



Reducing and Managing Contamination in Compost

James McSweeney • Compost Consultant & Educator



Compost
Technical
Services



Organic Materials



Physical Contamination



Biological Contamination



Chemical Contamination



Organic Materials

The nature of organic matter
“Living or derived from living matter”

Organic Matter and Volatile Solids Content

Describes the percentage of the material that is combustible and therefore, partially compostable.

Non-Volatile Solids

Describes the percentage of the material that is inorganic or mineral in nature and will not combust.



Organic Material. Any of the following Source-separated materials: vegetative material; food material; agricultural material; Biodegradable products; biodegradable paper; clean wood; or yard waste. Organic Material does not include Sanitary Wastewater Treatment Facility Residuals.

310 CMR 16.00: SITE ASSIGNMENT REGULATIONS FOR SOLID WASTE FACILITIES

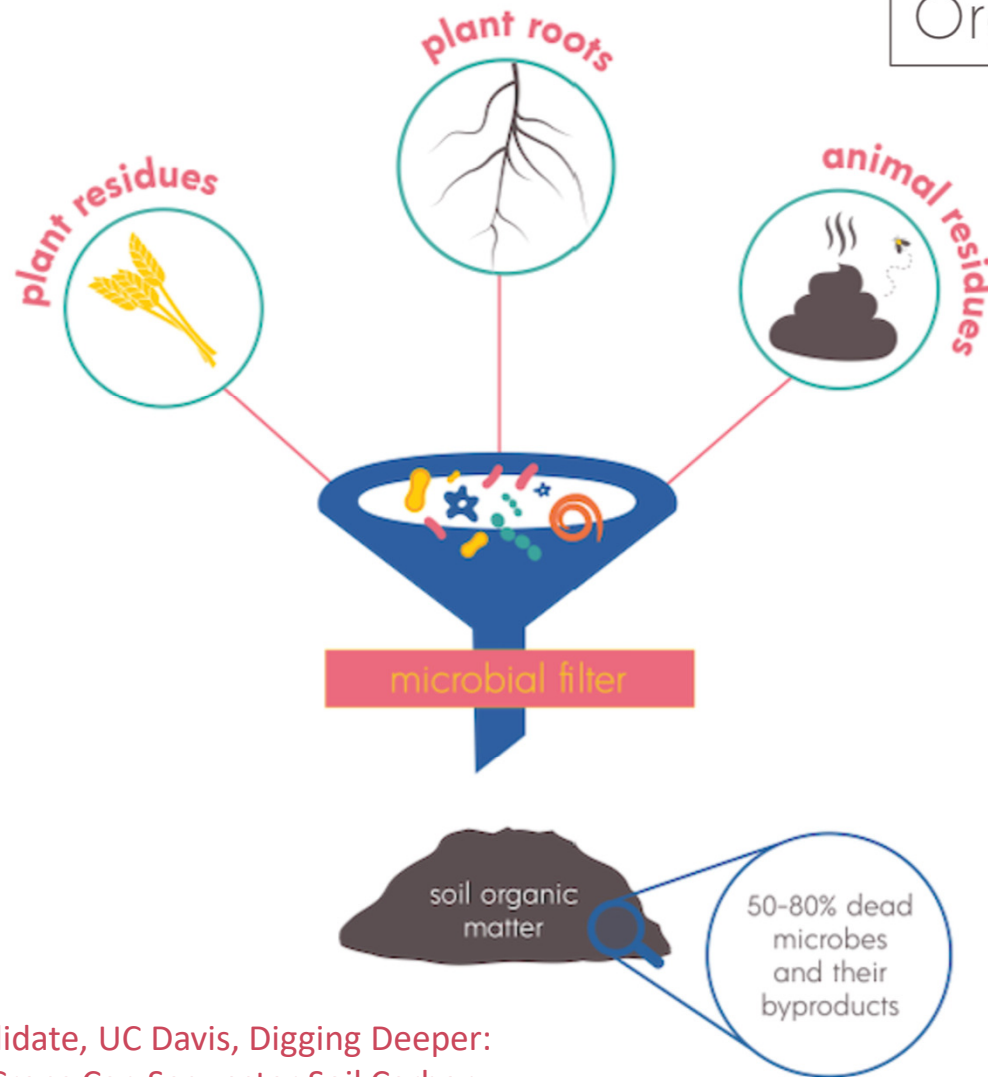
Biodegradable or Biodegradation means capable of being broken down into carbon dioxide, water and humus by biological organisms including but not limited to, microorganisms.

330 CMR 25.00: AGRICULTURAL COMPOSTING PROGRAM

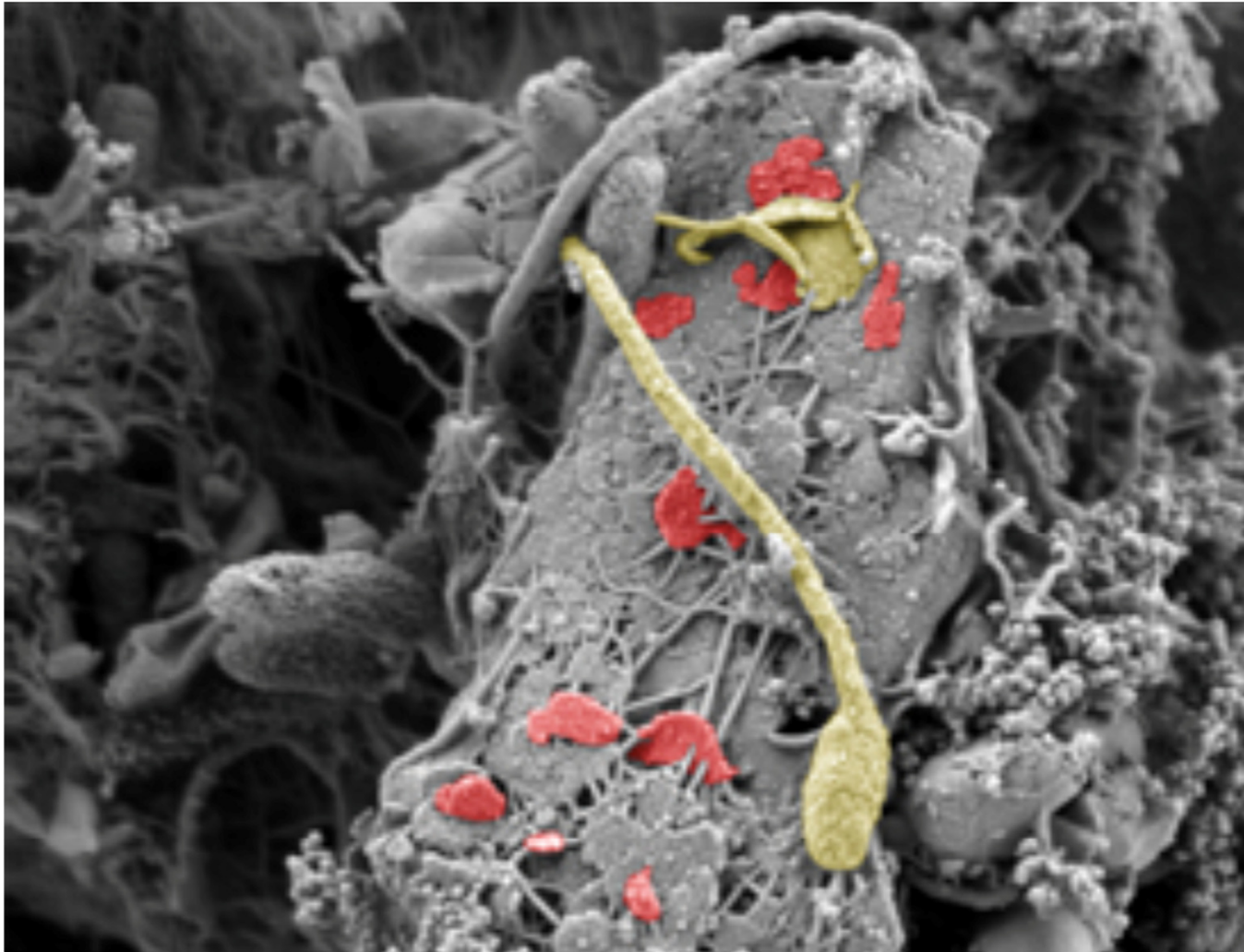
Biodegradable. Capable of being broken down especially into innocuous products by the actions of microorganisms.

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.

