Highest Quality Food Production with No Tillage, Mulching, Cover Cropping, using Animals in Rotation

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The Role of Soil Carbon

- You can't discuss raising healthy food without discussing carbon
- Carbon is the basic food for all life on the planet
- Carbon also hydrates soil. An acre of soil with 1% carbon stores over 20,000 gallons of water.
- Originally, many soils on earth were 10% or more carbon
- This carbon-rich world is the one in which plants, animals, and humans evolved

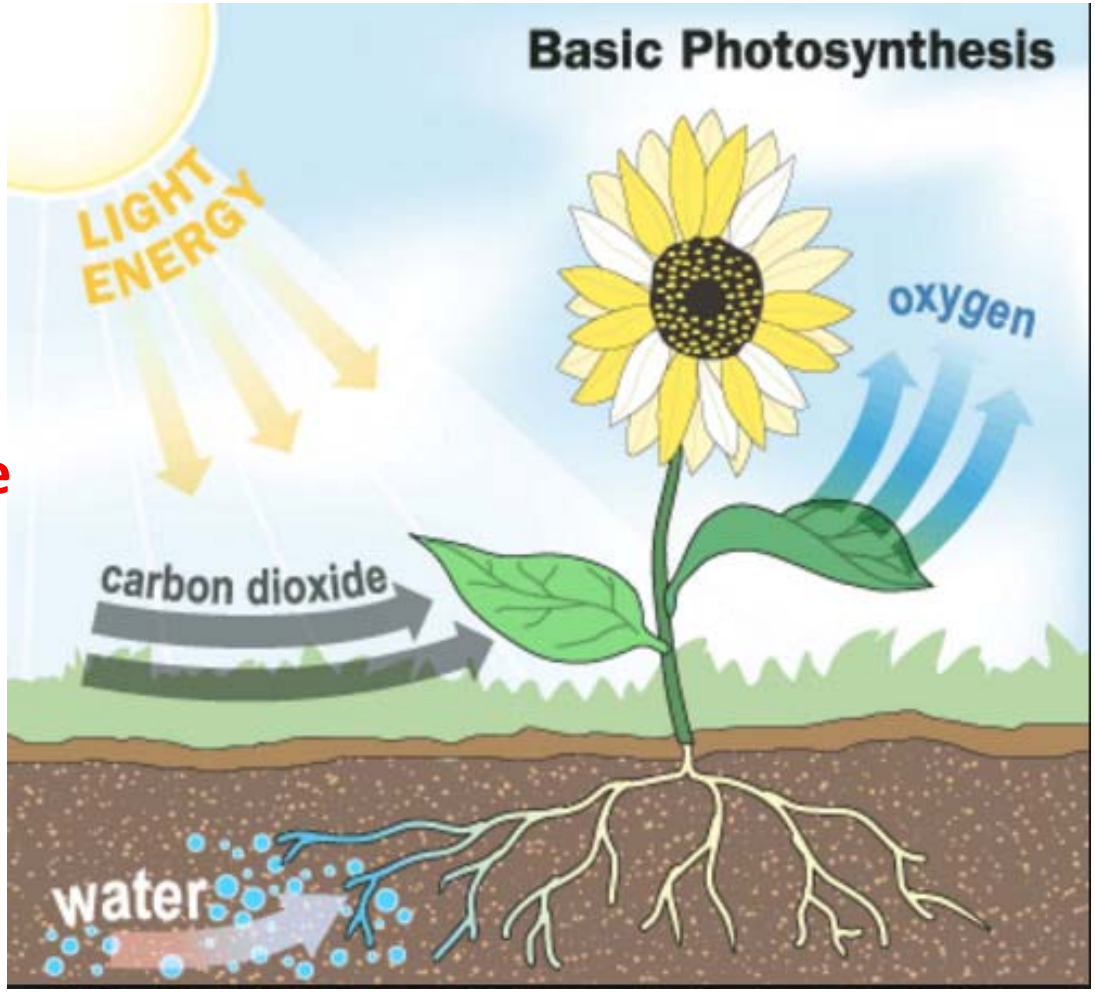
It is No Longer the Case, Tho

- Since human agriculture, much of that carbon has been oxidized and lost to the atmosphere
- It is no longer available to build healthy soil and plants
- In fact, combined with carbon dioxide from fossil fuel burning, those gases are now causing a damaging “greenhouse effect”

How exactly does carbon make healthy food?

