Biological Diversity

What is it?

How does it work?

How do we create it?

Organisms in a Gram of Soil

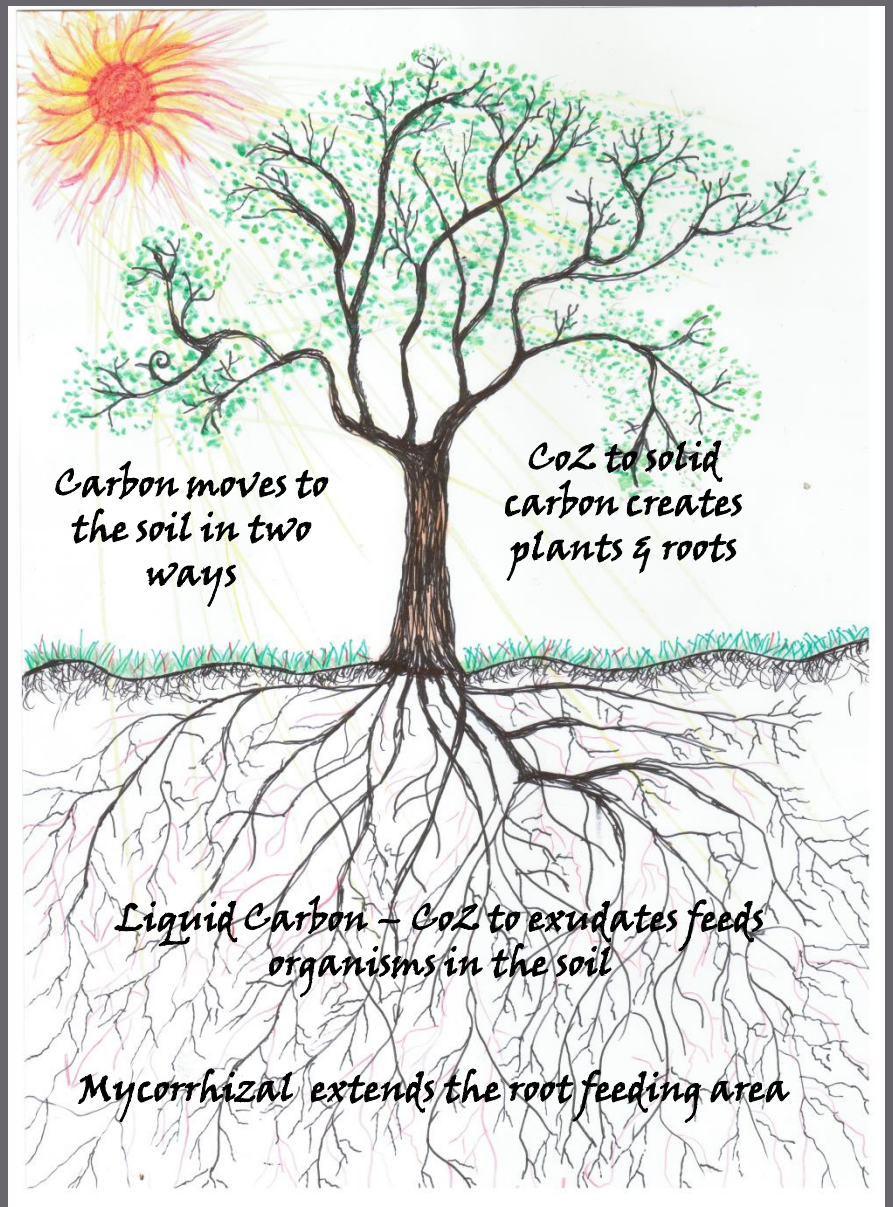
There are up to 10 billion bacterial cells inhabit each gram of soil in and around plant roots, a region known as the rhizosphere.

A single handful of soil contains in excess of 500 species of fungi and potentially more than 50km of fungal mycelium.

