

Soil Amendments, Composting and FSMA: Principles and Practices

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Overview

- **FSMA Compliant Treatments for BSAAO: Self-Heating (Composting) & other Processes**
- *E. coli* survival in soil & transfer to crops
- **Materials processing, handling, characteristics & testing**



FSMA Compliant Treatments for BSAAO

- FDA: conducting a risk assessment and research on application-to-harvest wait times for raw manure, to minimize pathogen contamination risk.
- “FDA does not object to farmers complying with the USDA’s National Organic Program standards” 90/
120 day wait time interval between raw manure application and fresh produce harvest.
 - FDA “considers adherence to the NOP standards a prudent step toward minimizing the likelihood of contamination while its risk assessment and research is ongoing.”

E. coli survival in manure-amended soil

Dairy Manure (DM)

Liquids

Solids

Horse Manure (HM)

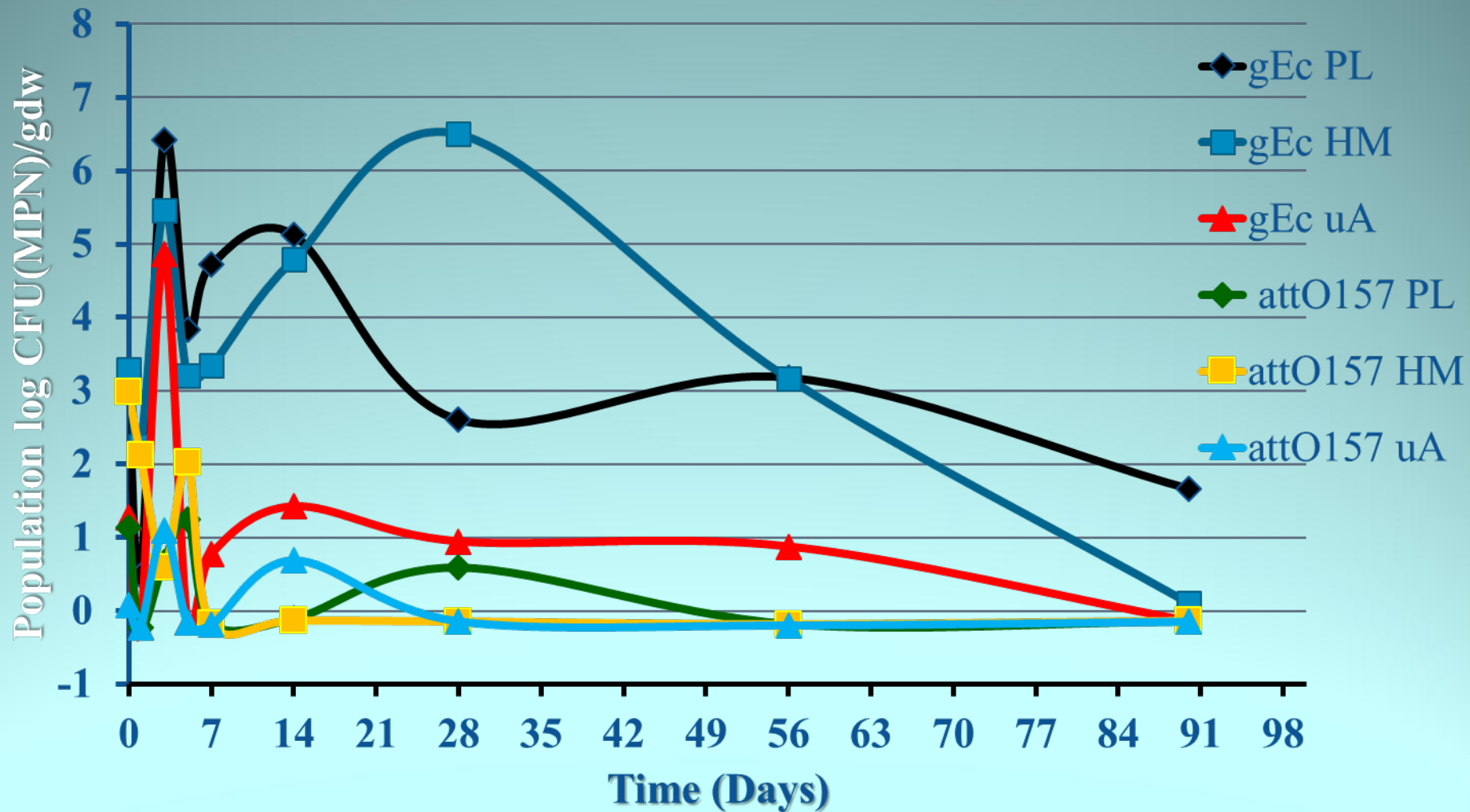
Poultry Litter (PL)