Factors Affecting Feedstock Value and Handling



Control over source



Do you anticipate this being a consistent (and clean) feedstock source?



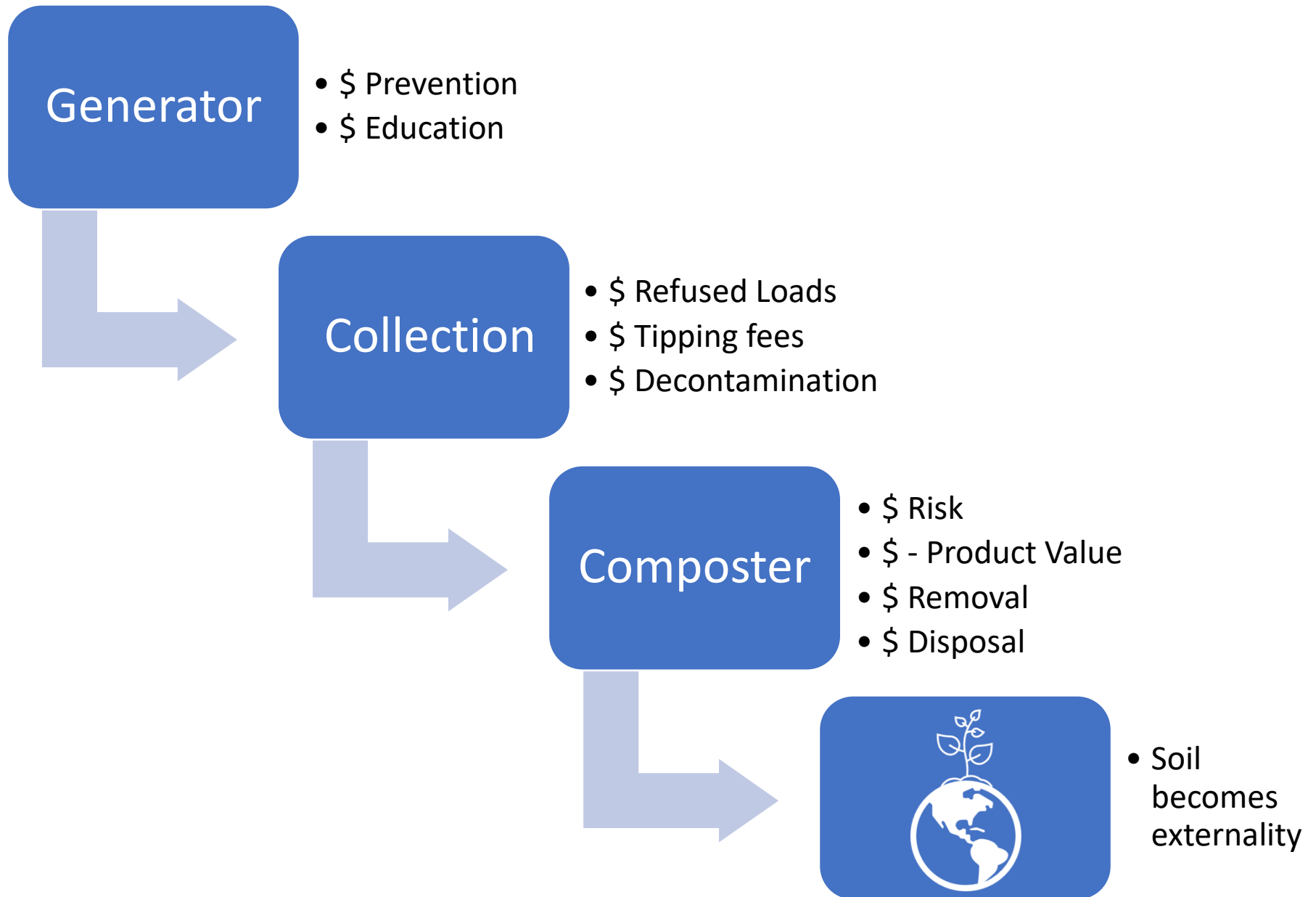
How much education will it require you to provide the generator? (to get a clean material?)



Will the generator commit to supplying (a clean) the material to you?



Will value derived from feedstock cover the cost of proper management?



Feedstock Generator Sectors

Food Scraps/Residuals

- Residential
- Commercial/
Institutional
- Food Processing

Agricultural

- Bedding & Manures
- Feed

Yard trimmings

- Leaves
- Grindings
- Chips

Cannabis

- Ground Plant
- Growing Media





Physical Contamination

- Non-organic inert human-made particles: Plastic, metal, glass
- “Eye of the beholder” contaminants: Mineral, sand, large organic particles
- “Conditional” contaminants: Bio-degradable and Compostable serviceware



Preventing Physical Contamination

Focus on the education of generators in source separating their organic materials for collection.



**A COMPOSTING PROGRAM FOR SCHOOLS
THAT CONNECTS CHILDREN WITH
LOCAL ENVIRONMENTAL ISSUES**

Highfields Center for Composting Video Series:

<https://vimeo.com/highfieldscomposting>

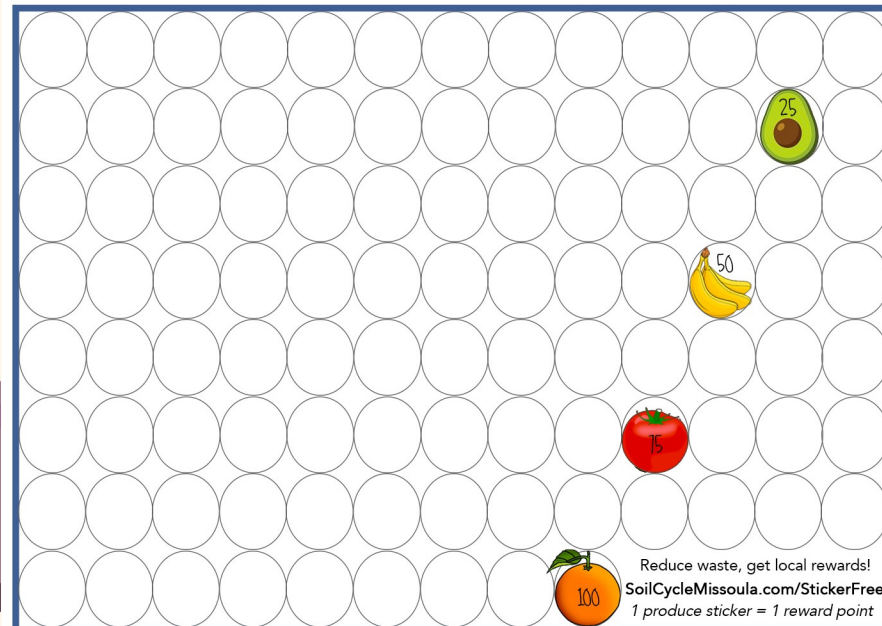
GOOD COMPOSTER.

PRODUCE STICKERS
HERE

1. FILL IN THE APPLE WITH PRODUCE STICKERS.

2. TAKE A PHOTO AND TAG @SUNCOASTCOMPOST #GOODCOMPOSTER

3. RECEIVE \$5 OFF YOUR NEXT MONTH



Reduce waste, get local rewards!
SoilCycleMissoula.com/StickerFree
1 produce sticker = 1 reward point

Soil Cycle's Sticker Rewards Program

1. Collect produce stickers
1 sticker = 1 reward point
2. Mail or deliver postcard to Soil Cyle
3. Visit SoilCycleMissoula.com/StickerFree
4. Email soilcyclemissoula@gmail.com
to receive your local rewards