There are 10 000 species and a staggering 100 billion individual specimens of bacteria

THE PLANT-SOIL-ATOMOSPHERE RELATIONSHIP

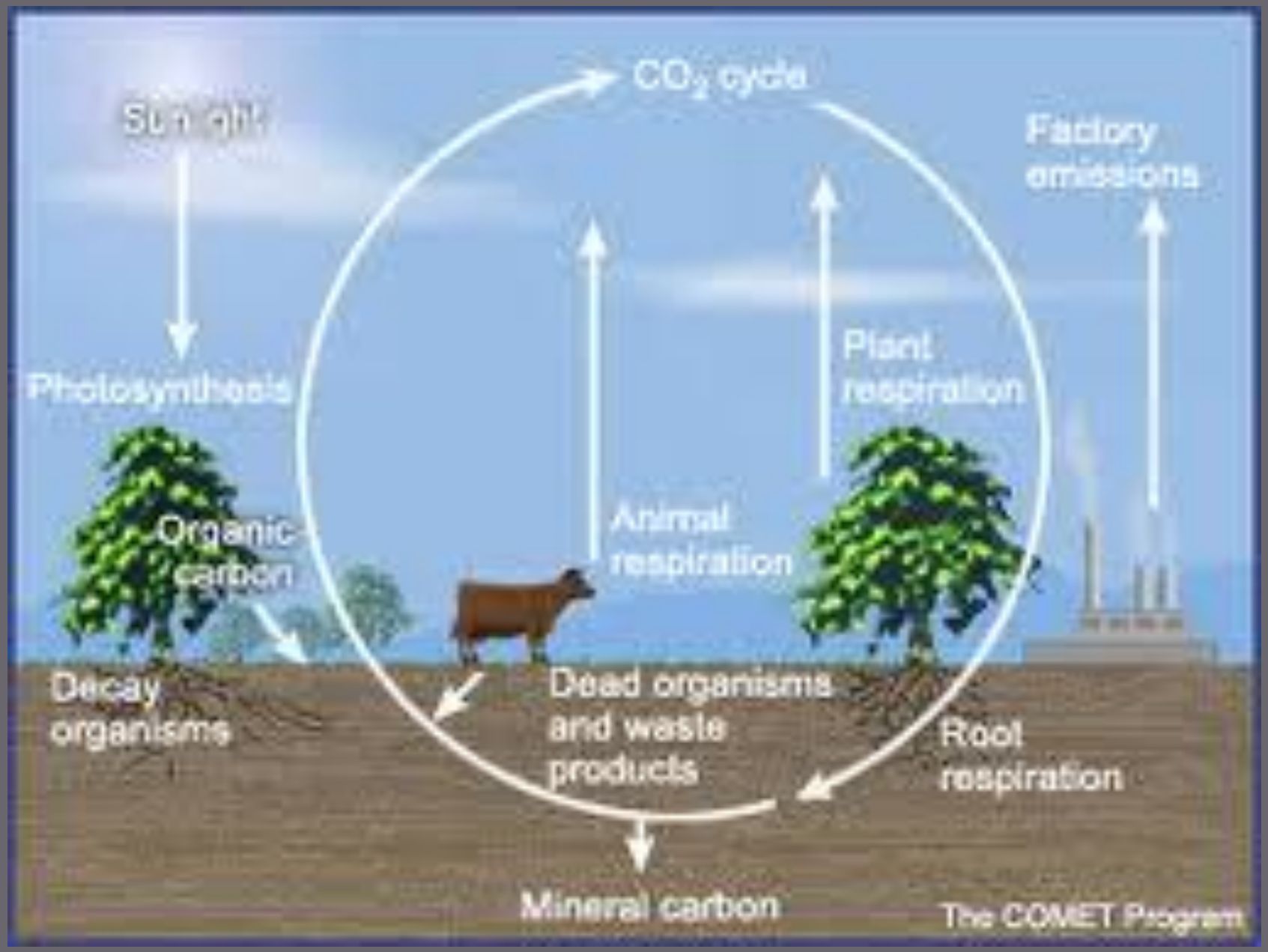
How the Soil Works



Through photosynthesis, plants gather and deliver nutrients to the soil in exchange for the nutrients they need to grow. But this is only the beginning of an amazing and complex relationship that creates the world we know.