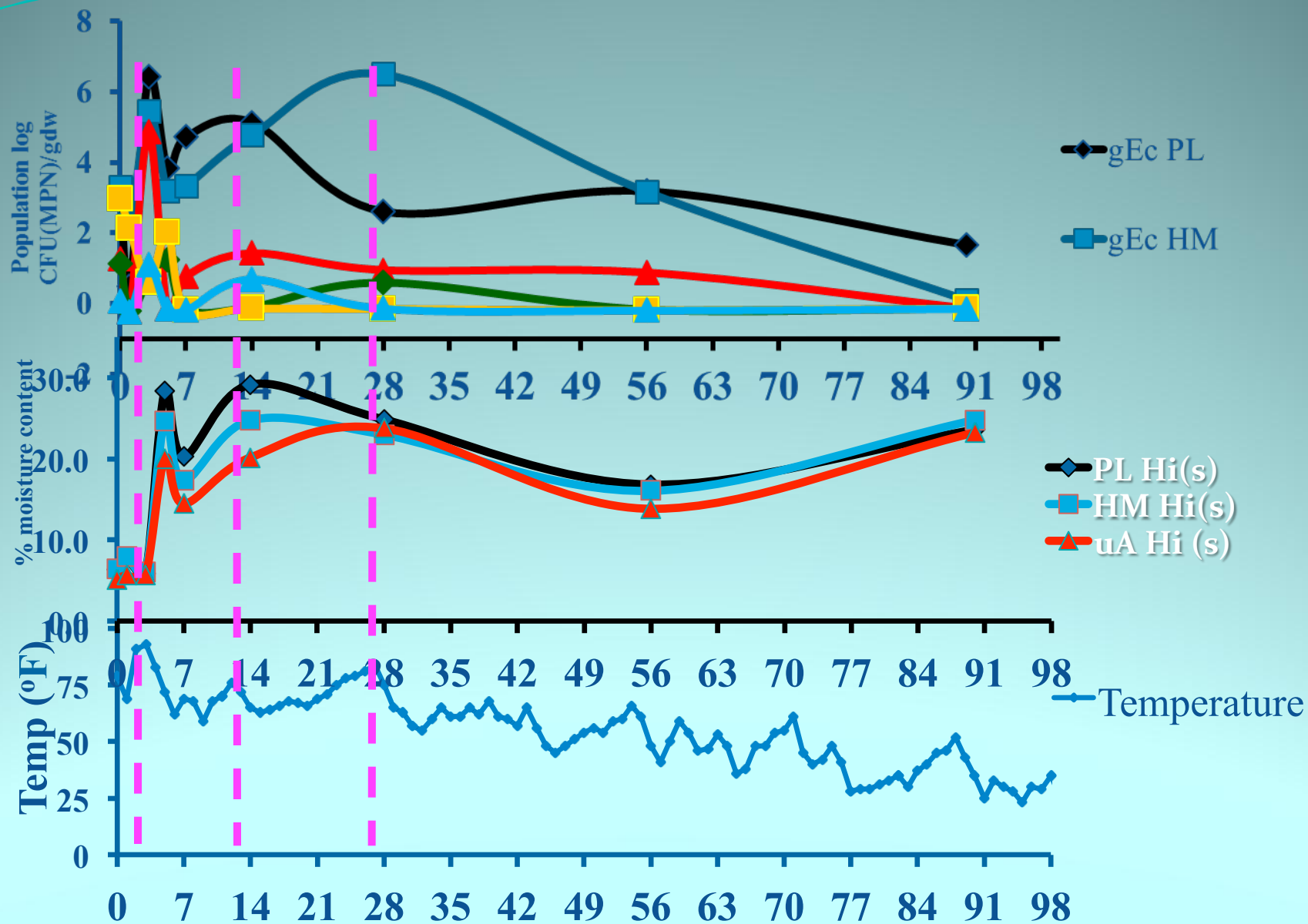
Unamended (UN)



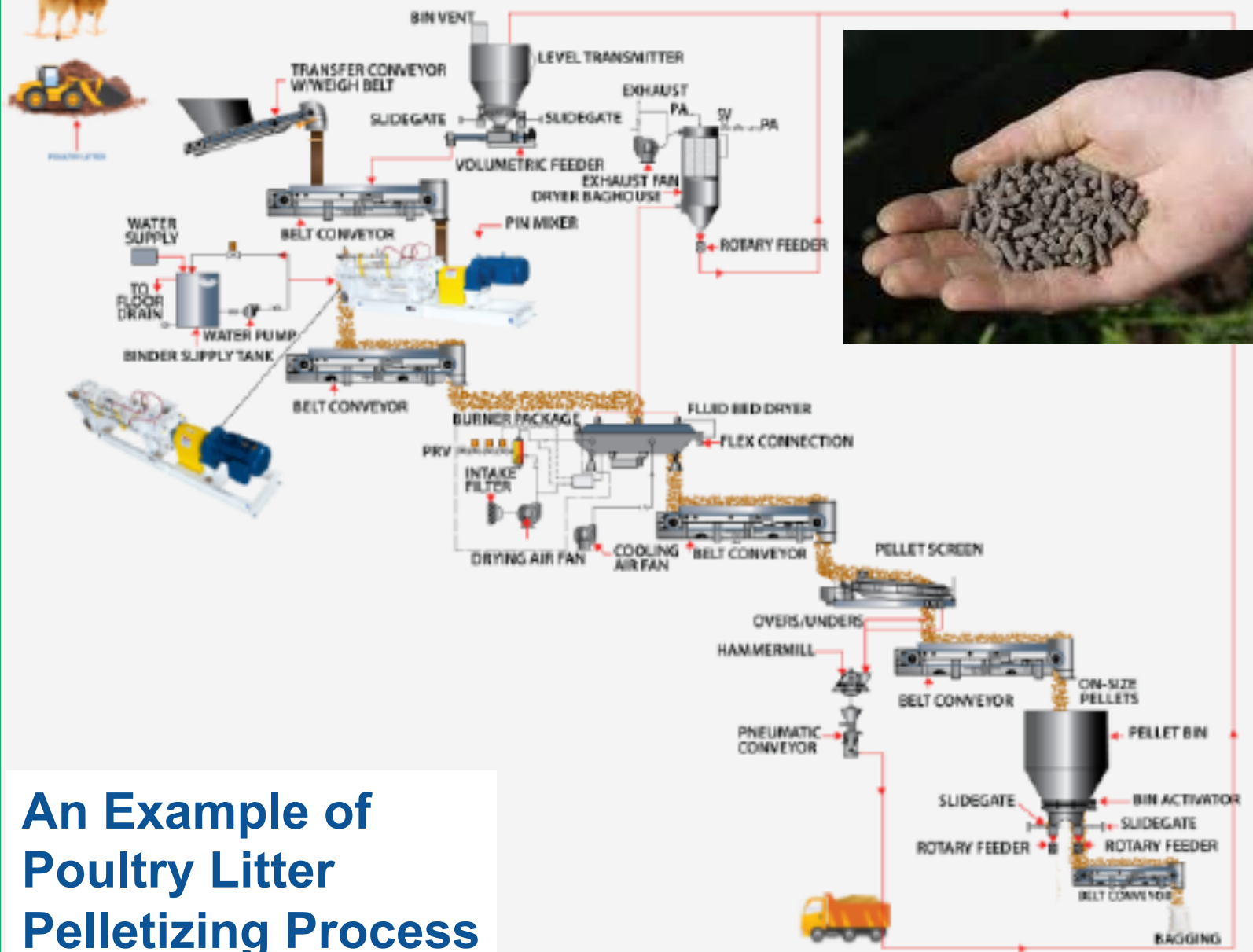
- 12 separate field trials in MD & PA
- Trials over 4 years leads to:
- 162 survival profiles for gEC over all sites
- 162 survival profiles for attO157 over all sites

High populations of gEc and attO157 from **SURFACE** samples of silty loam soil amended with PL, HM, or uA



