
Compost Site
Management

Compost's Benefits

Compost Basics, BMPs, & Nuisance Mitigation

Composting Methods


"Despite all our achievements we owe our existence to a six-inch layer of topsoil"
Anonymous

Climate change isn’t just hurting the planet – it’s a public health emergency

The Guardian - October 30, 2017

Climate change fueling disasters, disease in 'potentially irreversible' ways, report warns

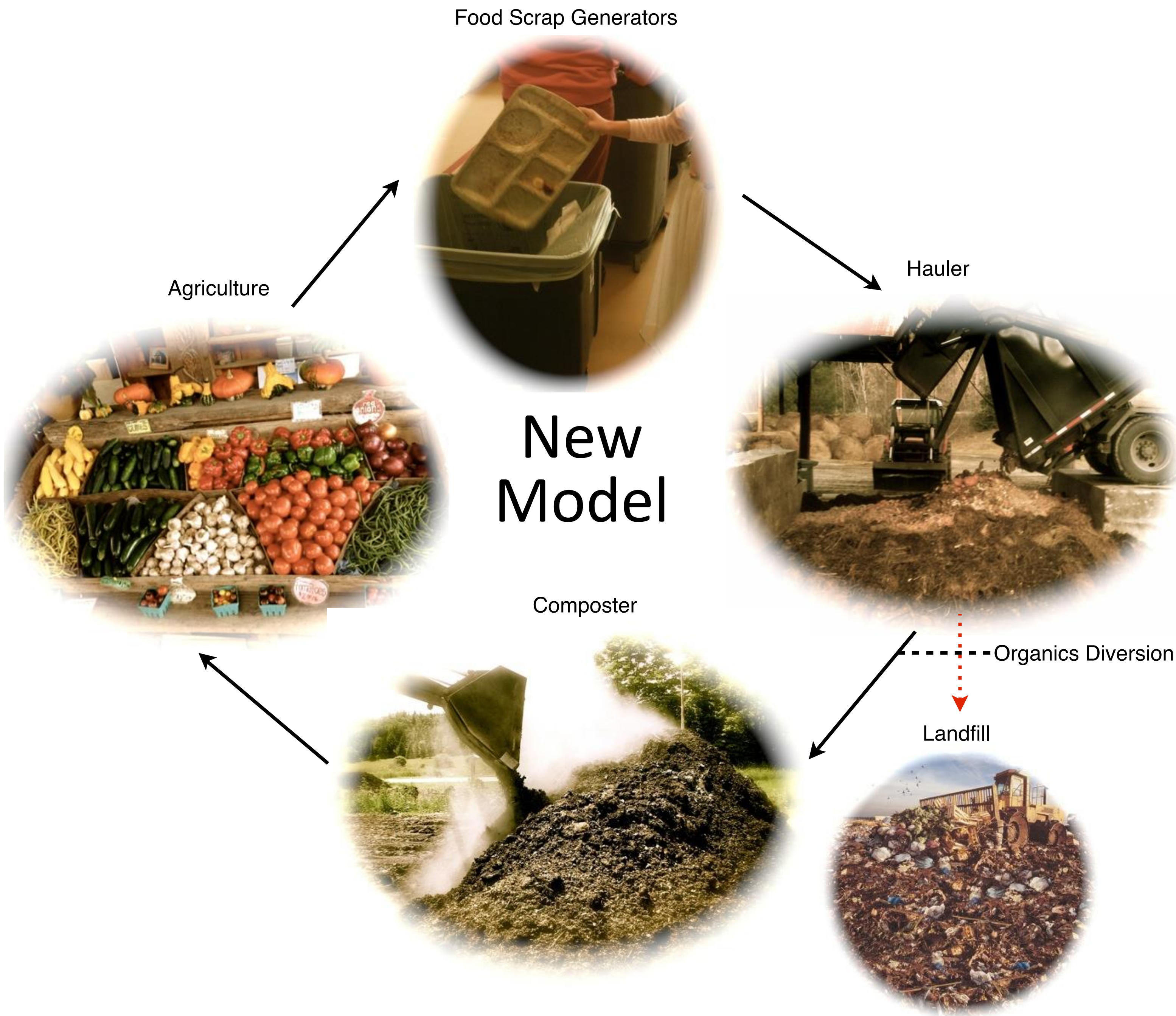
Avoidable food waste contributes 2% of total GHG Emissions in US

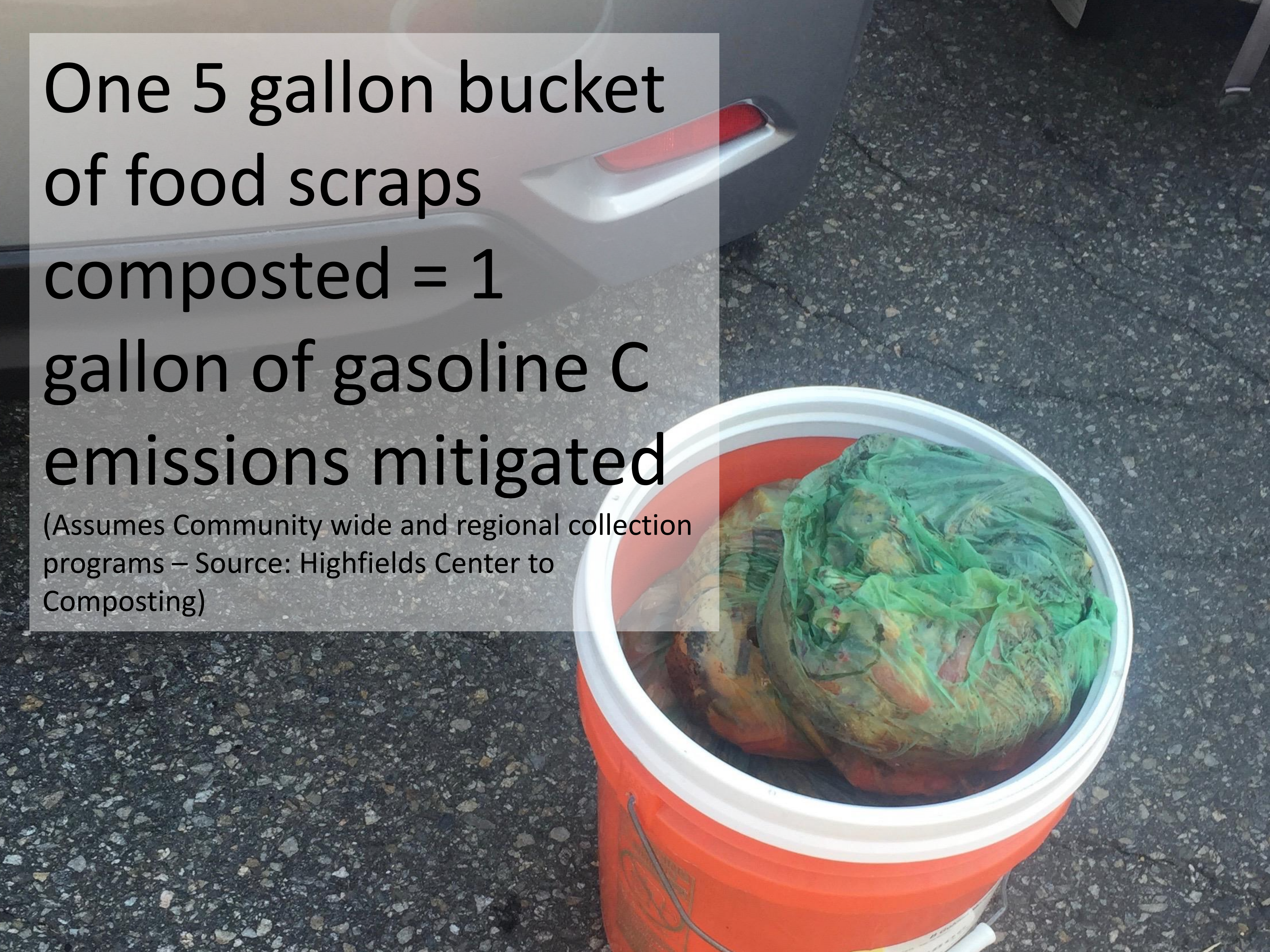
Campbell and Ingram, 2012.

Waste to Resource Paradigm Shift


COMPOST
Not Just a 1970's Jazz Fusion Band

- ~ 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)


Food Scrap Generators
Hauler
Agriculture
New Model
Composter
Organics Diversion
Landfill

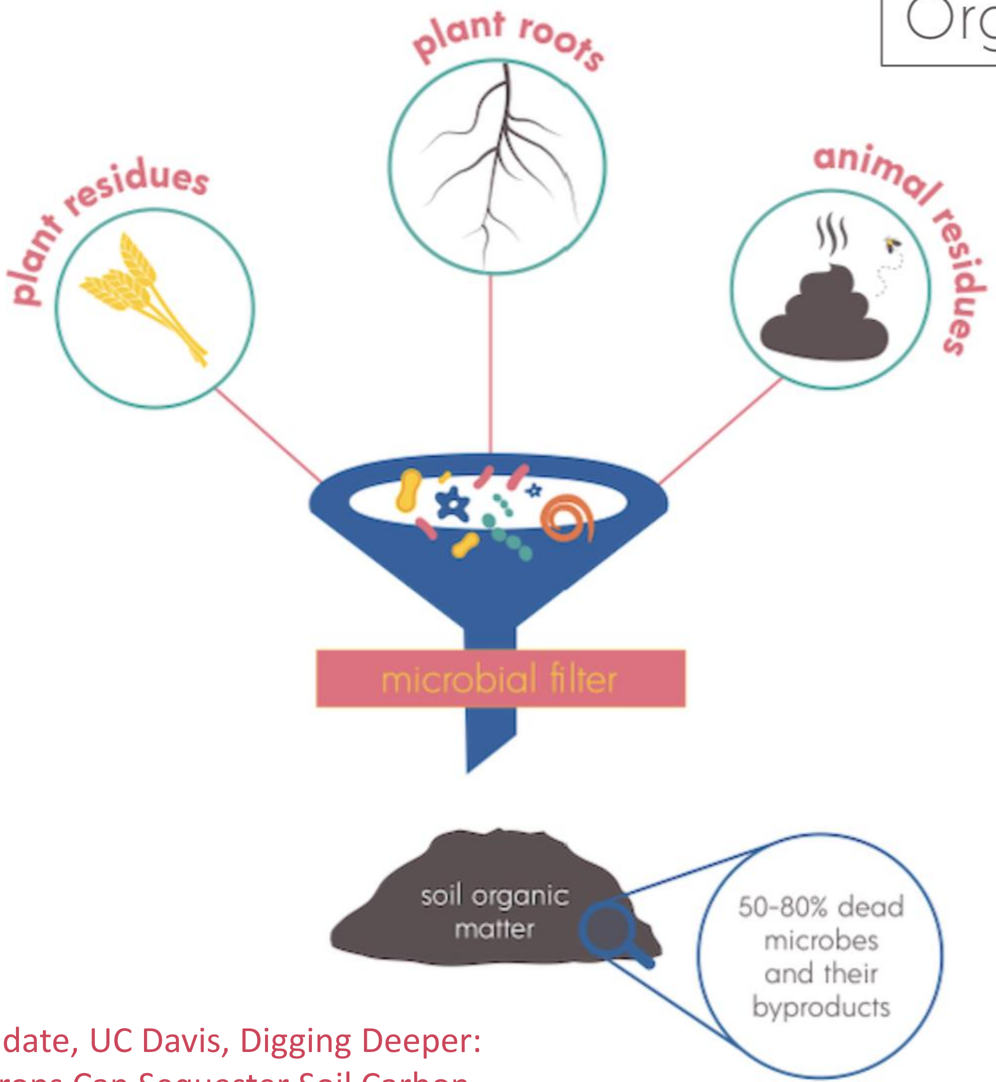

One 5 gallon bucket of food scraps composted = 1 gallon of gasoline C emissions mitigated
(Assumes Community wide and regional collection programs – Source: Highfields Center to Composting)