The Carbon Cycle

The **carbon cycle** is the biogeochemical cycle by which carbon is exchanged among the biosphere, pedosphere, geosphere, hydrosphere, and atmosphere of the Earth. It is one of the most important cycles of the earth and allows for carbon to be recycled and reused throughout the biosphere and all of its organisms

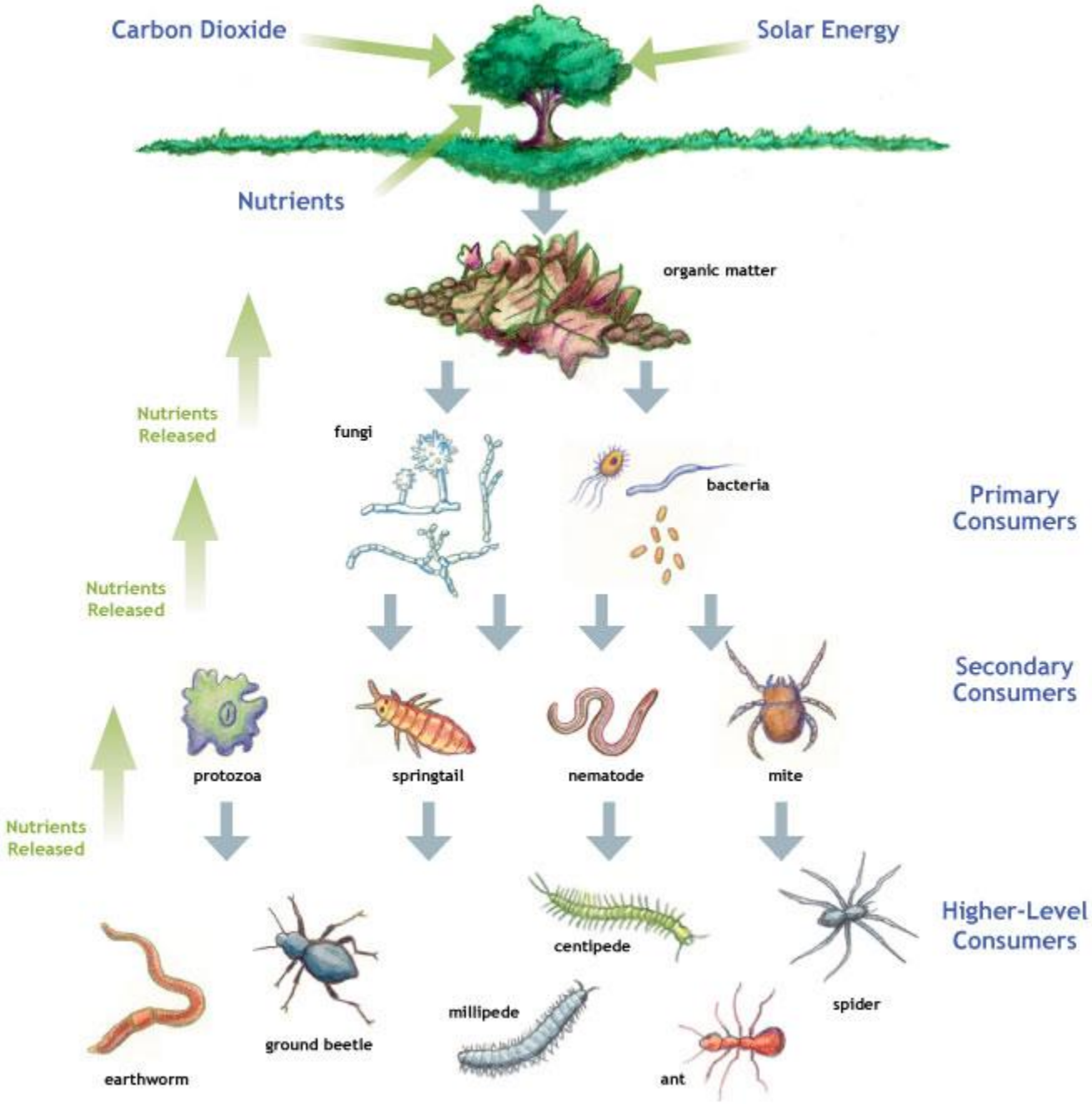

CO_2 cycle
Sunlight
Factory emissions
Photosynthesis
Plant respiration
Organic carbon
Animal respiration
Decay organisms
Dead organisms and waste products
Root respiration
Mineral carbon
The COMET Program

Photosynthesis

- Photosynthesis is a chemical process that converts carbon dioxide into organic compounds, especially sugars, using the energy from sunlight.

$$6CO_2 \text{ Carbon dioxide} + 6H_2O \text{ Water} \xrightarrow{\text{Light}} C_6H_{12}O_6 \text{ Sugar} + 6O_2 \text{ Oxygen}$$

Carbon Dioxide is approximately .0387% of the air we breath


Carbon Dioxide
Solar Energy
Nutrients
organic matter
Nutrients Released
fungi
bacteria
Primary Consumers
Nutrients Released
Secondary Consumers
protozoa
springtail
nematode
mite
Nutrients Released
Higher-Level Consumers
centipede
spider
millipede
ground beetle
earthworm
ant

Plants are in Charge

Through photosynthesis plants gather and deliver nutrients to the soil in exchange for the nutrients they need to grow. But this is only the beginning of an amazing and complex relationship that create the world we know.

