Carbon
Jack of All Trades

By Hugh Lovel

Hydrogen is a special case as the first amongst manifest elements, the basis of water which is the universal solvent and medium of chemistry. But from there on the basic characteristics of chemical reactions are revealed according to the pythagorean *Octave Rule* in the first round of eight elements from lithium to neon. In this round **carbon** stands squarely in the middle.

In the form of diamond carbon reveals its quintessential self-sufficiency. Yet, it is the great balancer and buffer, the master-combiner, the universal adept at sharing electrons in co-valent bonding. Rudolf Steiner described carbon as " . . . the Great Plastician through which all the cosmic imaginations manifest."

Being in the middle and buffering both acid and alkaline conditions, it reacts either as a positive or negative atom. It assumes whichever role is needed, meaning it combines with everything except the self-satisfied inert gasses like neon, helium, argon and krypton.

Carbon is the skeletal framework for life, the bones or framework of our body chemistry. In chemical parlance organic chemistry is carbon chemistry even though synthetic carbon compounds such as chloro-flourohydrocarbons, dioxins, DDT, dielderin, pentachlor, 2-4,5T, etc. rival the deadliness of radioactive waste. Interestingly, there are species of fungi which can consume these synthetic carbon compounds, eating them for the carbon they contain and leaving behind nothing more toxic than table salt.

Carbon, lying in the middle of all things, attracts life energy and is self-organizing. It not only attracts hydrogen, it attracts oxygen which is the basis of life. Oxygen is the activator of hydrogen in water, the balance in oxidation/reduction reactions. Because of carbon's affinity for both hydrogen and oxygen, carbon chemistry truly is life chemistry.

Being self-organizing whether the scale is small or large, carbon chemistry is self-similar, or fractal. Carbon follows what mathematicians dating back at least as far as Pythagoras called the Golden Mean, a mathematical function called *phi*[*] which is derived from the Fibonacci Series and whose value, 1.61803 . . . , is hauntingly similar to the value of its reciprocal, 0.61803 . . . .

Earth is very much the carbon planet as it is sheathed in a biosphere of rich carbon complexity. This carbon sheath draws in and stores up the life of the earth. Carbon's very strong attraction for hydrogen and oxygen ensures that earth also is the ocean planet with plenty of water at liquid temperatures. Even sea and lake bottoms are coated with a layer of limestone, which is mineralized carbon in the form of calcium and magnesium *carbon*ates.

Because of carbon's ability to build order out of chaos it is common to use carbon based mulches in landscaping. For example, highway builders lay down a life attracting carbon blanket with mulch hay and seed on new highway cuts in order to provide the conditions for healthy roadsides.

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[*] *Phi* [Greek letter φ] is known as the *Golden Mean*. It is derived from the Fibonacci sequence, and is an irrational number approximately equal to 1.61803 . . . Like *Pi* [Greek letter π, the relationship of a circle's diameter to its circumference], φ is an irrational number, and usually is written as a non-repeating decimal. The Fibonacci sequence it is derived from is one where the next number is the sum of the previous two, *i.e.* 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987, 1597, 2584, 4181, etc. Values for *Phi* are obtained by dividing the last number in the sequence by the previous one, as for example, 4181 divided by 2584 is 1.61803 . . . . Interestingly, the reciprocal [2584 divided by 4181] is 0.61803 . . . which is why φ is called the *Golden Mean*. Of course, as higher numbers are used to derive φ more decimal points of φ can be accurately obtained. *Phi* is associated with the self-organizational growth curves of many living organisms, *e.g.* snails and ferns.

Conversely if you wanted to kill the earth you would clear, burn, plow, herbicide, scrape the surface bare and burn up the soil's organic matter with large doses of nitrogen fertilizers in order to drive life away. Amazingly these are the dominant agricultural practices at the outset of the twenty-first century. What kind of sense does it make to kill the earth? One must ask, considering that over 70% of earth's top soils have been lost to erosion in the last 150 years. Worse, over much of the remaining area rainforests have been decimated and soil organic matter reserves burned out with nitrogen fertilizers.

One might think that overgrown pastures would be grazed, trampled or mowed rather than burned; that soil would be ripped and scarified rather than overturned; that beneficial non-crop species would be managed and encouraged rather than impoverished; and that, above all, biological nitrogen fixation would be fostered rather than overwhelmed. Farmers often behave like gamblers with rings in their noses, led to bet on deuces rather than aces.

There also is a direct correlation on the one hand with carbon in vegetation and soil, and on the other with hydrogen and oxygen in rainfall. Clouds are moderately organized moisture, and rainfall is a bit more organized. Since organization flows from lower to higher concentration, when soil carbon is highly organized rain is drawn in. After all, with its attraction for hydrogen and oxygen, carbon is a magnet for water.