Compost Cycle Ecosystem Services

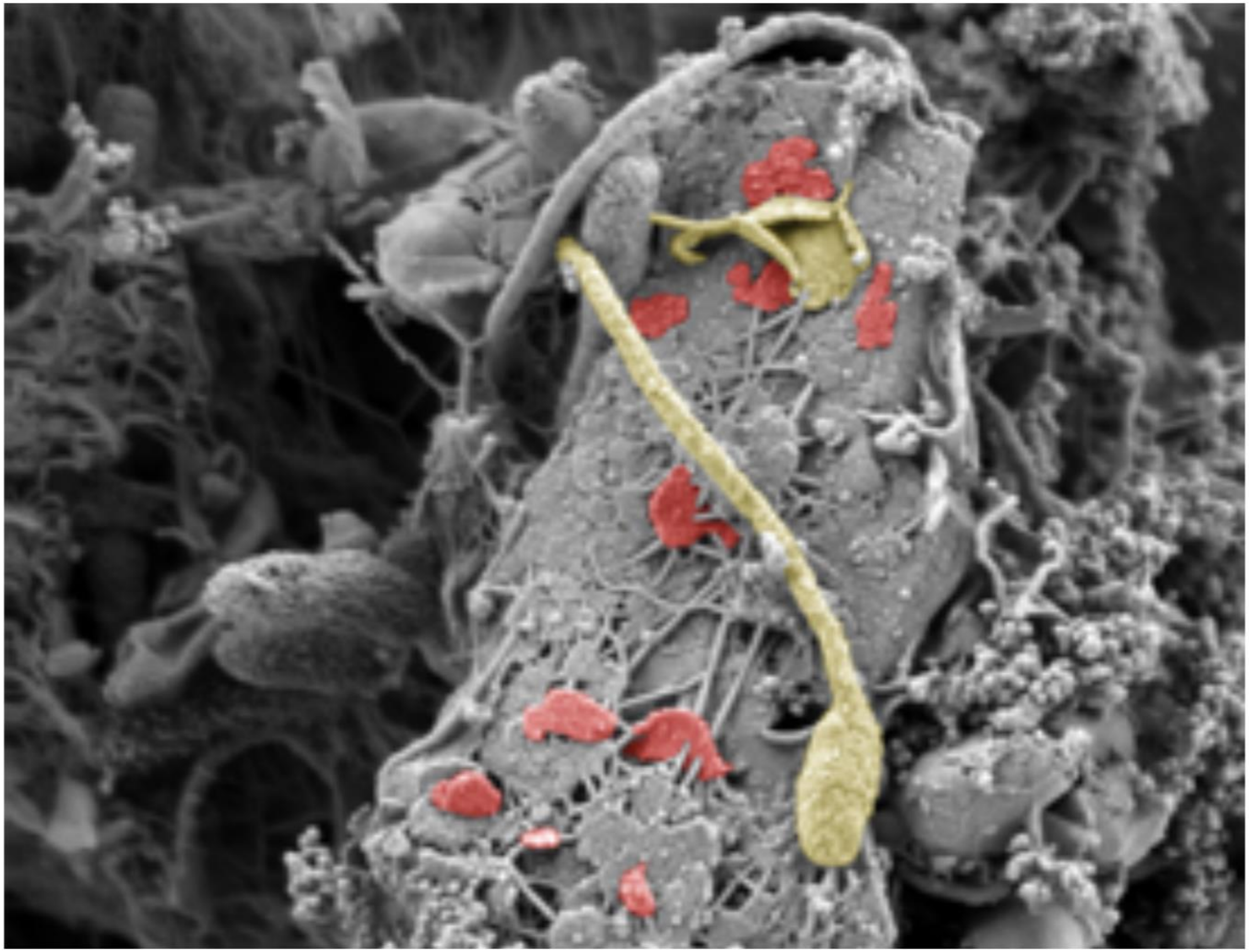
- Return – Energy, nutrients, life
- Soil Health – Organic matter, structure, soil food web
- Hydrological Cycles – Infiltration, retention, drought resistance, runoff & pollution mitigation
- Plant Health – root density, disease resistance & antagonism, reduction in agrochemicals
- Goal of <u>soil as sink</u> vs emitter of GHG

Soil Organic Matter

Organic Fraction



Jessica Chiartas, PhD Candidate, UC Davis, Digging Deeper:
How Compost and Cover Crops Can Sequester Soil Carbon



Scanning Electron Microscopy: bacteria cell wall (yellow) and contents inside bacteria (red) bonded to mineral particle.

Runaway GHG emissions

- **8.9 Pg C** emitted annually

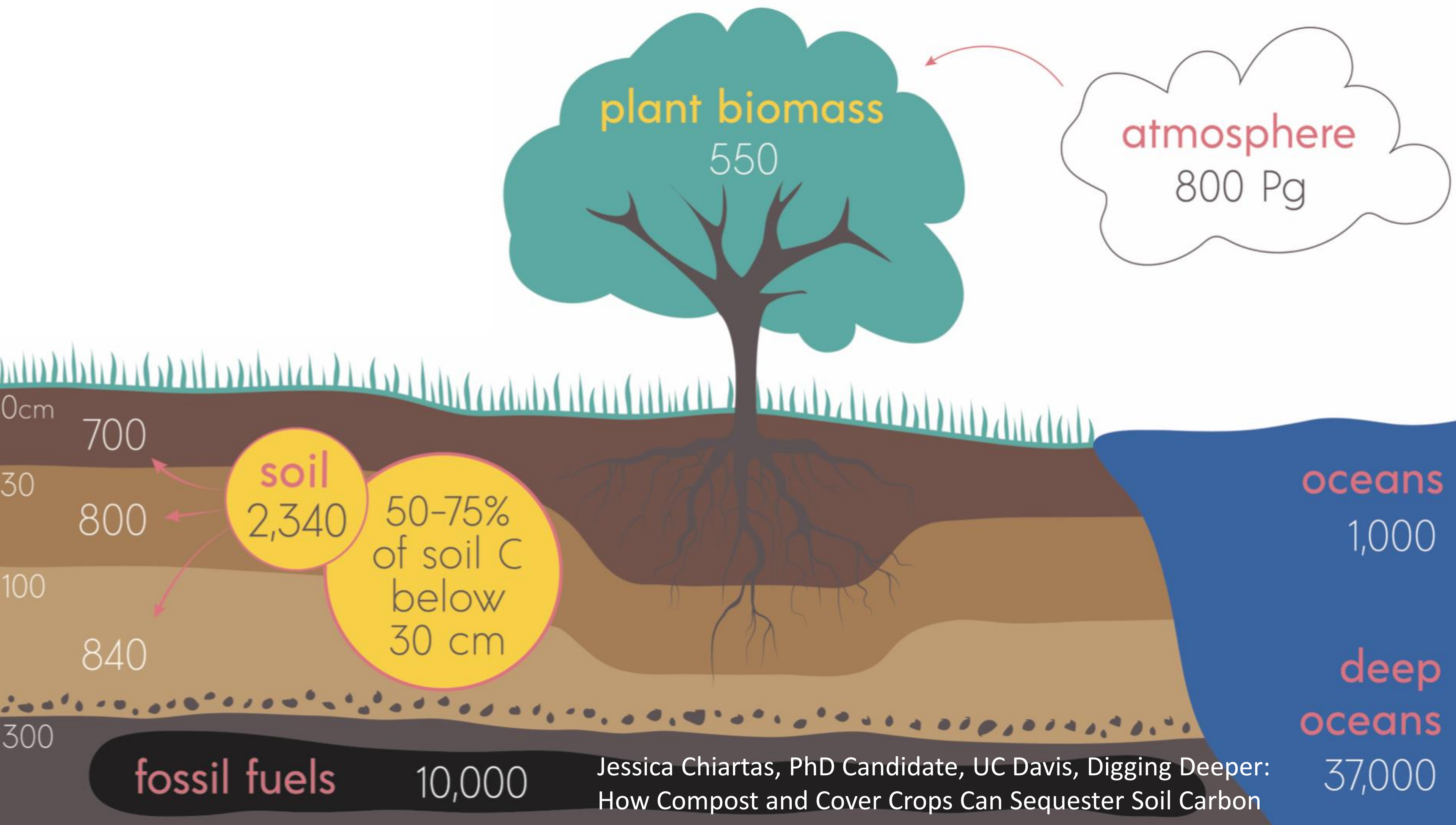
  (1 Pg = 1 Petagram = 1 Quadrillion Grams)

- Total emissions since Industrial Revolution
  - Conversion to Agriculture: 136±55 Pg C
    - Intensification: 78±12 Pg C

- Negative emissions of **150 Pg C** required to prevent **2°C rise** in temperature

Zomer et al., 2017; Hansen et al. 2016

Soil Carbon Stocks



Jessica Chiartas, PhD Candidate, UC Davis, Digging Deeper:
How Compost and Cover Crops Can Sequester Soil Carbon

Carbon Sequestration to the Rescue?