Plants
(and nobody else!)
can take it out of the air, combine it with water, and make carbohydrates.

This is a big deal!



15% of all CO_2 moves thru photosynthesis in plants each year!
An acre of wheat makes 22,000 pounds of carbohydrates.

These carbohydrates are the basis of all food on earth.

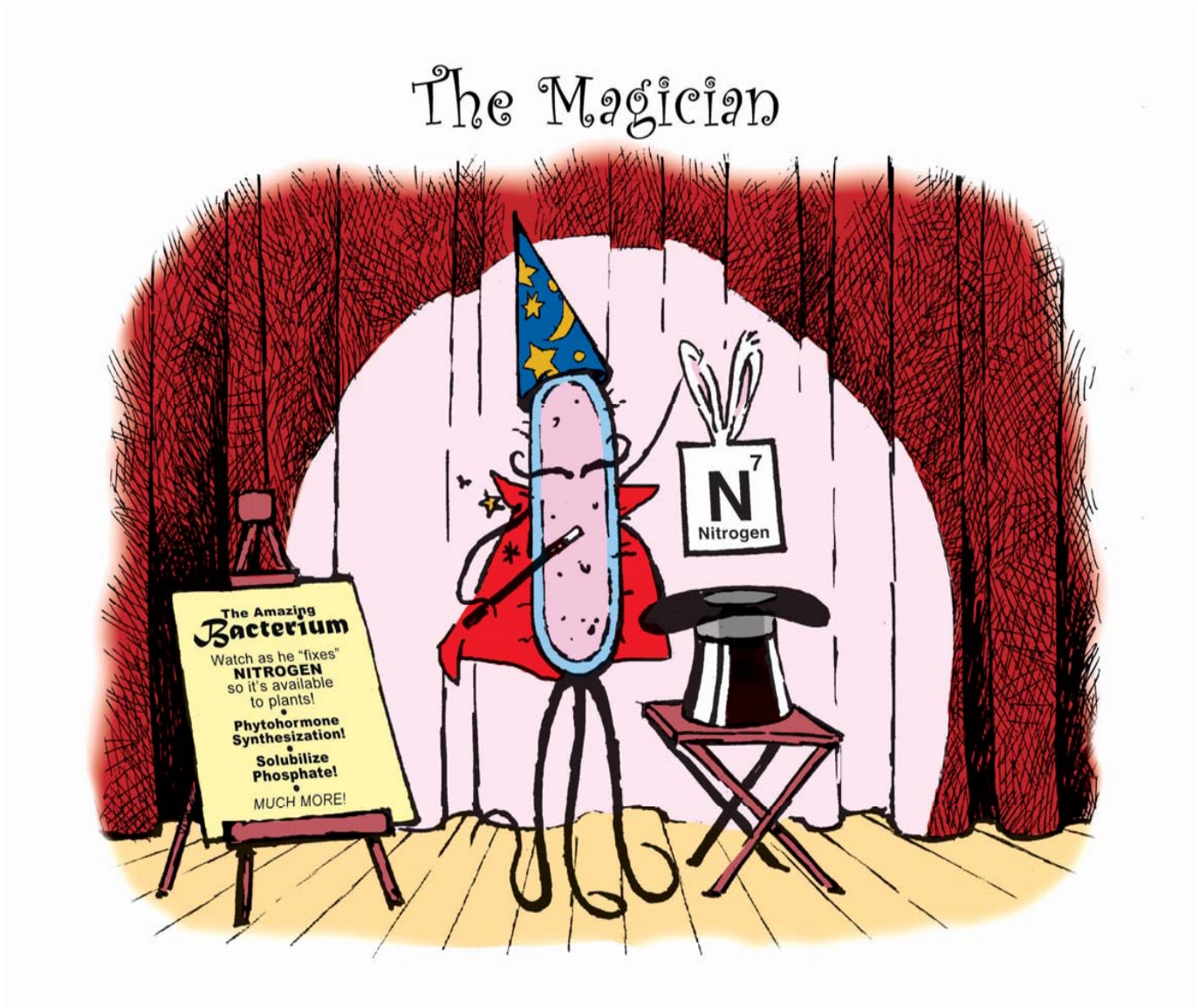
- Plants use them to build their bodies
- Animals eat plants to build their bodies
- Plants and animals live on the energy of consumed carbohydrates

