Symphony of the Soil

a report on the new class of
Complex Nutrition Enabling Fertilizers

REUNION PROCESS FACILITIES

Reprinted by: Perfect Blend, LLC
Manufacturs of 100% Organic and Organic Based Fertilizers

Introduction

From the prospect of a fertilizer manufacturer an ultimate goal would be to design a fertilizer that can simultaneously grow a crop to its full genetic potential while at the same time strengthen and amend the soil to make it completely sustainable. In addition, that fertilizer would be economical to apply, reluctant to leach or volatilize, easy to handle, pathogen free, have a long shelf life, and would not attract disease vectors or product predators before or after application. Finally, such a fertilizer would have to have one unique quality. After the soil has been brought to a certain level of nutritional excellence, the use of such a fertilizer would have to decrease until it was only used to balance out the nutrients actually used by the crops grown during an application rotation. There is such a fertilizer. This type of product is identified by its nature and is called a Complex Nutrition Enabling Fertilizer (CNEF). CNEF is a new product that will due to its many benefits soon become the fertilizer of choice for any grower. It is by nature a universal application product. Since it is designed to feed soil microbes and strength soils where it is applied it can be used across a wide spectrum of soil types and conditions.

This booklet discusses factors leading up to the design of CNEF, how it works in the soil and the benefits for growers from this product. In order to tell the CNEF story, a grower must know about the soil, its microscopic engines, and its bio-chemistry. This booklet is designed to bring a grower up to speed on the latest in soil developments and the manner in which the soil is nutritional, built, and sustained. It is an exciting journey with a story rich in a tapestry of microbial life.

In the next pages we will discuss the workings of the soil and the newest concepts in fertilizers. Before we progress we believe that it is important to disclose the fact that our business includes the design and construction of facilities that manufacture these new organic based fertilizers. As such, we have in the past, and continue even today, to struggle to understand the nature and workings of these new fertilizers. It is the intent of this report to question, educate, and advance the debate on the latest concepts in soil science. We will present our understanding of how these fertilizers work, based on our own research and the work of soil scientists who are breaking new ground behind their digital microscopes.

Thank you for your interest and the time it takes to consume this information. We believe that it will be of benefit to you.

John Marler
REUNION Process Company, Inc.

The Symphony of the Soil

a report on the new class of
Complex Nutrition Enabling Fertilizers

A 14.25 lb bok-choy cabbage grown by organic farmer Charles Long of Snohomish,WA.
This growth was achieved with a low-nitrogen, 4-4-4, 100% organic, complex nutrition- enabling fertilizer

We wish to express a very profound 'thank you' to Dr. Elaine Ingham of Soil Foodweb, Inc. for the generous time she has spent in review and debate over the material contained in the first edition of The Symphony of The Soil and for the strenuous effort she provided in attempting to keeping us scientifically accurate during the initial writing of this work.

While this work does not completely and accurately reflect all the views of Dr. Ingham, it draws extensively upon her work and the work of Dr. Russ Ingham for which we are grateful.

REUNION Process Company, LLC
Research & Development

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An Unseen Organic Soil Microorganism System DrivesThe Observable Above Ground Growth Of The Plant

The concept underlying all Complex Nutrition Enabling Fertilizers is the belief that growers must concern themselves with growing two crops in order to harvest one. The first crop that a grower must look after is the crop of microbial life that exists in his soil.

In a single acre of healthy farmland a grower has a population of bacteria that easily exceeds a ton in weight. The populations of soil fungus and beneficial nematodes each weight at least a ton. That is easily three tons of microbes. Microorganisms are made up of about 50% Carbon, 8% Hydrogen, 20% Oxygen, 14% Nitrogen, 3% Phosphorus and 5% of various secondary and trace elements. When they die they leave these important elements in the soil. Every life cycle of a healthy microbial colony donates hundreds of pounds of elemental nutrients to the soil.

The microbial population constitutes a growers first crop that must be cultivated, nourished, watered, and considered when making decisions that will affect them and your second crop. By themselves, they can actually yield a cash crop in the savings of labor, improvement of the soil, improvement of the quality of the crops, and improvement of the yield of a crop that can be sold for greater income.

Microbes are the engines of the soil. Rich, deep, nutritionally complex soils are the result of providing soil microbes with an efficiently transferable form of nutrition. Such nutrition will allow microbes to work in individual areas – each type and form performing a specialized soil service. Some increase nutrition, others fight off attackers with soil sourced antibiotics or create important enzymatic compounds that plants can uptake for robust health. It seems as if all the soil microbes are, by design, working in concert in a blended symphony of individual works to create the rich organic soils that will grow any plant in the world. The key to understanding the work of soil microbes is to realize that the whole structure of the soil works together. Individually, the microbes seem to be about tasks that are small and perhaps not really that important. Together, they are a powerful living engine that rumbles through soils creating next to perfect levels of complex nutrition. It is the symphony of the soil microbes that provide plants with the high levels of nutrition that they need.