California's Healthy Soils Program

Incentivizes farmers to build SOM

France's 4 per 1000 Initiative

Aims to sequester 3.5 Pg C yr^{-1}

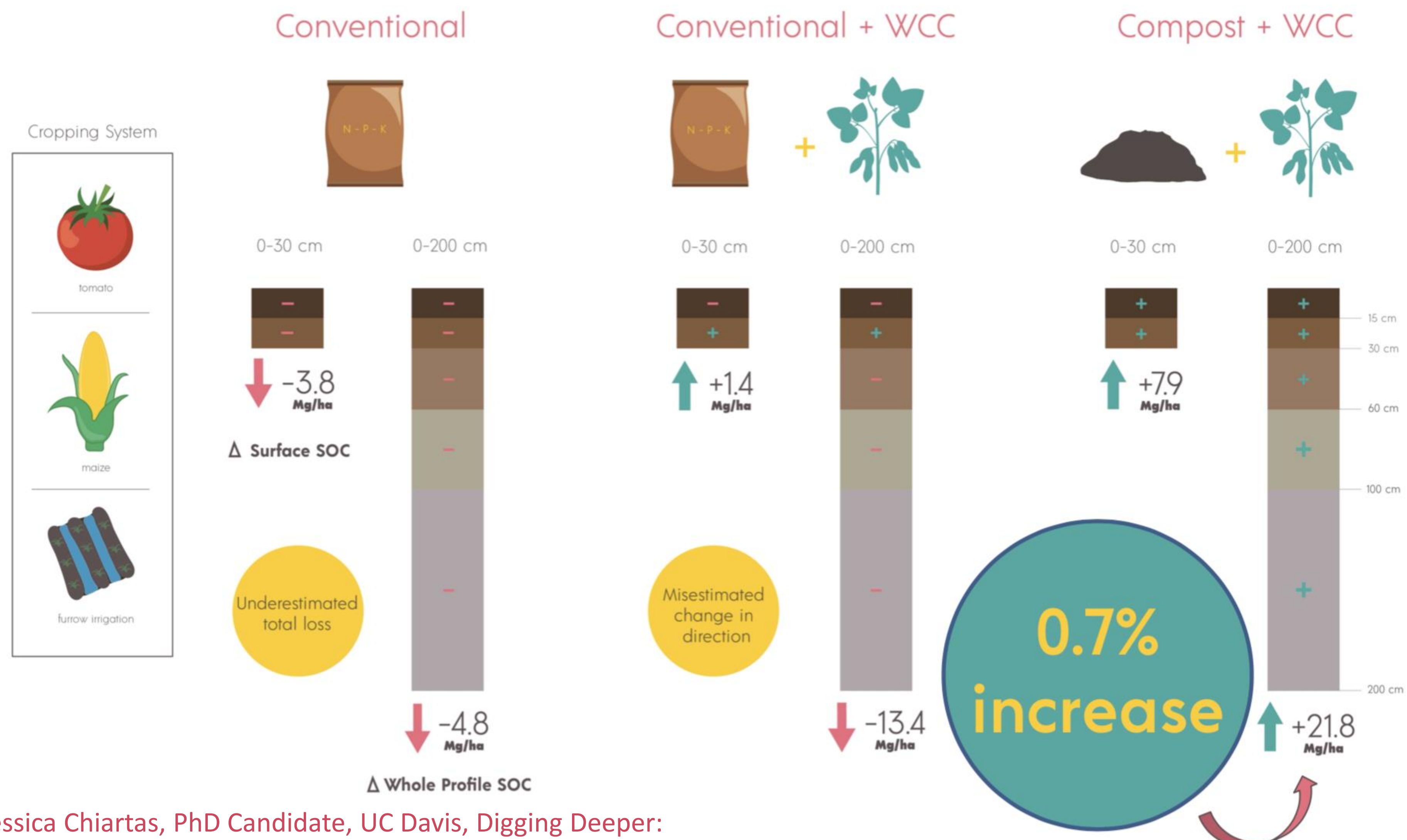
Maximum Potential*: 0.9–1.85 Pg C yr^{-1}

*According to scientific literature

Jessica Chiartas, PhD Candidate, UC Davis, Digging Deeper: How Compost and Cover Crops Can Sequester Soil Carbon

Zomer et al., 2017; van Groenigen et al. 2016

Surface vs. Deep Soil Inventories of Carbon Sequestration

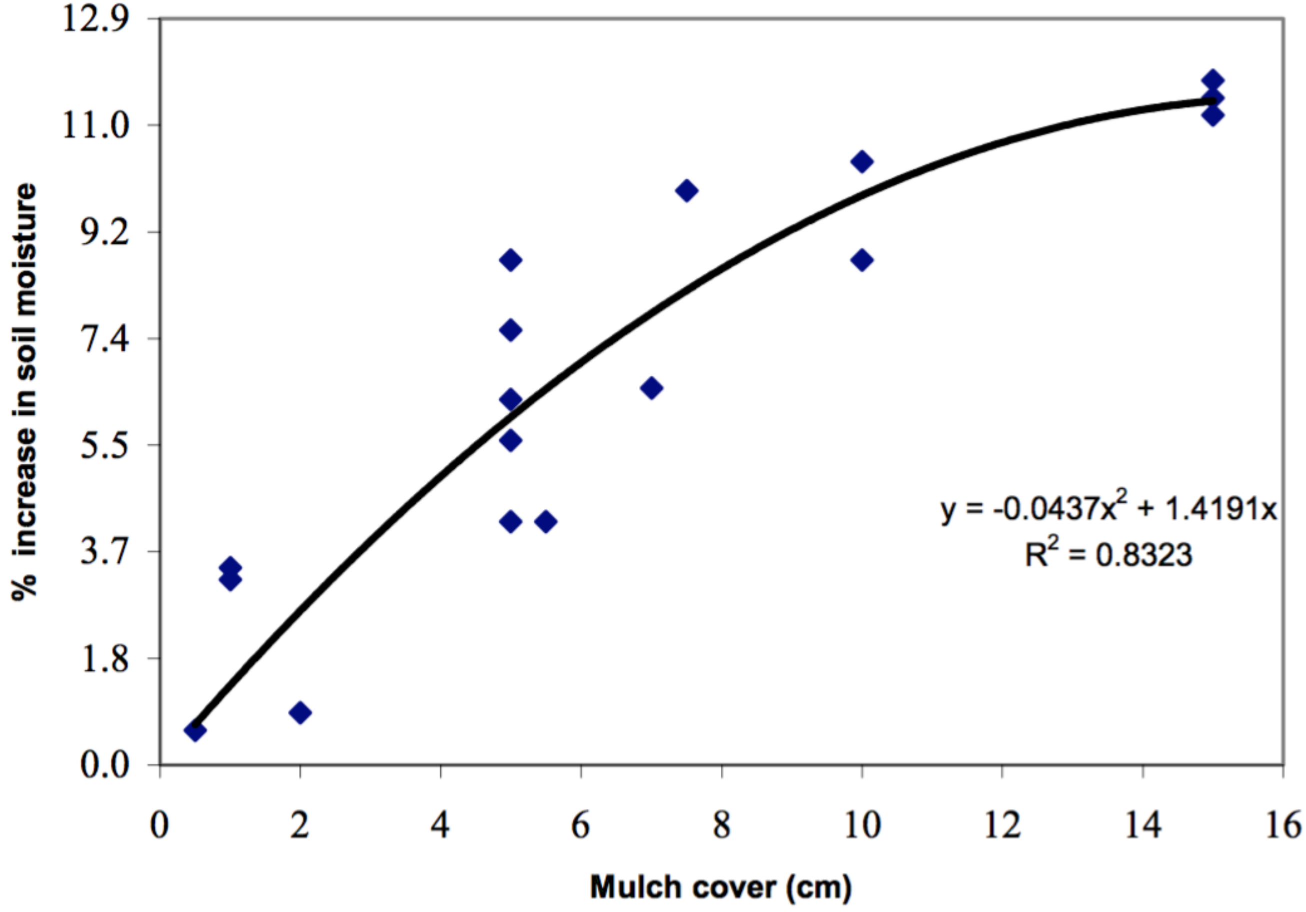


Jessica Chiartas, PhD Candidate, UC Davis, Digging Deeper:
How Compost and Cover Crops Can Sequester Soil Carbon

33-66% reduction in fertilizer required for vegetable production (Hill, 1984)

Drought Resistance

Figure 7.4 Effect of composted mulch on soil moisture content of 0–15 cm layer.

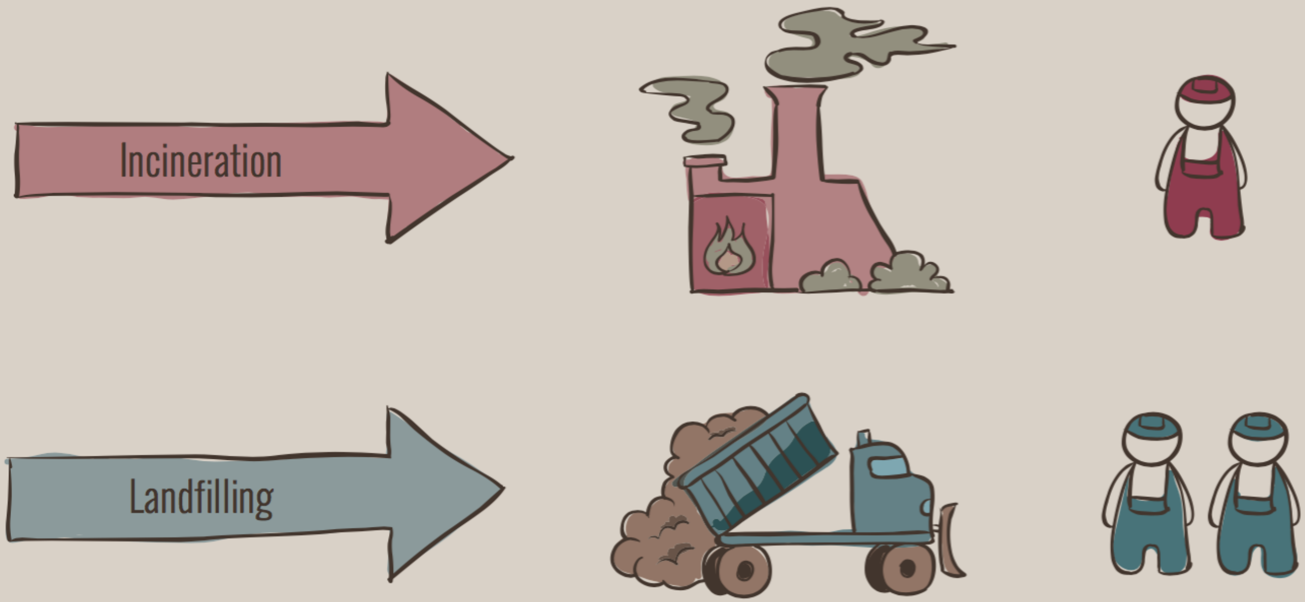


Life Cycle Inventory & Life Cycle Assessment for Windrow Compost Systems, 2007.

