

# Soil Basics



The 5 principles of soil health...  
...and then some!



Welcome to Soil Basics. The 5 principles of soil health... and then some!



Before we start, I need to give credit where credit is due.

There are many within the sound of my voice today including Claude Galipeau, Doreen McMurray, Wayne Campbell, and countless others who have contributed to the understanding and opinions I have today. I thank you.

Special thanks also goes out to Elaine Ingham and her work with the Soil Food Web

Gabe Brown inspiring us to convert Dirt to Soil

The Biological Farmer – Gary F. Zimmer

The Rodale Institute

BioTilth Living Soil Solutions

The Soil Health Institute

Soil Science Society of America

US Department of Agriculture and Natural Resource Conservation Service

Midwest Bio-Systems

True Earth Soil Exploration Farm



## Sustainable Farming

- Sustainable farming works in harmony with nature rather than against it. This involves using innovative techniques to achieve profitable crop yields without harming the natural environment or the people who live and work in it.





## Sustainable Farming

- It involves the use of biological materials, avoiding synthetic substances, and maintaining ecological balance thereby minimizing pollution and waste.

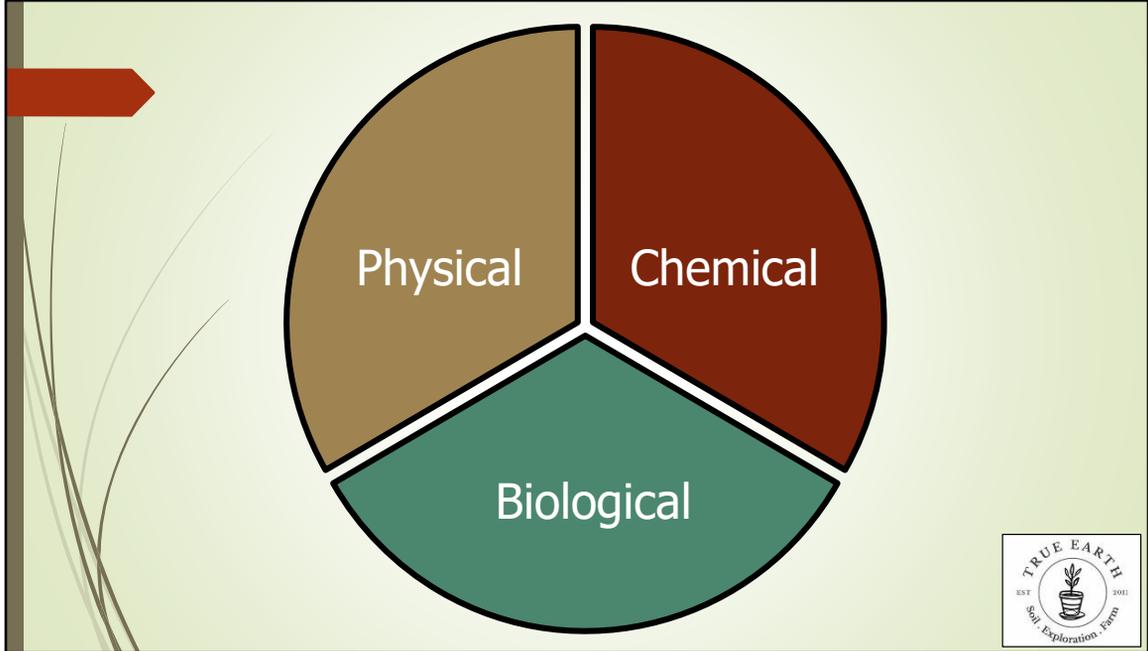




## Sustainable Farming

- It includes processes like timely crop rotations, composts & mulches, cover crops, organic waste management, biological pest control, etc.





When the Physical, Chemical, and Biological properties of the soil are all in balance, the soil is in balance.

How can we maintain the balance?

By applying the 5 principles of soil health.

## 5 Principles of Soil Health



1. Minimize Soil Disturbance
2. Soil Armor
3. Plant Diversity
4. Continued Live Plant/Roots
5. Livestock Integration



Special thanks to Jay Fuhrer, Marlon Winger, and Caitlin Cabanas of the USDA NRCS for helping us to understand the 5 principles of soil health.



## Minimize Soil Disturbance

- Physical - tillage
- Chemical – overapplication of chemicals
- Biological – overgrazing



What is soil disturbance?

- Biological disturbance, such as overgrazing
- Chemical disturbance, such as over application of nutrients and pesticides
- Physical disturbance, such as tillage

Why do we want to minimize soil disturbance?