Complex Nutrition Enabling Fertilizers are manufactured specifically to feed microorganisms. Plants lack a sophisticated digestive system and must rely on microbes to pre-digest all their foods. It is the purpose of CNEF products to provide to microbes the nutrient levels that allow them to grow in the numbers needed for their important work. It is the nutrition of microbes that allows a soil response that borders on the miraculous as billions of soil micro-organisms respond to the complex nutrition and the new root growth to produce balanced stem and foliage and then abundant flower and fruit.

If growing is your livelihood, the understanding of the information contained in this booklet may prove critical to your increase of appreciation of the true engines of the soil – microorganisms. Whether your interest is 100% organic, or a convergence of organic with synthetic nutrients, this booklet will provide you with important information that will bring an increase to your yields and bottom line.

The Original Organic Farmer

Farmers, for the most part, were the original settlers and the original organic growers of the United States. As they moved west, they usually sought out dark, deep, virgin top soils that had never before been broken for agriculture. On these soils they raised extraordinary crops that were close to being as pest and weed free as modern, chemically treated crops are today. It was not unusual for two or three generations to live on a homestead, clearing land until all the land was cleared, farmed until yields decreased, and then put into pasture lands. After the soils played out the settlers then often headed west to new lands. Today, there are far fewer areas of unfarmed land left in the U.S. As farm lands play out around us, there is a new technology that can literally restore these depleted lands to a level that is close to or in some cases superior to that of new, unbroken soil. This technology has resulted in the construction of the first plants of their kind in the world to create Complex Nutrition Enabling Fertilizers. This report provides answers to many of the questions concerning these wonderful new fertilizers.

The soil is an astounding organism composed of inter-reacting groups of varied hosts of micro-organisms, organic chemicals, electromagnetic reactions, and inorganic chemicals. Seemingly wholly different segments work together in a marvelous way to produce an enriched soil biosphere that maximizes conditions for the growth of plants. In the same manner that the individual components of a symphonic orchestra come together to produce beautiful music, so the elements contained in soil can combine purposefully to produce astounding growth in plants. The new classes of Complex Nutrition Enabling Fertilizers, which now exist or are currently planned, will soon be found in countries all over the world. These facilities are designed to enable the soil to maximize its potential. A soil that is enhanced to achieve its full potential is a soil in which many, if not most, of the limiting factors have been removed, a soil in which the full range of soil organisms and reactions are enabled.

Bacteria, fungi, protozoa, nematodes, earthworms, and a host of thousands of other microbes function together in the soil. Along with bacteria driven chemical and bio-chemical reactions their work forms an orchestrated organism that works to create an underground biosphere that seems almost magical in its structure and process. Soil microbial life, their products and biology combine to build a healthy soil that provides a wide range of essential services required for energetic plant growth. Indeed, we now know that it is almost impossible to raise naturally robust, healthy plants without healthy soil. Plants can be grown in sand, pebbles, or suspended over trays while fed with devised solutions. Are these plants as healthy as those grown in an enabled soil? Can they reach their full genetic potential? The simple answer is no. The difference is in the quality of the fruit and flower and in the basic health and heartiness of the plant. Consider the fact that a plant grown in deep rich organic soils typically has roots surrounded by natural sources of chelated mineral nutrition, antibiotics, nutritional exudates, glycoprotein storage and feeding elements, enzymes, hormones, vitamins, fats, sugars, amino acids, and a host of other vital nutrients. These nutrients keep a plant healthy and robust. Growers using sand, pebbles, or trays can match some growth and produce a crop that looks somewhat like a healthy plant. However, to reap the full value of soil nutrients a plant must be grown in the amazing bio-chemical production reactor that is organic soil.

We believe that the better way is to observe nature and then attempt to emulate and enable the ways of nature by facilitating the placement of all the nutrients and microbes needed by the plant into the soil along with a transformation system to insure that the plant can benefit from the soil's ability to retain, store, and then directly inject nutrients into a plant. We do so deliberately with great care as we know that we are actually feeding micro organisms that act as a plant's digestive system. The nutritional system detailed in this booklet will make a great deal of common sense to growers when compared to the "drive-by nutrition" programs currently used in conventional fertilizer programs.

