

Practical Skills Compost Workshop



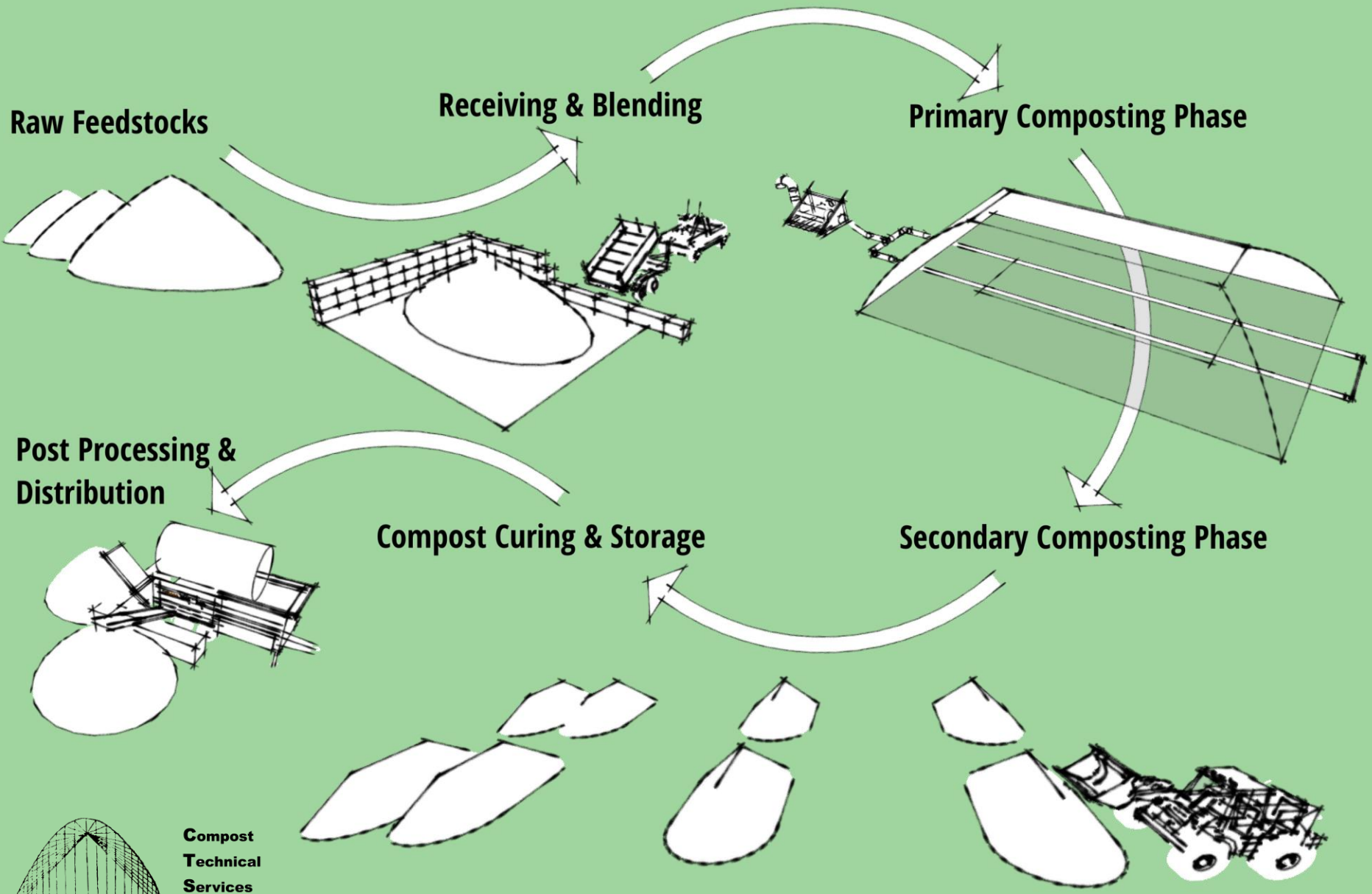
Workshop Goals:

1. Familiarize participants with the systems and management of a working food scrap composting operation in Massachusetts.
2. Provide hands on experience with compost recipe development, interpretation, blending, and pile formation.
3. Provide hands on experience with compost pile monitoring.
4. Answer questions and facilitate discussion.