## Adverse Affects of Soil Disturbance

- Destruction of soil structure
- Water erosion
- Wind erosion
- Soil crusting
- Depletion of carbon & organic matter
- Compaction



The adverse affects of soil disturbance include:

Destruction of soil structure, Water erosion, Wind erosion, Ponding water, Soil crusting, Depletion of soil organic matter, Compaction

Has anyone significantly reduced their soil disturbance? Have you experienced a reduction in these adverse effects?



On the left we see complete disturbance from a moldboard plow. The center photo represents strip tillage leaving corn residue between rows, and the photo on the right is a no-till field of wheat direct seeded into corn stubble.

No tillage or reduced tillage are much more sustainable farming practices and promote healthier soils.



As reported in a Spud Smart article, a farmer in Manitoba, who experimented with direct seeding and minimal tillage in a potato field, harvested a crop statistically on-par with his conventionally planted fields.



## Soil Armor

- Cover crops
- Companion crops
- Crop residue
- Mulch



Soil armor is organic material that covers and protects the soil.  
Cover crops, Companion crops, crop residue, mulch



## Benefits of Soil Armor

- Controlling wind and water erosion
- Reduces evaporation rates
- Moderates soil temperature
- Reduces compaction
- Suppresses weed growth
- Provides habitat, food, and protection for soil biology



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Has anyone significantly increased their soil armor? Have you experienced these benefits?



These are two different farms in Indiana. The one on the left, is a clover cover crop direct seeded into corn stubble residue. The one on the right is corn crop that was direct seeded into residue from last year's soybean crop followed by a late seeding of annual rye grass that matted and died during the winter.



## Plant Diversity

- Diverse crop rotations
- Companion crops
- Multi-species cover crops



Plant diversity can be achieved by implementing diverse crop rotations, companion crops, and multi-species cover crops.



## Benefits of Plant Diversity

- Balanced microbiome
- Balanced soil chemistry
- Reduced diseases & pests



Benefits of plant diversity include:

A more well balanced microbiome from diversified crop residues, nutrient storage, and root exudates.

Improved soil chemistry from diversified root exudates

Reduced diseases & pests

Has anyone significantly increased their plant diversity? Have you experienced these benefits?



University of Nebraska conducted repeated trials on corn. Inner seeding a companion cover crop between rows of corn during the V4-V7 stage with a seeding rate of 10-14 pounds per acre.

Seventy five percent of the fields where this was done have shown a yield increase.



## Continued Live Plants & Roots

- Companion crops
- Multi-species cover crops



Live plant roots can be maintained in the soil by adding companion crops, and multi-species cover crops to your crop rotation.



## Benefits of Live Plants & Roots

- Carbon sequestration
- Reduces erosion
- Reduces compaction
- Stores and releases organic nutrients
- Enhances soil aggregation
- Increases pore space
- Provides habitat and food for soil biology



Benefits of maintaining live plant roots in the soil include:

Carbon sequestration, reduces erosion, reduces compaction, stores and releases organic nutrients, enhances soil aggregation, increases pore space, provides habitat and food for biology

Has anyone significantly increased their continuation of live plants and roots in the soil? Have you experienced these benefits?

How many species in your cover crops?

Native species?



This is a cover crop blend I used in Utah following wheat. The wheat was harvested on July 10<sup>th</sup>. The 7 species cover crop was planted on July 12<sup>th</sup>, and these photos were taken end of September.



## Livestock Integration

- Fall or winter grazing
- Rotational grazing
- Organic amendments



Animals have always played a vital roll in soil health.

The most widely used approaches to integrating livestock into the crop rotation is through fall or winter grazing, rotational grazing, or adding organic soil amendments that include animal waste as a primary ingredient.



## Benefits of Livestock Integration

- Diversify revenue streams
- Relief from perennial grasslands
- Reduces nutrient export from our croplands by grazing in place
- Balance C:N ratio of crop residues
- Carbon sequestration
- Diversify soil biology



Benefits of livestock integration include:

Diversify revenue streams

Relief from perennial grasslands

Reduces nutrient export from our croplands by grazing in place

Balance C:N ratio of crop residues

Carbon sequestration

Diversify soil biology



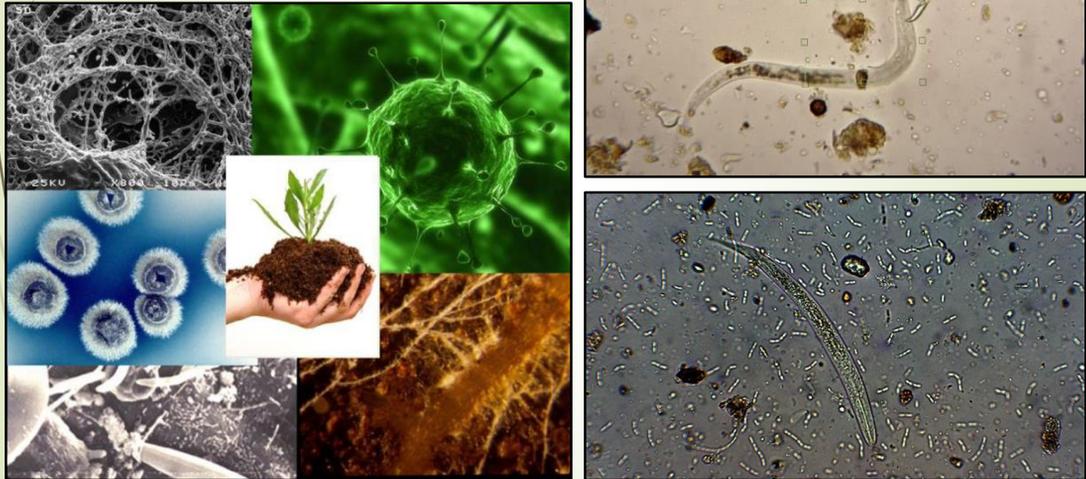
Here is a photo of livestock grazing corn stubble.



What do we gain from the all mighty cow pie and other organic waste?

Organic matter, and biology.

## Micro Life



Micro life. We can apply compost and compost extract to diversify the microbiome and animals that live there. The top right image is looking at a sample of a bacteria dominated soil with a predatory nematode. The bottom right image is looking at a sample of a fungal dominant soil with a bacteria feeding nematode. Ideally we would produce a compost or compost extract that is fungal dominated with high diversity and population of microbes.

What do we gain from these little critters?

- Nutrient cycling
- Balanced nutrient uptake
- Protection from pathogens and disease



There are about as many different approaches to making compost as there are compost piles. Unfortunately, not only is each pile unique, each pile is unique as to its output.

A good compost pile will contain 75,000 species of bacteria, 25,000 species of fungi, 1,000 species of Protozoa (Flagellates, Amoebae, Ciliates), 10-100 species of Nematodes (Bacterial Feeding, Fungi Feeding, Predatory).

The key to this approach to composting is layered ingredients proportioned to balance the Carbon to Nitrogen ratio. Monitoring temperature and oxygen levels to determine frequency of turning. For smaller piles like these, I would refer you to Elaine Ingham and soil food web for guidance.



Another approach to composting involves a stagnant, pile that is established with an automatic aeration system that aerates based on temperature.

Keys to this approach include metered ingredients proportioned to balance the Carbon to Nitrogen ratio, large and small particle sizes, pre-moistened and homogeneously mixed ingredients, temperature based aeration, 12" 'organic matter cap' and screening of final product.



The same principles for small compost piles apply to large piles. Match ingredients with similar breakdown rates. Depending on your available ingredients, you may need to stage or prepare ingredients ahead of time in a pre-composting step prior to blending with your final pile so that all ingredients can compost at a uniform rate. Ingredients should be added proportionately to balance the Carbon to Nitrogen ratio (25-30 to 1). Evenly moisten and homogeneously mix ingredients, turn the pile based on temperature and CO<sub>2</sub>/O<sub>2</sub> levels.

For larger composting operations like these, I would refer you to Midwest Biosystems for guidance.

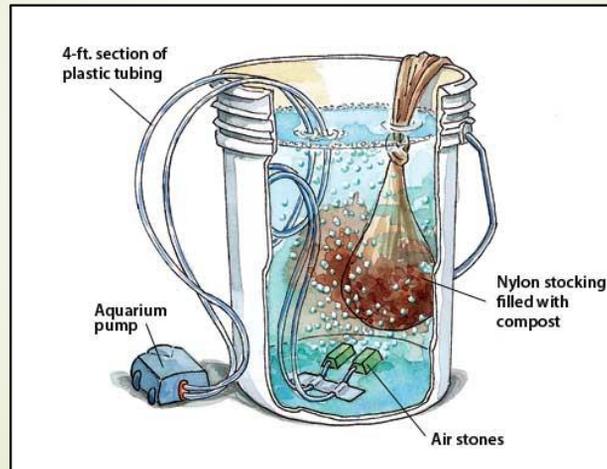
How much compost should be applied? 10-20 Ton /acre based on your nutrient management plan.



Regardless of your approach, in order to achieve a good living compost, you will need to manage the following aspects:

- Balanced proportion of ingredients to achieve optimum carbon to nitrogen ratio.
- Prepare ingredients beforehand to manage uniform digestion, wetness, and homogeneity of pile,
- Maintain optimum moisture in the pile.
- Maintain sufficient oxygen in the pile.
- Manage the temperature of the pile to be between 145 – 155 degrees F.