As we learn more about soil, however, we are learning:

- Other creatures living in the soil, microbes, are crucial to creating healthy plants.

Who are these microbes?

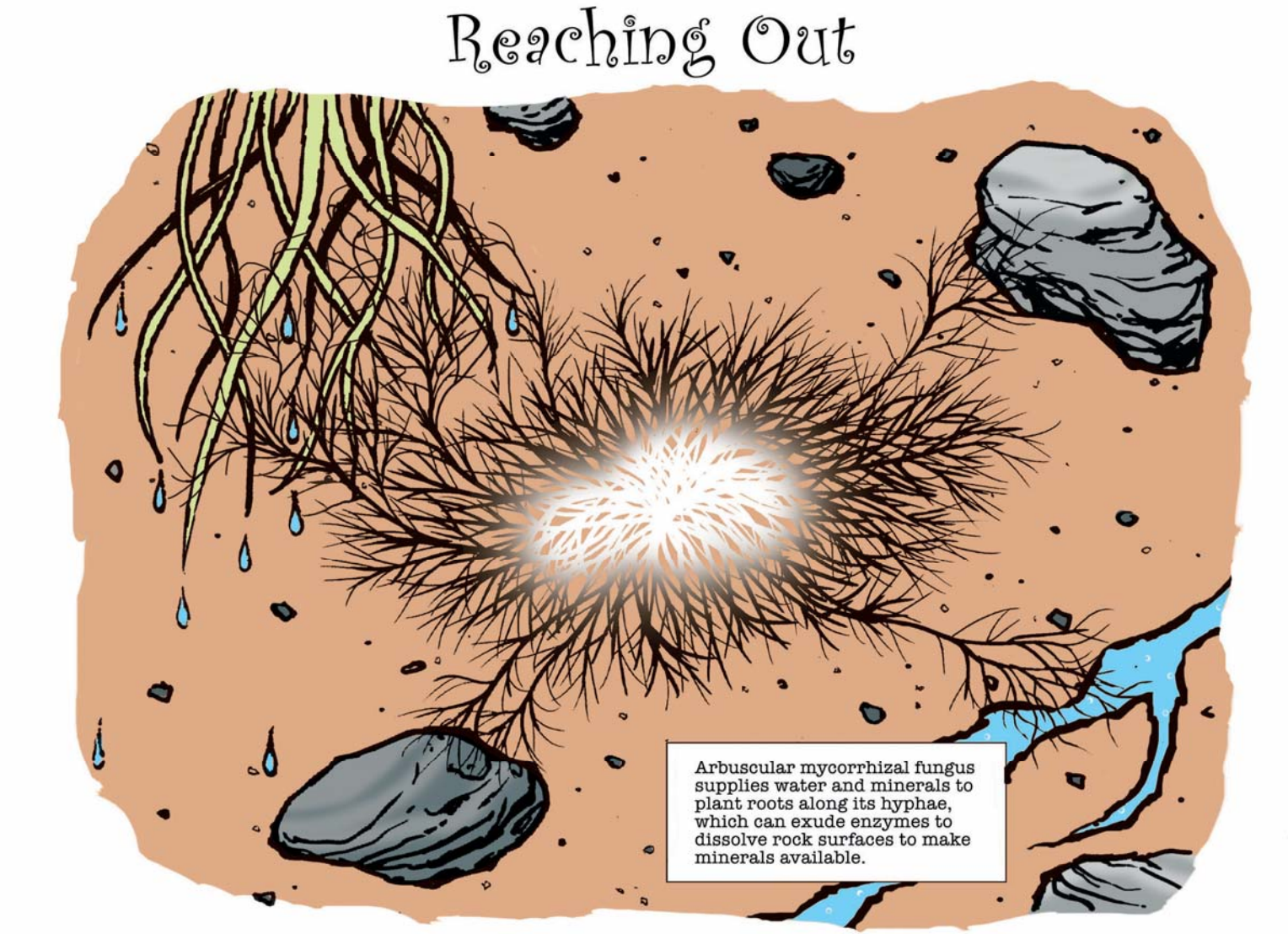
Bacteria are Nature's biochemists



Bacteria can help plants by:

- "Fixing" Nitrogen from the atmosphere