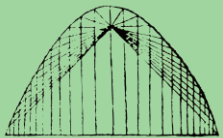
Managed Compost

The presence of oxygen *and oxygen loving organisms:*

- **Fast and complete decomposition**
- **Wider ranges of microbiological diversity**
- **Higher Temperatures** *needed to kill pathogens and weed seeds*
- **Minimal odors** *which are primarily caused by anaerobic organisms*



**Compost
Technical
Services**



Managed Compost

Aerobic 5-15% Oxygen

Semi-Aerobic 2.5-5% Oxygen

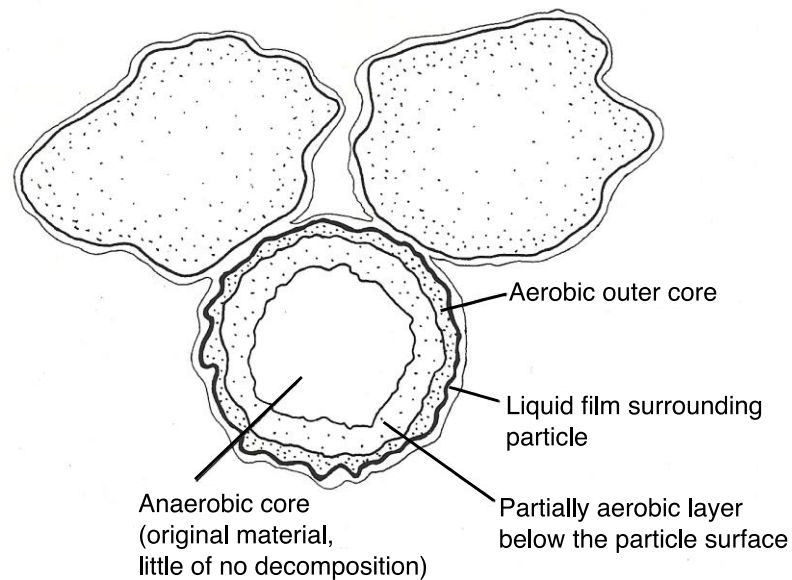


Figure 2.4
Decomposition of solid particles.

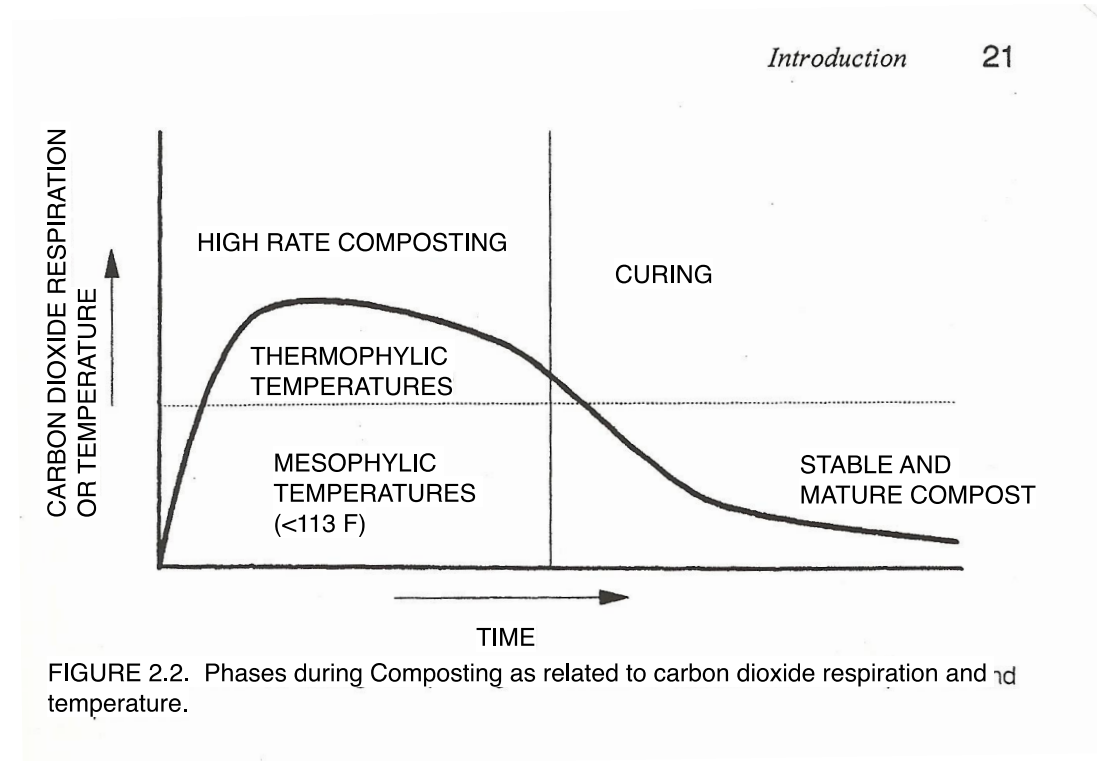
The Carbon to Nitrogen Ratio Throughout the Composting Process