Soil Cycle
736 S. 1st. W. #C
Missoula, MT
59801

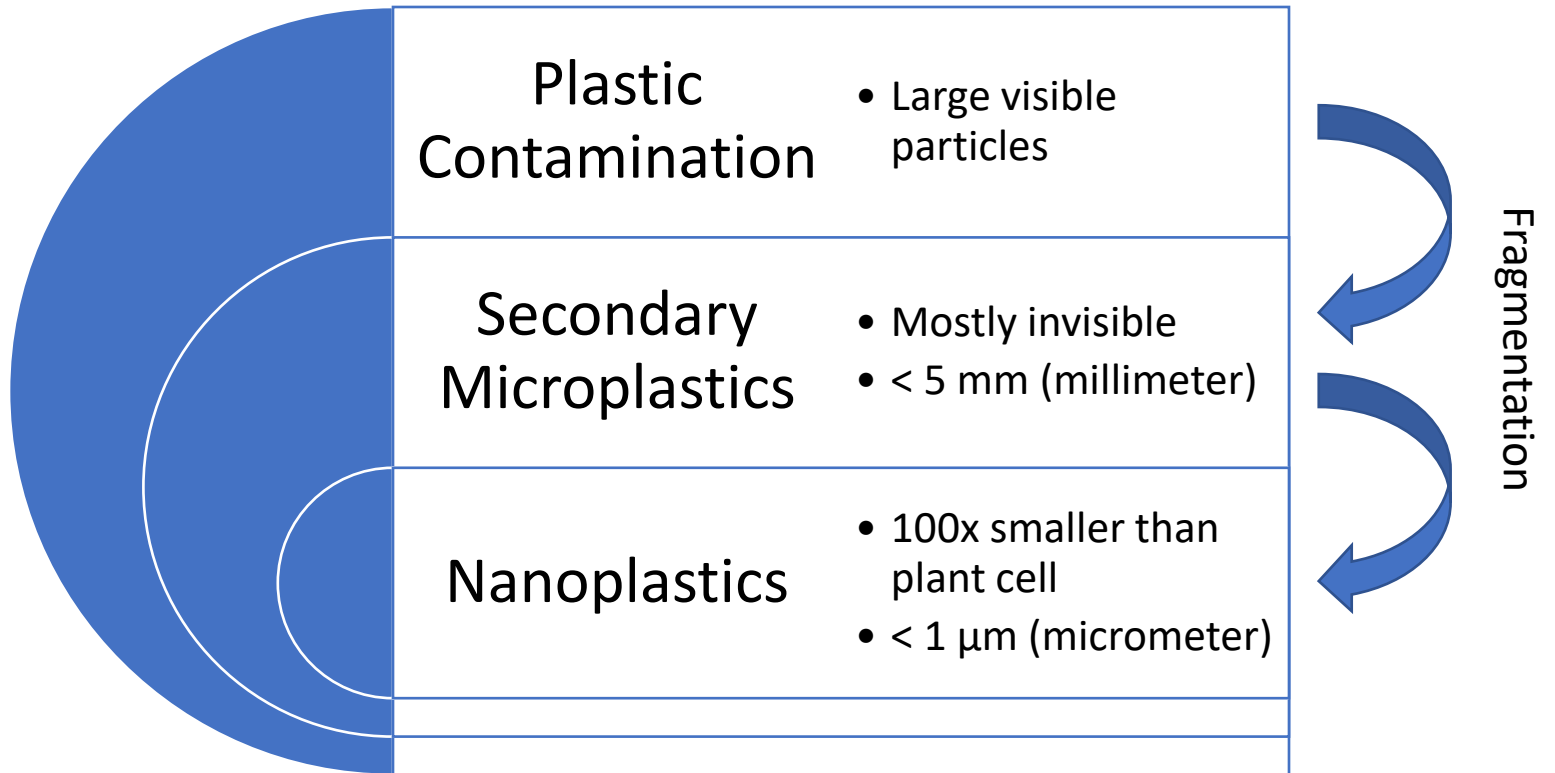


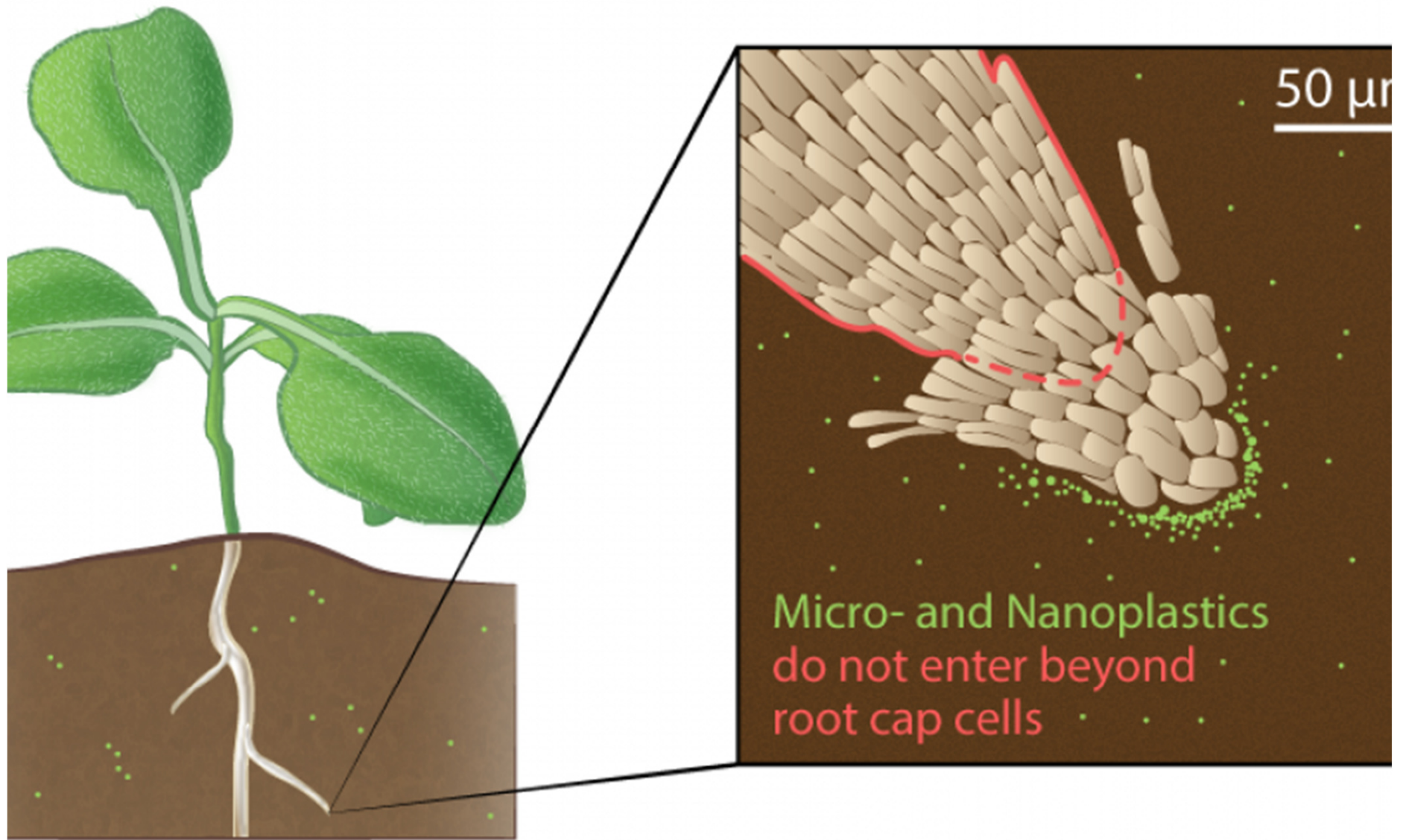
Little produce stickers can cause big waste and contamination issues. Produce stickers are most commonly made of vinyl or plastic, meaning they will not break down in the compost process. Thank you for removing stickers and improving compost!



Preventing Physical Contamination

- Clear contamination protocols between composter and hauler.
- **Inspect incoming loads** of feedstocks
- Refuse contaminated loads.







Managing
Physical
Contamination

Rubbish cans in convenient locations on site, including nearby the food-scrap receiving and mixing bay



Managing Physical Contamination

Pick visible rubbish and inorganic material from in-process compost

Managing Physical Contamination

Litter or construction fence can be placed around the perimeter of the facility to contain light weight contaminants if necessary.



