

Dr Paul R.Hepperly

Plant doctor with a Planetary Mission



Conceptualizing Carbon Changes

The Solar system flow of energy in the form of waves and particles and radiates in all directions out from our sun into space. In our Solar system, our Sun is the core energy source and power pack. Solar energy is generated by nuclear fusion and radiated as electromagnetic waves and particles which visible light is a small portion. A very minute portion of this light is intercepted on the surface of the Earth itself. Of the minute portion intercepting the earth a much small portion of light energy in the blue and red spectrum can be absorbed by green plants. These select spectra are uniquely able to transform simple gaseous carbon dioxide, the earthly source of carbon and oxygen, and liquid water, the source of hydrogen and oxygen. The marriage of carbon gas and water formed hydrated carbon or carbohydrate. In more common terms these are the plant sugars that provide the plant and animal kingdoms with chemical energy for life on Earth.

The enormous amount of solar energy that floods over our planet is very dilute in terms of the needs of life sources. Plants act as the soil collectors which distill the energy into utilizable forms for all other living systems. Interplay of the energy in to biological realms might be considered the most elegant and unique waste to resource system ever developed.

Our global energy system is all based on carbon bonds in the form of simple sugar and more complex carbon based plant compounds derived from sugar and plant photosynthesis as further elaboration of the carbon foundation piece. The carbon based compounds travel down the plant and through an unseen fungal partnership called mycorrhizae Greek for fungal roots. This partnership allows the plant to explore much deeper into the soil than the plant unaided by its fungal partnership can. In doing so the fungus aids the host plant procuring vital supplies water and minerals for plant growth and most interestingly shaping the very structure and nature of the soil itself.

All these reactions are based on energy from the sun translated into carbon bonds that generate and move terrestrial energy derived from forces in the air and soil. Much of the carbon from the plant and fungal inter-relationship is secreted directly into the soil as carbon compounds. These compounds become the source of soil humus characteristic of rich dark soil. Mycorrhizal carbon and conserved remains of animals and plants become the soil organic matter reserve. Soil organic matter is our legacy of decomposed plant and animal that is of vital importance to crop productivity, environmental health, and the health of the global climate.

"A nation that destroys its soil destroys itself" FDRoosevelt

The balance and health of atmosphere and climate itself is grounded in the symbiotic relationship between beneficial fungi and their plant hosts. As the content of carbon in the soil increases, there is a corresponding increase in soil productivity in terms of crop and plant yield. As soil carbon increases at the same time carbon dioxide, greenhouse gases and global warming can decrease. On the same vein the destruction of soil organic matter leads to increases in atmospheric carbon dioxide greenhouse gases and potential for global warming.

As Franklin Delano Roosevelt so aptly observed, " A Nation that destroys its soil destroys itself." Indeed we have often lost tract of this essential truth and our National legacy of rich top soil continues to deteriorate around North America and the majority of all nations of the World..

We will propose a simple economic model for tracking the changes in soil carbon. This accounting system can be used to help improve our atmospheric lot by decreasing the amount of carbon dioxide in our atmosphere. Accounting for gains and losses will be backed up by the use of measurements to verify results suspected by our accounting proceed. Although accounting for our carbon resources is a new endeavor for humanity we already know that our productivity and health of our environmental resource rise as the stocks of our carbon legacy are protected and increased.

Giving credit where credit is due

Finally, we foresee the developing market of soil resource improvement through carbon credits can used to monetarize the real value of this important to service the environmental needs of Mankind. Giving credit where credit is due will be the motivator of changed behaviors to stimulate improved management of our soil resources.

We believe this strategy will be the key to our future atmospheric success. This responds in general terms to Peter Druckers observation that only what we measure and propose to change can be positively and conclusively changed for our benefit.

Carbon that forms the major part of soil organic matter or humus has its origins in plant photosynthesis. Photosynthesis is a scientific term from the Greek. Synthesis is Greek for manufacturing and photo is from light. In other words the Greek term is making or manufacturing from light.

In green plants, photosynthesis takes carbon out of the air as carbon dioxide and combines that carbon with water from the soil delivered through plant roots and stems. In the plant leaf, energy from sunlight powers or catalyzes the union of carbon of the air from carbon dioxide with water from below. Photosynthesis hydrates carbon to form carbohydrate or simple plant sugar. Photosynthesis is a critical factor for the sweet success formula of life itself. Indeed our entire system of life on the globe depends on it either directly as in plant life or indirectly in the case of animals and decomposing organisms.

Sunlight plus Carbon dioxide from the air and Water from plant roots gives sugar and oxygen.

The first carbohydrate formed by photosynthesis is generally glucose. Glucose and fructose team up to form sucrose which constitutes mobile sugar that is a traveling energy reserve and source for most higher plants. Glucose transformed into sucrose translocates itself down the plant stem into roots where it is used directly as an energy storehouse. Sugars and their products are energy currency of life on earth.

Glucose and Fructose give Sucrose Glucose from Sucrose and Fructose forms starch with forms simple Sugars.

Plants exhale oxygen it is like a gift of life to the animal kingdom

When energy is needed for longer term storage, it becomes converted into starch. Starch is a long chain polymer of glucose. After being used as a storehouse starch can be mobilized back into glucose as ready energy source. Roots of many plants contain long term reserves of starch. When Carbohydrate is formed through photosynthesis, the breath of life of the plant is based on carbon dioxide, its leaves exhale back oxygen. When our plants exhale oxygen it is like a gift of life to animal kingdom who require oxygen for their ability to convert food into energy for their livelihood. The carbon dioxide waste is the prime material that plants breathe to produce energy in the form of hydrated carbon, carbohydrate or sugar.