Building Carbon in the Soil

The plant builds carbon in the soil through photosynthesis. This happens in two specific ways:

- The plant turns carbon dioxide into carbon in the plant and its roots
- The plant sends carbon straight to the soil through the liquid carbon pathway

CO2 to Carbon in the soil

- Carbon is taken in by plants through photosynthesis
- It is converted to carbon and held in the plant's trunk, branches, leaves, flowers and roots
- It becomes food for microorganisms
- The microbes turn the carbon into soil

CO2 to Liquid Carbon

- Photosynthesis
- Resynthesis
- Exudation
- Humifcation

Photosynthesis

- The conversion of CoZ to Carbon

Resynthesis

- This is the process whereby the sugars from photosynthesis is then converted or 'resynthesised' into a wide variety of carbon compounds, including proteins, organic acids, waxes, and oils

Exudation

- This is where the carbon compounds are delivered into the soil.

Humifcation

- This is where microorganisms convert the compounds to humus.

Sugar-Water/Mineral exchange

- This mutualistic association provides the fungus with relatively constant and direct access to carbohydrates such as glucose and sucrose supplied by the plant.

- The carbohydrates are translocated from their source (usually leaves) to root tissue and on to fungal partners. In return, the plant gains the benefits of the mycelium's higher absorptive capacity for water and mineral nutrients (due to comparatively large surface area of mycelium: root ratio), thus improving the plant's mineral absorption capabilities.

- Plant roots alone may be incapable of taking up phosphate ions that are demineralized, for example, in soils with a basic pH. The mycelium of the mycorrhizal fungus can, however, access these phosphorus sources, and make them available to the plant through exchange.