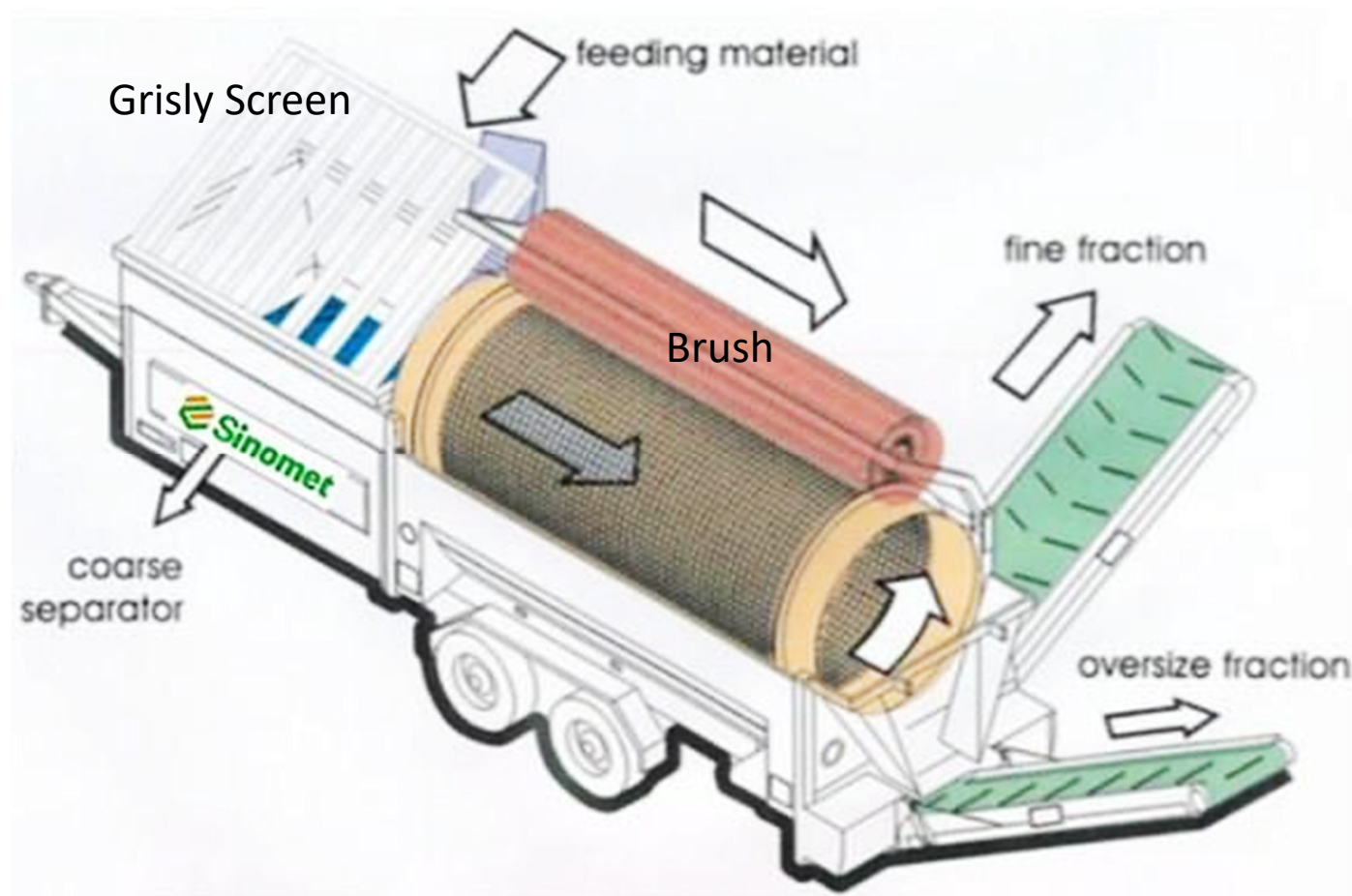
Image Source:
BioCycle Connect

Screening

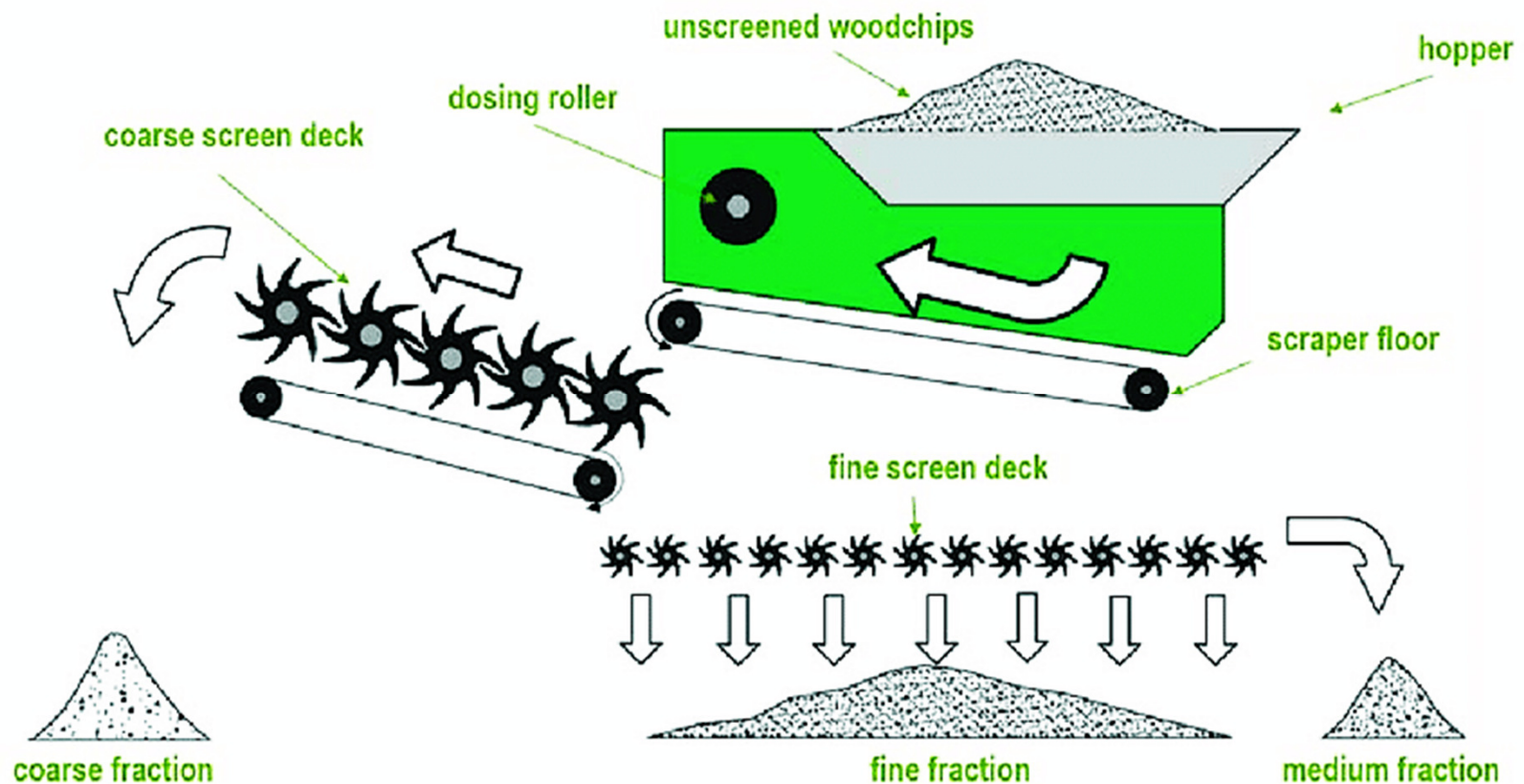
- Trommel
- Star (similar to disc)
- Deck or flat
- Grisly
- Orbital
- Screening buckets
- Micro-screens



Trommel Screen

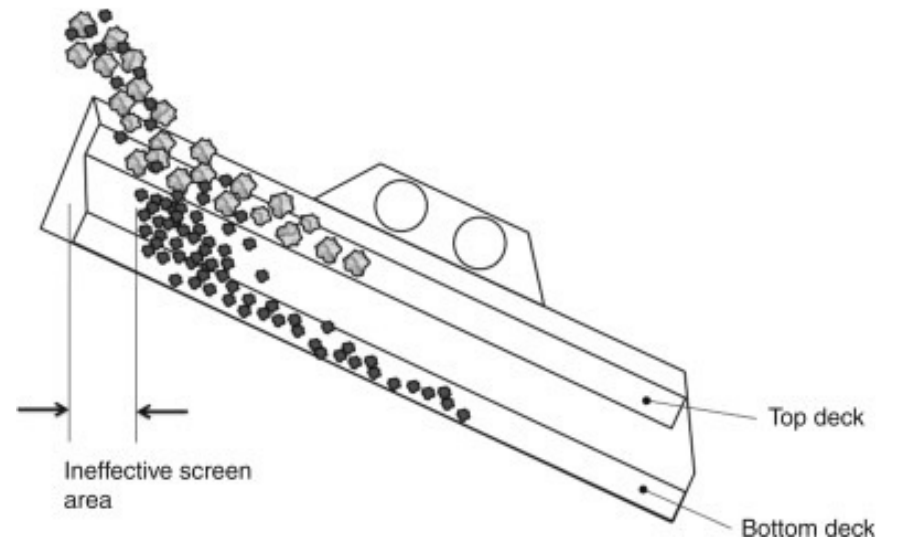
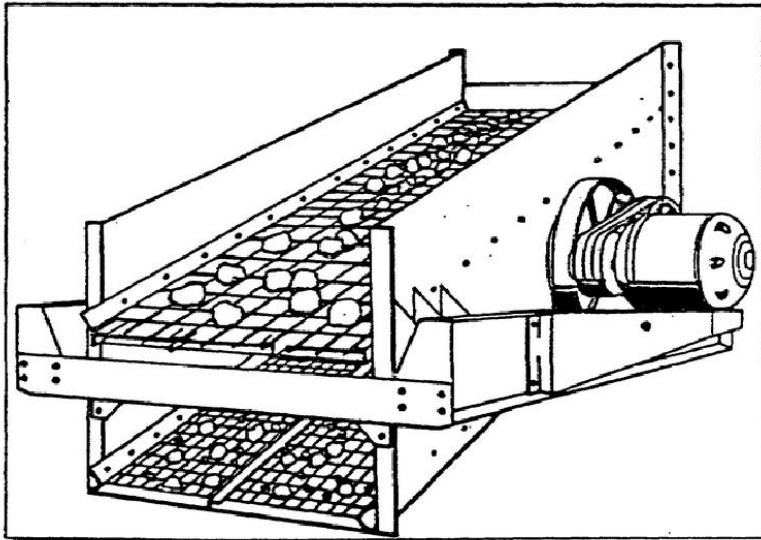