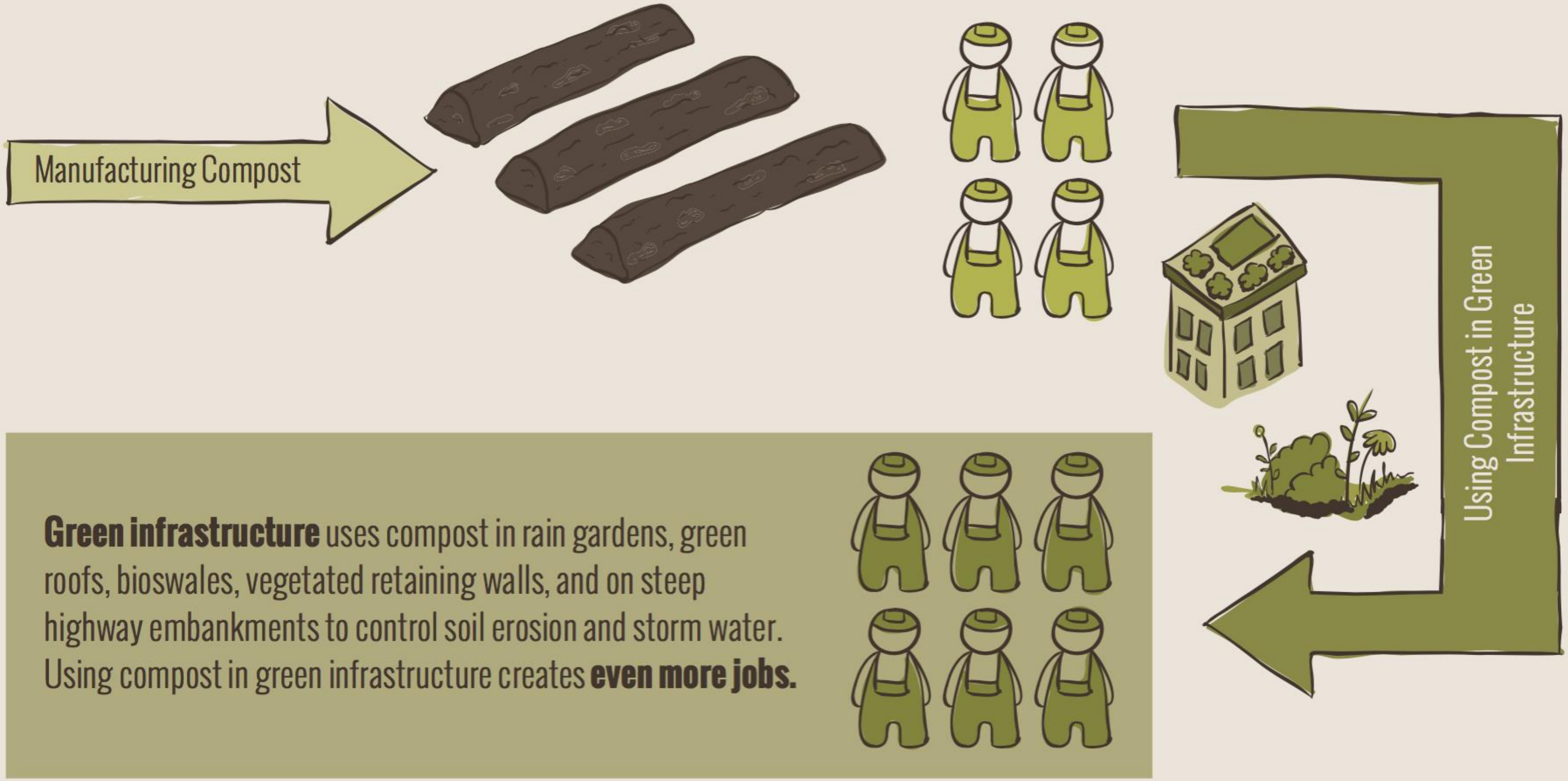
Composting Creates Jobs

Jobs are sustained in each stage of the organics recovery cycle.

PER 10,000 TONS WASTE/YEAR | **JOBS SUSTAINED**



On a per-ton basis, making compost alone, employs **2x more workers than landfills** and **4x more than incinerators.**



Green infrastructure uses compost in rain gardens, green roofs, bioswales, vegetated retaining walls, and on steep highway embankments to control soil erosion and storm water. Using compost in green infrastructure creates **even more jobs.**

SOURCES:

Brenda Platt, Bobby Bell, and Cameron Harsh, Pay Dirt: *Composting in Maryland to Reduce Waste, Create Jobs & Protect the Bay*, Institute for Local Self-Reliance (ILSR), May 2013.

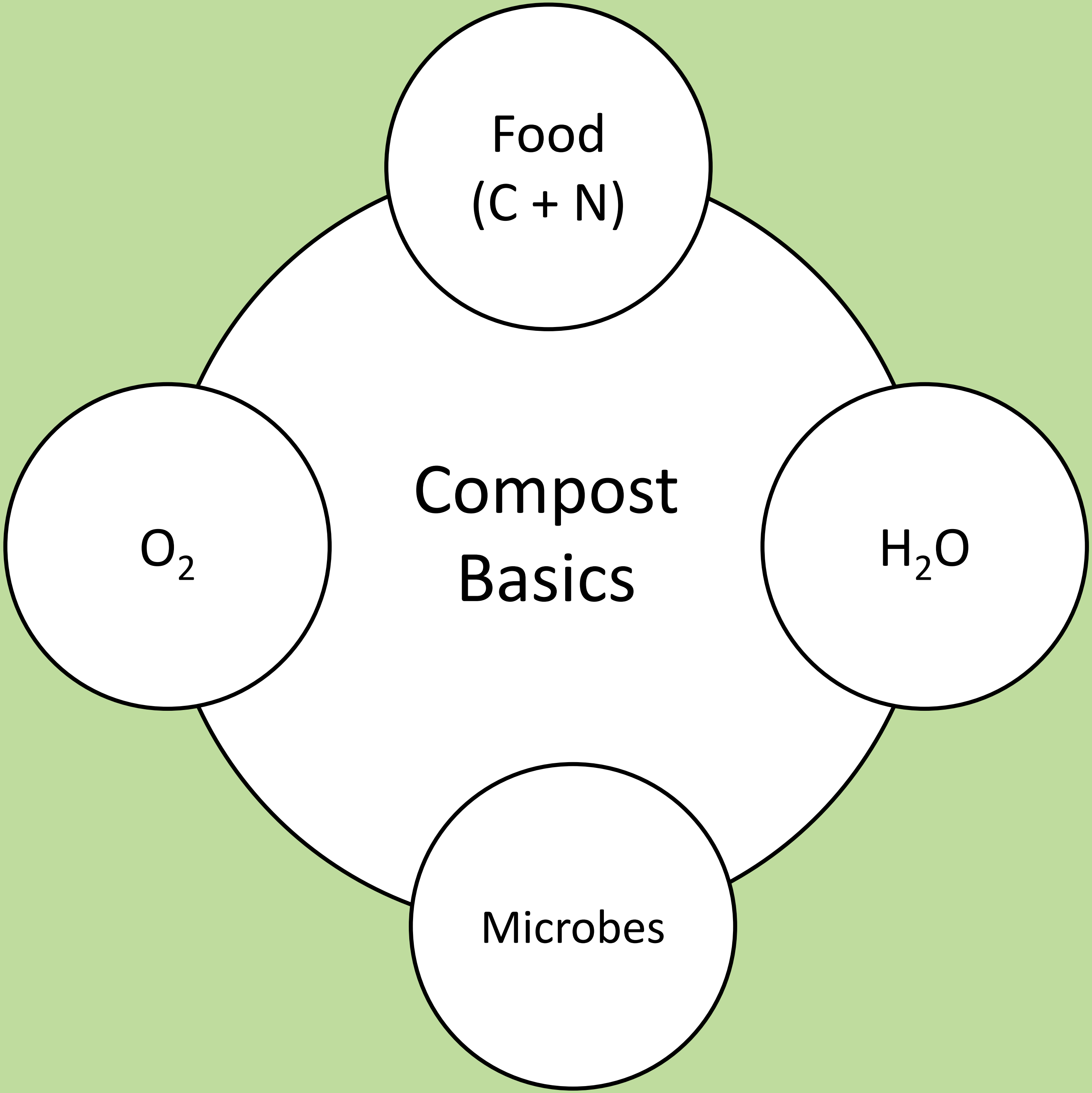
Brenda Platt, Nora Goldstein, Craig Coker, and Sally Brown, *The State of Composting in the U.S.: What, Why, Where, & How*, Institute for Local Self-Reliance (ILSR), June 2015.

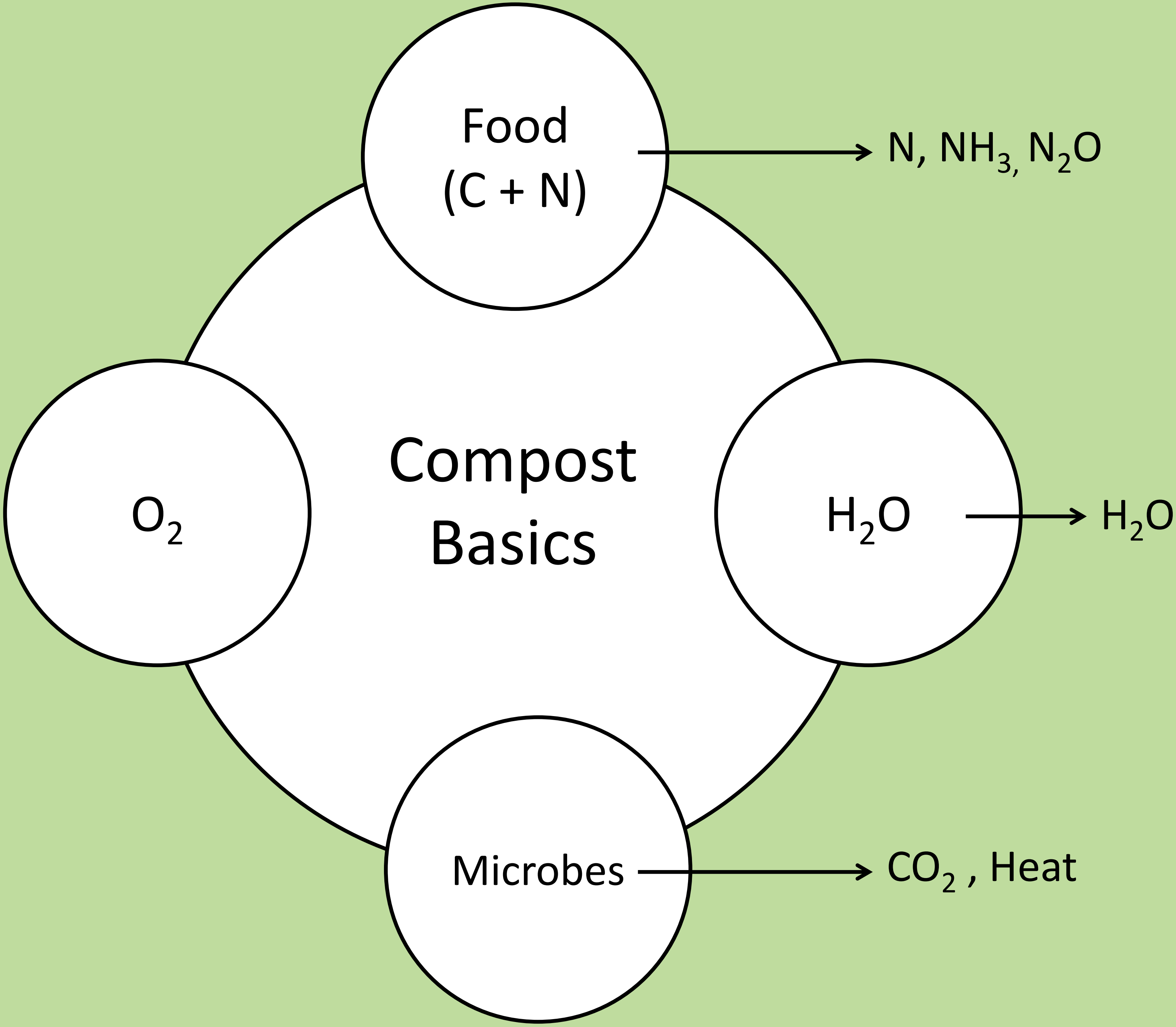
Brenda Platt and Neil Seldman, *Wasting and Recycling in the United States 2000*, Institute for Local Self-Reliance (ILSR), 2000.