  (N_2 inert gas into ammonia NH_3)
- Synthesizing Plant Phytohormones (PGPH)
- Solubilizing Phosphate
- Producing Antibiotics and Fungicides
  (on demand by plant)
- Many, many more ways

Fungi are transport engineers



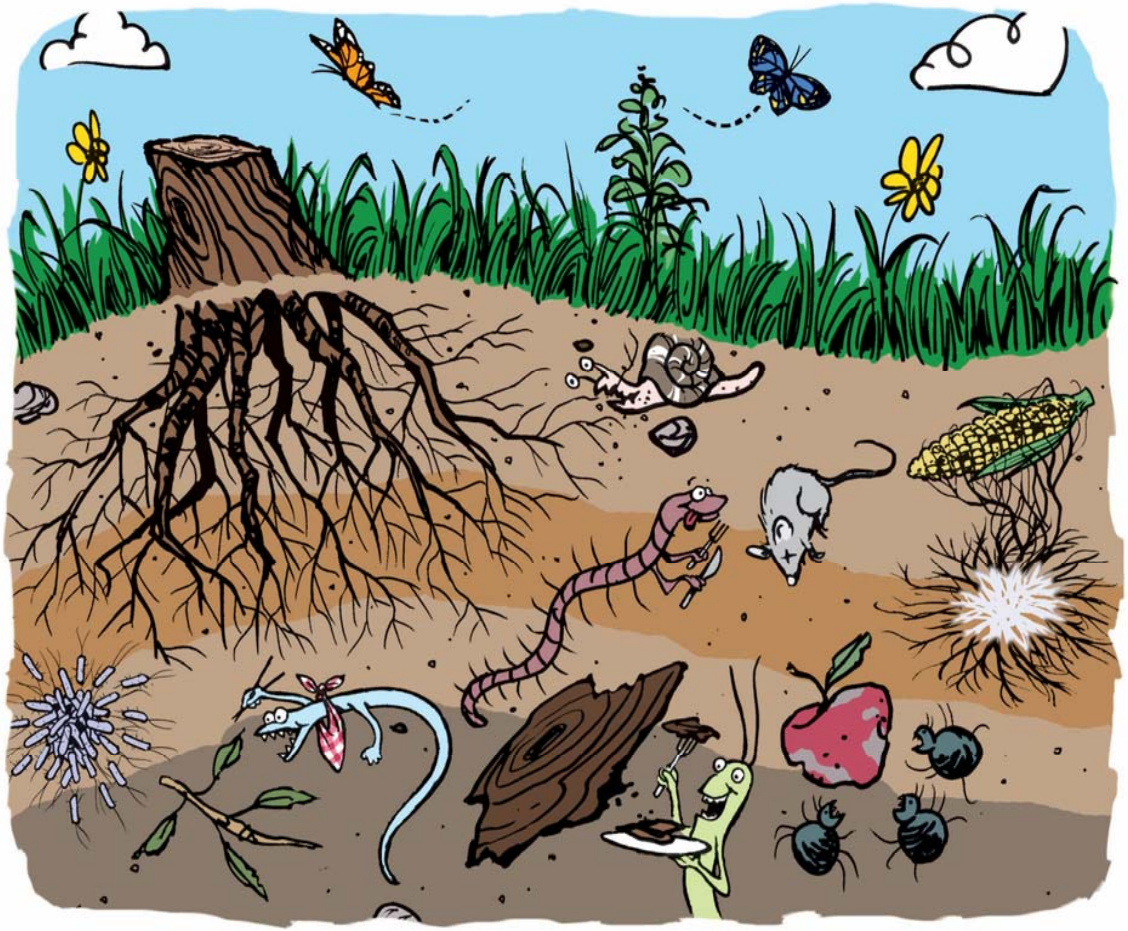
Fungi can help plants by:

