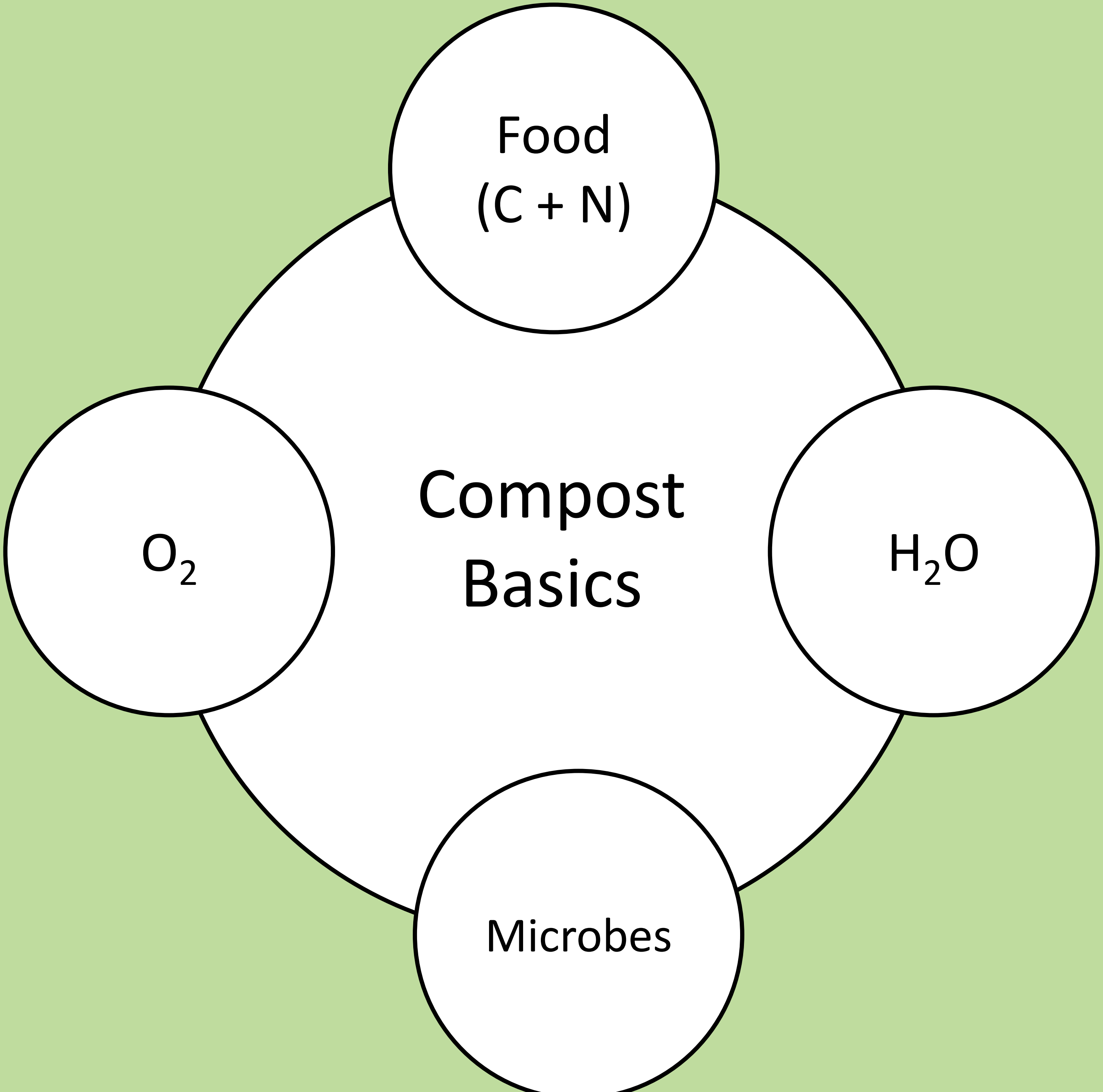
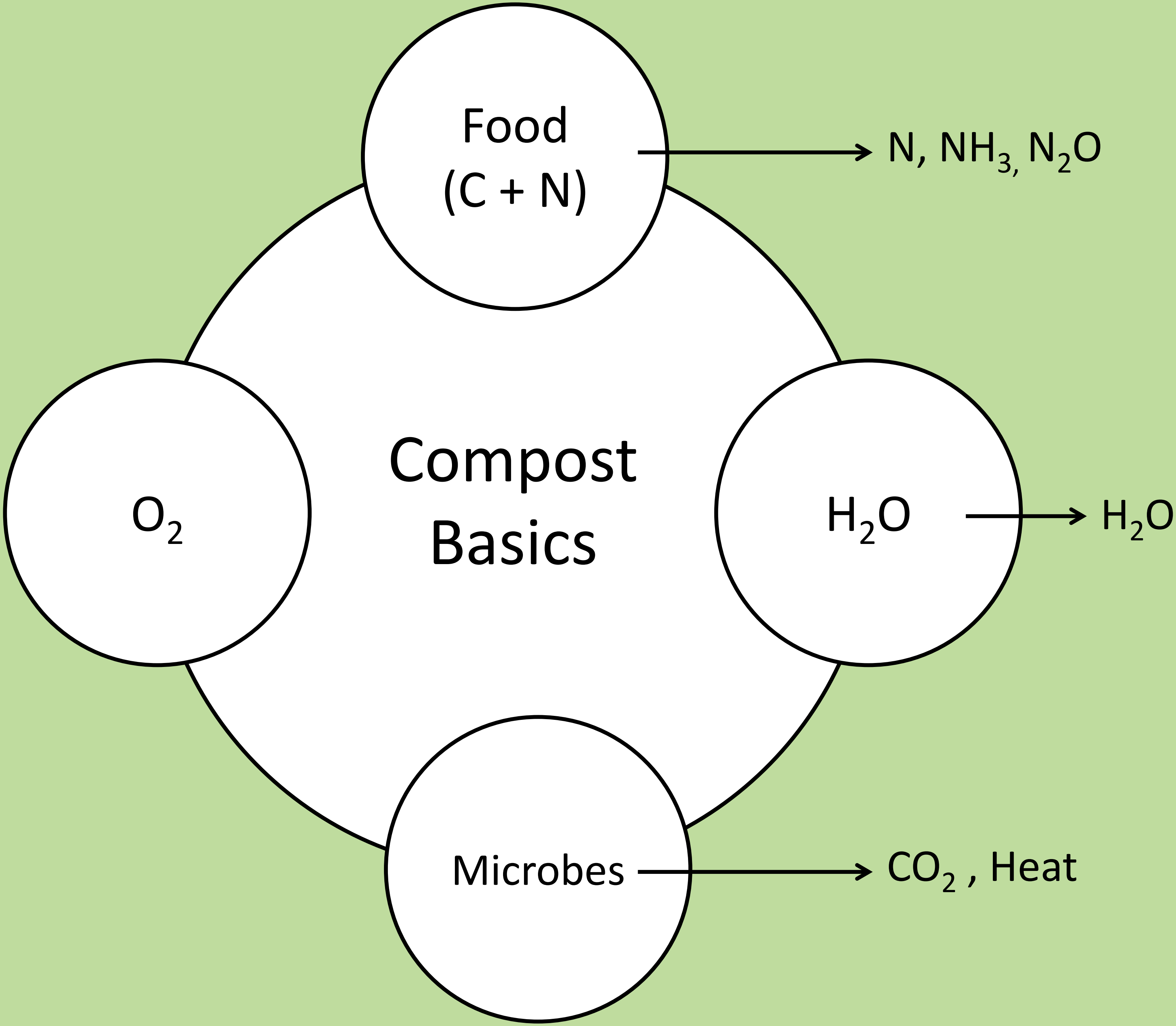