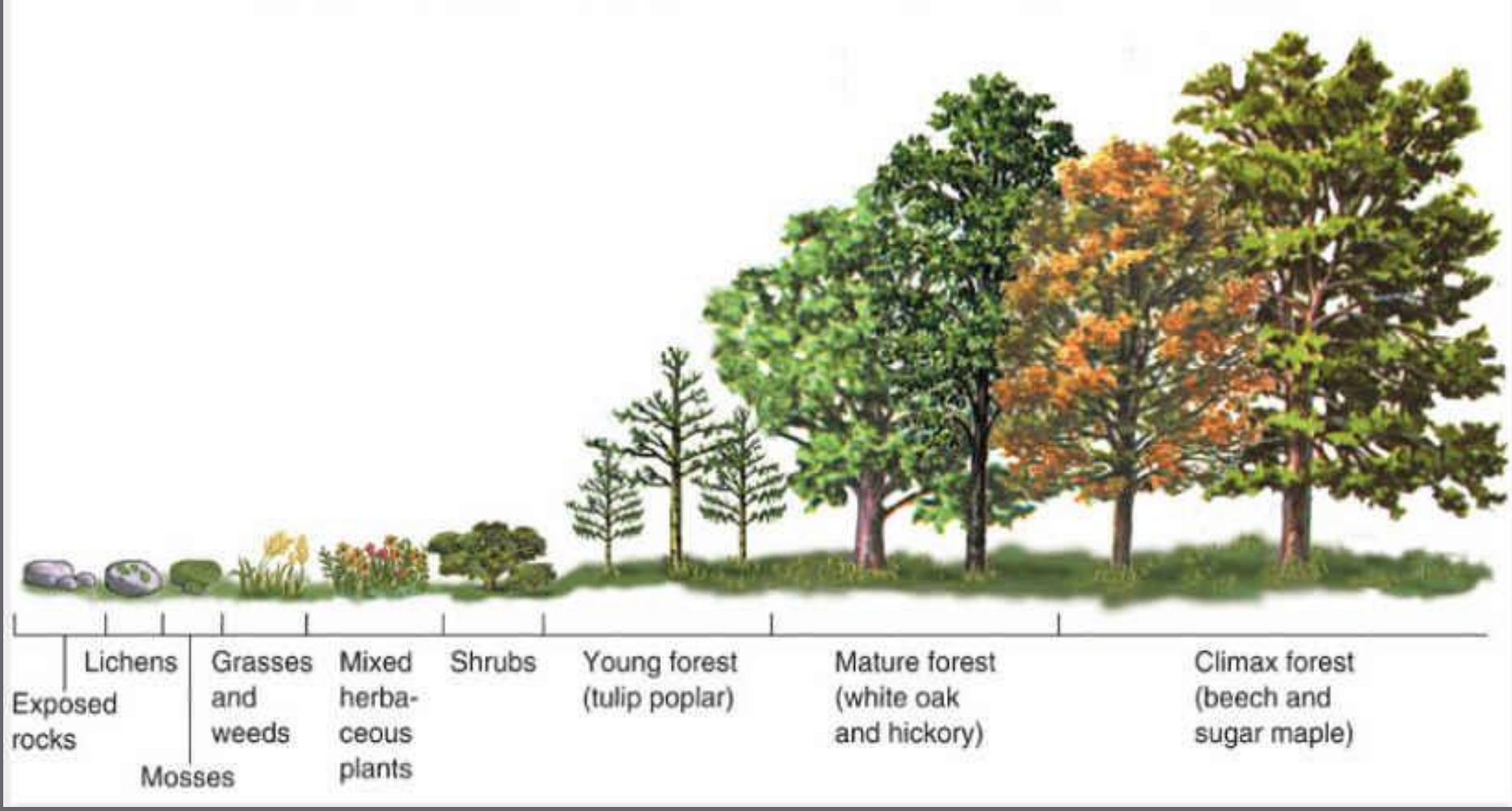
Mycorrhiza Fungi

A **mycorrhiza** is a symbiotic (generally mutualistic, but occasionally weakly pathogenic) association between a fungus and the roots of a vascular plant. Mycorrhiza are commonly divided into two types