Star Screen



Huber, et al, Performance of a Mobile Star Screen to Improve Woodchip Quality of Forest Residues, Forests, 2017.

Deck Screen



Small & Micro-Screens

Sittler Trommel



DeSite Deck

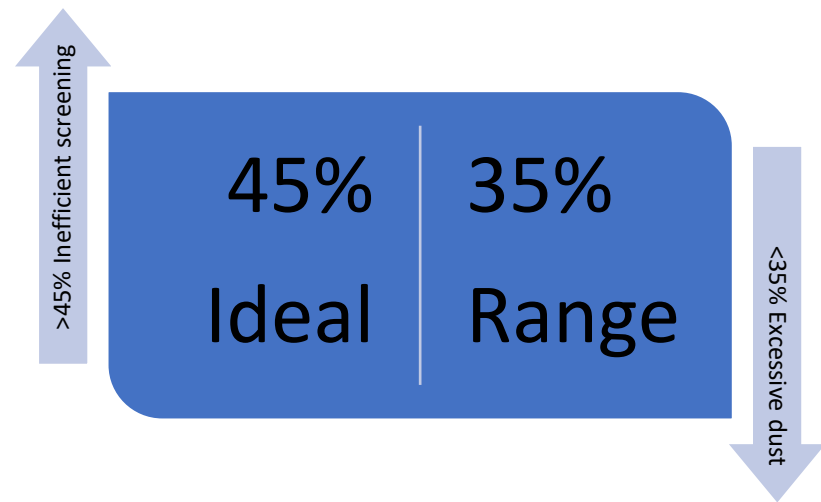


Modified Cement Mixer



Increasing Efficiency

- Target moisture content
- Drying
- Blending sand, peat



Reuse of “Overs” (over-sized particles)

- Minimize contamination
- Double screening
 - Remove large particles (large trash, branches, rocks, >1-2 inches)
 - Rescreen for finer grade
 - Left with cleaner middle sized particles
- Air separators (vacuum for light weight particles)



Screening Considerations

- Throughput and time using screener
- Hopper size and height
- Conveyor reach and rotation
- Wire size – smallest gauge wire possible for material weight opens screening area (tensioned screen panels)
- Screen size (general grades):
 - $\frac{1}{4}$ - $\frac{3}{8}$ inch – bagged products, potting mixes
 - $\frac{1}{2}$ - $\frac{3}{4}$ inch – garden and landscaping
 - $\geq \frac{7}{8}$ - $1 \frac{1}{4}$ inch bulk agricultural, mulch



Bio-Plastics

Not always a simple choice for composters:

- Not allowable as feedstock if compost is to be used on certified organic farms
- Easily confused with contaminants
- Aesthetic considerations - appearance of trash
- Require greater process control



Biological Contamination

- Pathogens – human, plant, animal
- Invasive species

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).

Time/Temperature Relationship

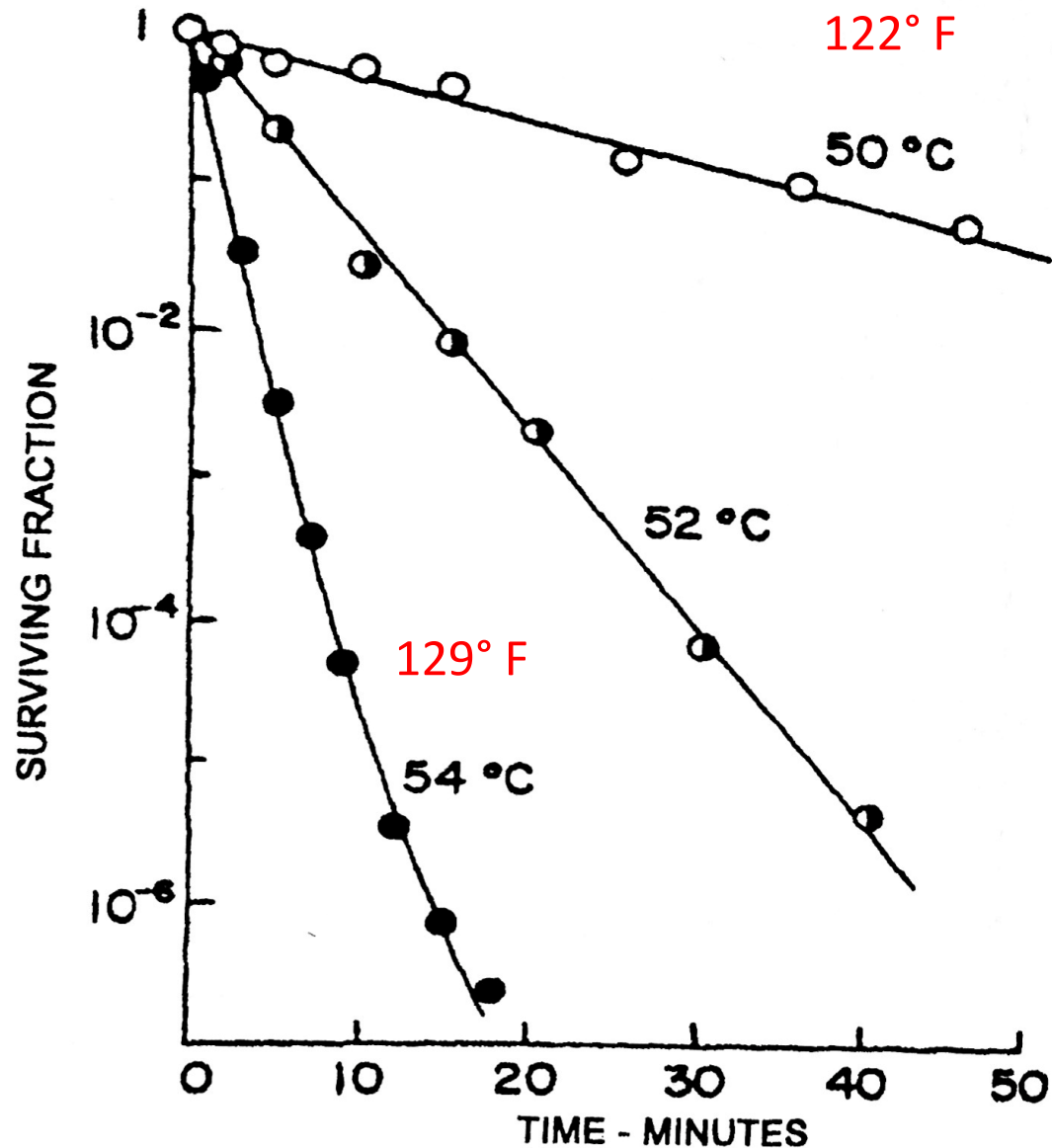


FIGURE 8.4. Heat inactivation of *Salmonella enteritidis* serotype Montivideo in composted biosolids. (Data from Ward and Brandon, 1977.)