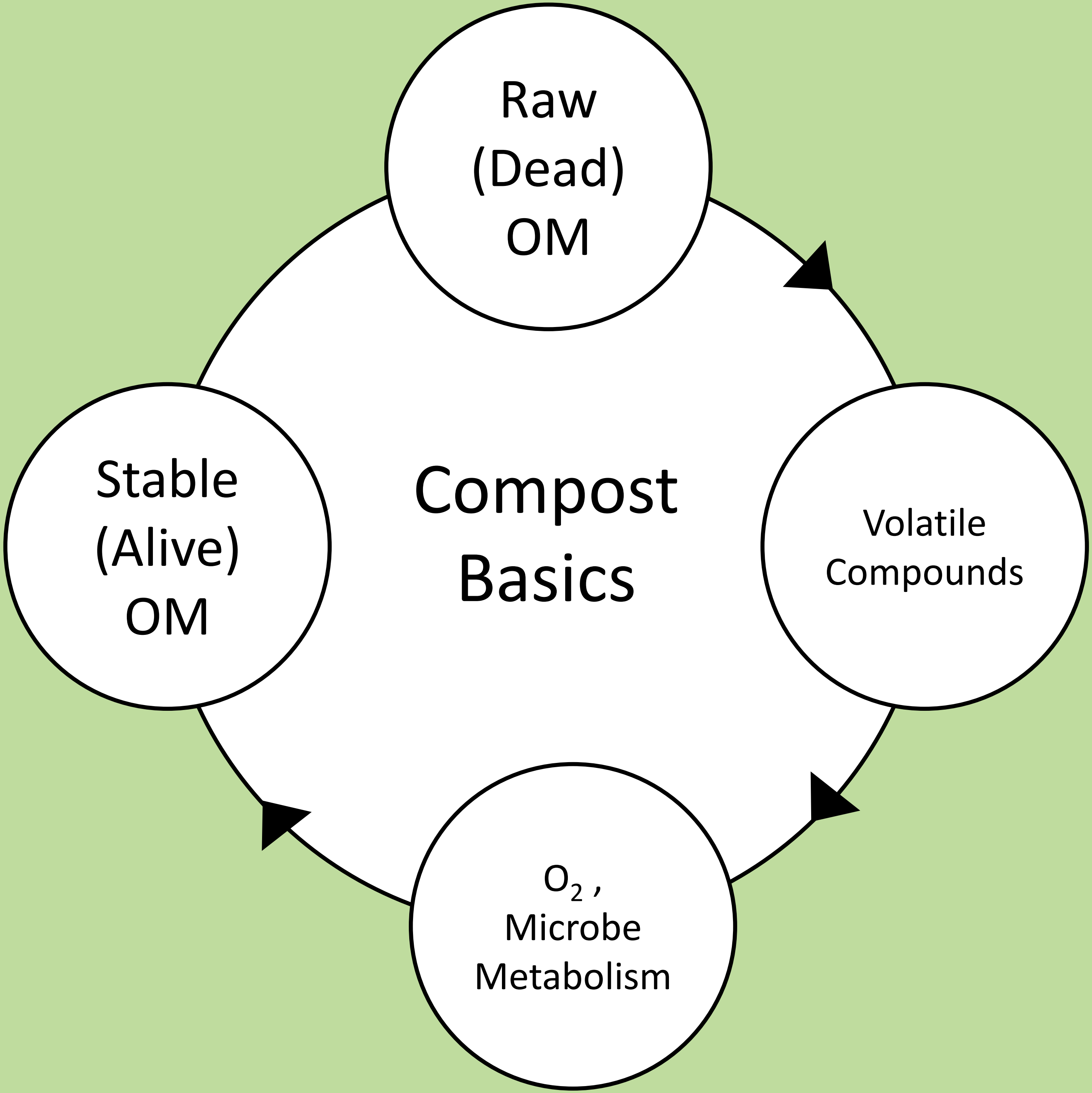
ILSR INSTITUTE FOR Local Self-Reliance

To learn more, visit: **ilsr.org/compost-impacts**


Compost Basics, Best
Management Practices,
& Nuisance Mitigation


Food
(C + N)
O_2
Compost
Basics
H_2O
Microbes

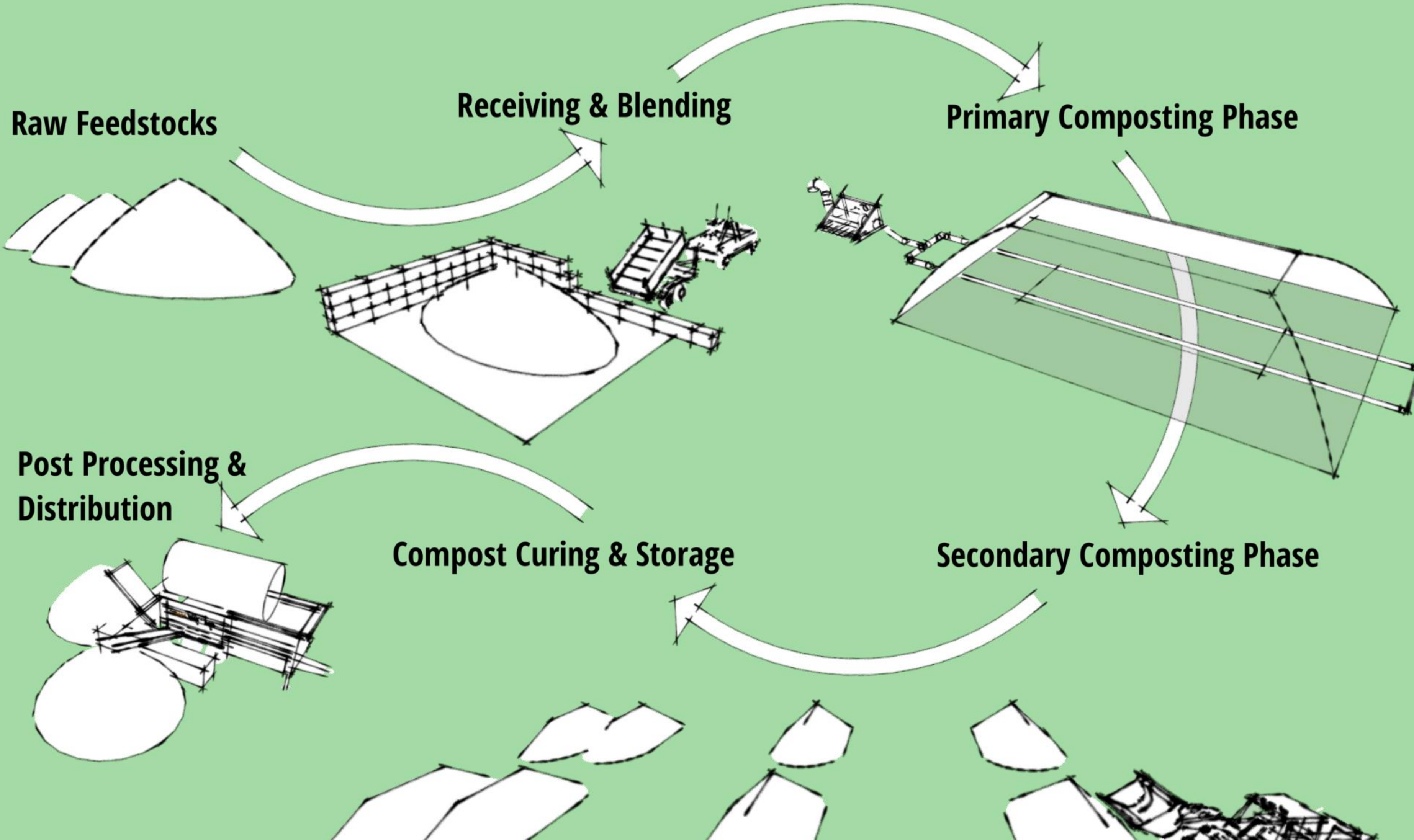

Food
(C + N)
N, NH3, N2O
Compost
Basics
O2
H2O
H2O
Microbes
CO2 , Heat


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

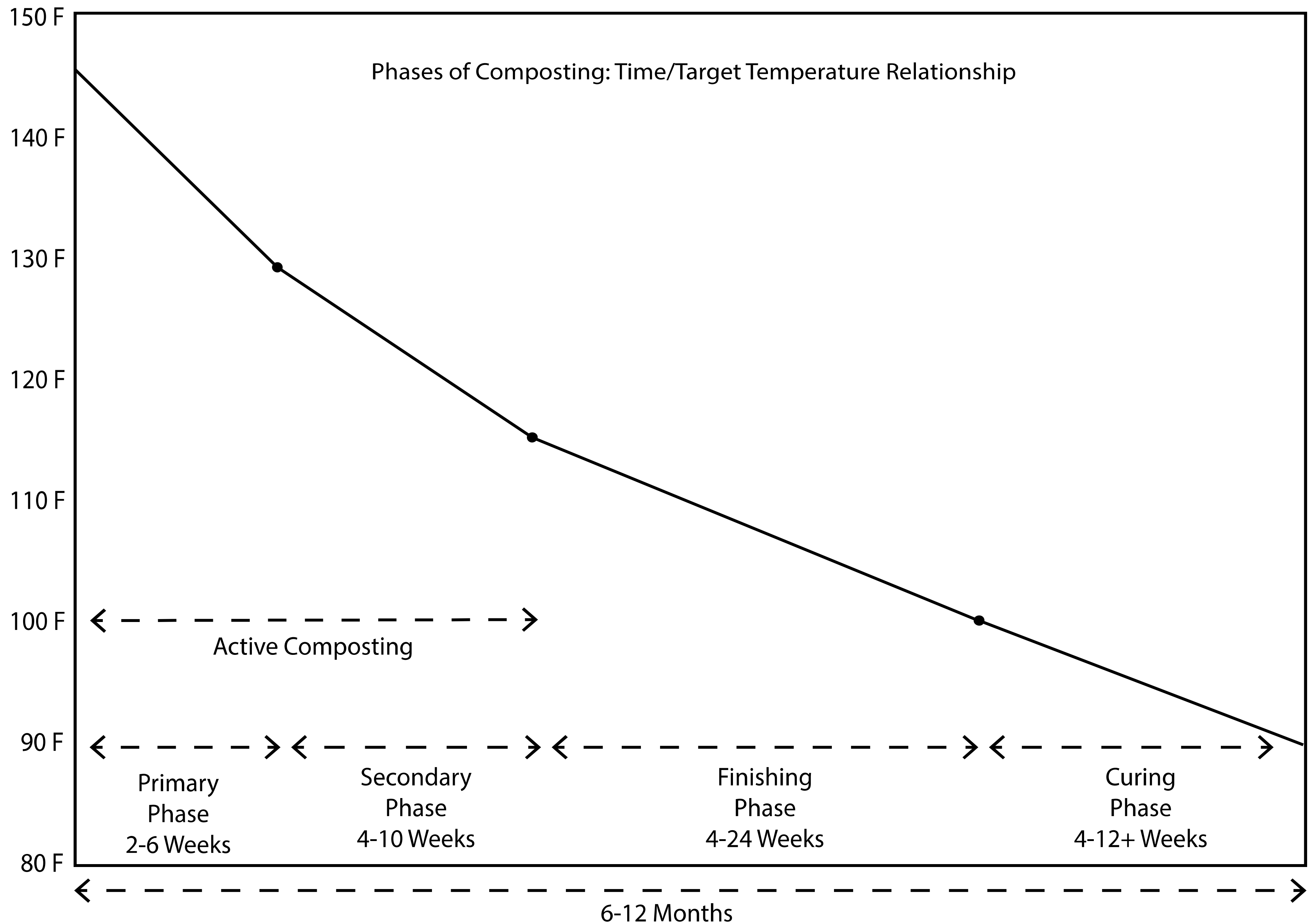
Managed Compost

The presence of oxygen *and oxygen loving organisms:*

- **Fast and complete decomposition**
- **Higher Temperatures** *needed to kill pathogens and weed seeds*
  - *All particles reach 131° or greater for at least 3 days*
  - *Achieved through effective aeration and turning*
- **Minimal odors** *which are primarily caused by anaerobic organisms*



Compost
Technical
Services



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

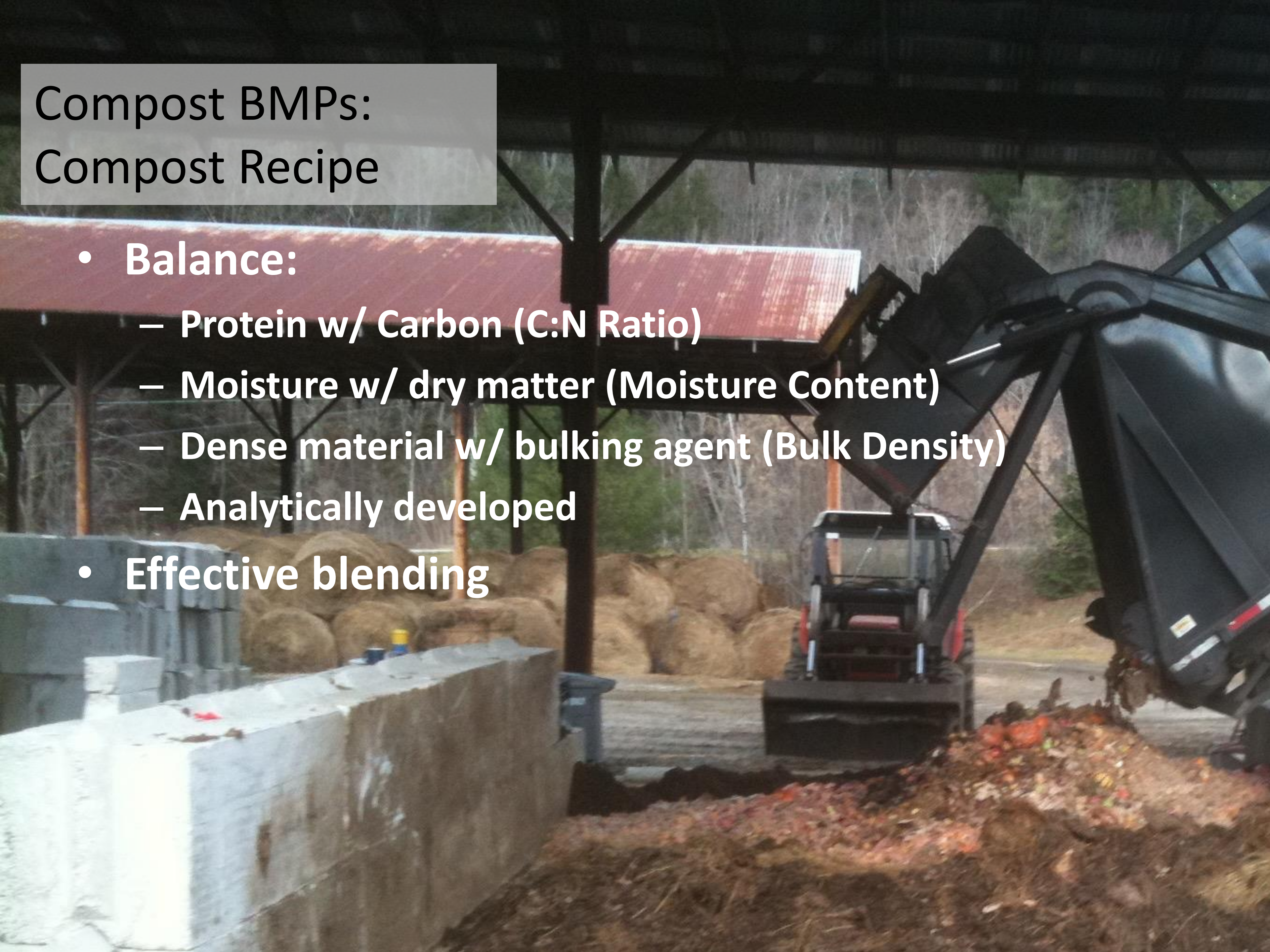
Why Sites Close

- #1 Odor (and odor complaints)
- #2 Over or under capacity
- Also: economic factors, vectors, nimby-ism

Good planning, training, and <u>best management practices</u> can help.

Compost BMPs:
Compost Recipe