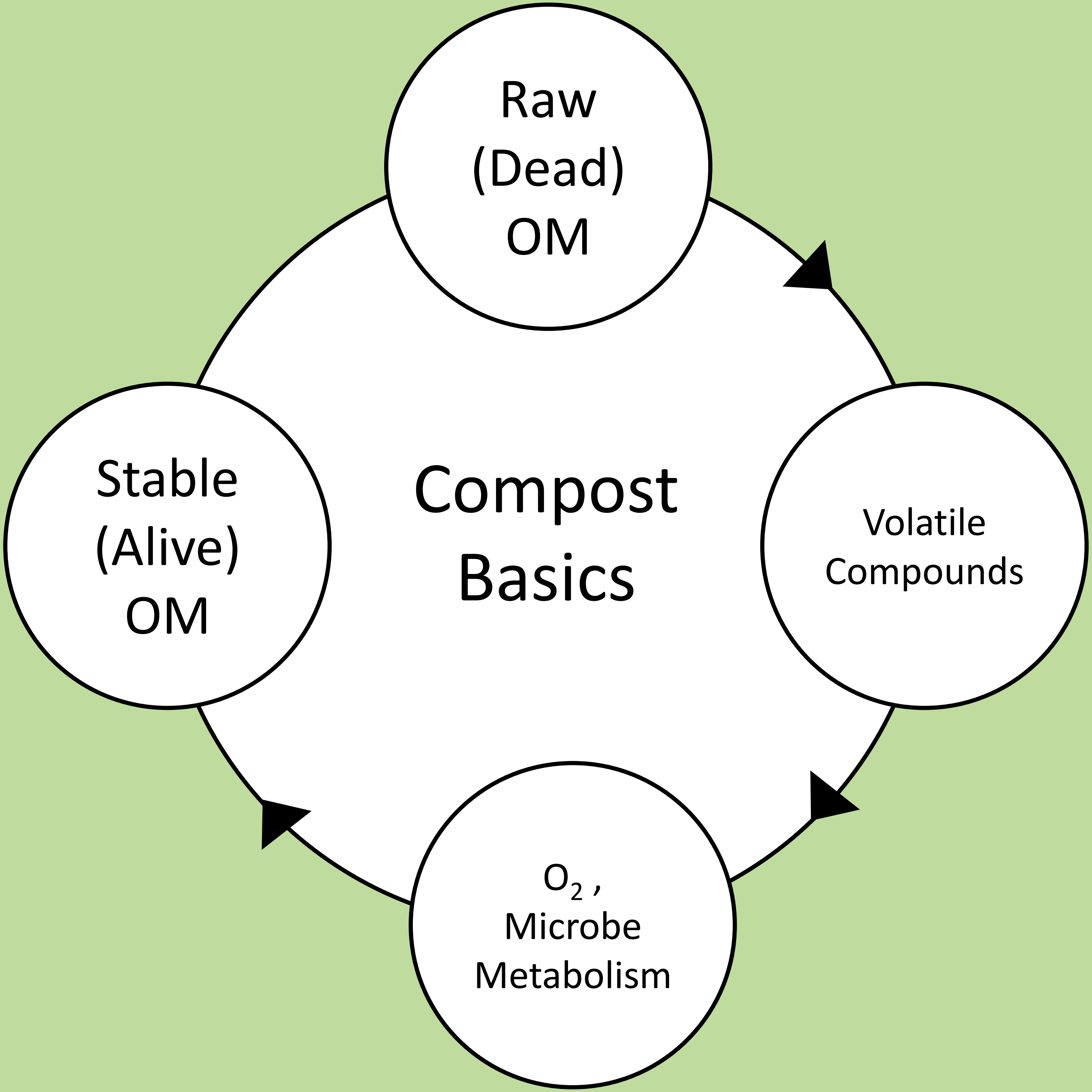
Compost Site Management: The Basics