Process to Further Reduce Pathogens (EPA *PFRP*)

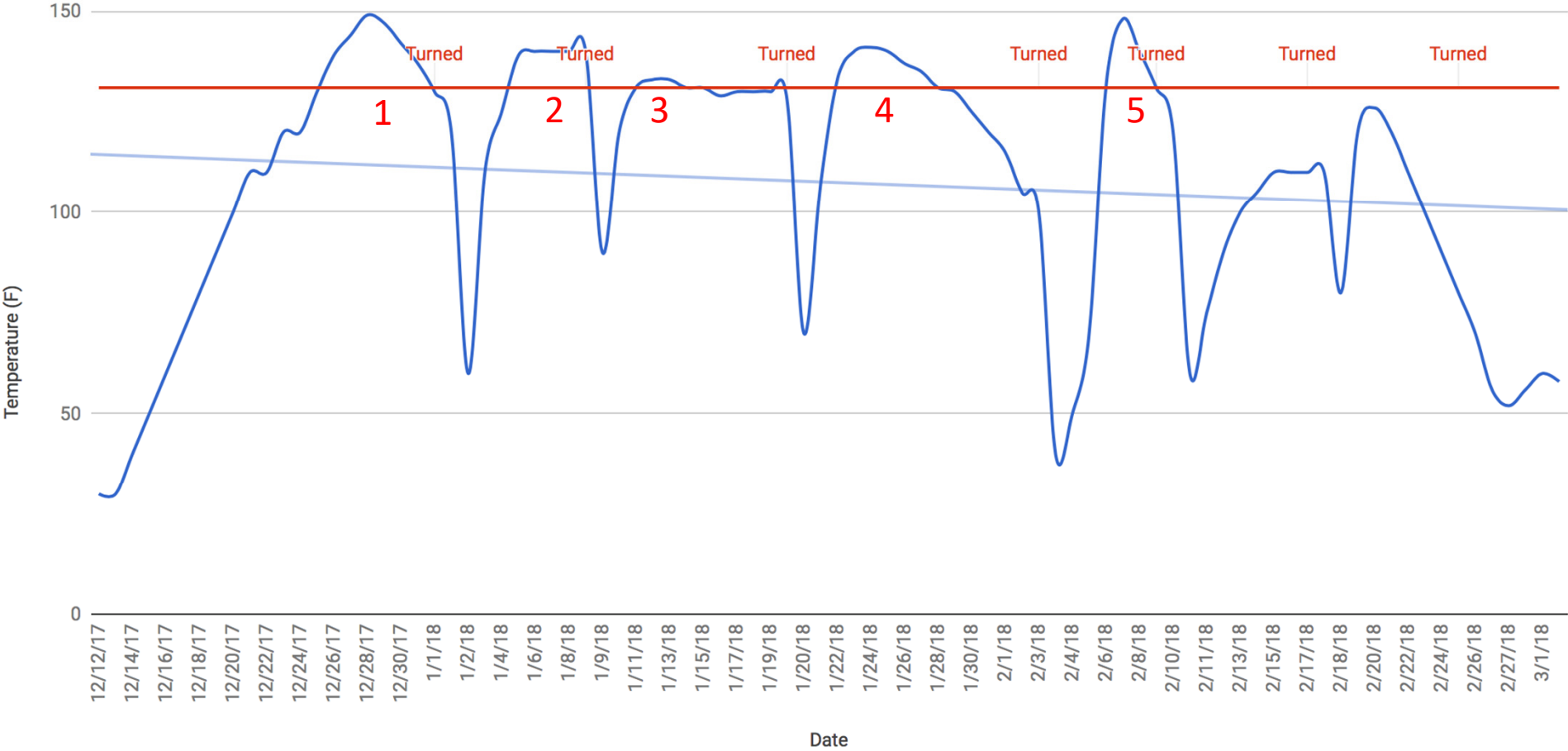
Turned Windrows

- **PFRP standard** *is to turn pile at least five times while maintaining $\geq 131^{\circ}$ F for at least 15 days*

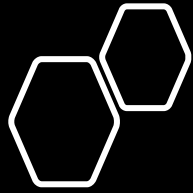
Aerated Static Pile or In-Vessel

- **PFRP standard** *is that the material reaches $\geq 131^{\circ}$ D F for at least 3 days*

Compost Temperature Log (Pile ID Borus)



- Temperature (F)
- Trendline for series 1
- Target (≥ 131 F)



Prevent
reintroduction
of pathogens

Keep out of stream of
storm water and leachate
from active piles

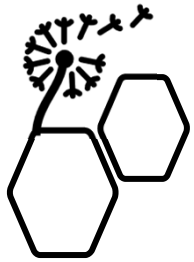
Manage material from
oldest to newest and clean
equipment if switching
from Pre-PFRP to post PFRP

Table 4. Number of hours required to kill 90% of seeds (LD₉₀) calculated from nonlinear models.

Weed species	Temperature (C)				
	60	50	46	42	
	140° F	122° F	h	115° F	108° F
Annual sowthistle (Dandelion relative)	— ^a	2.1	13.3	46.5	
Barnyardgrass	— ^a	5.4	12.6	na ^b	
London rocket (Mustard family)	— ^a	4.0	21.4	83.1	
Common purslane	1.3	18.8	na ^b	na ^b	
Black nightshade	2.9	62.0	196.6	340.6	
Tumble pigweed (Amaranth family)	1.1	107.0	268.5	na ^b	

^a Model did not converge, and seeds died quickly.

^b Species not affected at this temperature.



Prevent reintroduction of weed seeds

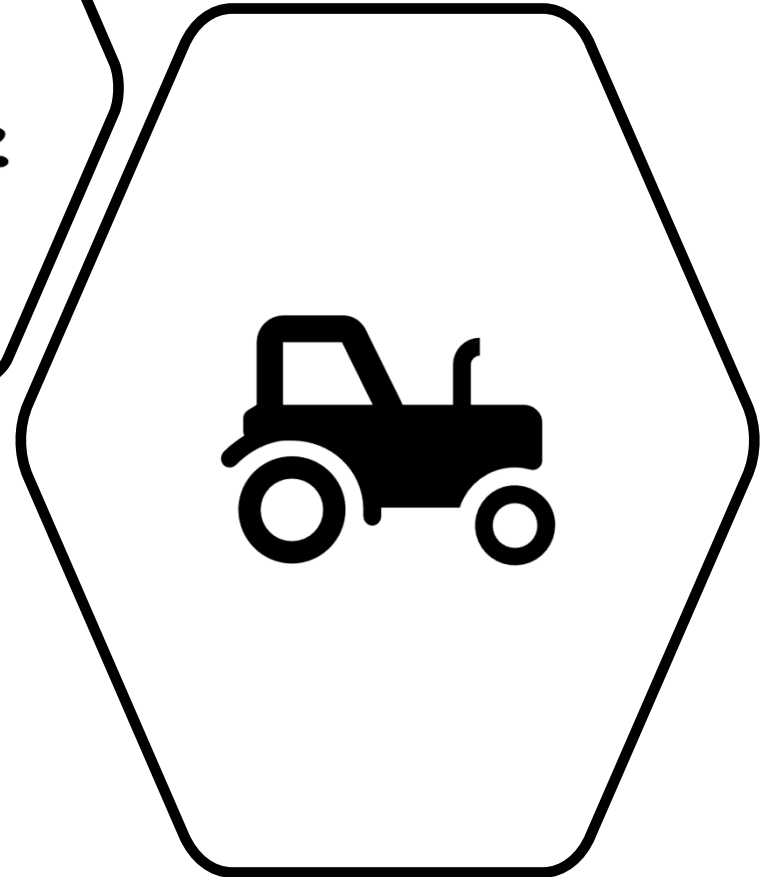
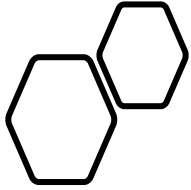
- Cover piles with fleece or other compost covers
- Mow around site before weed seed sets





Chemical Contamination

- Spills
- Salts
- Heavy metals
- PAHs
- PFAS and PFOAs
- Agrichemicals and pharmaceuticals
- Persistent Herbicides



Spills

- Avoid working on equipment around compost
- Have Spill Response Plan in place
- Clean up kits
- Biobased equipment fluids