<u>Ectomycorrhizas</u> fungi do not penetrate individual cells within the root

<u>Endomycorrhizas</u> penetrate the cell wall and invaginate the cell membrane

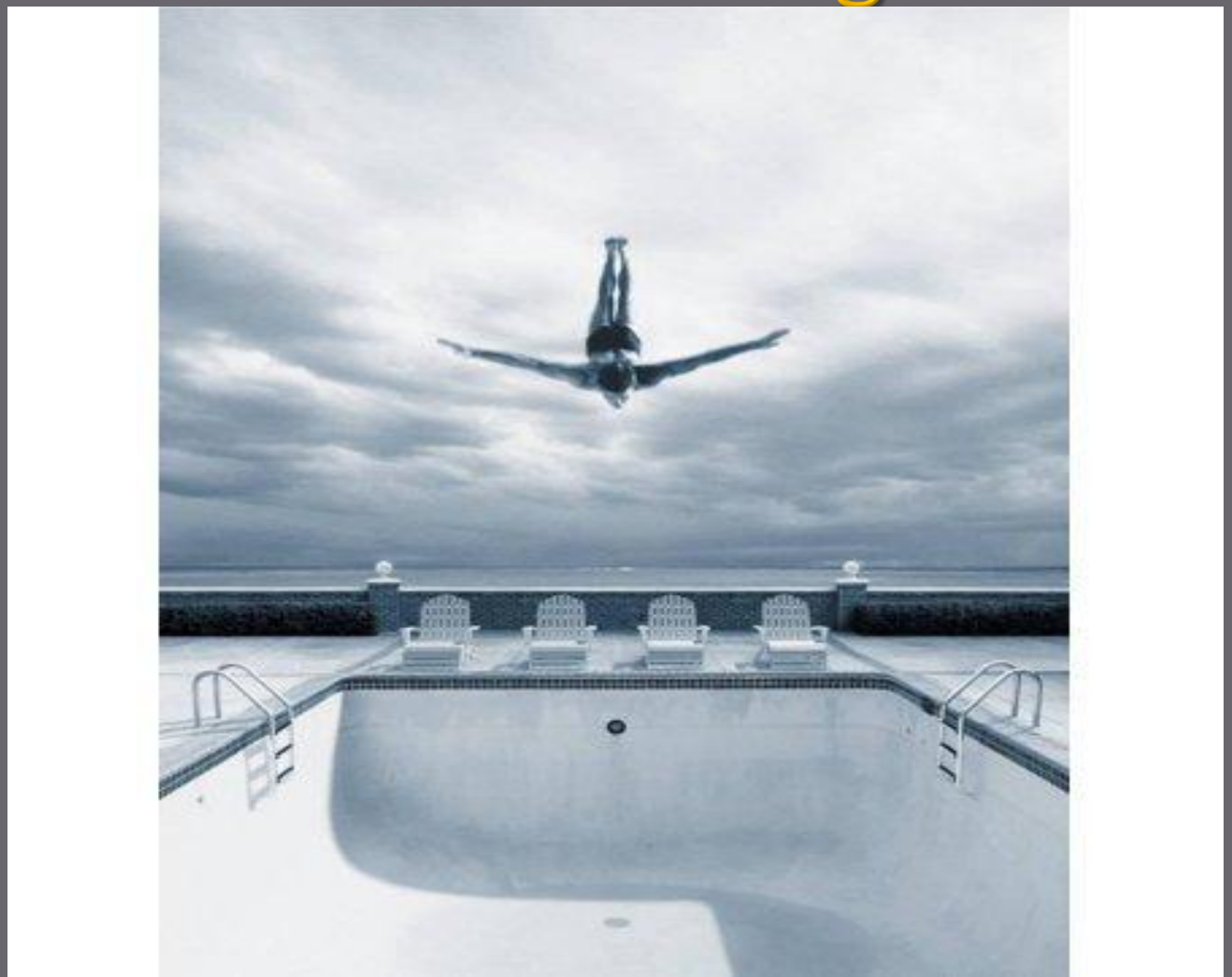
Plant Succession



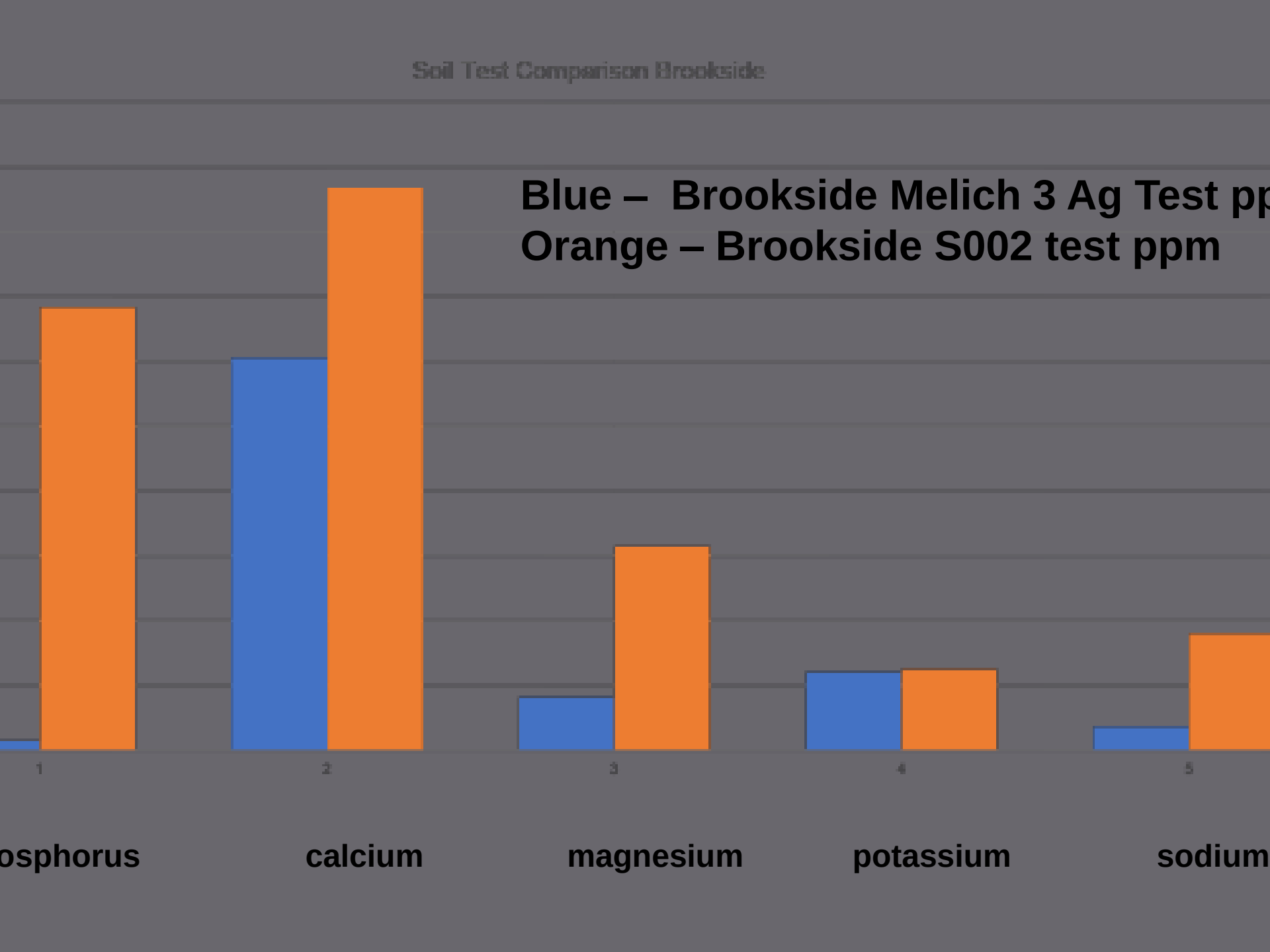
1/1000 fungal to Bacterial ration 1000/1