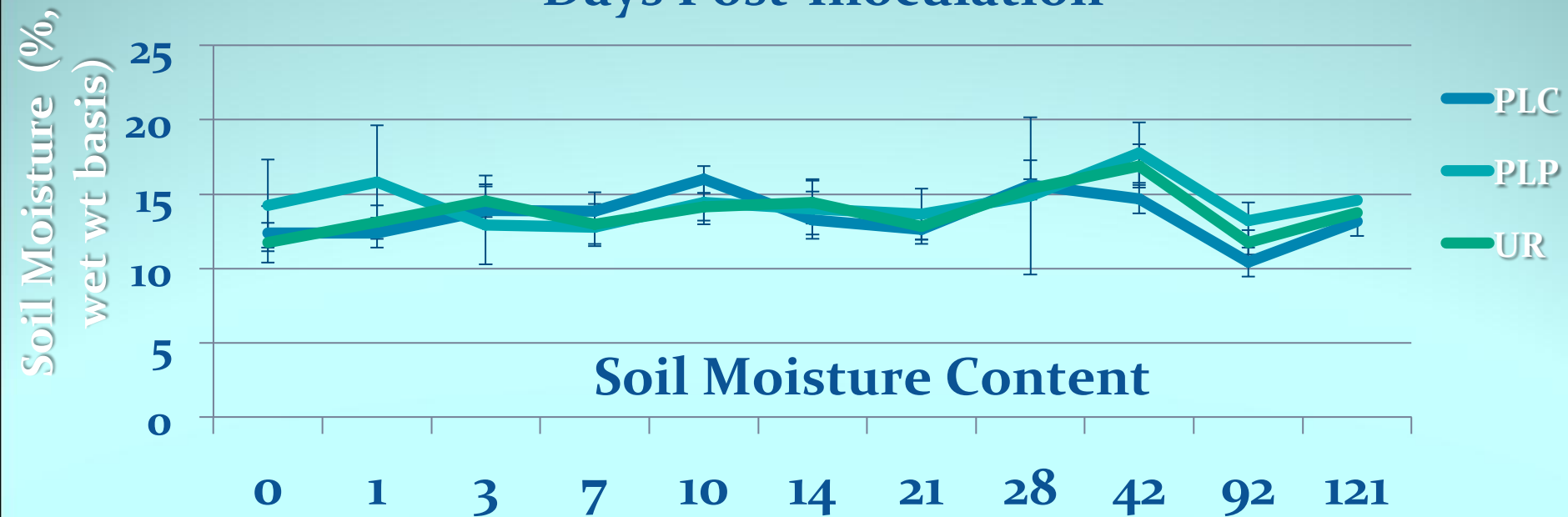
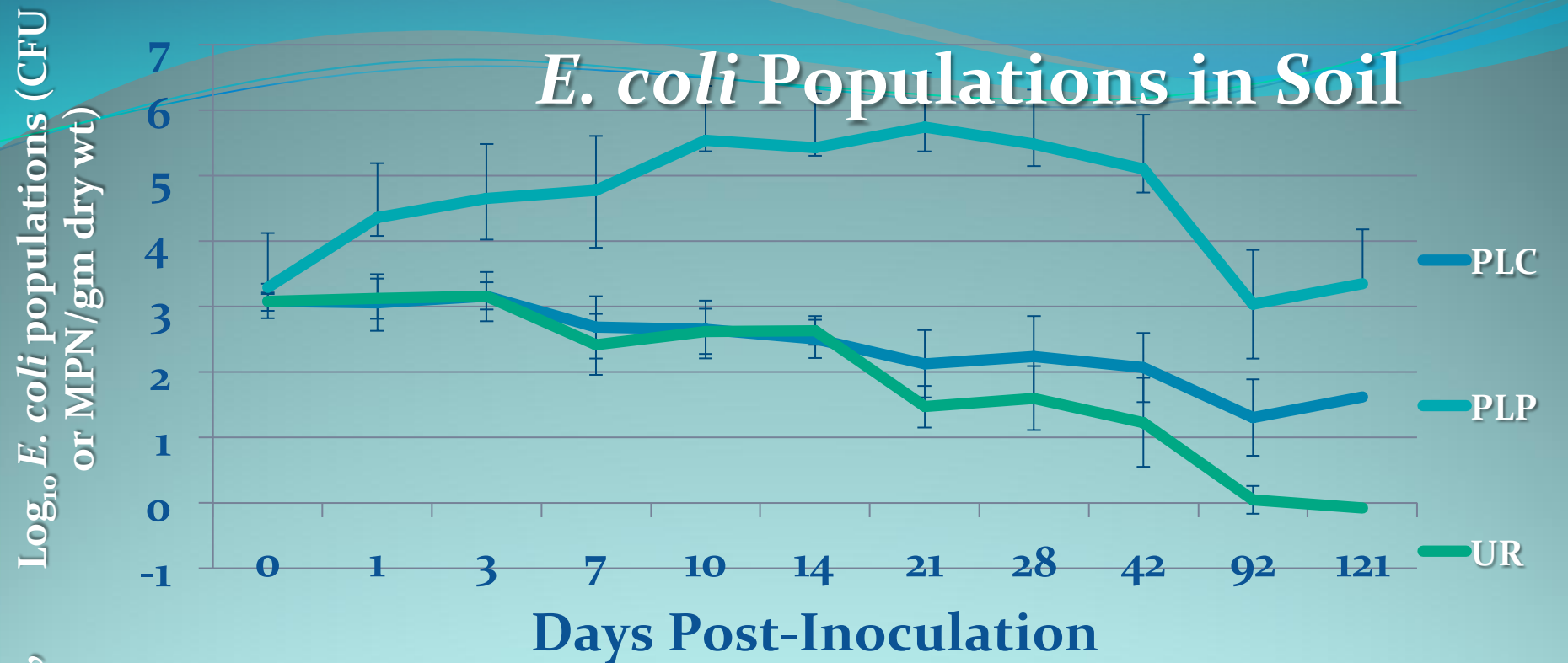