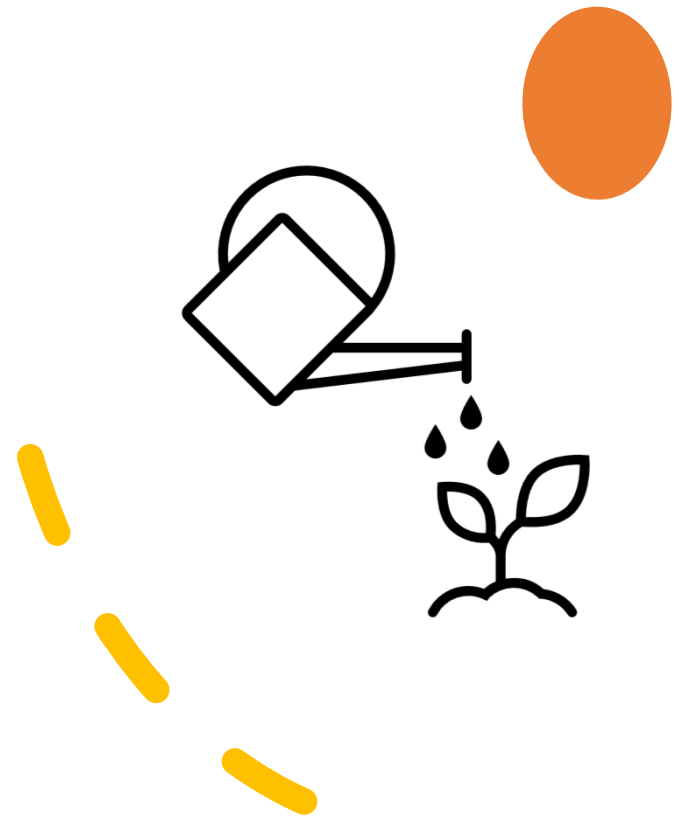
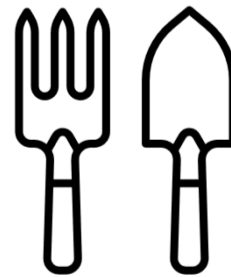
Soluble Salts

- Animal and human foods
- Measured on a scale of electrical conductivity associated with salts in a feedstock.
- Conductivity above 5 mmhos/cm (Millimhos/centimeter) can be harmful to plants in concentrated applications of compost



Soluble Salts

- Use high salt compost in lower concentrations
- Salts are minerals and valuable plant nutrients in the right forms and concentrations
 - Testing of specific salts
 - Compost Ag Index¹
 - Sodium (Na^+) and chloride (Cl^-) are harmful to plants



Heavy Metals

Can be found in:

- Glossy magazines
- Pressure Treated Lumber
- Painted Wood
- Biosolids
- Yard debris in contaminated areas

Periodic testing is recommended in commercial operations and places of concern

EPA investigates toxic 'forever chemicals' in pesticides

BY RACHEL FRAZIN - 03/08/21 05:30 PM EST



© istock

PFAS
Per- and
Poly-
Fluorinated
Alkyl
Substances

PFAS no longer permitted in Biodegradable Products Institute “Certified Compostable” Products

BioCYCLE

THE ORGANICS RECYCLING AUTHORITY
SINCE 1960

COMPOSTING AD & BIOGAS FOOD WASTE MARKETS CLIMATE

MORE CATEGORIES

SIGN UP FOR BIOCYCLE



FEBRUARY 4, 2020 | GENERAL

BPI's New Standard On Fluorinated Chemicals In Effect



BPI's new standard for fluorinated chemicals went into

RELATED POSTS

Commentary: Is Bill Gates Clued In To Compost?



Beyond The Bag






Teflon in my Compost?? What are PFAS and Why Should You Care: An Introduction for Composters

Cary Oshins, US Composting Council | Rhodes
Yepsen, BPI | Ned Beecher, NEBRA | Geoff Kuter,
Agresource | Rooney Kim Lazcano, Purdue University

Tuesday, December 18th, 1-2:30pm EDT

The Composting Collaborative:

<https://www.compostingcollaborative.org/resource-category/webinar/>



Agrichemicals and pharmaceuticals

- Fungicides
- De-wormers
- Pesticides

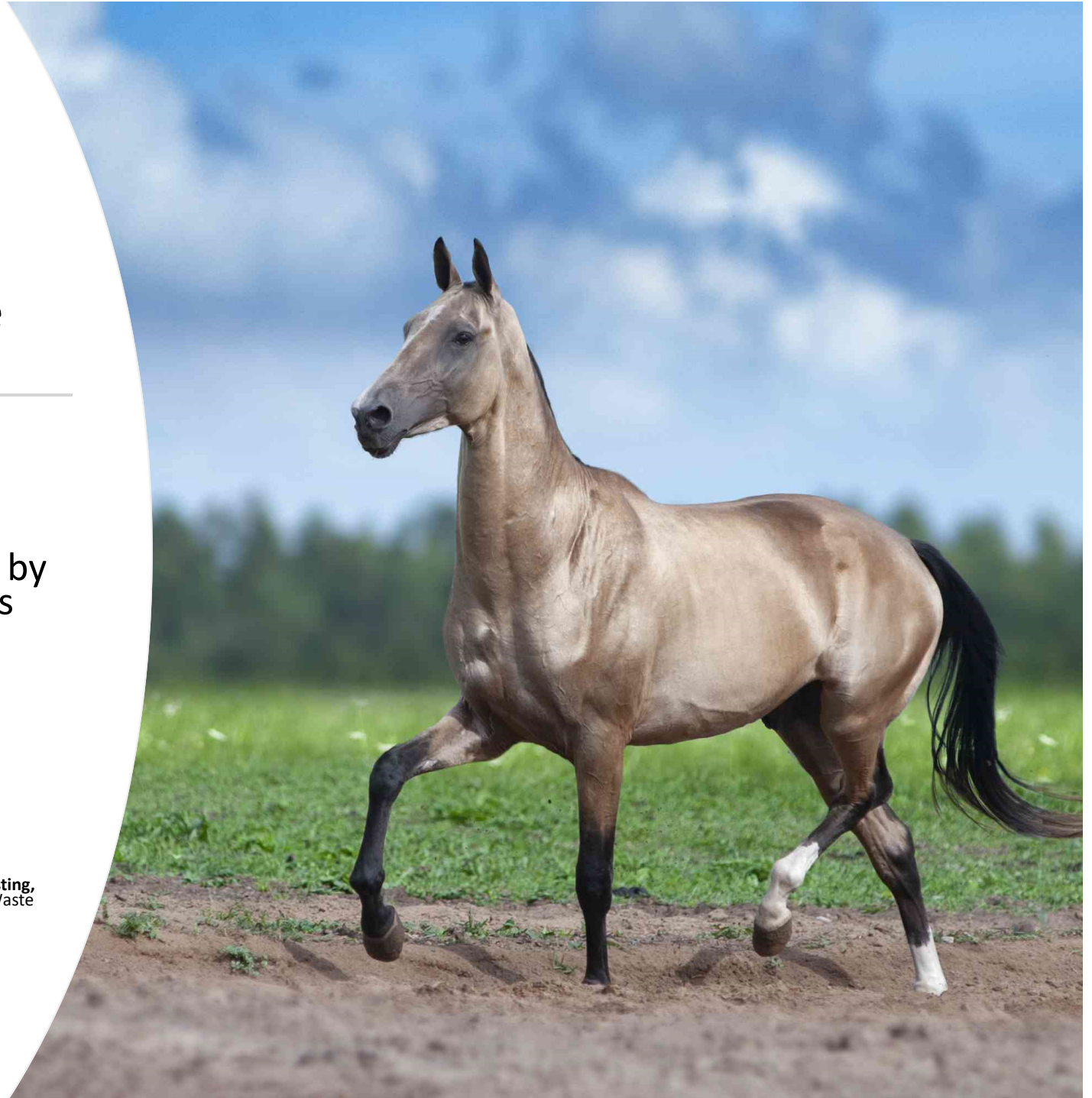


De-wormers

De-wormers in livestock manure

Ivermectin reduced by
~98% over 6 months

(The Fate of Ivermectin in Manure Composting,
Mary Schwarz and Jean Bonhotal, Cornell Waste
Management Institute, 2011)



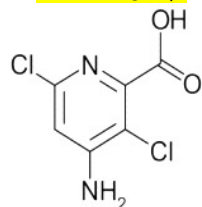
Persistent Herbicides

Herbicides that may still be plant toxic following the composting process.