James McSweeney

Compost
Technical
Services


Food
(C + N)
Compost
Basics
O_2
H_2O
Microbes

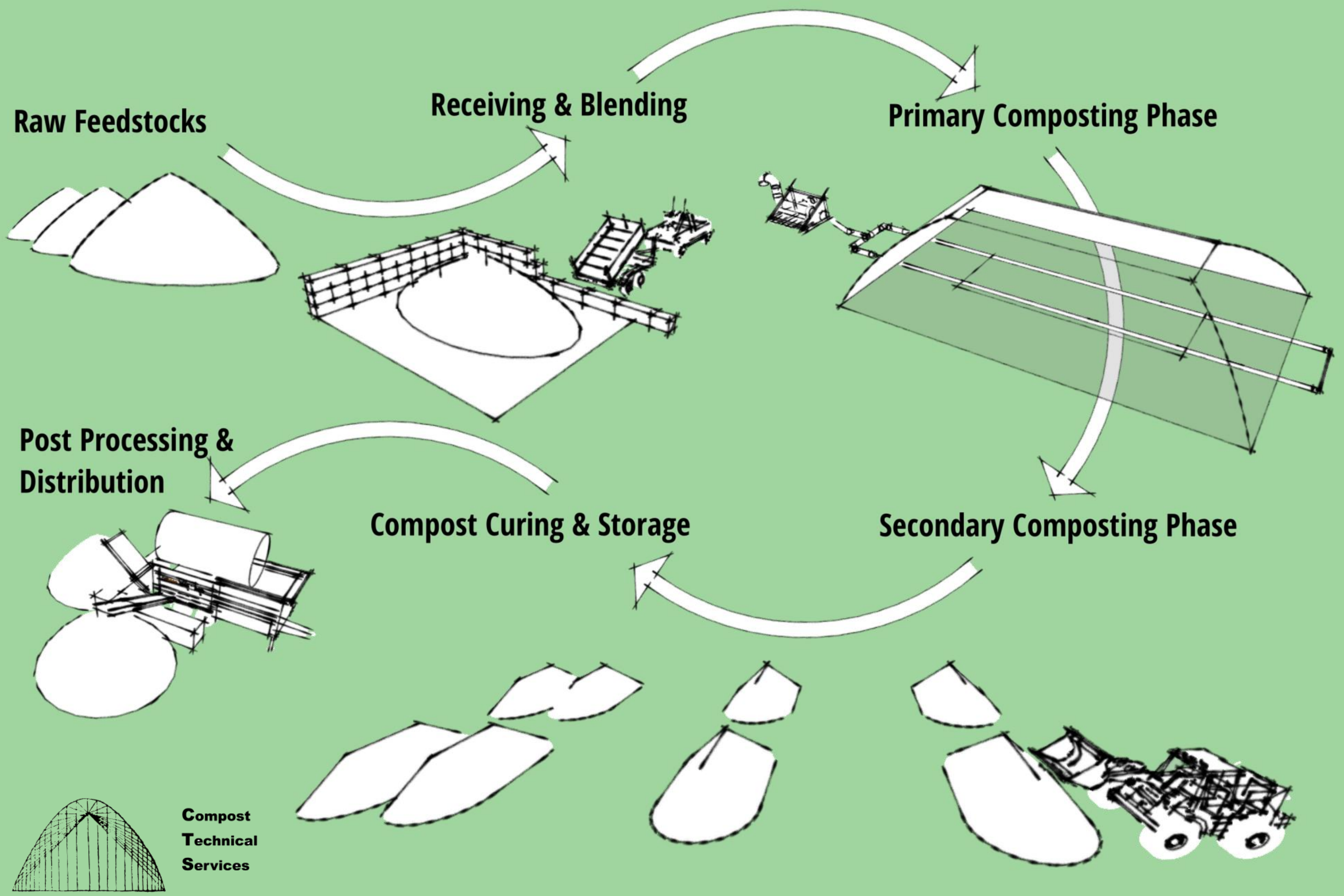

Compost Basics
Food (C + N)
N, NH3, N2O
O2
H2O
H2O
Microbes
CO2 , Heat


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

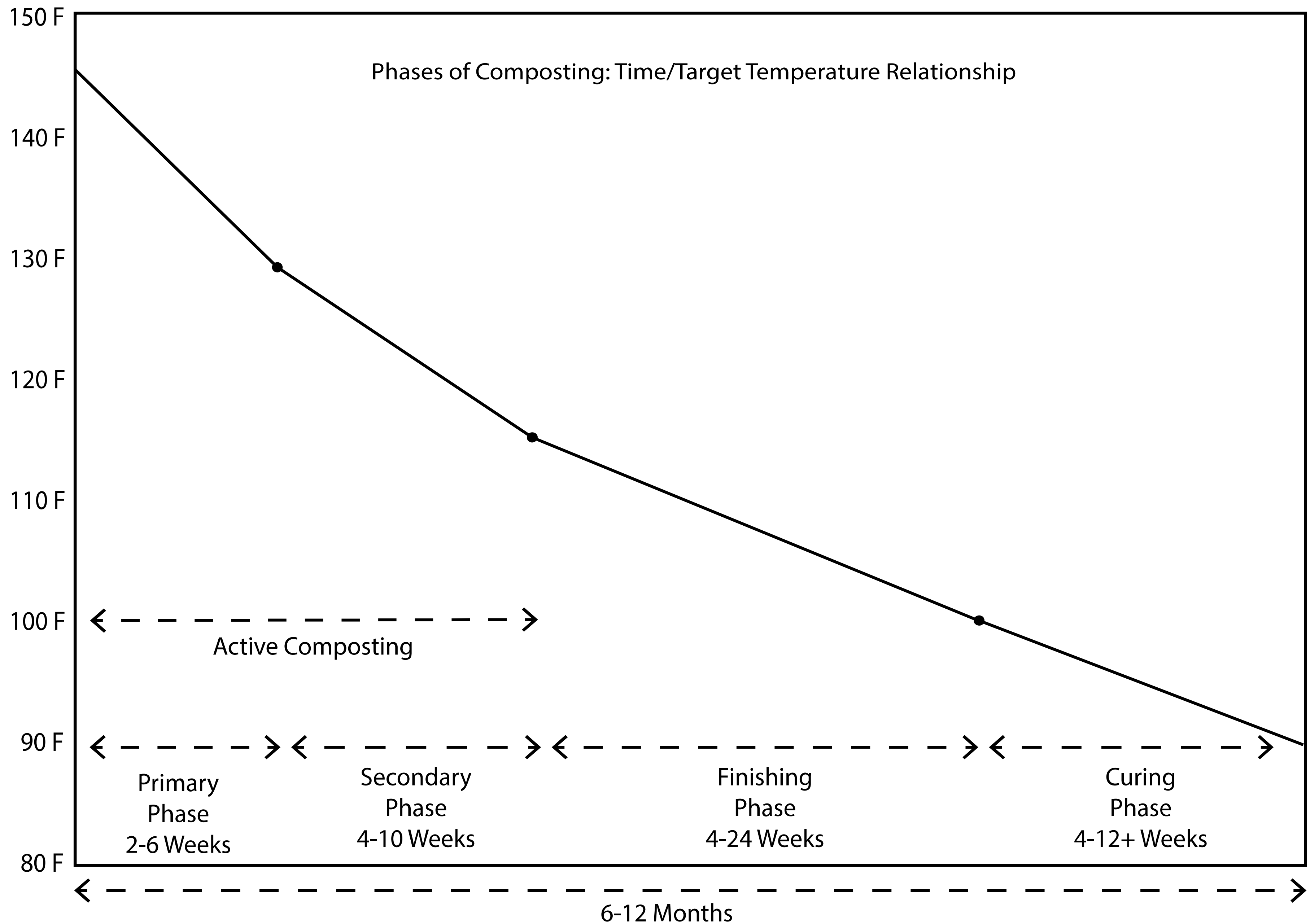
Managed Compost

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*



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



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

Why Sites Close

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

Good planning, training, and best management practices can help.

Why use a recipe?

- Create conditions favorable to aerobic and thermophilic organisms
  - Pathogen and weed seed inactivation
- Retention of carbon and nitrogen/nutrients
- Odor mitigation
- Your eyes can’t perform chemical analysis
- To be in compliance with State & other regulations
- <u>To have a reference point</u>

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	133/141				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).