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



1 Part
High Nitrogen
(Green)

1-2 Parts
High Carbon
(Brown)

1-2 Parts
Neutral
(Balanced C:N)

½-1 Part
Bulking Agent
(Porous)

Compost BMPs: Temperature Treatment

- **Monitoring**
- **Turning**

Monitoring Pile Activity

Compost Monitoring Log

Pile Identification: FW28 Pile Location: Date Pile Built: 6/22/11

Feedstocks and Mix Proportions:

Date	Pile Temperature 1 (1'/3')	2 (1'/3')	3 (1'/3')	4 (1'/3')	5 (1'/3')	Air Temp	MC	Odor	Visual	Notes (mgmt, weather, vectors):
7/28	142/130	144/117				80	55	NH4		① rolled 1/3 7/27 (half of pile)
8/1	139/121	154/130				80	70	manure		Turned 1/3 8/3
8/4	154/138	137/141				75	65	manure NH4		
8/8	150/133	133/120				70	65	NH4		
8/11	146/120	152/130				75	60	NH4		
8/18	134/140	142/142				77	55			
8/22	140/124	125/124				75	60	earthy		turned 1/3
8/25	150/138	130/127				70	60			

8/29 117/123 128/123 70 65 musty

9/1 136/121 120/124

9/6 128/109 129/120

9/19 132/113 127/115.

70% NH4

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).

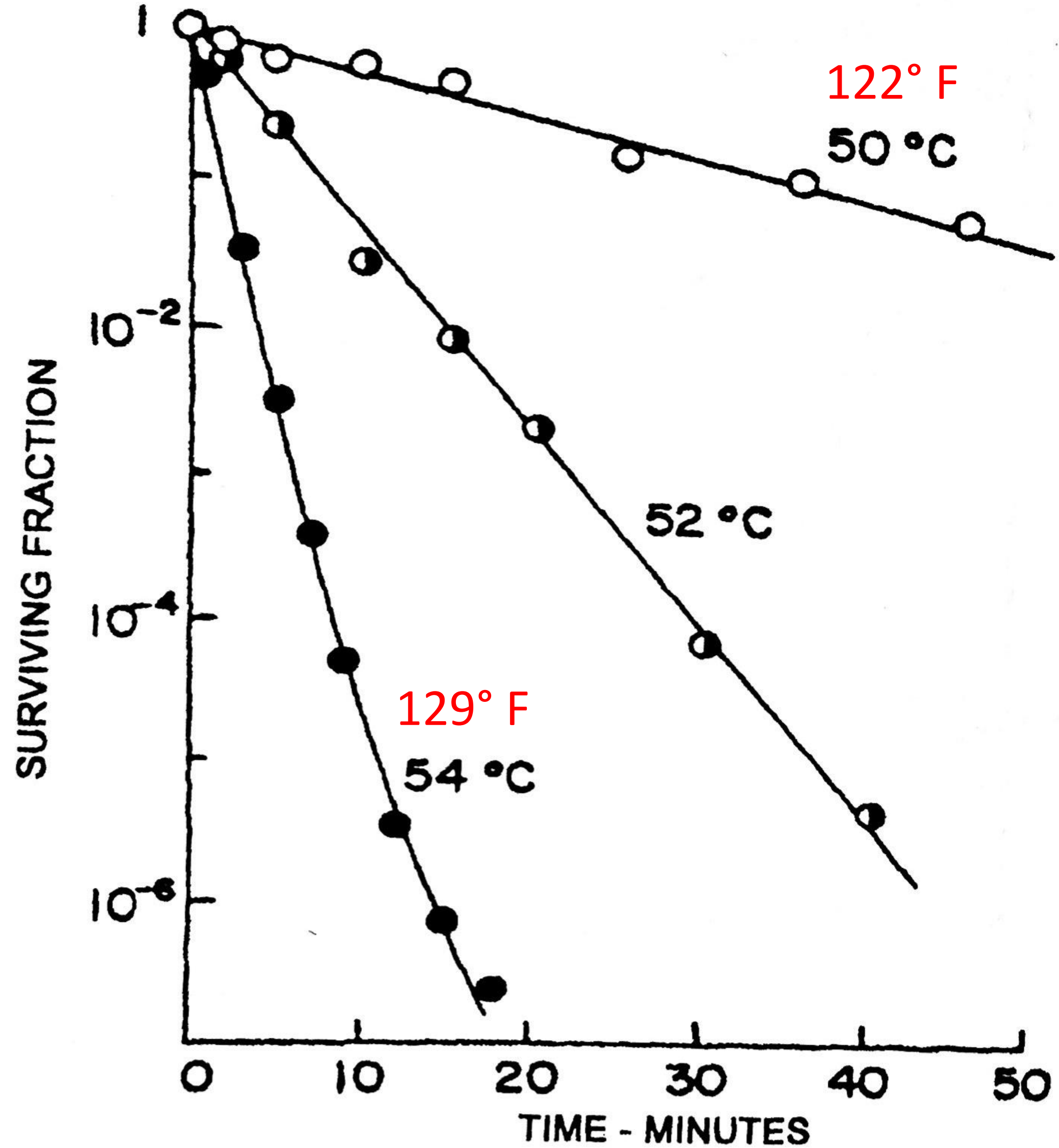


FIGURE 8.4. Heat inactivation of *Salmonella enteritidis* serotype Montivideo in composted biosolids. (Data from Ward and Brandon, 1977.)