Pyridine/Pyrimidine Carboxylic Acid Herbicides

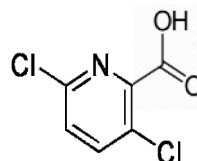
Aminopyralid

1-amino 3,6-dichloro
2-Pyridine carboxylic acid
Aerobic soil metabolism
half-life 103 days



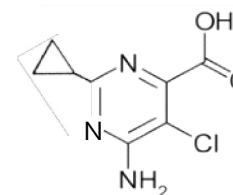
Clopyralid

3,6-dichloro
2-Pyridine carboxylic acid
Aerobic soil metabolism
half-life 300 days



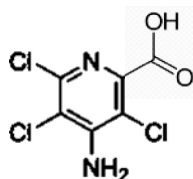
Aminocyclopyrachlor

6-amino-5-chloro-2-cyclopropyl pyrimidine
4-carboxylic acid
Aerobic soil metabolism
half-life 144-433 days



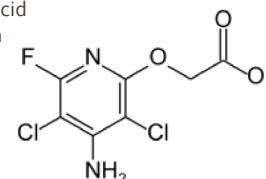
Picloram

4-Amino-3,5,6-trichloro-2-pyridine carboxylic acid
Aerobic soil metabolism
half-life 120 days



Fluroxypyr

[(4-Amino-3,5-dichloro-6-fluoro-2-pyridinyl)oxy] acetic acid
Aerobic soil metabolism
half-life 8.3 to 30 days

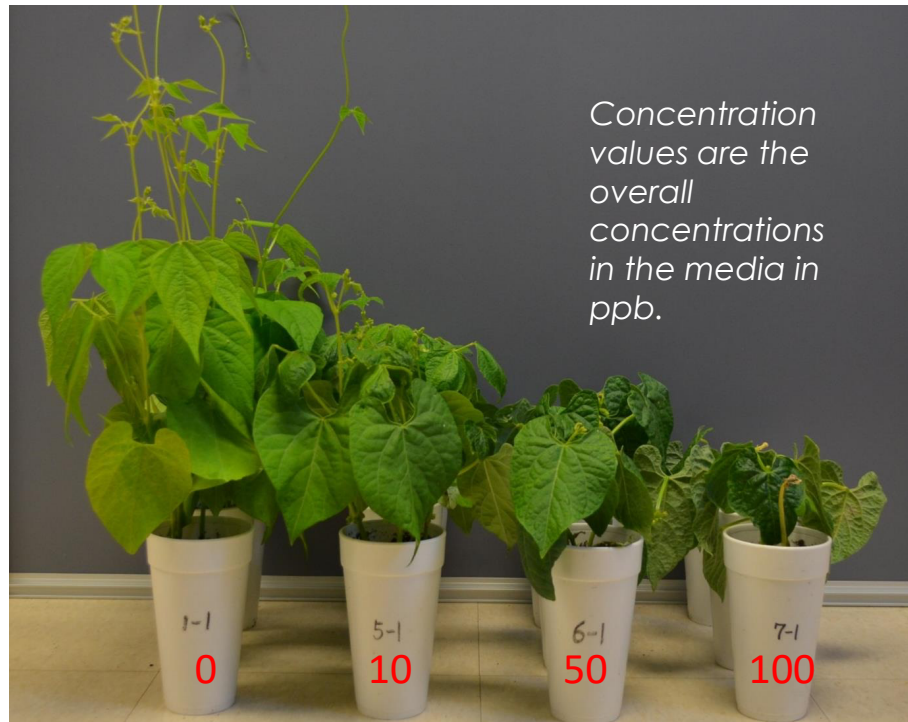


Persistent Herbicides

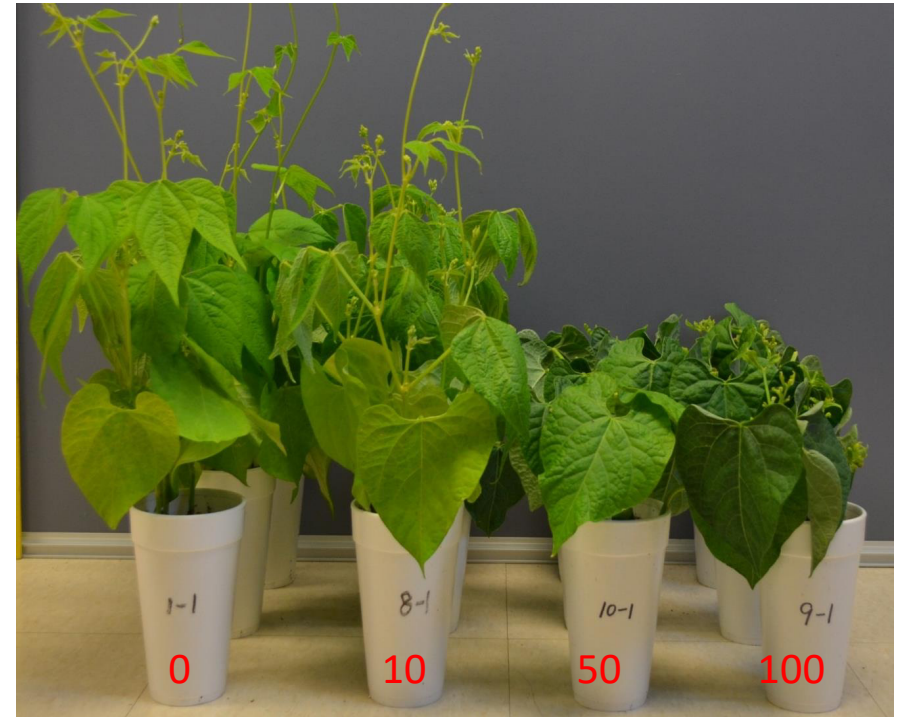
Auxin-mimic type herbicides
(Auxin is a plant growth
hormone)



Aminopyralid in YT Compost (ppb db)



Clopyralid in YT (ppb dw)



Persistent Herbicides: Aminopyralid

- Horse Manure most likely source of contamination
- Aminopyralid is NOT approved for use on New England pasture, hay, or feed.
- Aminopyralid MAY NOT BREAKDOWN in the composting process although there are conflicting opinions in this area
- Does breakdown in soil



Dow Milestone
Herbicide, 1 qt.

\$119.99

Tractor Supply Co...

★★★★★ (4)

Persistent Herbicides: Aminopyralid

- URGE EXTREME CAUTION AND DILIGENCE TO PREVENT RECEIVING THIS CONTAMINANT
- Chemical testing for this agent is extremely limited and expensive
- Talk to horse farmers – share info
- Trade Names:
 - Milestone
 - Forefront



I Think I Poisoned My Garden • The ...
theprairiehomestead.com

Persistent Herbicides: Clopyralid

- Breakdown with Composting (6-24 months)
- Chemical analysis found it to be widespread in commercial horse feeds (sweet feeds), which contain sugar beet residues and grains
- Also found to be widespread in raw horse manure feedstocks, although the composting process is effectively degrading it to below plant toxic levels
- SHORTER COMPOSTING PROCESSES MAY NOT EFFECTIVELY DEGRADE THIS AGENT



Sonora Clopyralid
Herbicide - 1 Gallon

\$170.00

Seed World



Mitigating the Effects of Persistent Herbicides

Time degrades Clopyralid, but not Aminopyralid

- *Plant assays (Bioassays) are best way to prevent the distribution of a harmful product*
- *High Carbon Wood Ash – 2-4% of recipe by Volume*
- *Chemically ties up herbicides*
- *Can blend with finished compost if needed, but blending with raw materials is more effective*



Biocycle: Another Tenacious Herbicide:

Biocycle: Part I - Unraveling the Maze of Persistent Herbicide in Compost

Biocycle: Part II - Composters Defend Against Persistent Herbicides

Biocycle: Part III – Testing For Persistent Herbicides in Feedstocks and Compost

Biocycle: Coping With Persistent Herbicides in Composting Feedstocks

WEDNESDAY OCT 21st @ 2 p.m. EST



US Composting Council®

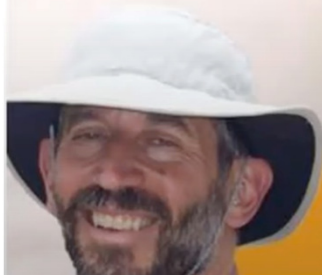
Persistent Herbicides in Compost

WEBINAR

Learn what is causing this issue, how the industry is fighting back, and what you can do to be apart of the solution!

Sponsored by:

MCGILL



Cary Oshins CCOM™
Associate Director
US Composting Council



Frederick Michel Jr.
Ohio State University Department
of Food, Agricultural and Biological
Engineering

<https://www.youtube.com/watch?v=Tzvs4W-Z4vc>



QUESTIONS



THOUGHTS



COMMENTS



RECOMMENDATIONS