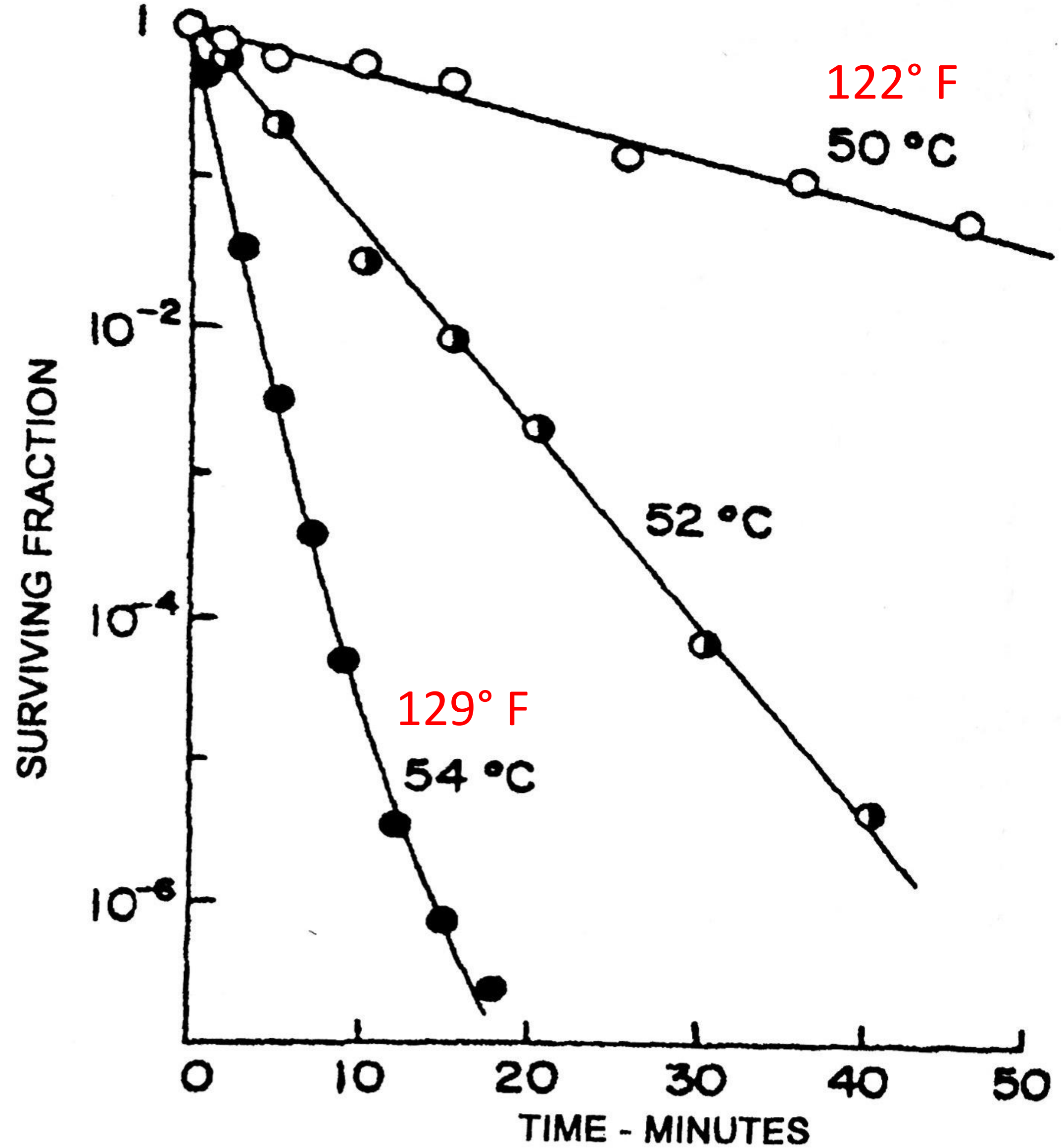


FIGURE 8.4. Heat inactivation of *Salmonella enteritidis* serotype Montivideo in composted biosolids. (Data from Ward and Brandon, 1977.)

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

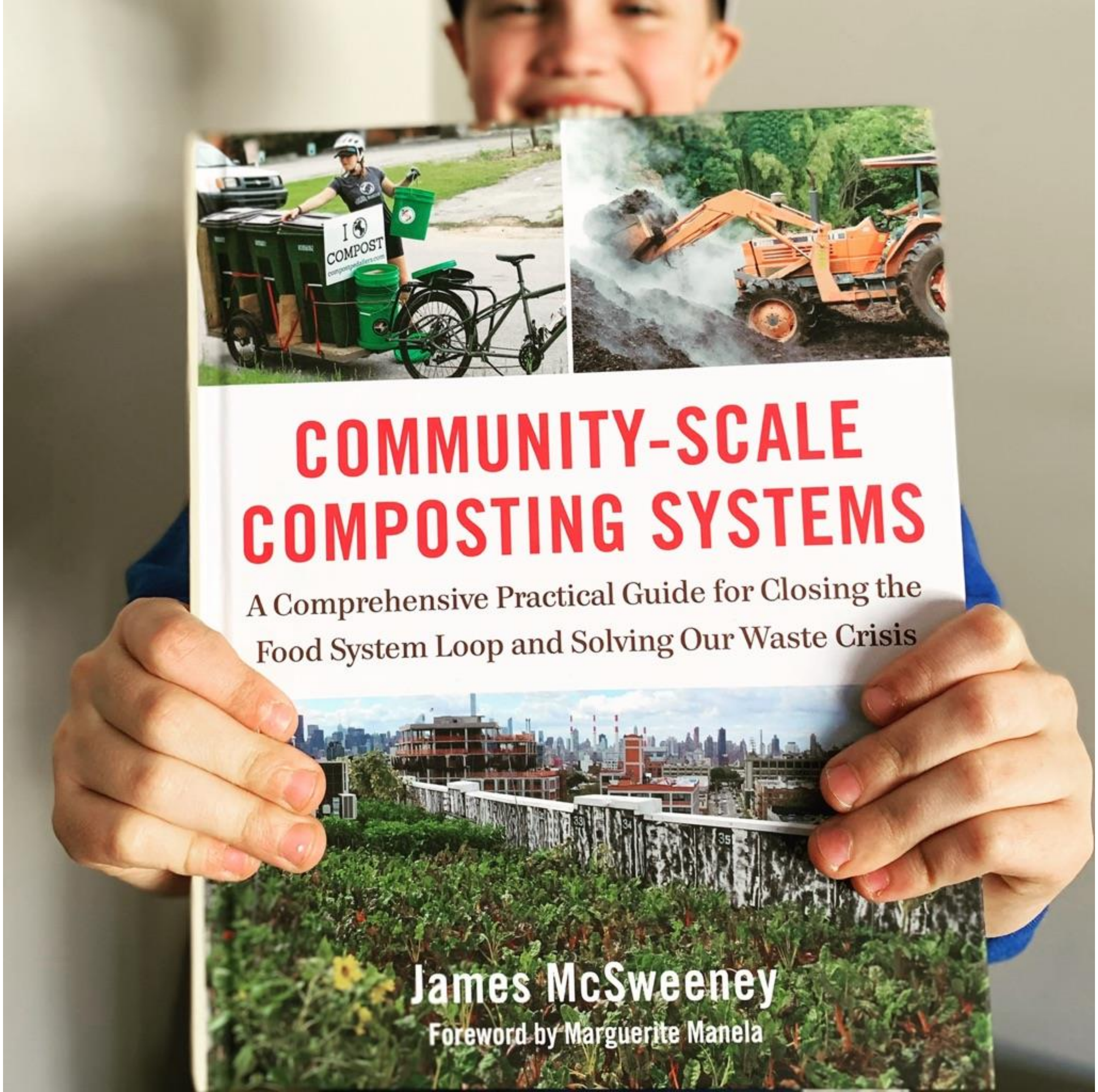
- **Earthy smell**
- **Friable**
- **Temps below 100 F**
- **O_2 demand, CO_2 & N_2O production minimal (test)**
- **Alive!**

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>


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


“Despite all our achievements we owe our existence to a six-inch layer of topsoil”
Anonymous
Making the argument for the soil.

