The Emerging Challenge is to go from....

Dirt Poor

----> Soil Wealth



What does this mean for the composting industry?

It's not magic – it's science

- There has been a revolution in our understanding of how soil is created, how it works, and what it can do for us
- As a society, we need to re-think how we manage soil
- As an industry, we need to recognize and seize the opportunity to become leaders





Opportunity #1: Building Good Soil Structure

- Get the soil structure right, and keep it right, and everything else will follow
- Why?
- Because good soil structure optimizes the soil's most vital functions, such as:
 - Water management
 - Fertility
 - Plant health & disease suppression
 - Pest management
 - Stabilizing climate

What is "soil health"?



First: What does the term "soil is alive" really mean? One handful of garden soil: more living organisms than there are people on the planet!

Soils = Living Ecosystems

The Soil Food Web



Credit: Wikimedia Commons

Why is Soil Life So Important?

Web of soil organisms predators and prey are responsible for about 90% of the soil functions that make aboveground life possible



Surface of Mars -- Photo Credit: NASA and the NSSDCA

Managing Compaction

- Gravity, water, and time
- Add downward pressure from foot traffic, wheels, etc.
- So....we need to increase ability of soil to resist and recover from compaction --- create a soil "sponge"
- What makes soil into a sponge?

Stable soil aggregates

Good soil structure – crumbly, well aggregated

Crumbly texture, macroaggregates



Platy, blocky, no aggregates

Photo credit: Mel Luymes and Adam Ireland

The Key Players in Soil Aggregation Processes

Electrical charges, chemical attractions: clay particles, organic molecules

Biological glues: produced by earthworms, bacteria and fungi

Filaments: fungi and plant roots

The Process of Aggregation in Soils



Weil, R.R., and N.C. Brady. 2017. The nature and properties of soils. 15th ed. Pearson, Columbus. 1086 p.

Soil Aggregation: First Steps



Bacteria in Action

Video Credit: Tim Wilson of Microbe Organics

Bacteria: The Glue Guys

Microscopic: fraction of a micron diameter; a few microns in length (micron = one millionth of a meter)

All secrete glues thru cell walls – WHY?

One teaspoon of healthy soil contains roughly how many bacteria?

I think I'd like to stick around!

Between 100 million and a billion Photo credit: Soil and Water Conservation Society. SWCS. 2000. Soil Biology Primer

Soil Aggregation: Last Steps



Fungi – Pulling it all together

- Important decomposers, breaking down tough materials, such as lignin
- Grow as long threads, known as "hyphae", which are just a few microns in width



"mycelia" are groups of hyphae massed together (these are often visible)

Fungal Hyphae under the Microscope



Photo Credit: Tim Wilson, Microbe Organics

Network of fungal hyphae stabilizing an aggregate



Eickhorst, Thilo & Tippkoetter, Rolf. Micropedology – The hidden world of soils. University of Bremen, Germany.

Attributes of Stable Soil Aggregates

- 1 These large aggregates are of different sizes and shapes and thus create pore spaces
 - 2 The glues and hyphae are waterresistant and thus stable under most conditions
 - 3 Well-aggregated soils are ideal environment for both microbes and plant roots

Soil organisms within a soil aggregate



Source: Soil and Water Conservation Society

Saturation, Field Capacity and Wilting Point



Benefits of Good Soil Structure - Infiltration

- Good structure means good rainfall infiltration rates:
 - Reduced run-off
 - Therefore: less erosion, nutrient loss/pollution, sedimentation, etc.





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Benefits of Good Soil Structure – Water-Holding Capacity

- Drought resistance
- Higher productivity
- Other soil functions remain active RESILIENCE
- Recent 14-year study found that yield volatility and minimum yield potential directly related to water holding capacity of soil (Wiliams et al 2016)



Infiltration Rates

Effect of Compaction on Infiltration Rate



Practices that Build Good Soil Structure

- Minimize soil disturbance
 - No-till, strip till, etc.
- Keep the soil covered
 - Cover crops, residues
- Keep live roots in the ground
 - Cover crops, intercropping, etc.
- Maximize diversity
 - Rotations, multi-species covers, etc.
- ✓ Innoculate!

Animal integration, organic amendments (especially mature compost)

Ecological Succession



Level of diversity rises until climax stage, then decline slightly

Important Changes During Ecological Succession



Ecological succession

NPP – up or down?

Nutrient availability – up or down?

Nutrient-use efficiency – up or down?

Soil food web balance?



Assessment Tools – 1 Penetrometer



Assessment Tools – 2 Slake Test

https://www.youtube.com/watch?v=5UfnbiBo-Ds

Assessment Tools – 3 Infiltration Test



A COMPOST COUNCIL PILOT PROJECT: SECTOR MENTOR

- A phone app that has been designed to help a soil manager track changes in the health of the soil
- Uses GPS to track sampling
- All tests can be done on site by the app user
- Protocols for tests are provided
- Computer app converts data into userfriendly tables and charts that allow user to track progress

Key Messages

- Opening up the soil opens up its *full potential*, including all of the vital soil functions
- To open the soil, you need to build and sustain stable soil aggregates, including macro-aggregates
- 3. Macro-aggregates are fundamentally important in creating and maintaining the soil sponge
- 4. To build macro-aggregates, you need robust and diverse populations of soil fungi

Key Messages (2)

- 5 Fungi thrive when the main *soilhealth principles* are employed,
- 6 But *inoculants* such as compost and mycorrhizae are also important
- 7 Mid-successional systems are *more efficient and productive* than early-successional systems

8 Diversity, diversity, diversity

Who's getting rich?





Prototaxite – Extinct about 350,000,000 years ago



Thank you!



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