Soil Testing - a snap shot in time
Looking Good

But your farm is a dynamic moving picture snapshots can be misleading



kside mps	Waihi	compos ite	totals SOO2 Test	ppm + -	% + -	2004	2011	2013	Differe nce betwe en 2004 &2013	total Percent age differen ce	% per year
	10.67	10.7				13	10.5	10.67	-2.33	-17.92%	
er	6	6.3				5.8	6.1	6	0.20	3.45%	
	5.8	5.9				5.2	5.2	5.8	0.60	11.54%	
matter	14.22	15.61				11.87	10.13	14.22	2.35	19.80%	
	15	14				30	15	15	-15.00	-50.00%	
orus											
3 ppm	28	29	1368	1340	4785.71 %			28			
pm	69	56				108	42	69	-39.00	-36.11%	-3.61%
om											
	1233	1211	1736	503	40.79%	1140	859	1233	93.00	8.16%	0.82%
ium	140	165	631	491	350.71%	138	76	140	2.00	1.45%	-3.61%
um	186	242	251	65	34.95%	200	142	186	-14.00	-7.00%	-0.70%
	68	72	361	293	430.88%	57	67	68	11.00	19.30%	1.93%


Soil Test Comparison Brookside
Blue – Brookside Melich 3 Ag Test pp
Orange – Brookside S002 test ppm
1
2
3
4
5
osphorus
calcium
magnesium
potassium
sodium

MINERAL COMPOSITION AND NUTRITIVE VALUE OF SOME COMMON PASTURE WEEDS

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- MINERAL COMPOSITION AND NUTRITIVE VALUE OF SOME COMMON PASTURE WEEDS
- TABLE 1: The macronutrient composition (% of dry matter) of pasture and weed
- species from organic dairy pastures. Figures in bold are significantly

	N	P	K	S	Ca	Mg	Na
perennial ryegrass	3.77	0.37	3.8	0.347	0.42	0.173	0.182
white clover	**4.56**	0.347	2.83	0.213	1.19	0.237	0.205
chicory	4.35	**0.663**	3.8	**0.627**	1.18	0.393	0.591
narrow-leaved plantain	3.37	0.48	1.97	0.53	1.77	0.253	**0.618**
broad-leaved dock	**4.5**	0.43	**4.1**	0.287	0.8	**0.52**	0.026
Californian thistle	2.8	0.357	2.93	0.57	**1.87**	0.307	0.047
dandelion	3.6	0.57	3.43	0.393	0.96	0.353	0.42
hairy buttercup	2.93	0.457	3.03	0.323	1.16	0.25	0.433
Yorkshire fog	2.7	0.4	3.2	0.26	0.36	0.173	0.175
LSD ($P<0.05$)	0.84	0.071	1.06	0.148	0.473	0.074	0.161

TABLE 2: The micronutrient composition (mg/kg) of pasture and weed species from organic dairy pastures. Figures in bold are significantly higher than in either perennial ryegrass or white clover.