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

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

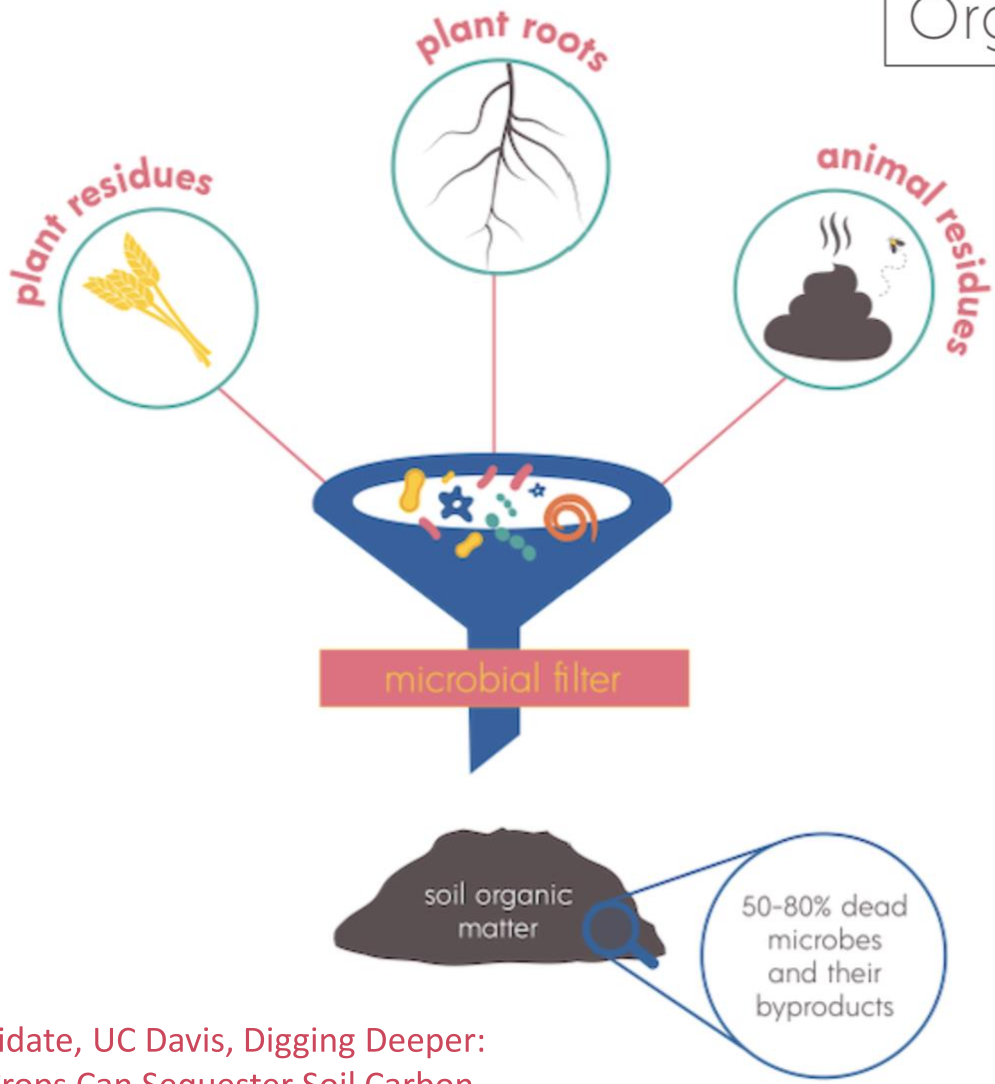
Campbell and Ingram, 2012.

One 5 gallon bucket of food scraps composted = 1 gallon of gasoline C emissions mitigated