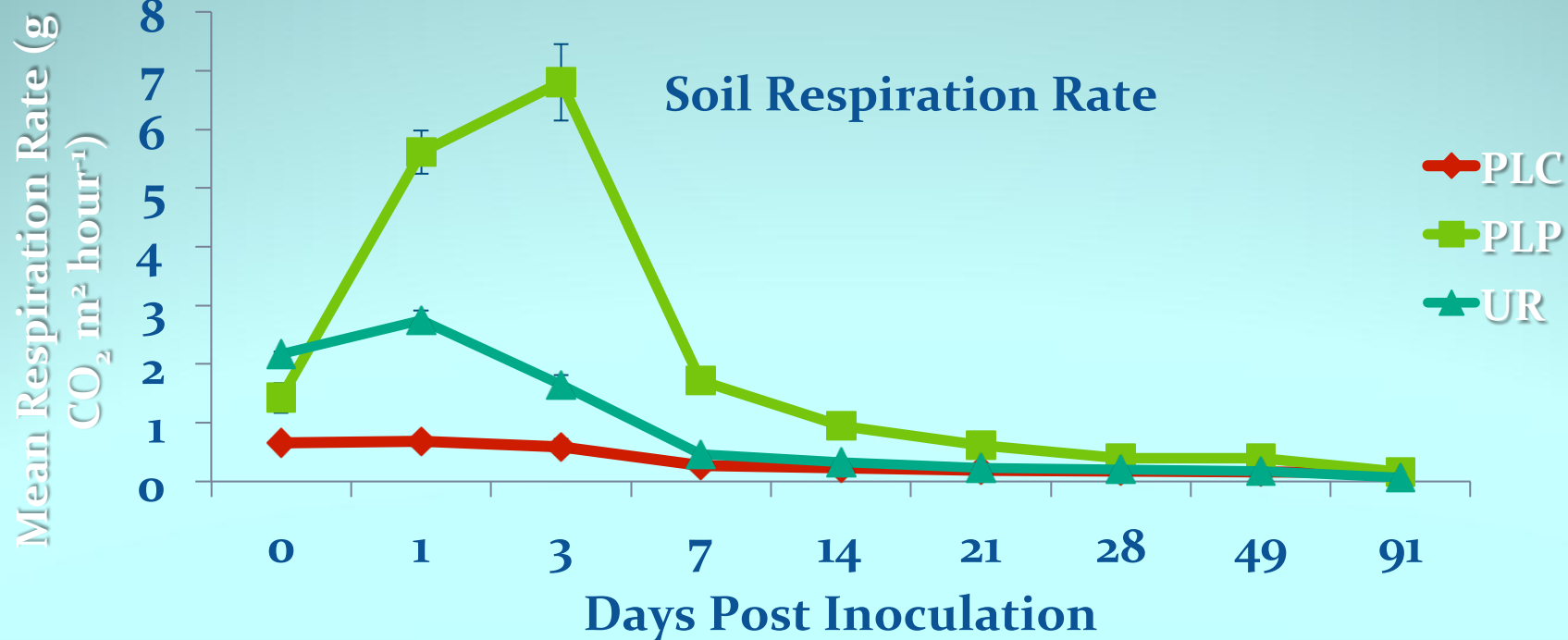
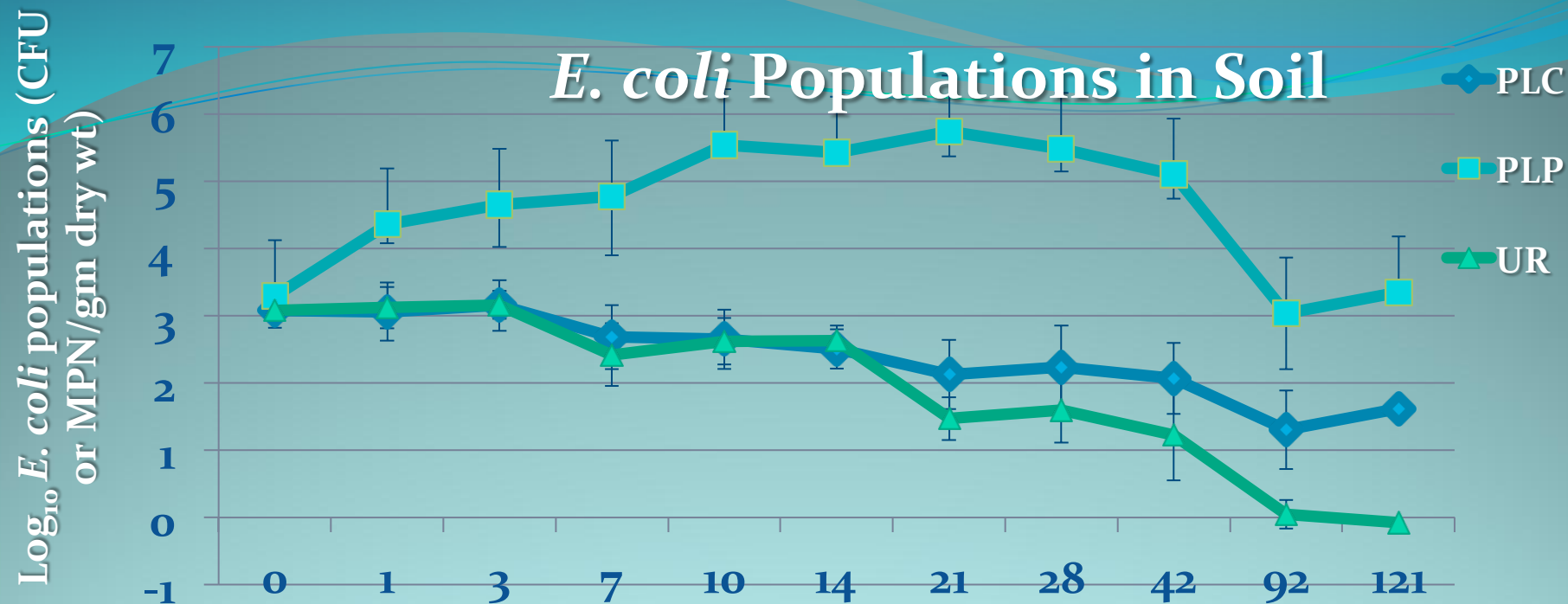
MANURE PROCESSING LINE EQUIPMENT