- Dissolving soil minerals with enzymes
- Transporting minerals and water along hyphae to roots
- Producing glomalin, a glycoprotein which binds soil aggregates so they hold water and exclude oxygen, enabling bacterial biochemistry
- Many, many more ways

And myriads of other organisms form a “soil food web”

- Algae, protozoa, nematodes, micro-arthropods, earthworms, insects, small vertebrates and many others perform vital services, too.
- But they all need carbon to live and function

How can we get that carbon into soil?



Soil is hungry!

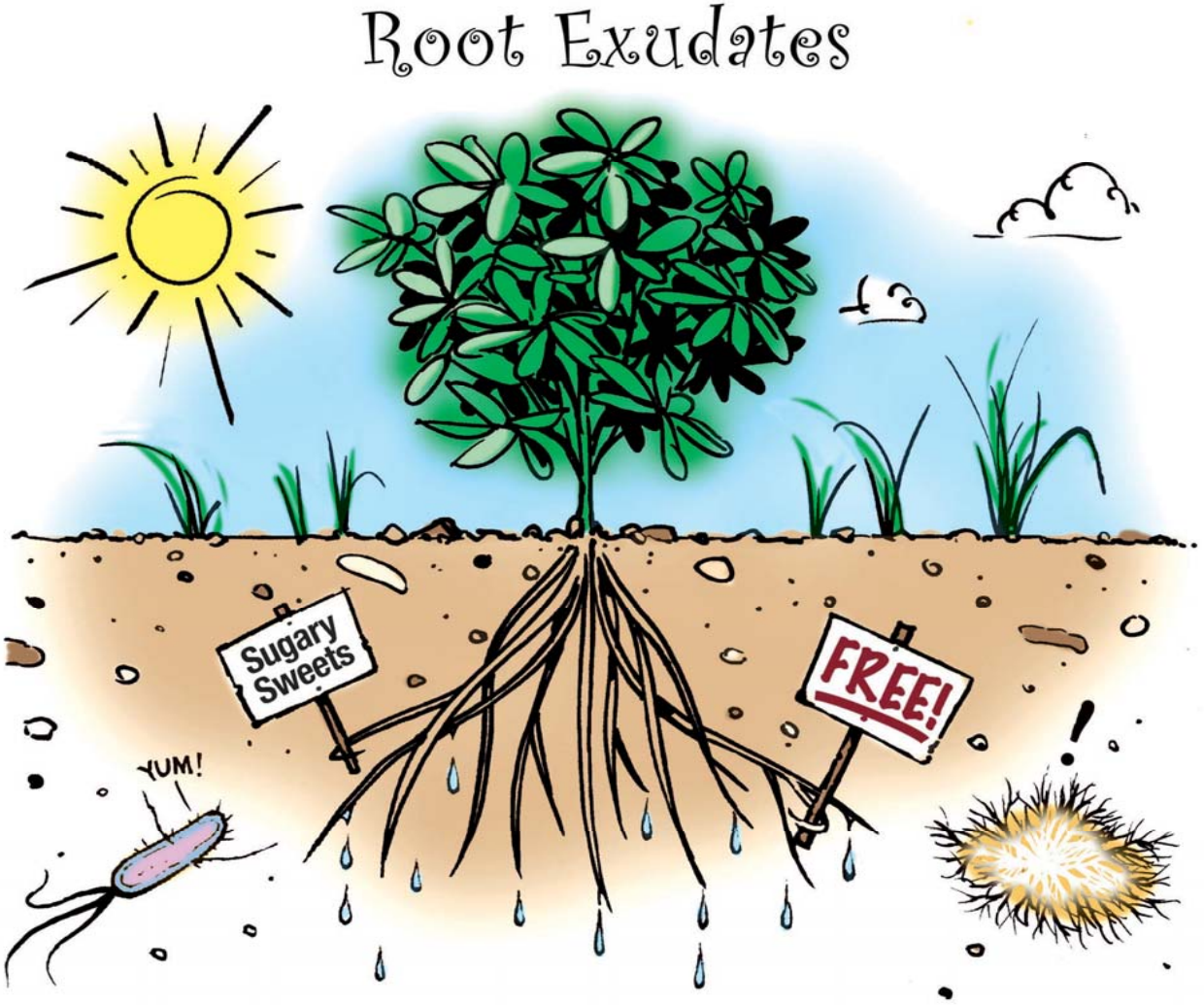
1000 lbs. of microbes live in every acre!