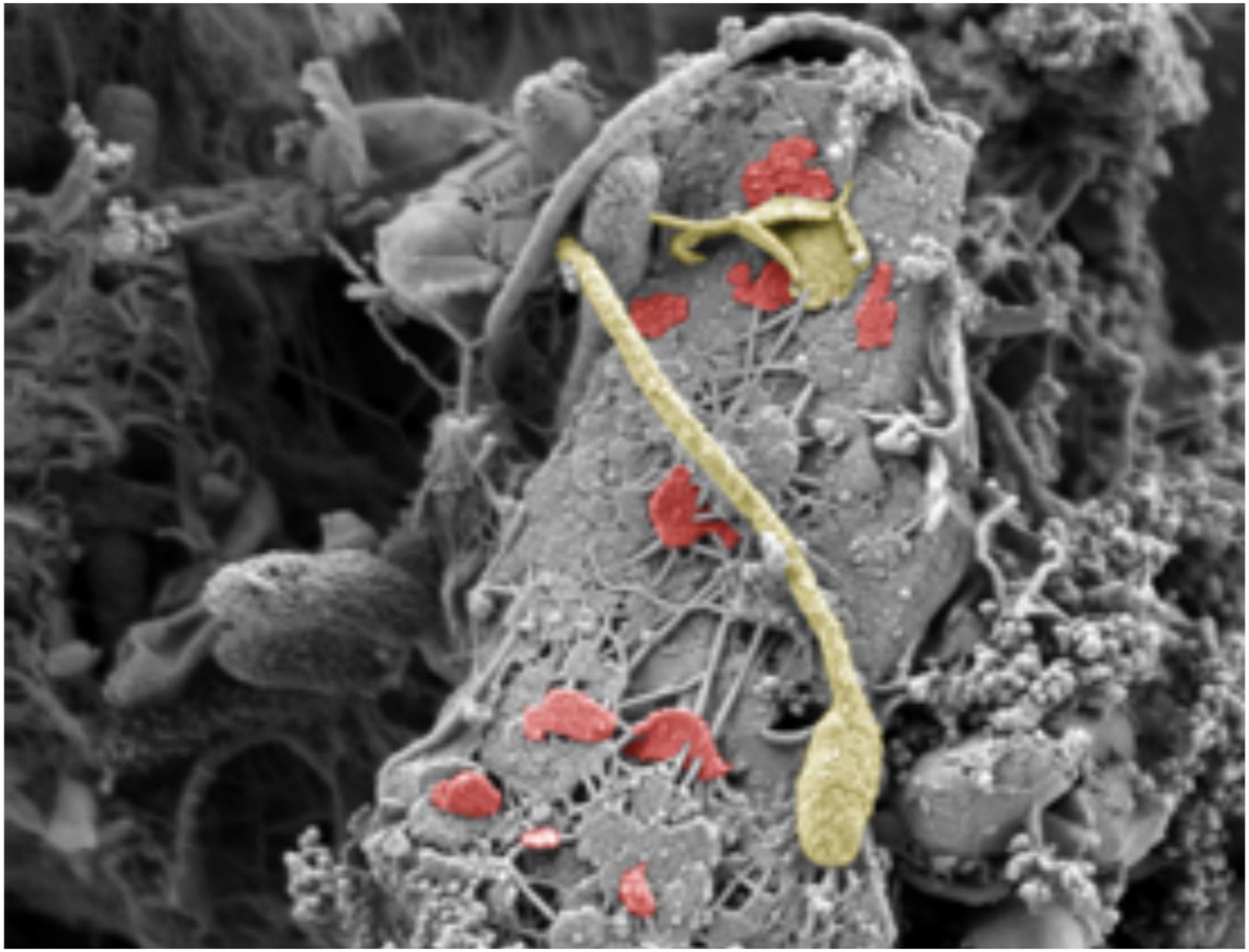
(Assumes Community wide and regional collection programs – Source: Highfields Center to Composting)

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

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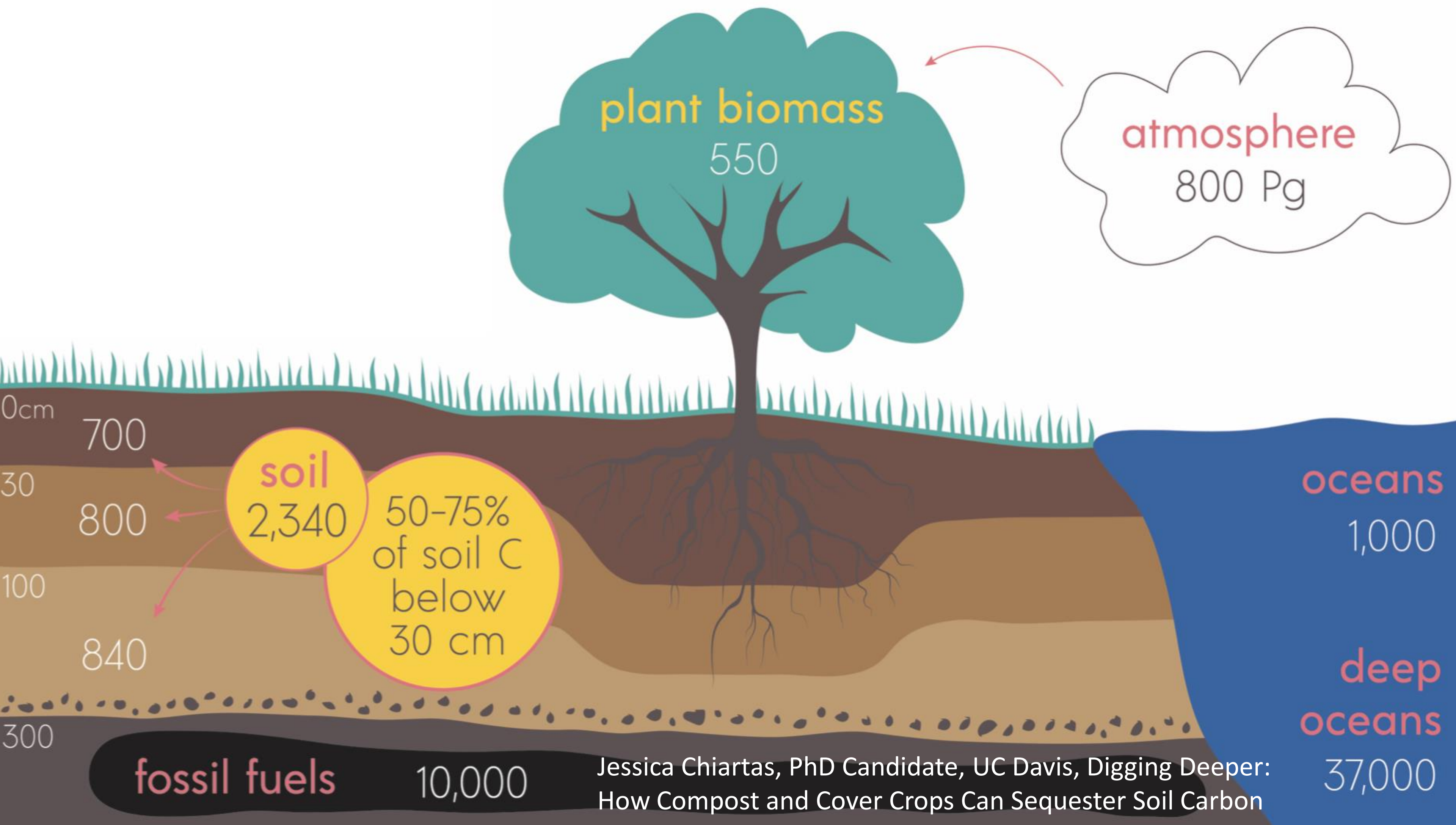
Zomer et al., 2017; Hansen et al. 2016