Soil foodweb organisms are the engine of the soil. Given a comfortable environment that is properly moistened and within their temperature comfort zone the microbes are dynamos driving soil nutrition. Microbes transform nitrogen, extend the ability of plant roots to obtain nutrition, fight pathogens, and store valuable nutrients in the root zone. They improve soil structure, prevent erosion, and improve drought tolerance while lessening the effects of stress caused by extremes of temperature. Soils of a wide range and nature along with the foodweb organisms that live within these soils are fully capable of engendering the growth of robust plants when properly supplied with organic sources of complex nutrition.

Achieving a plant's full genetic potential is such a startling event when it happens many growers attribute the event to a rare happenstance of luck. However, the truth is that it is not luck. It's only biology and chemistry. So much has been learned recently that it's almost as if almost nothing was ever known before about healthy soils.

In our business we meet many growers who do not have the time to wade through the mass of scientific work that is currently being produced on soil and soil nutrition. Typically, their experience in transformation of organic materials into stable, high grade fertilizers is limited to concepts involving composting and dehydration.

This report is designed for those who would like to bring the bits and pieces of information that are swirling around out there into a coherent concept that will allow them to make educated decisions about their fertilizer programs. The orchestrations and ways of the soil are as old as time. There is a host of practical and scientific observation and knowledge about the soil that has built up over generations. The past decade has seen the development of the understanding of how bacteria, fungi, protozoa, nematodes, earthworms, and micro anthropods interact with and modify nitrogen, potassium, potash, oxygen, sulfur, carbon, calcium, and a full range of micro nutrients. With the aid of digital microscopes, computer modeling, infrared spectroscopy, along with a whole host of other specialized computer driven equipment coupled with a growing group of inquiring scientists around the world we can now begin to understand how healthy soil works.

The most critical aspect of agriculture today is the task of providing long term sustainability of our soils. Without sustainable soils, our rich agriculture practice will ultimately fail. This requires an understanding of nutritional transfer in the soil by soil acids along with the renewal of the mineral content of our soils. Achieving this task is essential for the long term health of the soil and for the microorganisms, plants, animals and humans who are dependent upon them

Agriculture in the Last Half of The 20th Century

First, we must acknowledge the debt that is owed to the old ways of growing crops and at the same time marvel that the old ways are not really that old. There are those who might condemn the chemical fertilizer usage of our fathers and grandfathers. Many of the generation who farmed from the late 1940's through present times departed from the ways of our great grandfathers who, for the most part, were at least semi-organic if not completely organic in their approach to the land. Others of us, with grateful hearts, will readily acknowledge the debt that the entire world owes to the pioneers of industrial farming for their methods. These pioneers are the men of muscle and brain and the intelligent, resourceful women who worked alongside them to forge new, large scale methods of farming. Together, they often gambled their very source of income for their family to make a crop or grow a livelihood. Over the last fifty years these growers have economically fed hundreds of millions of people in a true miracle of agriculture. We must applaud them, and not forget their work as we look onto the horizon and seek the next way. The next way is a future very close where growers will be armed with new biological solutions that will provide resolution to problems of soil sustainability, growing crops to their full genetic potential, and a complete new understanding of how the soil works. The solutions to these questions will include a reunion in the soil of organic resources and the mineral supplements that are critical to the soil biosphere.Most importantly, it is time to marry both the recycling elements of the older ways with the large scale mindset of the newer. Both must coexist in the future.

Let us first look back to post World War II as it is important to understand the past in order to understand the future. After World War II there was an explosion of industrial farming that forever changed the nature and pace of agriculture. Technologies converged to provide growers with a set of tools and inorganic soil nutrients that, being easily manipulated, fit well into industrial agriculture. Powerful diesel engine technologies, developed and then mass produced during the war, were available for a new breed of tractors. Likewise, the new technology of hydraulic components provided muscle and power that enabled growers to plow deeper, faster, and longer. Suddenly, instead of the traditional family farm of five or six hundred acres, growers could economically farm thousands of acres. Before, a farmer could only scratch the surface of the ground. Now a farmer could turn soils three feet deep. One grower could suddenly do the job of fifty men. Armed with real power tools, growers needed robust fertilizers. WWII ended with a surplus of explosive and hydrocarbon industries that produced feedstock that allowed the development of agriculture products. These facilities readily turned to producing fertilizers after the war. It was only a matter of a few years before a spurt of new fertilizer facilities pumped out huge quantities of super-phosphates and elemental nitrogen. Growers were able to grow an abundance of crops such as the world had never before seen.