- **Support microbial processes effectively**
 - *Carbon Provides Energy*
 - *Nitrogen Builds Proteins*
- **Ideal starting C : N ratio is 25 to 30:1 by weight**
- **Carbon Dioxide (CO₂) is released through respiration**
- **C : N ratio reduces (*12:1-15 : 1 ideally*)**

Managed Compost

Hot or Thermophylic

(All particles reach at least 131 F for at least 3 days)



Compost Recipe Development

Do you predict that your recipe will make a good mix when real feedstocks are combined?

Compost Recipe Development

If you already create analytically based recipes at your operation, why do you find it valuable?

If the process is new to you, is this a practice your operation would see value in?

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
- To have a reference point

Characteristics of a Proper Thermophilic Compost Pile Blend

All Parameters are critical to an effective recipe

- C:N Ratio of 20-40:1 with most ideal being 25-30:1
- Moisture Content of 50-65% with the most ideal being 55-60%
- Bulk Density Below 1200 lbs/yd³ with ideal being 700-1000 lbs/yd³
- pH between 6-8
- >40% Volatile Solids (or Organic Matter)
- Pore Space (30-33%) and Material Structure
- Stackability

What the formula won't tell you

*Analytically based recipe development and **field evaluation** of compost mixes go hand in hand.*

Observe “as is” mix characteristics *such as*:

- Porosity vs Density**
- Structure and stackability**
- Readily available carbon**
- Variable Moisture Content**

Things to watch out for

- **Low Carbon availability materials**
 - **Woody**
 - **Old**
- **Larger particles are typically less absorbent**
- **Unrepresentative samples and book values**
- **Misleading dry matter readings**

High Nitrogen
(Green)

High Carbon
(Brown)

Neutral
(Balanced C:N)

Bulking Agent
(Porous)

LAB ID:	SAMPLE ID:	REPORT DATE:	SAMPLE TYPE:	FEEDSTOCKS	COMPOSTING METHOD	COUNTY
C10487	2018 Mixed Food Scraps-Martin's Farm	05/03/2018	Feedstock			

COMPOST ANALYSIS REPORT

Compost Test 1A

Analyte	Results (As is basis)		Results (Dry weight basis)
	(Weight basis)	(Volume Basis*)	
pH	4.9	—	—
Soluble Salts (1:20 w:w)	3.13 mmhos/cm	—	—
Bulk Density*	—	917 lb/yd ³	—
Solids	39.7 %	364 lb/yd ³	—
Moisture	60.3 %	553 lb/yd ³	—
Organic Matter	27.5 %	252 lb/yd ³	69.3 %
Total Nitrogen	1.18 %	11 lb/yd ³	3.0 %
Carbon	14.6 %	134 lb/yd ³	36.9 %
Carbon:Nitrogen Ratio	12.40	—	12.40

LAB ID:	SAMPLE ID:	REPORT DATE:	SAMPLE TYPE:	FEEDSTOCKS	COMPOSTING METHOD	COUNTY
C10484	2018 Cardboard-Martin's Farm	05/03/2018	Feedstock			

COMPOST ANALYSIS REPORT

Compost Test 1A

Analyte	Results (As is basis)		Results (Dry weight basis)
	(Weight basis)	(Volume Basis*)	
pH	6.7	—	—
Soluble Salts (1:20 w:w)	1.60 mmhos/cm	—	—
Bulk Density*	—	211 lb/yd ³	—
Solids	37.3 %	79 lb/yd ³	—
Moisture	62.7 %	132 lb/yd ³	—
Organic Matter	34.4 %	72 lb/yd ³	92.2 %
Total Nitrogen	0.50 %	1 lb/yd ³	1.3 %
Carbon	23.7 %	50 lb/yd ³	63.7 %
Carbon:Nitrogen Ratio	48.00	—	48.00