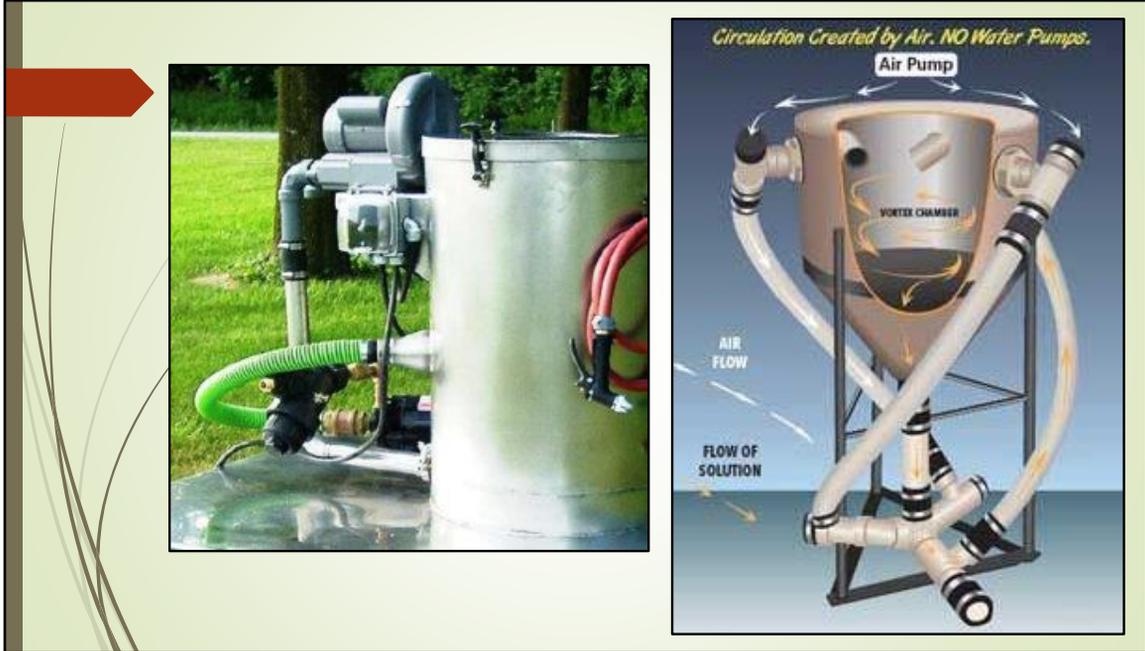
## Compost Tea



What is compost tea?

Compost tea is an extract of the compost wherein the microbes that exist in the compost are released into solution for ease of application.

If you are making a tea, allow to aerate for about 24 hours. If you are simply making an extract, gently agitate, and aerate for about 30 minutes.



Teas and extracts can be made in flat bottom tanks or cone bottom tanks. The nice thing about a cone bottom tank is that all ingredients are recirculated and do not settle out on the bottom of the tank.

However, I will caution you that the vortex style systems have a potential to be too aggressive and can kill your microbes. Hence, emphasis on the word gentle agitation & aeration.



Large batches of extract can be produced for large scale operations.



The best investment you will make is to establish a compost tea extraction system and the needed equipment to inject or spray compost tea every time you make a pass across your field.

Injecting microbes when subsoiling invigorates your soil and breaks up compaction.

Applying with seed at the time of planting, will inoculate your seed with beneficial microbes and will help to mitigate negative effects of soil disturbance.

This is a very economical way to breath life back into the soil.

I would apply 20 gallons per acre.



## Keys To Compost Extract /Tea

- Clean water source
- Diverse, living compost
- Careful about the food ingredients added
- Temperature
- Dissolved oxygen
- Moderate agitation



Keys to successful compost extract or tea:

- Water source (Neutral pH (6.8 – 7.2), No chlorine, No salts, No heavy metals)
- Start with fully finished, inoculant balanced compost (Fungal dominant or at least half and half fungal /bacteria with high diversity and high population)
- Be careful about the amount and type of food ingredients you add to the brew. (Fungal foods like fish hydrolysate, kelp, and brown organic materials will promote reproduction of fungal species. Bacteria foods like simple sugars and fresh greens will promote reproduction of bacterial species.)
- Temperature should be maintained between 70 – 90 degrees
- Dissolved oxygen level should be maintained > 6ppm
- Moderate agitation – enough to dislodge microbes off of the surface of compost but not so much that you kill the microbes.

# Soil Basics



The 5 principles of soil health...  
...and then some!



Naturally balanced, healthy soils are the key to resilient, high producing crops. Please feel free to give us a call or send an email with any questions you may have. We look forward to working with you and we are confident that together, we can gain a better understanding of your soil health and make the appropriate adjustments to improve the productivity of your farm.

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