An Example of
Poultry Litter
Pelletizing Process

E. coli Populations in Soil





Recovery of g <i>E. coli</i> from Spinach and Radish grown soils amended with urea (UR), composted (PLC) or pelletized poultry litter (PLP)			
<u>Commodity</u>	<u>Day Post Inoculation</u>	<u>Biological Soil Amendment</u>	<u>Mean <i>E. coli</i> MPN/g or presence in 30 g sample enrichment (E)</u>
<u>Spinach</u>	42	PLC, PLP, UR	30 g , 4/4 E Negative
	123	PLC	4.5 MPN 1/4 E
	123	PLP	7.0 MPN; 2/4 E
	123	UR	0.6 MPN; 1/4 E
<u>Radish Bulb</u>	56	PLC	44.4 MPN
	56	PLP	4207 MPN
	56	UR	1.88 MPN
	92	PLC, PLP, UR	All E negative
	124	PLC	4/4 E positive
	124	PLP	3/3 E positive

Concentrations of Water Soluble Carbon (C) and Nitrogen (N) in Amended Soils

Amendment	μg soluble C per g soil (mean \pm sd)	μg soluble N per g soil (mean \pm sd)
UR	30.63 ± 0.7	40.53 ± 0.53
PLC	60.13 ± 2.0	20.73 ± 0.13
PLP	100.5 ± 5.8	30.40 ± 1.54

Concentrations of Water Soluble Carbon (C) and Nitrogen (N) in Soil Amendments

Amendment	μg soluble C per g soil (mean \pm sd)	μg soluble N per g soil (mean \pm sd)
DMC	288 ± 96	3.47 ± 3.4
PLC	284 ± 106	3.90 ± 3.3
PLP	2449 ± 989	5.23 ± 3.6
VC	244 ± 98	11.0 ± 5.1

Microbial Standards for Treatment Processes

FDA (§§ 112.54 and 112.55)

- **Scientifically valid controlled processes:**
 - physical (thermal),
 - chemical (high alkaline pH), or combinations,
 - composting

demonstrated to satisfy microbial standards:

<i>Listeria monocytogenes</i>	Undetected using a method that can detect 1 CFU/5 grams analytical portion
<i>Salmonella</i> species	Less than 3 MPN/4 grams of total solids (dry weight)
<i>E. coli</i> O157:H7	Less than 0.3 MPN/gram analytical portion
Fecal coliforms	Less than 1,000 MPN/gram (dry weight)

What is Composting?

- Composting is a managed, aerobic (oxygen-requiring) process in which natural biological decomposition of organic residuals results in the production of a stabilized, humic, organic soil amendment.
- Proper Composting
 - Stabilizes nutrients
 - Reduces plant and animal pathogen concentrations
 - Reduces vector attraction and production of odors

FDA: two types of valid aerobic composting processes

1) Static composting: aerobic (i.e., oxygenated)

- minimum 131°F (55°C) for 3 days
- adequate curing
- proper insulation



1) Turned composting: aerobic conditions

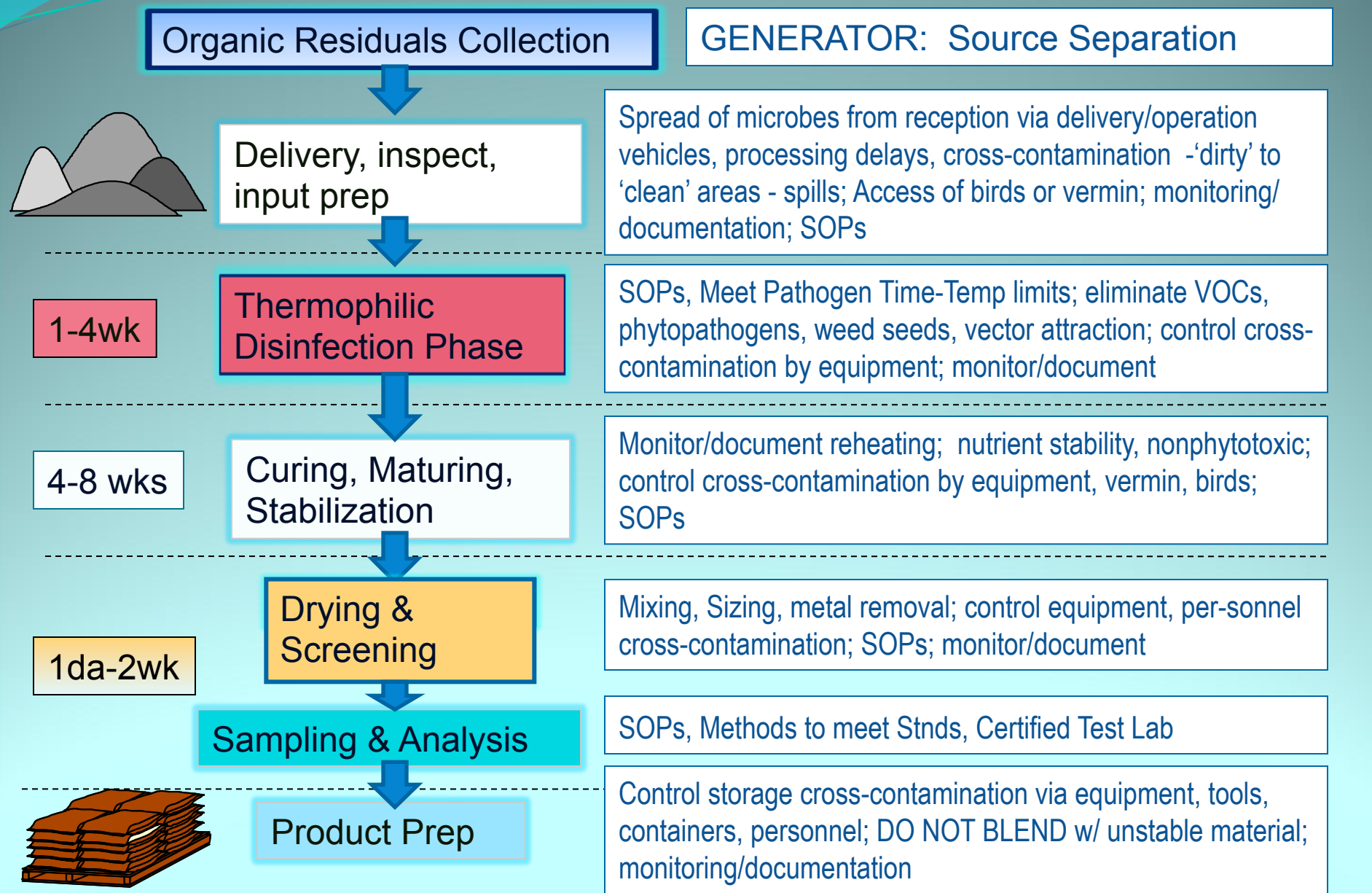
- minimum 131°F (55°C) for 15 days
- at least 5 turnings
- curing
- proper insulation



