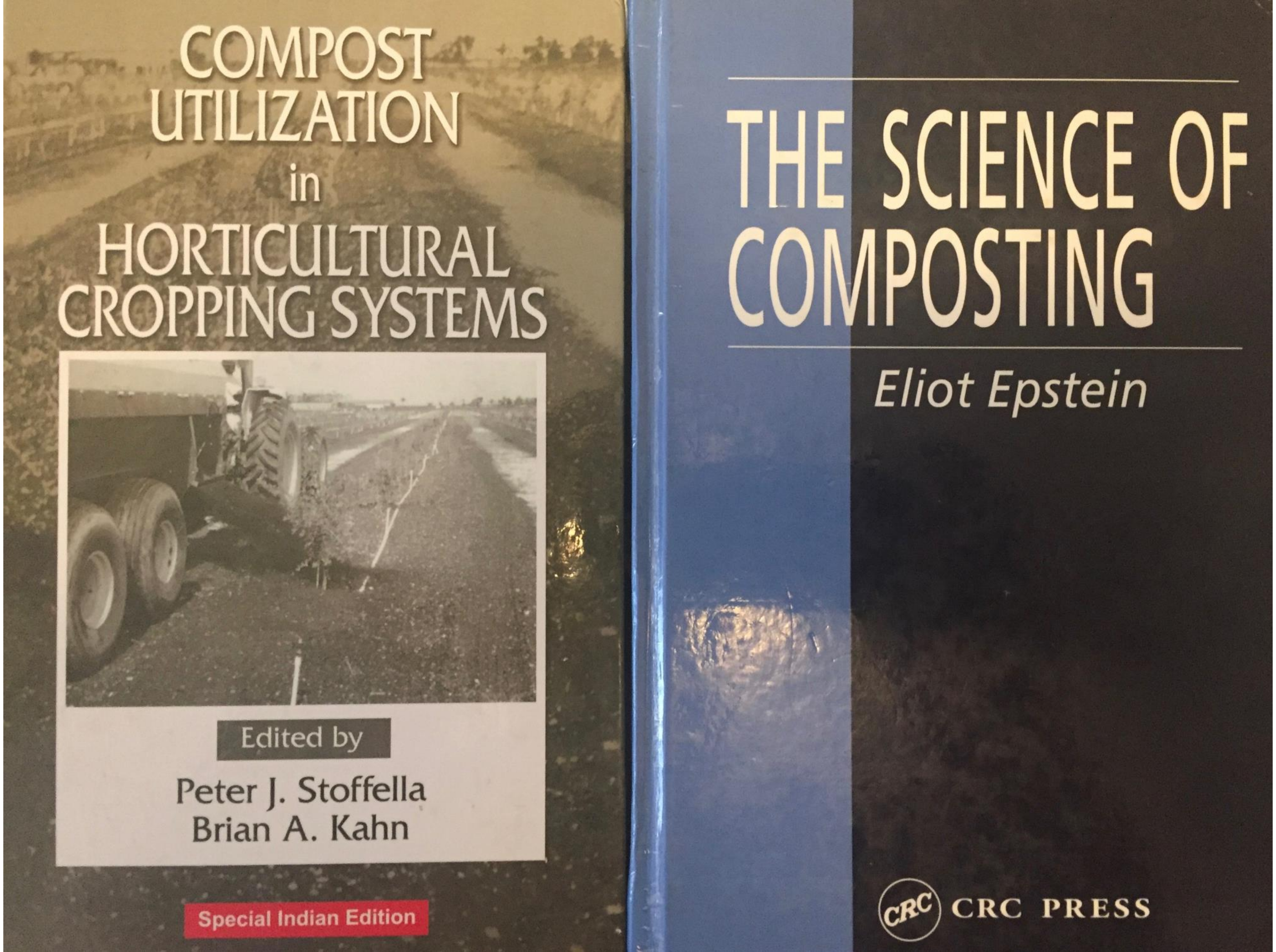
BioCycle CONNECT®

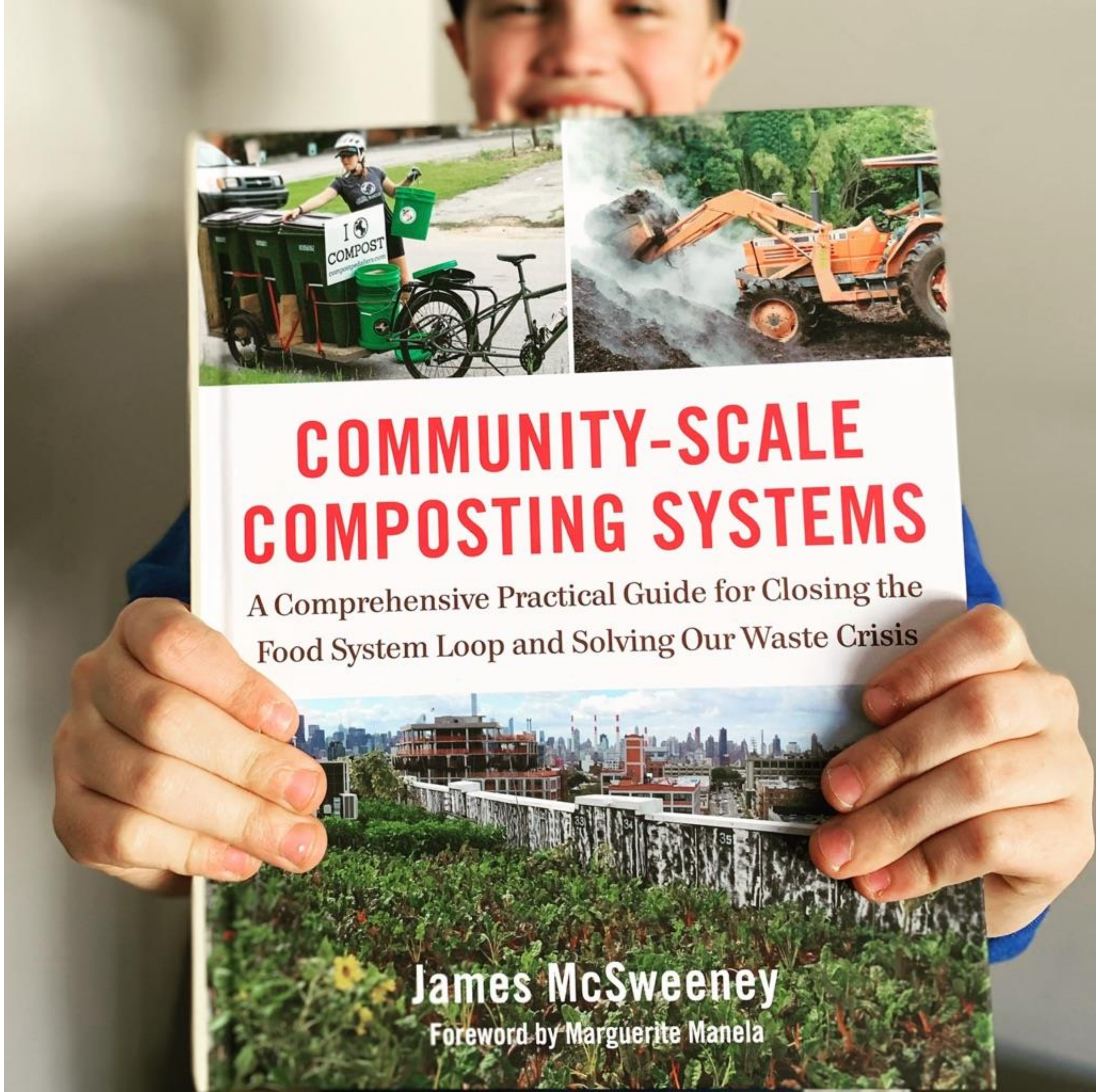
A new BioCycle for the new decade.

US Composting Council®


THE COMPOSTING HANDBOOK
Compost Research & Education Foundati
A how-to and why manual for farm, municipal, institutional and commercial composters
EDITED BY
ROBERT RYNK WITH
GINNY BLACK
JOHANNES BIALA
JEAN BONHOTAL
LESLIE COOPERBAND
JANE GILBERT
MARY SCHWARZ
AP


NRAES–54
On-Farm Composting Handbook
Natural Resource, Agriculture, and Engineering Service (NRAES)
Cooperative Extension
NRAES–114
FIELD GUIDE TO ON-FARM COMPOSTING


COMPOST UTILIZATION in HORTICULTURAL CROPPING SYSTEMS
Edited by
Peter J. Stoffella
Brian A. Kahn
Special Indian Edition
THE SCIENCE OF COMPOSTING
Eliot Epstein
CRC PRESS


I COMPOST
COMMUNITY-SCALE COMPOSTING SYSTEMS
A Comprehensive Practical Guide for Closing the Food System Loop and Solving Our Waste Crisis
James McSweeney
Foreword by Marguerite Manela

Free Online Resources

- Guide to Agricultural Composting. MDAR. *2010* http://www.mass.gov/eea/docs/agr/programs/compostguidetoagcomposting2011.pdf
- Vermont Agency of Natural Resources Composter Resources – Developed by CTS. Site Planning & Management, School Composting, School Curriculums https://dec.vermont.gov/waste-management/solid/materials-mgmt/organic-materials

Free Online Resources

- RecyclingWorks Source-Separation BMPs: http://www.recyclingworksma.com/local-health-department-guidance-for-commercial-food-waste-separation/
- MassDEP: http://www.mass.gov/eea/agencies/massdep/recycle/reduce/composting-and-organics.html
- Institute for Local Self-Reliance: https://ilsr.org
  - Yes! In My Backyard: A Home Composting Guide for Local Government
  - Growing Local Fertility: A Guide to Community Composting
  - Pay Dirt
- The Composting Collaborative: https://www.compostingcollaborative.org

Free Webinars and How-To Videos

- Institute for Local Self-Reliance: https://ilsr.org/tag/webinar/
- The Composting Collaborative: https://www.compostingcollaborative.org/resource-category/webinar/
- Highfields Center for Composting Video Series – Recipe Development, Pile Monitoring & Turning, School Training – https://vimeo.com/highfieldscomposting

Need Training and Education in Best Management Practices (BMPs)

- RecyclingWorks MA Compost Site Technical Assistance
- Facility Management Plans
- Intensive trainings
    - Maine Compost School (1 Week)
    - US Compost Council Composter Training Programs
    - The 131° School of Composting
    - Neighborhood Soil Rebuilders (ILSR)