If you wanted to force rain away, you would drive away the carbon by clearing, burning, plowing, herbiciding and scraping the surface bare, leaving things this way so far as possible, just as is commonly done today. Satellite infrared photos show how these practices increase the reflective index of the land, or albedo—a measure of how much energy is conserved or released. Deserts all have a high albedo, while forests have low albedos. Farmland, depending on how it is farmed, can have either a high or low albedo, with clean cultivation and chemical methods driving this reflective index up even in rich organic soils.

In any event regenerative agriculture's top priority is harvesting carbon from the atmosphere. It's all about catching carbon. Why? Besides catching life energy as well as rain, one does NOT want one's nutrients to be soluble. They should be insoluble but available, which only happens when they are held in the biology of the soil.

The idea that plant nutrients must be soluble goes back more than a hundred years to the birth of chemical agriculture when Justus von Liebig discovered the robust responses he could obtain from plants with a bit of potassium nitrate and some phosphoric acid. Clearly plants took these soluble nutrients up very readily. The fact is, soluble nutrients sometimes were taken up to the exclusion of other necessaries. For example, plants could luxury feed on soluble potassium and become magnesium deficient. High levels of soluble potassium short circuit magnesium uptake. Also plants take up nitrogen salts such as urea, nitrates and nitrites ahead of amino acids. The more nitrogen salts, the lower the uptake of amino acids.

This is harmful because the more nitrogen salt taken up the weaker, more watery and *thirsty* plants become. Salts water down their protoplasm, stretch their cell walls thin, and limit photosynthesis. This also short circuits the synthesis of long chain amino acids which provide protection against insect pests with their primitive digestion. Insects eat easy to digest plants, but shun those with dense cells and complex protoplasm as poison. And, since nitrogen salts tend to decrease calcium uptake and calcium is key for cell development, low pH soils tend to deliver insufficient calcium. This makes plants susceptible to fungi, which then find an easy place to grow and take off.

Since nitrogen so highly digestive, in an aberated process where plants absorb salt nitrogen the leaves spread out lush and watery but are prone to digestion. Between fungi and insects this is an invitation to the dinner table, and such plants are digested above ground even though normally digestion would be confined to the soil.

In the soil what ameliorates and buffers nutrient activity is carbon—the more alive the better.[‡] Plants all catch carbon via photosynthesis, but unlike tight fists and misers they do not hoard their riches. They give off somewhere in the vicinity of 30% of their sugary bounty

[‡] A point to consider is that plant life is formative and animal life is transformative and thus intensified. Plant and animal life must be balanced for both to thrive. Soil life, being digestive, is primarily animal-like, whereas algae, mosses, plants, etc. being carbon builders relying on sunshine, are plant-like.

to the soil as root exudates. This provides a carbon banquet for all the soil microbes living in symbiosis with the plant. Root exudates fuel nitrogen fixation and the elaboration of minerals from the soil, chief amongst which are silicon and calcium. Drawn into the organization of carbon, its sibing silicon provides the lift that carries calcium up into plants, while calcium, along with amino acids, fills out plant forms and governs cell growth and reproduction.

The microbial activity of the soil is unimaginably complex, and good soils may contain upwards of 40,000 different species, many of which are major players in nitrogen fixation and the digestion and elaboration of nutrients. The balances that maintain soil microbial activities can be delicate.

For example, phosphorus is the key to energy transfers. This means phosphorus loving bacteria, such as azotobacters, must have sufficient phosphorus to tap the energy in root exudates. But it is mainly soil fungi that unlock the soil's phosphorus reserves such as calcium phosphates. High levels of water soluble, acidic phosphates suppress soil fungi and limit their activity. Phosphoric acid based fertilizers burn their delicate filaments like taking a flame thrower to fine fleece. Initially superphosphate appears to give a good response because by killing off these fungi and releasing their store of phosphorus it provides the plant with a brief flush of phosphorus. Then the leaf's energy transfers from chlorophyll into sugars work quite well. However, this destroys the long-term, fungal dependent, phosphorus release processes in the soil. Then as the superphosphate fertilizer combines with other soil minerals and becomes locked into mineral form there is insufficient fungal activity to release it, and the plant—like a crystal methadrine junkie—has no staying power in the long haul. Of course, the complexity does not stop there.

Like cows and sheep, the soil's grazing fungi do not directly release much phosphorus for the benefit of bacteria, such as the sugar loving nitrogen-fixing azotobacters. This requires predators like dingos, lions and humans—i.e. amoebas, nematodes and earthworms. As a portion of the phosphorus unlocking fungi are eaten and digested small amounts of phosphorus nutrients are released in the near vicinity of plant roots where root exudates feed azotobacters as well as fungi. This sustained, micro-managed phosphorus release is far superior to occasionally blasting the soil with phosphoric acid compounds.

