Urban Soil
&
EM Bokashi Method

Reduction of soil contamination
and improving soil health
with
fermented food waste & leaf waste

Urban soil issues

- Excavated, compacted, disturbed, mixed, filled in, and contaminated.

--- Urban Soil Primer, NRCS, USDA

- Contaminated with chemicals and toxic metals from past industrial shops (manufacturing and warehousing).

Some ways to improve urban soils

- Removal and replacement
- Bioremediation
- Phytoremediation
- Natural soil additives

Soil additive options

- Natural fertilizers
  (NPK, macronutrients, some micronutrients, not balanced, no remediation)
- Compost
  (micronutrients, some macronutrients, balanced, time for mature finished compost, remediation depends on compost quality)
- EM Bokashi
  (as fermented food waste, macro- & micronutrients, balances the soil after application, significant remediation)

Remediation through soil additive

- Use of local resources:
  food waste
  leaf waste
- Organic matter replenishment
- Macro- and micro-nutrients
- Microbial remediation

EM Bokashi?

- Japanese term “bokashi” means fermented organic matter
- EM Bokashi is organic matter fermented with EM
- EM, Effective Microorganisms, a specific combination of naturally existing microbes:
  - **Lactic acid bacteria**
  - **Yeast**
  - **Phototrophic bacteria**

Fermenting food waste

- EM Bokashi as a fermentation starter
- Food waste is placed in airtight container sprinkled with EM Bokashi (about 1:33 ratio)
- Fermentation takes 2 weeks, at room temperature

- The fermented food waste (FFW), which is and looks like pickled food waste, is then used as a soil amendment:
  - buried or trenched for 2 weeks before planting
  - sandwiched between soil in pots or planters for 2 weeks before planting
  - fed to earthworms **with leaves** in worm bins or worm farm, 2-3 weeks => worm compost

EM Bokashi Method

- Directly uses microorganisms to ferment
  (compared to creating the condition to attract the microorganisms)
- Same microbes to ferment foods and beverages
- Fermentative microorganisms
  vs. putrefactive microorganisms
- *This is **not** the same as methane **fermentation***
- *This is also **not** the same as **anaerobic** putrefaction*

Fermenting or "pickling"

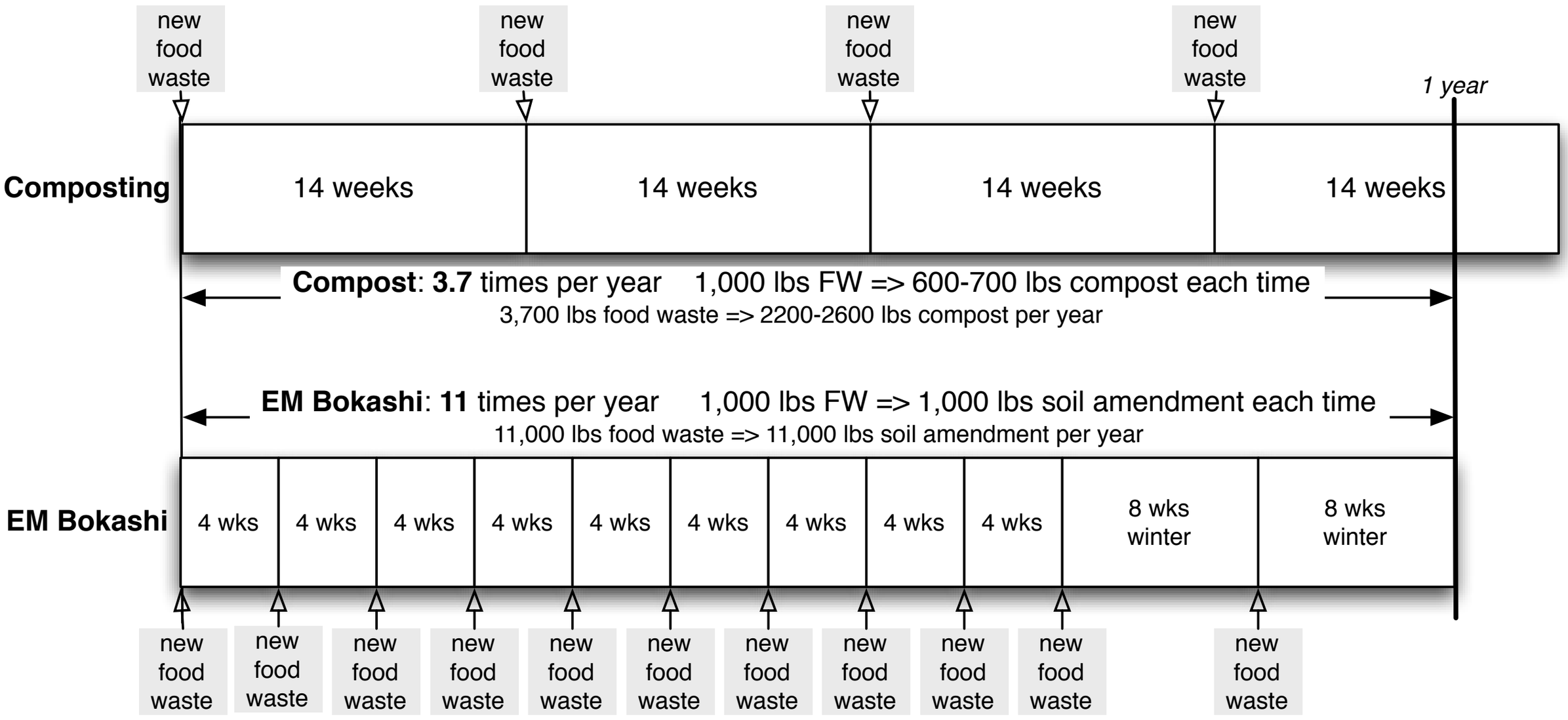
- Same principles as fermenting foods and beverages
- Magnified by the combination of microbes (EM)
- **Antioxidants** (natural preservation, not rot)
- **Organic acids** (deals with pathogens)
- **Enzymes** (break down materials, chemicals, toxins, pollutants) including bacteriocins (anti-pathogen) and coenzymes