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:
Compost Maturation

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

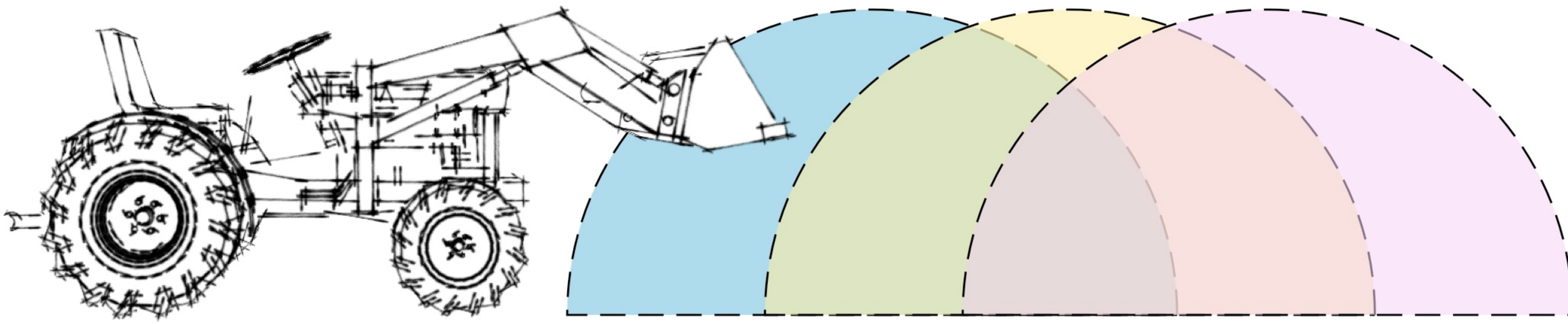
Compost BMPs: Vector Controls

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

Compost BMPs: Housekeeping

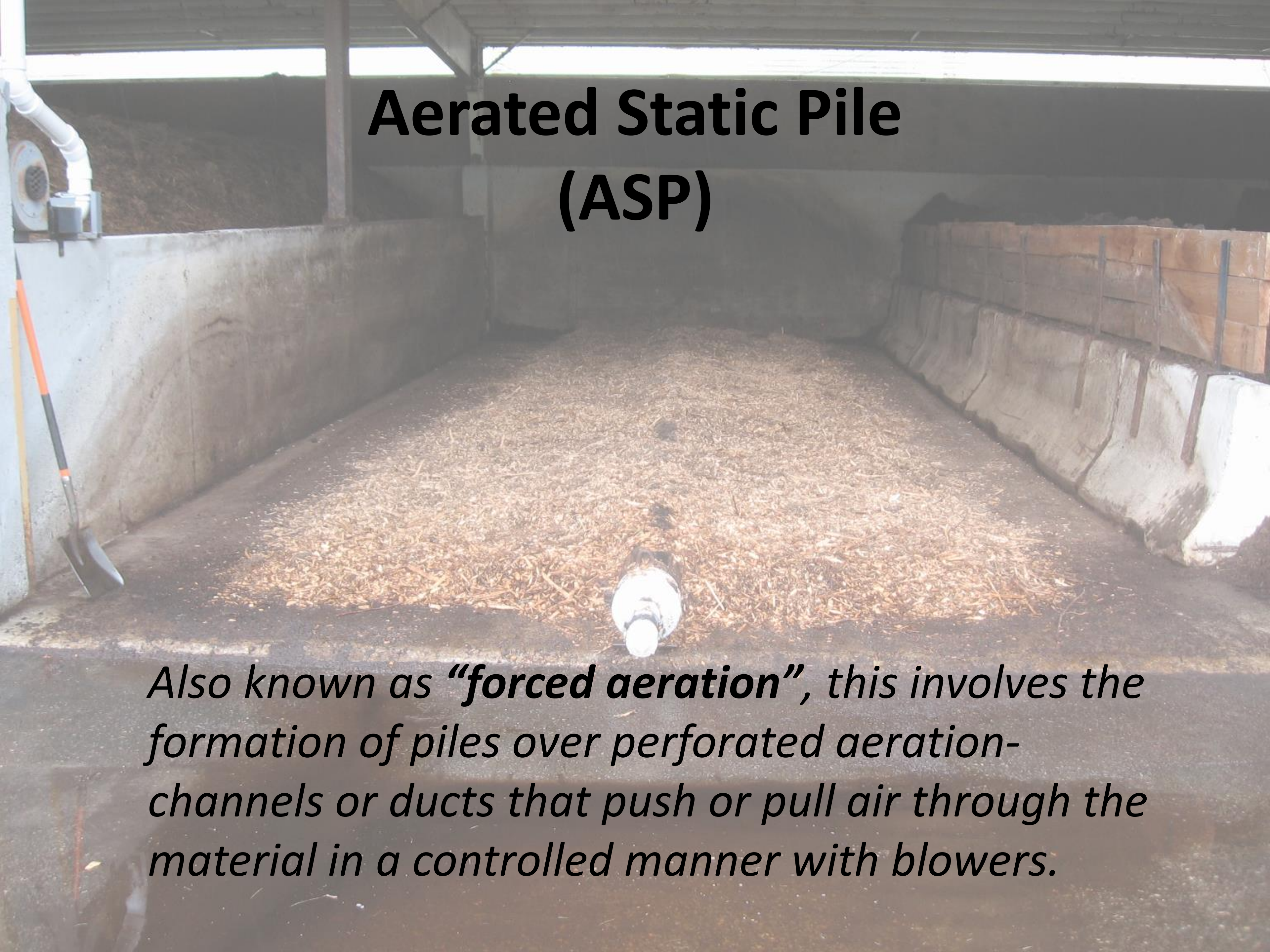
- Aesthetics matter! People smell w/ their eyes
- Remove trash
- Organized space
- <u>Size properly</u>

Methods of Aerobic Composting



Turned Windrows

Involves the formation of composting windrows and the periodic turning of the windrows with a **bucket loader, windrow turner, or excavator**



Aerated Static Pile (ASP)

*Also known as **"forced aeration"**, this involves the formation of piles over perforated aeration-channels or ducts that push or pull air through the material in a controlled manner with blowers.*

Aerated Static Pile (ASP)

Positive Aeration is when air is <u>pushed</u> through the composting material

Negative Aeration is when air is <u>pulled</u> through the composting material

Aerated Static Pile (ASP)

In-Vessel

Contained composting systems in which the composting materials are processed and aerated by a system of agitation or forced aeration and often a combination of the two

In-Vessel

Basic Styles of Aerobic Composting Bin Systems

Forming piles in large bins and turning them periodically, usually from one bin to the other.

Basic Styles of Aerobic Composting
Vermicomposting

Worm composting is facilitated by specific species of earthworms that rapidly process organic wastes and produce worms castings.

- *Pre-composted at thermophilic temperatures*
- *Cured*

Basic Styles of Aerobic Composting
Static Pile or “Passive” Composting

Used to describe composting in an unturned pile.

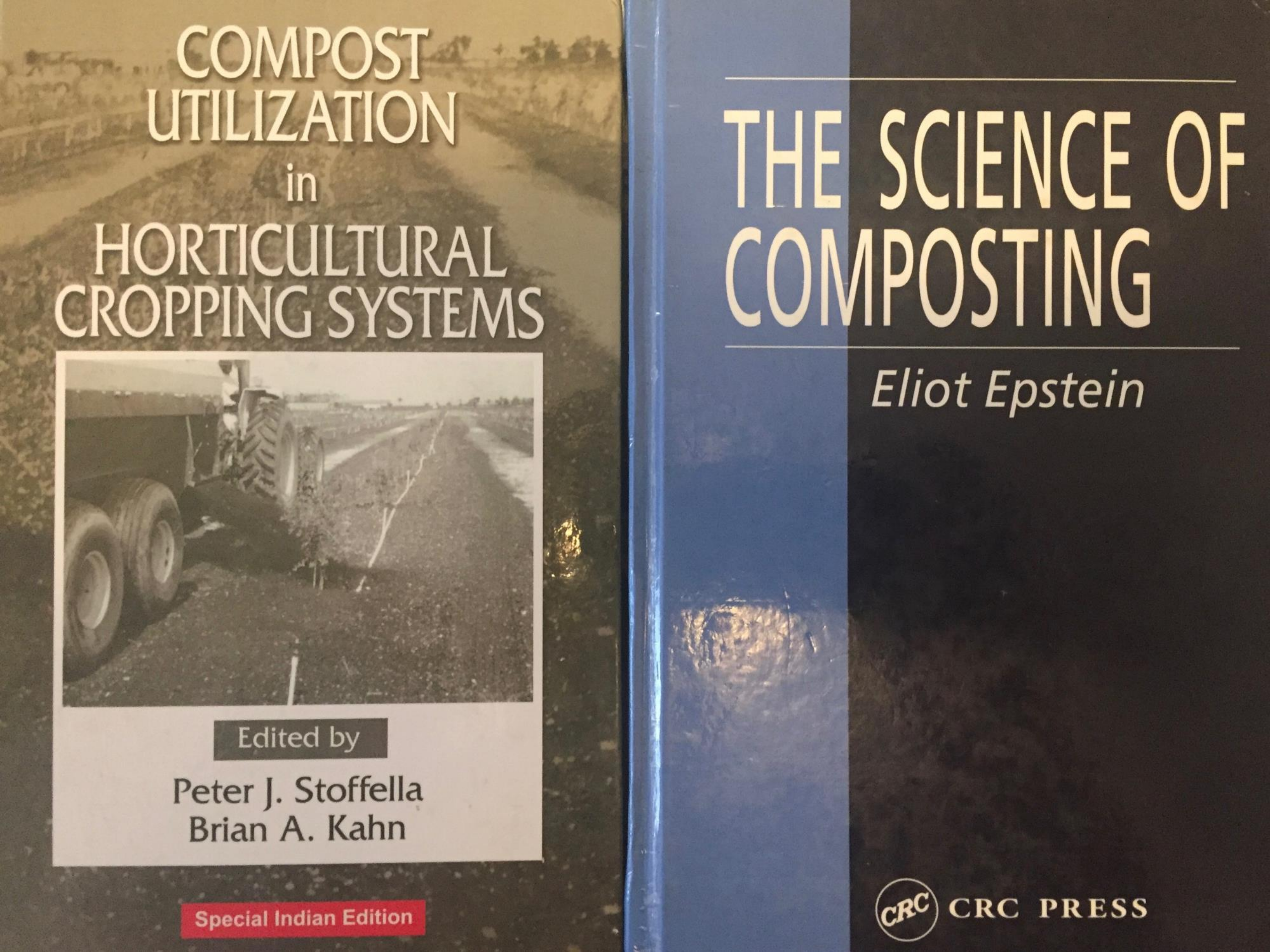
THIS IS NOT RECOMMENDED WHEN HANDLING FOOD SCRAPS FROM OFF SITE AS IT DOES NOT MEET THE INTENT OF THE PATHOGEN REDUCTION STANDARD