If the total soil phosphorus reserve falls below a certain level, perhaps around 600 ppm, the activity of phosphorus providing fungi can be boosted by application of rock phosphates or other insoluble but available phosphate minerals. Just be aware that too much water soluble phosphorus ruins fungal phosphorus release which then starves phosphorus dependent nitrogen fixers who, without phosphorus, are unable to make good use of root exudates.

How much soluble phosphorus is too much? Sometimes this is not clear from soil testing. Because most soil tests rely on easy solubility little distinction is made between water soluble salts and nutrients held by soil organisms. For example, soaking a soil specimen in a mild acid such as citric or acetic acid will cause nutrient release from cellular protoplasm. These acids can dissolve living cells such as delicate fungal hyphae and release what phosphorus they contain. If there is rich fungal activity this may give a high soluble phosphate test, but in the soil this phosphate would not actually be soluble. It would only be released if there is also high digestive activity from protozoans and other soil fauna—something a mineral test does not reveal. However, a soil with high *total* phosphorus and low fungal activity due to lack of abundant root exudates can test low in soluble phosphorus and still give a good response when planted with a crop like corn or sugar cane that contributes generous root exudates.

What builds depth, complexity and resilience into soils is carbon, but of course carbon in the form of graphite, charcoal or coke is not nearly as useful as biological carbon such as sugars, starch, pectin, cellulose, humic and fulvic acids, living protoplasm, etc. Even highly stable organic compounds such as lignin and glomalin are preferable to graphite. A carbon rich soil such as a peat bog could have 15% organic matter and low biological activity, while a soil with 3.5% organic matter could have rich and balanced biological activity and give a far, far, better response. So it isn't simply a matter of how much carbon is in the soil but how much biological activity there is. In short, how *organized* is the carbon?

This means the carbon question not only is *how to catch carbon*, but *how to keep soil carbon balanced in the most living and beneficial forms*. Think how much better it is to have a few grams of earthworms rather than the same amount of carbon in the form of charcoal.

Frequently farmers grow a cover crop to increase soil organic matter—only to mow, disc, plow and rotovate it back in. In the process they destroy much of the bacteria, fungi, soil animals and soil structure they gained in the process of mechanically incorporating their crop residues. This causes population crashes just when active, complex biology is needed to digest the cover crop. This isn't so bad, though. It can be and often is worse.

Currently cover cropping tends to involve sowing a single species and favouring only a narrow clique of players in the complex soil ecology. This can cause population boom and bust cycles while failing to promote abundant, complex, stable and healthy soil biology as is needed to hold a living storehouse of minerals in insoluble but available form. One must have stable, active biology for the on-site nitrogen fixation plants require to optimize their nitrogen uptake as amino acids so they attain the highest quality and fullest growth. Optimizing amino acid uptake yields the finest quality, and is both the grower's greatest reward and greatest challenge. The key to doing this lies in harvesting carbon and feeding the soil biology in a rich and diverse way.

Cover crops cannot do this unless they are mixed and cover a number of different bases simultaneously. As a case in point it is better if lucerne, a plant that needs lots of boron, has dandelions growing with it, because the milky sapped dandelion improves boron levels in the soil. As another example, a winter cover of cereal rye or wheat should include a winter legume to balance the rye's silicon biology by making biological calcium abundant for future nitrogen fixation. The mix might also include crucifer companions such as mustards, turnips and radishes as well as a valerian like corn salad (rapunzel) that would make phosphorus available by blooming and finishing ahead of returning the rye to the soil.

If, prior to planting the rye, crop residues were sufficient to feed and maintain soil critters—earthworms and ants are good indicators—these will be present in abundance when it is time to digest the rye. This should keep the biological cycles going whether the rye is incorporated into the top few inches or laid down as mulch for the next crop to be planted in. And if the rye is grazed down, the manure may be a plus if it is fairly evenly distributed.

Clean cultivation causes boom and bust cycles whereas strip cropping minimizes these. Strip cropping provides for greater diversity and complexity, and if the strips are mowed or cultivated at different times this allows critters and microbe populations a chance to transfer from strip to strip as need arises. In general life and complexity arise at the boundaries between strips. Other useful strategies for keeping carbon as active as possible include companion planting, beneficial weed management rather than weed eradication, succession cropping and minimizing tillage as much as possible. For example one may harvest, graze, mow, roll down or lightly disc down a cover crop and then no-till into the residue. This provides long term nourishment for maintaining soil life as the next crop grows.

The hard truth is that the richest and best organic activity cannot be achieved and maintained by purchased inputs. There are some excellent, high quality carbon based inputs such as composts, seaweed, kelp, fish and humates, but these all come with a price and are primarily economical as inputs to get soil biology going. The way carbon is managed once soil biology gets going is the key to eliminating these costs. When harvesting and managing carbon reaches a level of expertise where self-sufficiency is achieved, lowest cost and highest quality will meet under the same management. With such quality one is likely to be in the position to sell direct. Is there any better marketing edge?

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