Plants & microbes have made a deal!

- Bacteria, Fungi and the other soil organisms will help plants thrive in exchange for carbohydrates
- Plants will supply carbohydrates as long as soil organisms are providing useful services

It is called “symbiosis”

To supply those carbohydrates, plants, exude them from their roots



It's a fact: 20% to 50% of the carbon a plant photosynthesizes is exuded (leaked) out of it's roots into the soil!

- The carbon attracts hungry soil organisms
- Those organisms eat it
- They want more
- Stronger plants exude more carbon
- The microbes have evolved ways to help plants grow stronger
- More microbes are attracted, come to the feast, etc.
- Plants are Nature's only source of food
- We aren't the only ones farming them!

If you take away anything from this presentation, it should be this:

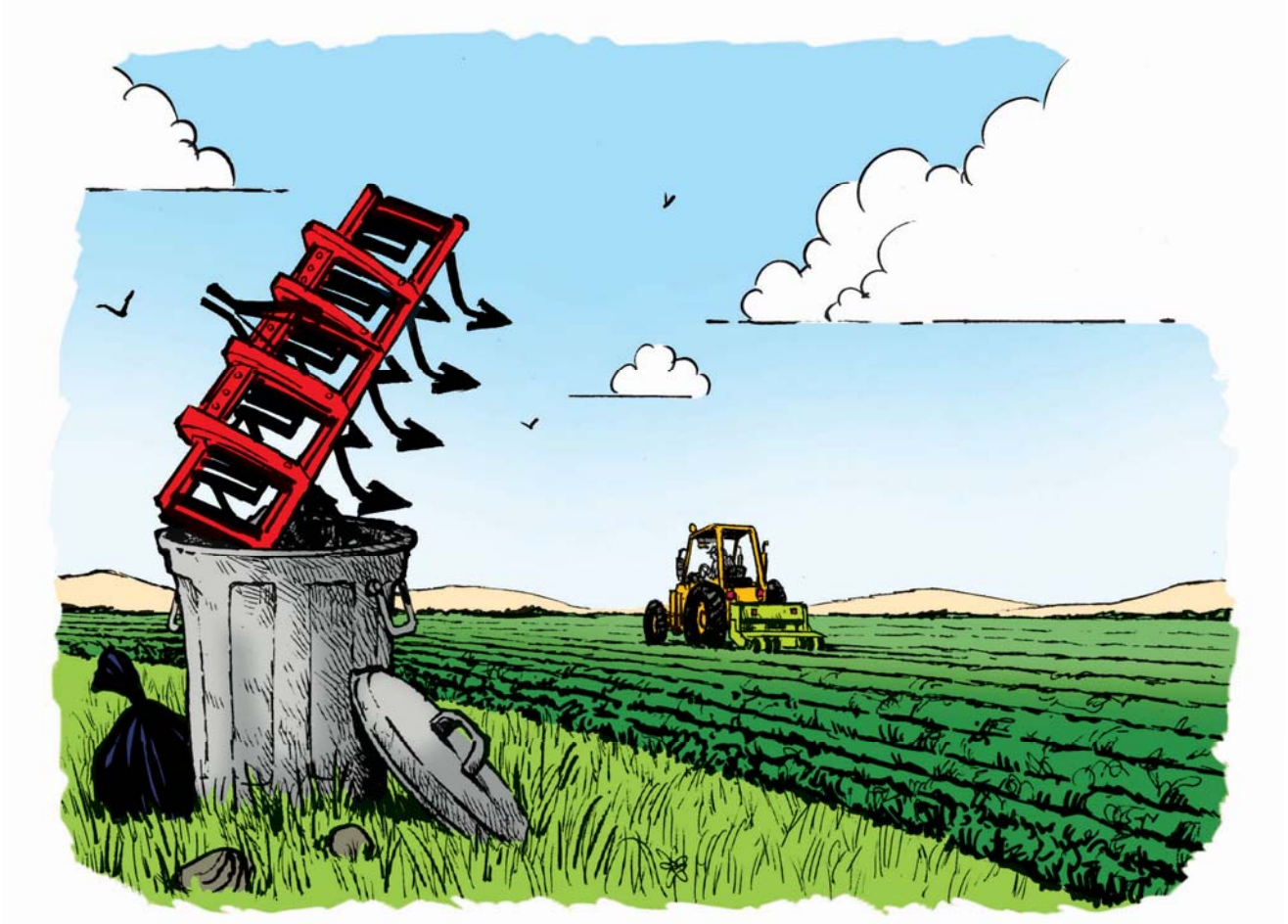
Many scientists believe 85% to 90% of plant nutrients are acquired thru symbiotic carbon exchange with soil microbes

How can we build better soil biodiversity, and thus more and healthier plants?

Maximize Carbon Flow to Soil

- Keep soil green so carbon always pumping in
- Keep soil covered to protect from rain & erosion
- Never let soil be brown, oxidizing carbon to air
- Shun chemicals, they destroy microbial activity
- Use cover crops before, after, around crops
- Rotate with animals, diverse crops for soil health
- Minimize tillage

Minimize tillage



Tillage

- shreds fungal networks and destroys fungi
- exposes soil to oxidation and loss of carbon
- creates plow pans, destroys soil aggregates (pea-like structures that protect microbes and enable bacterial processes such as N fixation, phyto-hormone creation)
- creates a large flush of annual weeds

Keep land covered with green plants

Green Plants

- drive the soil economy
- cover soils, prevent oxidation and erosion,
- loosen soil, aid infiltration

Keep Soil Covered

Rain drops, surface flows and wind are highly erosive to soil. Sufficient litter cover maintains top soil and carbon, improves germination, and increases soil moisture.

No chemicals

Chemicals

- Kill microbes, acidify soil
- Stunt root growth, minimize carbon exudation, decrease plant-microbe symbiosis

Utilize diverse cover crops

Cover Crops

- Maintain photosynthesis
- Cover soil

Rotate/diversify crops and livestock

Crop/ Livestock Rotation

- Nutrient diversity
- Disease prevention

What it is all about!