	Fe	Mn	Cu	Zn	B	Co	Se	Mo
perennial ryegrass	151	99	7.9	22	19	0.193	0.023	0.64
white clover	109	55	8.6	22	28.7	0.173	**0.073**	0.223
chicory	167	161	**18.6**	**57.7**	**38.3**	0.273	0.043	0.42
narrow-leaved plantain	**182**	109	15.1	37.7	23.3	0.36	0.053	0.27
broad-leaved dock	95	**283**	7.6	30.7	23	**0.56**	0.047	0.42
Californian thistle	139	120	17	41.7	29.3	0.33	0.033	0.21
dandelion	115	93	14.2	37	35	0.18	0.043	0.373
hairy buttercup	117	150	18.4	41.7	27.7	0.253	0.043	0.497
Yorkshire fog	116	142	5.7	19.3	16	0.163	0.027	**1.243**
LSD ($P<0.05$)	67	70	2.8	12	5.4	0.105	0.075	0.261

Dynamic Accumulation of Minerals in Plants

- The idea that plants can accumulate certain minerals in their bodies is well documented in Dr James Duke's Phytochemical and Ethnobotanical Databases. This link has an extensive list of plants and the minerals they tend to accumulate: https://phytochem.nal.usda.gov/phytochem/help/index/about
- But this is only part of the power plants have to change the soil and feed the microbiology in the soil. There is also a biological component and an energetic component, but these two are very poorly understood.
- In developing the plant extract program on our farm we paid attention to not only the references about plants and minerals, but also what we saw taking place on our farm as we applied these extracts

The Biological Engine

- Although it is the sun driving this system it is the plant that is in charge. The plant through its relationship with the soil and atmosphere and the help of the trillions of microbes that surround it are what fire up the biological engine.

How to Build Biological Diversity

- Diversify plants
- Diversify foods
- Compost
- Compost extracts and teas

Compost is more than organic matter!
The Great Debate

- Adds Biology
- Adds Mineral
- Adds food for organisms such as
  - Humic Acid
  - Fulvic Acid
  - Enzymes
  - Sugars
  - Many other organic compounds

And Organic Matter

Compost Extracts & Teas

- Compost extracts are simple extractions of the nutrients and biology of compost. They can be applied to the ground or as foliar to the leaf surfaces.
- Compost teas are extracts that are brewed over time with the addition of food resources like fish and seaweed to increase the biological content of the extract.

The Arboreal Food Web

- As the soil food web works below the ground the arboreal food web works above on plant, leaf and bark surfaces.
  - Endophytes – work inside the plant structure.
  - Epiphytes – work on the plant surfaces.
- These organisms protects and help nourishes the plant and soil.
- Plant extracts can work both in the soil and on the plant surface, they are a powerful to drive your Biological Engine.

Beyond Carbon Building

There are other aspects of the Plant/Soil Relationship that go beyond just building carbon in the

What about Energy?

- What else do plants do
- that we still do not understand?

Energetic Systems

- Soil energetics is the circuitry of the soil/plant system. Most people understand that soil minerals contain positive and negative charges. But soil energetics goes beyond simple charges to the interactions of all the vibrations that exist in soils, plants and the atmosphere. Phil Callahan did extensive research on the vibrational energy of plants, soils and animals. Many theories and systems exist for managing the energetic system of agriculture. Biodynamics as described by Rudolph Steiner in 1924 is probably the best known method. Although we are only beginning to understand the importance and power of this aspect of soil management we believe it is essential to take into account the energetic component in your soil management plan.

Phillip Callahan

According to Prof. Phil Callahan, the acknowledged expert on this subject (along with numerous other energy-related subjects such as insect antennae, ELFs, etc.), paramagnetism is the ability of a substance to collect or resonate to the magnetic fields of the Cosmos—but it is not magnetism. Rock powders use crystals or crystal-like forms to collect subtle cosmic energies, transforming them into uses from which we can benefit

Cosmic Rays and tree growth patterns linked

- Here's a surprise. The growth of trees in Britain appears to correlate to cosmic ray intensity. University of Edinburgh researchers have found that trees are growing faster when high levels of cosmic radiation arrive from space.
- The researchers made the discovery studying how growth rings of spruce trees changed over the past half a century.
- The variation in cosmic rays affected the tree growth more than changes in temperature or precipitation.

- The study is published in the scientific journal New Phytologist. Abstract below.
- **A relationship between galactic cosmic radiation and tree rings**

Thank you Chaos Springs 2021