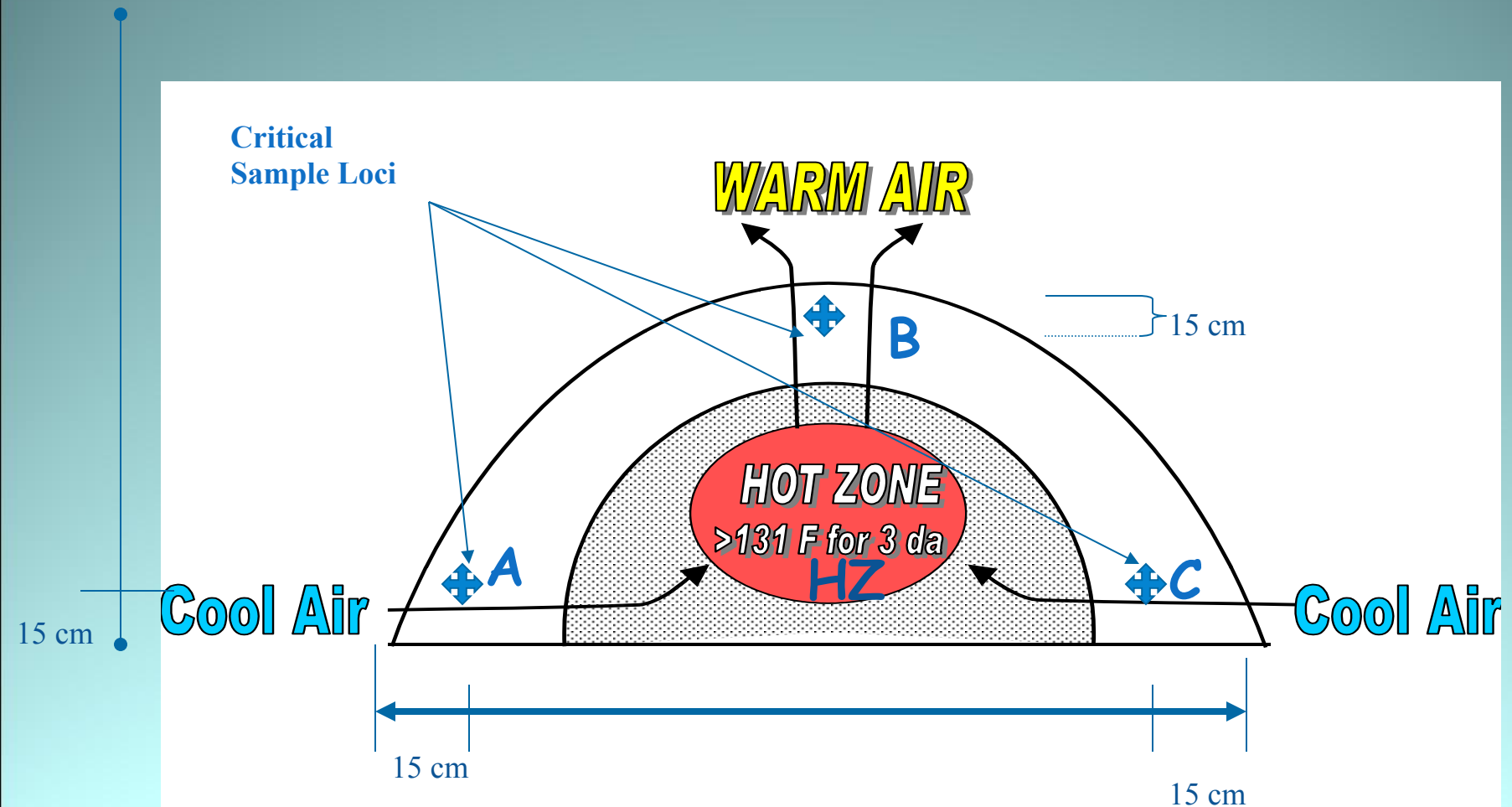
Compost Process Criteria: maintain optimal conditions for microbial degradation

- ***C:N*** - 25:1 – 30:1
- ***Moisture Content***: 40-60%,
- ***Structural Porosity***: 35 – 50% free air space for O₂ transfer
- **Optimize recipe for type of feedstock**
- **Material handling efficiency- 2x limit**

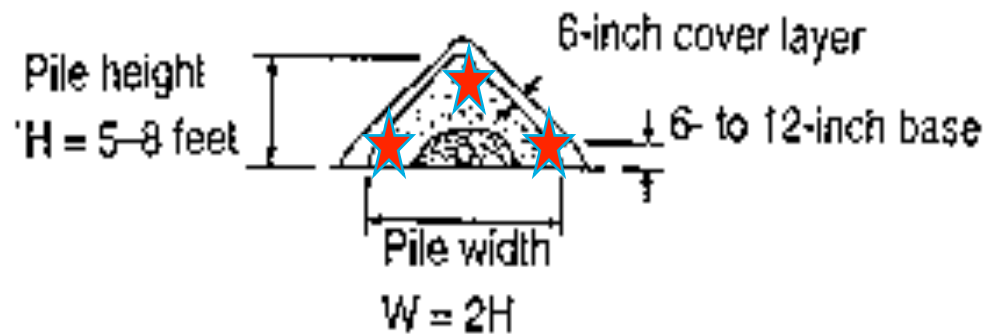
Composting Process Stages & HACCP Critical Control Points



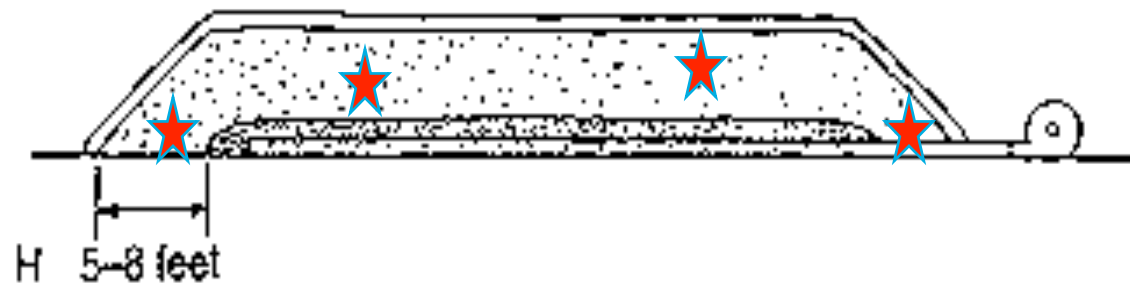
Compost Windrow Temperature Gradient (Cross-Section) and Recommended Sample Points at the Toe Ends