Soil Carbon Stocks



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Carbon Sequestration to the Rescue?

California's Healthy Soils Program

Incentivizes farmers to build SOM

France's 4 per 1000 Initiative

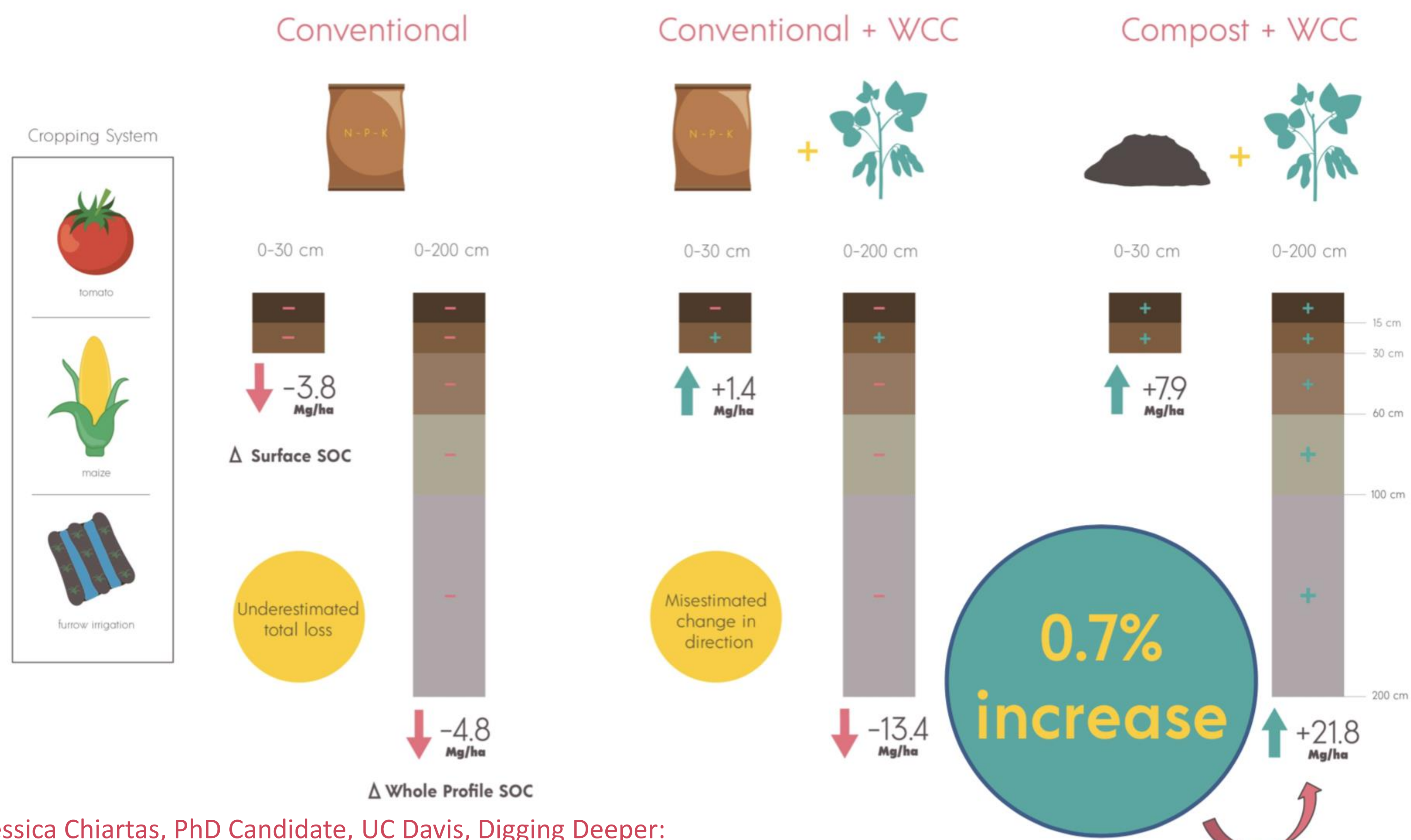
Aims to sequester 3.5 Pg C yr^{-1}

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

*According to scientific literature

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

Surface vs. Deep Soil Inventories of Carbon Sequestration



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Our soils need compost
Our communities need composting
We have the tools to compost right


Questions?