C11941	NDPW Grindings	10/07/2019				
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COMPOST ANALYSIS REPORT

Compost Test 1A

Analyte	Results (As is basis)		Results (Dry weight basis)
	(Weight basis)	(Volume Basis*)	
pH	7.0	—	—
Soluble Salts (1:5 w:w)	0.52 mmhos/cm	—	—
Bulk Density*	—	545 lb/yd ³	—
Solids	64.8 %	353 lb/yd ³	—
Moisture	35.2 %	192 lb/yd ³	—
Organic Matter	45.8 %	250 lb/yd ³	70.7 %
Total Nitrogen	0.61 %	3 lb/yd ³	0.9 %
Carbon	17.1 %	93 lb/yd ³	26.3 %
Carbon:Nitrogen Ratio	28.10	—	28.10

LAB ID:	SAMPLE ID:	REPORT DATE:	SAMPLE TYPE:	FEEDSTOCKS	COMPOSTING METHOD	COUNTY
C10488	2018 Horse Manure-Martin's Farm	05/03/2018	Feedstock			

COMPOST ANALYSIS REPORT

Compost Test 1A

Analyte	Results (As is basis)		Results (Dry weight basis)
	(Weight basis)	(Volume Basis*)	
pH	7.7	—	—
Soluble Salts (1:20 w:w)	0.87 mmhos/cm	—	—
Bulk Density*	—	680 lb/yd ³	—
Solids	41.6 %	283 lb/yd ³	—
Moisture	58.4 %	397 lb/yd ³	—
Organic Matter	27.1 %	184 lb/yd ³	65.2 %
Total Nitrogen	0.17 %	1 lb/yd ³	0.4 %
Carbon	15.6 %	106 lb/yd ³	37.6 %
Carbon:Nitrogen Ratio	89.90	—	89.90



Compost Recipe Calculator

Enter Data From Analysis

Calculated

Material	Cubic Yards Material	Moisture Content (%)	Total Carbon (% Dry Weight)	Total Nitrogen (% Dry Weight)	Bulk Density (Lbs/CY)	Carbon : Nitrogen Ratio	Material Weight (Lbs)	Notes
Food Scraps #1	1.0	60.3	36.9	3	917	12	917	MF Analysis 5/3/18 (Low Moisture)
Food Scraps #2	0.0	75.2	36.9	3	917	12	0	Same Analysis (Higher Moisture)
Straw	0.0	9.5	45.4	0.76	61	60	0	
Fresh Grass	0.0	71.9	44.9	4.56	121	10	0	
NDPW Old Grass	0.0	60.1	36.8	3.10	150	12	0	
NDPW Grindings	0.0	35.2	26.3	0.94	545	28	0	
NDPW Wood Chips	0.0	26.7	50.0	0.58	315	87	0	
NDPW Dry Leaves	0.0	10.4	47.1	1.71	43	28	0	
						#DIV/0!	0	
						#DIV/0!	0	
						#DIV/0!	0	
Recipe Parameter		Results				Ideal Range		Reasonable Range
Carbon:Nitrogen Ratio		12				25-30		20-40
Moisture Content (%)		60				55-60%		40-65%
Bulk Density (Lbs/ CY)		917				≤1000		≤1200



Compost Recipe Calculator

Enter Data From Analysis

Calculated

Material	Cubic Yards Material	Moisture Content (%)	Total Carbon (% Dry Weight)	Total Nitrogen (% Dry Weight)	Bulk Density (Lbs/CY)	Carbon : Nitrogen Ratio	Material Weight (Lbs)	Notes
Food Scraps #1	0.0	60.3	36.9	3	917	12	0	MF Analysis 5/3/18 (Low Moisture)
Food Scraps #2	1.0	75.2	36.9	3	917	12	917	Same Analysis (Higher Moisture)
Straw	0.0	9.5	45.4	0.76	61	60	0	
Fresh Grass	0.0	71.9	44.9	4.56	121	10	0	
NDPW Old Grass	0.0	60.1	36.8	3.10	150	12	0	
NDPW Grindings	1.0	35.2	26.3	0.94	545	28	545	
NDPW Wood Chips	1.0	26.7	50.0	0.58	315	87	315	
NDPW Dry Leaves	0.0	10.4	47.1	1.71	43	28	0	
						#DIV/0!	0	
						#DIV/0!	0	
						#DIV/0!	0	