Animal Feeding

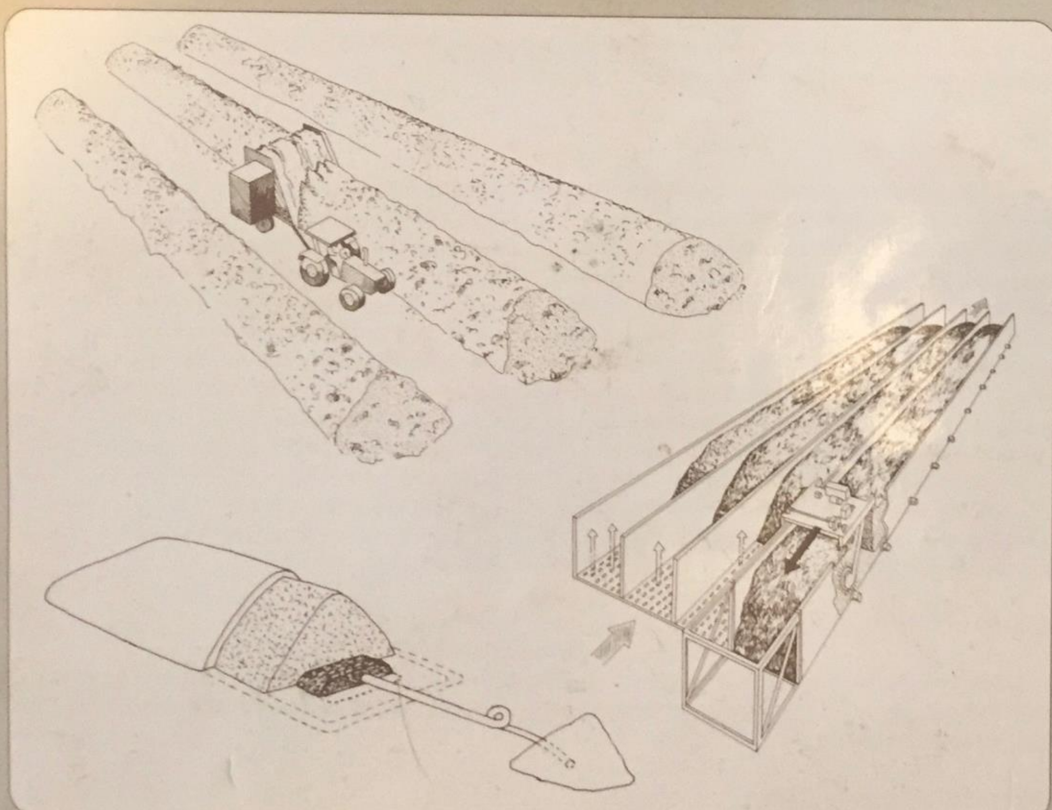
Not technically a "composting method", but is an important form of food scrap recycling. Effective composting of residuals or "refused feed" is an important Best Management Practice.

Animal Feeding

Feeding food residuals to swine is limited to non-meat and cooked products in Massachusetts.


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

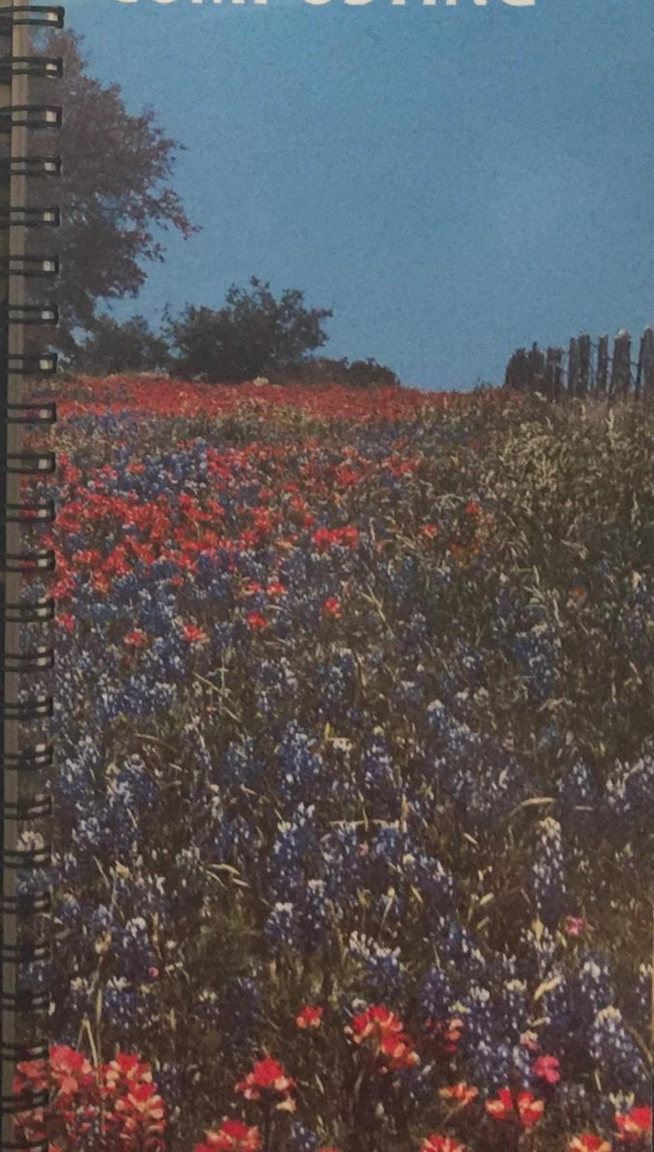
On-Farm Composting Handbook

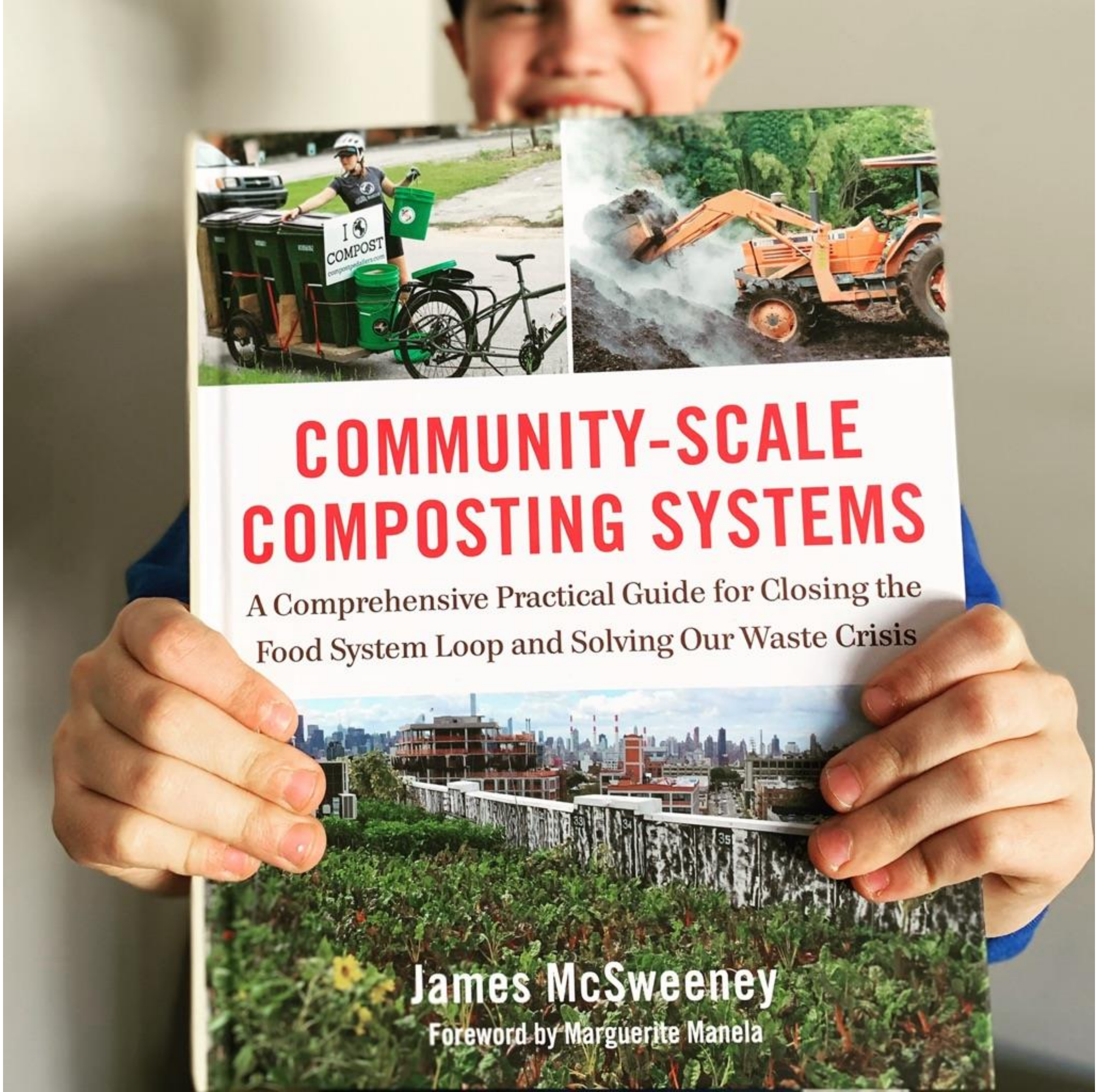


Natural Resource, Agriculture, and Engineering Service (NRAES)

Cooperative Extension

FIELD GUIDE TO ON-FARM COMPOSTING




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

US Composting Council®

BioCycle

Free Online Resources

- Leaf & Yard Waste Composting Guidance Document. MA DEP. http://www.mass.gov/eea/docs/dep/recycle/reduce/06-thru-l/leafguid.pdf
- Guide to Agricultural Composting. MDAR. *2010http://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 http://www.anr.state.vt.us/dec/wastediv/compost/resources.htm
- Online Materials Management & Tracking Tool
  http://goo.gl/7dqsZh

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

Our soils need compost

Our communities need composting

We have the tools to compost right


Questions?