Other benefits

- Low tech, low cost, low maintenance
- Mini-cycle of **food waste to growing food** in apartments
- Carbon negative
  (fossil fuels = carbon positive, composting = carbon neutral)
- Touch same food waste 2 or 3 times
  (non-mechanical, managed composting, over a dozen times)
- 2 weeks to ferment, 2 weeks in soil, and plant
- Short cycle => multiple, continuous soil replenishment per year

Short cycle => Greater capacity

By same-space restrictions processing 1,000 lbs food waste (FW) at a time
(Does not include locations that would use the resulting compost or soil amendent.)



EM Bokashi Method: possibility for much faster cycles for soil remediation, replenishment, and nourishment.

Remediating effects

- Improves soil microbial populations
- Improves food chain
- Improves soil organic content
- All of the above combined improves soil structure, root zones, etc.
- Reduces toxic metals

EM Bokashi Remediation

- Started spring 2012, at St. Mary's Episcopal Church, Harlem, 521 W 126th St, soil contaminated with heating oil over many years.
  Initially using straight EM Bokashi (fermented wheat bran) and Activated EM

- Started summer 2010, Children's Garden, East Village, 12th St & Ave B.
  Using fermented food waste, leaves, and Activated EM
  Soil test results of heavy metals, before and after, on next slide.

Children's Garden
East 12th St & Ave B

Soil test results of heavy metals before and after the application of EM*

Children's Garden heavy metals [ppm]	interior 7/2010 before	interior 7/2011 after1	interior 8/2012 after2	perimeter 7/2010 before	perimeter 7/2011 after1	perimeter 8/2012 after2	*normal soil level (avg. soil level)*	*unsafe level*
Chromium (Cr)	37	21	20	35	19	12	*84*	
Cobalt (Co)	6.4	4.0	5.0	5.8	3.0	2.2	*1.0-40.0 (average: 7.0)*	
Nickel (Ni)	17.4	14.0	13.0	17.3	10.0	7.0	*0.5-50.0*	*>200 (veg) >500 (child)*
Copper (Cu)	27	24	19	33	20	13	*1-50*	*>200 (veg) >500 (child)*
Zinc (Zn)	132	153	100	**217**	131	100	*9-125*	*>**200** (veg) >500 (child)*
Arsenic (As)	7.3	5.0	5.1	7.2	5.0	3.0	*5.0-20.0 (avg: 3.0-12.0)*	*>50 (veg) >200 (child)*
Cadmium (Cd)	1.4	1.2	0.2	1.4	1.0	0.5	*0.1-1.0*	*>10 (veg) >50 (child)*
Mercury (Hg)	1.5	1.5	0.9	0.1	0.7	0.1	*<1.0*	*>10 (child)*
Lead (Pb)	141	85	102	107	53	54	*10-70 [EPA safe<50]*	*>500 (veg) >1000 (child)*

">200 (veg)" means greater than 200 ppm (vegetables unsafe to grow at this level). Underlined numbers indicate an increase.

* EM (Effective Microorganisms) was applied by various methods using EM•1 Microbial Inoculant: by trenching food waste fermented with EM (bokashi method) [interior only], and by watering at various dilution rates with Activated EM (EM•1 fermented with molasses, water) and EM•5 (EM•1 fermented with molasses, vinegar, vodka (40% alcohol), garlic, spicy peppers and water) [interior & perimeter].

Interior = walking area, Perimeter = flower bed by fence only.

Note. This was not done under controlled conditions. Several cubic yards of compost and mulch were added during the before and after. Soils were sampled (10 spots each, 2" & 6" deep) according to, and analyzed by, Brooklyn College's Environmental Sciences Analytical Center