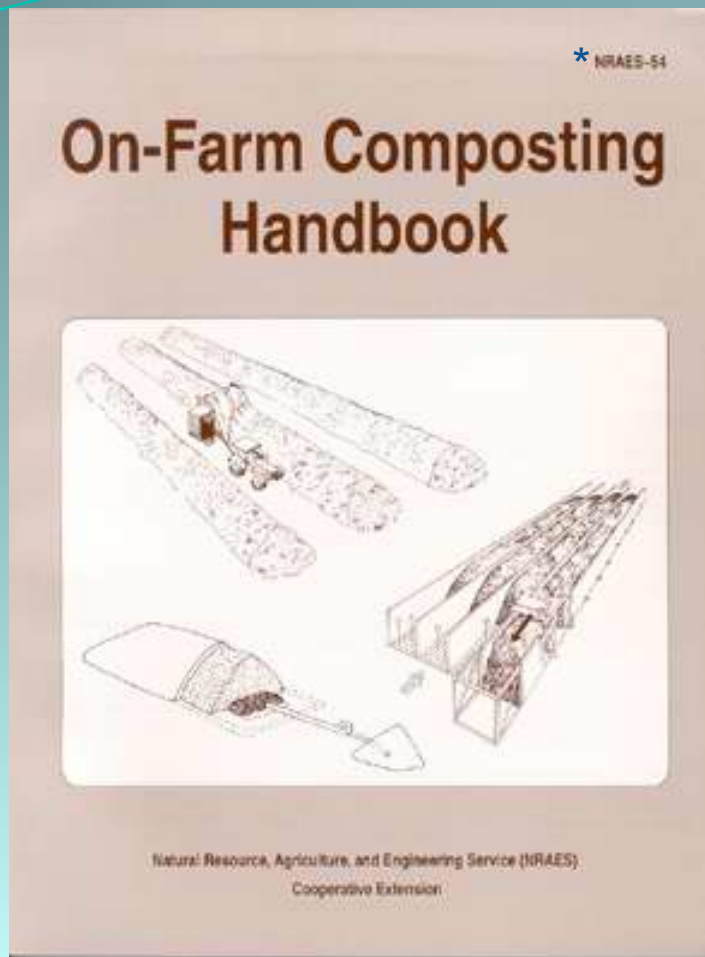
Critical Sampling Loci (A & C) relative to the "Hot Zone" (HZ) and Positive Checkpoint (B)



★ **Points for monitoring temperature**



Aerated static pile layout and dimensions.



*Item #1165



*Item #1168

*<http://extensionpubs.umext.maine.edu/ePOS/form=item.html&item=1157&store=413>

**http://www.sanjuanislandscd.org/Information/Composting/assets/Small_Farm_Composting.pdf

Cornell Waste Management Institute: <http://cwmi.css.cornell.edu/>

Sampling-When, Where, Who, How

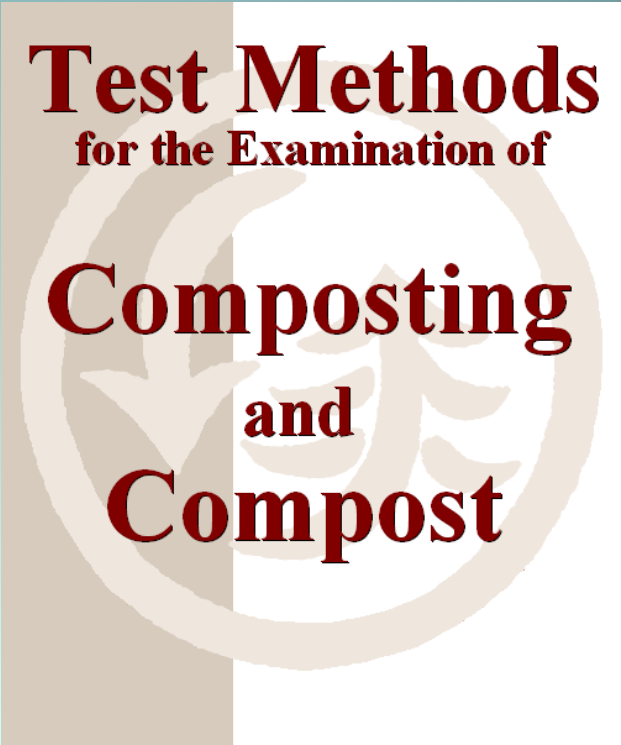
- **US Composting Council-TMECC**

- <http://compostingcouncil.org/tmecc/>

- **Seal of Testing Assurance – STA**

- <http://compostingcouncil.org/seal-of-testing-assurance/>

USDA-ARS with support from the Center for Produce Safety conducted a validation study of microbial test procedures for compost



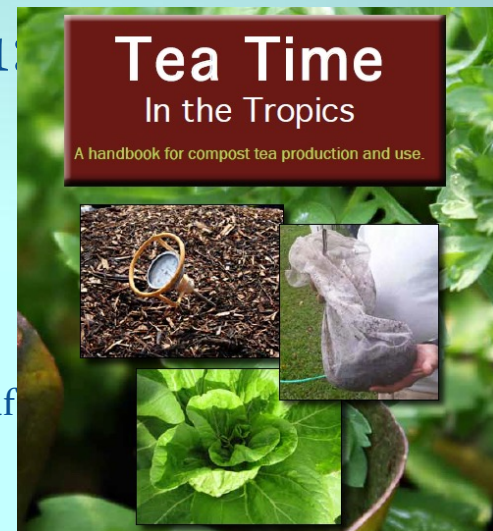
Test Methods
for the Examination of
Composting
and
Compost

Reduce Cross-Contamination: Tools, probes, containers; double bag; ship in insulated containers; use frozen gel-paks