In the process of respiration carbon based sugars plus oxygen produce energy and carbon dioxide and water. This process of converting sugar into energy is the opposite of photosynthesis reaction with takes carbon dioxide and water to create sugars. While the 19 and 20th century manufacturing process started and fixed point and ended in a line with a pile of waste. In a nature the whole process of manufacturing has remnant materials being recycled and returned to works as added infrastructure.

Starting with the basics of the environment air, soil, water, and sun our plants inhale of carbon dioxide. They exhale of oxygen in the same process. In animals we do the reverse we inhale oxygen and exhale back the carbon dioxide needed by our green plant community. Working together plants and animals the two major kingdoms complement each other they constitute in their reaction the global inhale and exhale of the global organism. To reiterate plants breathe in carbon dioxide and breathe out oxygen, animals breathe in oxygen and breathe out carbon dioxide. Together they form the united inseparable breathe of Global Life, Abundance and Regeneration

A never ending cycle of prosperity

Within the unseen kingdom of the roots higher plants sugars can feed a beneficial fungal partner that grows into the soil and has the capacity to supply much greater amounts of water and minerals such as phosphorus, zinc and copper to the plant than in a plant which does not have the symbiosis or beneficial mutual living arrangement. Ninety percent of all high plant species are dependent of mycorrhizal fungi.

While a root hair can extend about 1mm into the soil the beneficial fungus can extend up to 15 cm. In this way, mycorrhizae are able to enlist water and nutrients from about 1,000 to 2,000 times more area than plants without the fungal partner. Up to 20% of all energy captured by green plants are fed back to the partner mycorrhizal fungus and this components teamed together with the plant and animals secretions and remains becomes the building blocks of living soil bioreactor.

Sugars in the plants feed mycorrhizal fungi in the roots and soil. The mycorrhizal fungus absorbs water and nutrients which feed the host plant.

The environment provides for green life which provides for the fungal network which provides for the soil that provides for the plant in a never ending cycle of prosperity.

The mycorrhizae is a partnership or symbiosis between a higher plant and fungus. Literally in Greek mycorrhizae means fungal roots. Often the soil is recognized as an environment hostile to live roots and the microorganisms that inhabit them. The mycorrhizal fungus copes with the challenge of their own desiccation or drying out and attack by other microorganisms in the exposed soil environment by secreting a protective sugary protein coating called glomalin. Glomalaceae is the name of the largest family of beneficial root fungi. The nature of Glomalin is an extreme resistant to a wide range of environmental conditions and decay.

Scientists have marveled at the ability of unseen mycorrhizal fungi to help plants become sufficient in water and nutrients. This corporate relationship and partnership is thought to pre-date land plants and was critical to evolutionary success of both plants and these fungi on dry land. The plant can live without the mycorrhizal partner however unless the plant roots are available the mycorrhizal fungus component cannot be cultured at all. It is strictly dependent on live roots for its survival.

The Glomalin glycoprotein is sticky by nature. Its stickiness helps holds soil particles together. In addition it is known to repel water not only water proofing the aggregates but also preventing their erosion and dissolution. Finally it has been shown that glomalin has a long life in soil catalyzing the improvement of soil texture and function. Interesting the Glomalin protein is extremely stable in both high heat and alkali solvents. Extracted in concentrated oven cleaner at autoclave temperatures it is part a class of protein known to be produced under severe conditions in plants and other organisms called heat shock proteins. Another interesting property of the component is its richness in iron.

The ability to promote clumping of soil particles to form granules or aggregates is a very key indicator of soil quality and excellence and is associated with stability of carbon fraction from being decayed readily. The mineral clay component of soil is characterized by a overall negative electrochemical charge which naturally repels humic materials which are also electronegative in their overall nature. Multi positively charged cations such as iron, aluminum and calcium are not to bridge the repulsive nature of the two materials and are suspected as keys to help permit initial aggregation processes to process. The physical threading and sticky chemical nature combined with electrostatic interactions allow both the

growth and stabilization of critical aggregate masses. These particles by their size and nature permits air and water to flow better and root to proliferate more robustly and constitute key natural components of improved healthy soil.

The plant feeds the fungus and the fungus feeds the plant and forms the soil that feeds the plant. Symbiosis, life, and nature's blessings.

Information and scheduling of lectures for Dr Paul Hepperly (insert new Website).

- International and national speaker
- Doctorate in Plant Pathology,
Masters Science in Agronomy,
Bachelors Science in Psychology
- Over 170 publications on weed management and science, pathology, fungal diseases, plant disease resistance, disease management, epidemiology, diagnosis, fungal ecology, seed pathology, management, agronomy and horticulture, carbon sequestration, and other topics.
- Upcoming book *From the Valley to The Mountain Faith Food Fitness* authors Tom Hafer and Paul Hepperly
- Featured speaker list (partial)

Thailand Go Organic Bangkok, Thailand October 2009

"Organic agriculture affects seedling health and soil quality"

Body and Soil Conference, Maui, Hawaii September 2008

"Building a compost pile with minimal turning, materials used in holding on to VOCs."

Tilth Producers Annual Conference Seattle Tilth, October 2008

"No Till, Organic and Traditional Agriculture: They Can All Work Together;"

16th IFOAM Congress Modena, Italy June 2008

Organic Agriculture and Climate Change Workshop

"Organic Maize and Soybean Cropping Systems significantly mitigate Greenhouse Gases through increasing soil Carbon and Nitrogen