Recipe Parameter	Results	Ideal Range	Reasonable Range
Carbon:Nitrogen Ratio	26	25-30	20-40
Moisture Content (%)	54	55-60%	40-65%
Bulk Density (Lbs/ CY)	592	≤1000	≤1200



Compost Recipe Calculator

Enter Data From Analysis

Calculated

Material	Cubic Yards Material	Moisture Content (%)	Total Carbon (% Dry Weight)	Total Nitrogen (% Dry Weight)	Bulk Density (Lbs/CY)	Carbon : Nitrogen Ratio	Material Weight (Lbs)	Notes
Food Scraps #1	0.0	60.3	36.9	3	917	12	0	MF Analysis 5/3/18 (Low Moisture)
Food Scraps #2	1.0	75.2	36.9	3	917	12	917	Same Analysis (Higher Moisture)
Straw	0.0	9.5	45.4	0.76	61	60	0	
Fresh Grass	0.0	71.9	44.9	4.56	121	10	0	
NDPW Old Grass	0.0	60.1	36.8	3.10	150	12	0	
NDPW Grindings	2.0	35.2	26.3	0.94	545	28	1,090	
NDPW Wood Chips	1.0	26.7	50.0	0.58	315	87	315	
NDPW Dry Leaves	0.0	10.4	47.1	1.71	43	28	0	
						#DIV/0!	0	
						#DIV/0!	0	
						#DIV/0!	0	

Recipe Parameter	Results	Ideal Range	Reasonable Range
Carbon:Nitrogen Ratio	26	25-30	20-40
Moisture Content (%)	50	55-60%	40-65%
Bulk Density (Lbs/ CY)	580	≤1000	≤1200

MANAGE FOOD SCRAPS FOR MOISTURE

- Often $\geq 80\%$ Moisture Content
- As cell walls break down moisture is released
- Typically require 3-5 Units of carbon/dry matter to balance the recipe

FOOD SCRAP HAVE VARIABLE BULK DENSITY

- ~1,000 Pounds/Yard³ as collected
- $\geq 1,200$ Pounds/Yard³ at site following tipping
- Wash water adds weight
- Paper products add bulk
- To test BD: fill $\frac{1}{2}$ a 5 g bucket & drop 10x > fill $\frac{1}{2}$ & drop 10x \geq fill full & drop 10x > Fill Full. BD = weight X 40

Compost Pile Monitoring

Temperature

Moisture Content

Visual Observations

Olfactory Observations (Smells)

Management Activity

**EACH COMPOST PILE SHOULD BE TRACKED
THROUGHOUT THE PROCESS**

Resource List

Books/Publications:

- BioCycle Magazine. *BioCycle.com*
- Paul, J & Geesing, D. Compost Facility Operator Manual. *Available through BioCycle.com*
- Rynk, R. The On-Farm Composting Handbook. *NRAES 54*. 1992.
- Dougherty, M. Field Guide To On-Farm Composting. *NRAES 114*. 1999.
- Alexander, R. The Practical Guide to Compost Marketing & Sales. *2010*.
- McSweeney, J. Community-Scale Composting Systems. *2019*.

Resource List

Free On-line Resources:

- Leaf & Yard Waste Composting Guidance Document. MA DEP.
<http://www.mass.gov/eea/docs/dep/recycle/reduce/06-thru-1/leafguid.pdf>
- Guide to Agricultural Composting. MDAR.
2010<http://www.mass.gov/eea/docs/agr/programs/compostguidetooagcomposting2011.pdf>
- Highfields Center for Composting Video Series – Recipe Development, Pile Monitoring & Turning, School Training –
<https://vimeo.com/highfieldscomposting>
- 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>

Resource List

Free On-line 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>
- Coming Soon: Center for Ecotechnology's Wasted Food Solutions and BioCycle's Guidance Document on Adding Food Waste to a Yard Trimmings Compost Site
<https://wastedfood.cetonline.org>