Compost Tea and Leachate

- **Leachates and teas as foliar fertilizer/soil amendments**
 - Leachate: liquid from compost piles.
 - Compost tea (aerated and non-aerated): intentionally water-steeped compost -
- **Aerated:** manure/compost:water (1:10-50); aerated by injection or re-circulating water 12-24 hrs
- **Non-aerated:** manure/compost:water (1:10-50); stationary , 1-3 wks

https://www.sare.org/content/download/66749/944806/Compost_Tea_Manual.pdf



Compost Tea Use to Reduce Contamination Risk from Foodborne Illness Pathogens

- Use potable water when mixing compost teas: No *E.coli*
- Use properly composted manure: no wait time; should only apply to soil, not the edible portion of the crop
- Raw manure tea: can only apply to soil; not directly on plants; has a **one-year harvest wait time interval**
- Additives (molasses, yeast, etc.) must follow the same **one-year harvest wait time interval**
- Compost leachate: applied to soil with the 90/120 day rule; NOT for direct application to plants
- Teas may NOT be applied to edible seed sprouts

Soil Amendments: Summary

◆ Key Factors

- ◆ Compliance with FSMA & NOP
- ◆ Farming operations are local, site specific
- ◆ Soil amendments are unique and varied
- ◆ Poultry litter/manure: prolongs *E. coli* persistence
- ◆ Environment, Employees, Equipment
- ◆ Materials Handling & Management
- ◆ Training, Operations, Maintenance

BEST PRACTICES (Cont'd)

- Plan site layout with slope and water movement in mind
- Keep the site clean
- Manage leachate and runoff appropriately
- Actively manage dust
- Use clean water
- Manage vehicles and equipment
- Actively manage stockpiles
- Segregate tools and containers
- Control access by pathogen vectors
- Inform personnel on methods to avoid contamination and to protect their own health – **Training!**
- Test to verify that facility management is resulting in clean products – **USCC STA (Seal of Testing Assurance)**
- Stay current

Acknowledgements

USDA-ARS

- Manan Sharma
- Cheryl East
- Eric Handy
- Kathryn White
- Cary Coppock

FDA-CFSAN

Division of Produce Safety

- Michael Mahovic
- David Ingram
- Scarlett Salem
- Annmarie Buchholz

University of Maryland

Eastern Shore:

- Dr. Fawzy Hashem
- Russell Reynnells
- H. David Clark
- Ms. Corrie Cotton
- Lorna Graham
- Celia Whyte
- Brett Smith
- Natalia Macarisin
- Daniel Wright
- Nicci (Jamie) Coffee
- Richard Stonebraker
- June DeGraft Hansen

SEAREC (Penn State):

- Dr. Alyssa Collins / Staff

REGULATORY COMPLIANCE ISSUES- Local

- **Local Zoning and State Permits (as needed)**
 - **Erosion and Sediment Control**
- Surface Water Contamination – **Runoff**
- Ground Water Contamination – **Infiltration**
- **Nitrate & Phosphate** in Agricultural Soil

NC DEQ: Composting x NCSU Compost Learning x

carolinacompost.com/ncsu-compost-training-facility/

NC Composting Council
U.S. COMPOSTING COUNCIL

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NCSU Compost Learning Lab

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Visit the NC State Compost Learning Lab!
To schedule a tour, contact sherman@ncsu.edu.

NCSU Compost Learning Lab
4000 Chi Road, Raleigh NC



Calling all environmental enthusiasts! Are you ready for the challenge established by the US EPA and USDA to reduce and divert excess food by 50% by 2030?

The NC State University and NC Composting Council, along with other private sector companies and charitable organizations, are ready for the challenge! We have created NC State University's Compost Learning Lab as a premier regional composting demonstration and training site in the United States.

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#Sustainable Spirits is like the Olympics of good conversation...in Hillsborough.

mailchi.mp/ec6889efd128/s...

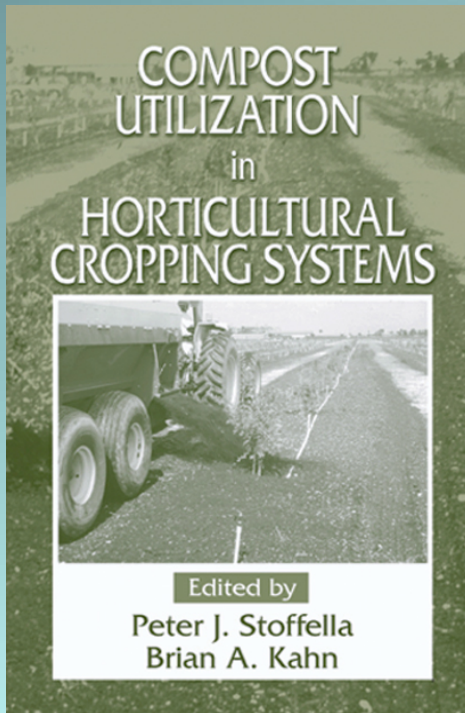
Urban farms and community gardens may compost without a permit as long as they do not offer the finished compost to the public and stay within certain volume limits if material is brought in from off site.

Composting Guidance for Urban Farms and Community Gardens

COMPOST vs. OTHER MEDIA

	Compost	Manure	Peat	Topsoil
Nutrients	M-H	H	vL	L-M
Sol salts	M-H	M-H	vL	L
pH	M	M-H	L-vL	L-M
WHC	M	L-M	H-vH	L
OM	M-H	M-H	H-vH	L

Thickness	Cu. yd/1,000 ft.	Cu. yd/Acre
1/2 inch	1.5	67
1 inch	3	134
2 inches	6	269
3 inches	9	402



CRC Press 2001
ISBN: 978-1-56670-460-1

Field Guide to Compost Use. 1996. U.S. Composting Council.
www.compostingcouncil.org/compost-use-instructions/

Compost Troubleshooting

Low pile temperature

- Pile too small, cold weather, too dry, poor aeration, or lacks nitrogen
- Make pile bigger or insulate sides, add water, turn the pile, add greens or manure

High pile temperature

- Pile too large, insufficient ventilation
- Reduce pile size, turn

Suitability of Compost as a Potting Media for Production of Organic Vegetable Transplants

Sean Clark & Michel Cavigelli

2005 Compost Science and Utilization 13: 150-156.

Study of comparison of food waste compost (included landscape trimmings) vs. horse bedding compost.

100% and 50:50 blend with bark, peat, sand

Food waste compost produced plants comparable to those in standard commercial peat-based potting mix.

Horse bedding compost was unacceptable at both rates for transplant production (likely high salts and N immobilization)

Carcass compost: suitability for fresh produce ?