Many Hands Organic Farm

Mixed Animal and
Vegetable operation – Barre, MA
55 acres (14 open),
3 acres annual vegetables,
1 acre orchard, small fruit,
200 meat birds, 3 cows, 3 pigs,
100 turkeys, 200 layers, shiitakes,
Certified Organic since 1987

Maximize Photosynthesis for Healthy Productive Crops

- **Nutrition**
- **Soil Carbon and Biology**
- **Educational Resources**

Nutrition practices on our farm

- Albrecht Soil Balancing of major cations – Ca, Mg, K, Na and then then important anions like S, P, and the micronutrients – notably – Cu, Fe, Zn, Mn, Co, Se, Mo – Logan labs – NOFA/Mass can help
- At planting – drenching with complete nutrition, worm castings, fungal composts, bacterial composts, a good blended organic fertilizer
- Regular foliar feeding – fungal inoculants, liquid fertility products (be careful of too much N -fish), but embrace kelp/seaweed
- Targeted foliar feeding at critical points of plant growth
- Targeted use of salt in drench during excessive rainy or cloudy periods
- Side dressing of ash for slugs – a management issue with early adoption of no till
- Rotating in animals whenever possible – 120 organic certification rule

Soil Carbon and biology

- Manage from the top down like the forest does
- Minimal to no soil disturbance
- Green as long as possible – with living pathways in gardens, cover crops whenever you can, mobstocking for animal management
- Foliar microbial digesters before cropping – AEA, Agri-Dynamics
- Seed treatment of bacteria and fungi – many sources
- Sugar/molasses when things are slow – drench or foliar – sugar on soil can work wonders with toxic clean up also – followed by cover crops

Educational Resources

- NOFA/Mass – www.nofamass.org
  - /carbon
  - /soil-technical-assistance-program
  - /events
  - /webinars
  - /podcasts
  - The Natural Farmer – thenaturalfarmer.org
  - Advancing Eco Agriculture – advancingecoag.com- business side for fertility, also webinars and podcasts for education
  - Amazingcarbon.com – Christine Jones – my first mentor
  - Agri-Dynamics – product – agri-dynamics.come

Economical Drench set up – Brookdale Fruit Farm, Hollis, NH

Gasoline Powered foliar feeding

Korean Natural Farming Compost – search NOFA/Mass site

Johnson-Su Composter – David Johnson

Home brewed microbes for foliars

Animals in Rotation

- Pre and post season in vegetable areas
- Throughout the season in hayfields/pasture, woods edges (and in the woods for pigs), in orchards
  - Mob stocked to build maximum fertility and for animal health
- Free range chickens around small fruit plantings in off season

Preparing a pasture for No till

Cardboard, leaves and hay

Wood ashes for slug control

Cover Crops as under sown mulch

Managing under sown Crimson Clover

Lettuce under sown with winter kill cover crops

Chip or hay mulch over planted with crimson clover

Pre-season Cover Crops

Wood chips for perennials

Free Wine Caps

No Till Potatoes and Inadvertent mulch experiments

Lessons Learned and Plans Going Forward
Remember Maximum photosynthesis as main goal

- Sold the tiller and bed former! Enter the rogue how
- More intricacy with in season under sown cover crops – cocktails when possible, pre-season cover crops
- Prioritize animal rotation in animal and perennial system
- Heavy cardboard mulch with dead something cover for a period of time can recharge an area and bring back the earthworms and company
- Source cheap and free mulch hay, etc. when possible
- Make and use composts and inoculants and bio-stimulants
- Prioritize foliar feeding –John Kempf - AEA
- Innovation, innovation, innovation – side by side trials
- Mulch as soon as you can – oversow with cover crops when possible
- Mulch perennials with chips: Mulch annuals with hay, leaves, straw, etc.;
- Embrace grass pathways
- Planning for next year starts this year – no later than September 1 as I select winterkill vs. overwinter covers


That's All
Folks!