After only a decade or so of the new industrial methods, some growers were beginning to sense that trouble had arrived in paradise. Soil seemed to be thinning and becoming increasingly susceptible to acute erosion from a simple rainfall. Heartland rivers, swollen with rainwater which previously had been held by the soil, carried hundreds of tons of suspended soil past any given point in the river every hour. Soil color turned from deep black to brown and then to light brown silt or sand. Crops demanded more water as the soil weakened and was no longer able to act as a reservoir of moisture. Salts built up in soils due to the fact that soils could no longer contain moisture and had to be over-watered to make crops grow.

Within a decade of the onset of industrial mono-culture agriculture other problems started to become evident. Crops, weakened by poor nutrition, could no longer rely on their self-protection systems to ward off insects, disease, or weeds. Old agriculture systems that had long kept chronic pests, and weeds, at bay had been abandoned along with most of the other sustainable practices. An immense hydrocarbon-based agriculture industry developed as it responded to the urgent new needs of growers. They, in turn, pumped out millions of gallons of insecticides, herbicides, and fungicides.

The detrimental aspects of the new agriculture practice became evident to everyone as algal blooms appeared in our lakes, ponds, and coastal waters. Millions of fish died as a result of excess nutrients in our water. Nitrates began showing up in ground water. Frogs started dying or, even more ominous, began changing their sex spontaneously or growing superfluous appendages. Toxicologists started finding new and startling compounds in our soils. These compounds were made in the soil from combinations of seemingly benign farm chemicals. These compounds threatened human reproduction and human health.

The very nature of the soil and the perception of those growing up around the soil changed. Farm children grew up having never seen an earthworm outside of a classroom. Even more unfortunately, some farm children and even children living in cities close to agriculture areas were being diagnosed with blue baby syndrome, caused by an excess of nitrates and nitrites in the groundwater.

Before any of us can level blame at farmers or chemical companies, we must first look inside our own refrigerators to see that we, as a society, have greatly benefited from the agricultural revolution that has been brought about by the combined efforts of growers and agricultural suppliers. Truly, it seems that there are few growers who do not deeply love the land. However, sometimes caught between economics, the love of the land, and the love for a family, a grower will turn on the one of the three least likely to protest. Out of economic necessity, the needs of economics and the family will, in many farming families, outweigh the needs of the soil. The farming practices of some of the better practice on the part of our great-grandfathers have, in many cases, largely been forgotten or ignored. Many growers began to believe that the ideas of cover crops and allowing land to lay fallow were old-fashioned and no longer necessary in an age of high powered, mono-culture agriculture. Then, seemingly suddenly, there was very little more westward land that begged for a plow.

Indeed, the world has been fed. However, it has been at a real cost to the land. According to international soil fertility experts more topsoil has been lost in the last 50 years than in all the preceding 8,000 years of human history. Fifty percent of the top soil has been lost around the world. According to 2004 United Nations statistics during the mid-1990s to 2000, 1,374 square miles have turned into deserts each year -- an area about the size of Rhode Island. That's up from 840 square miles in the 1980s, and 624 square miles during the 1970s. By 2025, two-thirds of arable land in Africa will disappear, along with one-third of Asia's and one-fifth of South America's. Some 135 million people -- equivalent to the populations of France and Germany combined -- are at risk of being displaced. The loss is not just confined to over-grazed and over-farmed land bordering some desert in Africa. Some USDA soil scientists say that over 35% of the top soil in the US has been lost. Others believe that number exceeds 50%. Plowing, plowing techniques and poor land practice account for much of the loss. Another, more insidious culprit, is the vast amount of non-organic nitrogen fertilizer put onto the land. A vicious cycle started with the advent of the application of synthetic chemical fertilizers. Each year, a little more nitrogen was needed to produce a crop.

Each year, a little more water was needed to water the crop.Most of us, whose lives are focused on soil and the growth of plants, would be reluctant to acknowledge that we have, in any way, engaged in a practice that is harmful to the soil. To do so might be as personally painful as the acknowledgment that we have purposely done harm to another human being. However, for years agronomists have known about carbon-nitrogen ratios. Despite that knowledge, and the knowledge that nitrogen-based fertilizers drive the reduction of carbon levels in soils, few agronomists have raised a cry of alarm over the use of these fertilizers or the importance of replacing organic nutrients in heavily fertilized soils.

Soil Organic Matter, or SOM for short, is the term soil scientists call soil carbon storehouses in the soil. The three main components of SOM are fulvic acids, humic acids, and humin. In addition to these three main components, and the actual dirt or sand structure, there are a lot of other components including glycoprotein, dissolved minerals, sugars, fats, waxes, resins, carbohydrates, amino acids, and a whole list of organic compounds. The primary nutrient bearing structures in SOM are fulvic and humic acids which, for the purpose of this paper will be simply referred to as soil acids. These active carbon components can contain the complete nutrients needed to grow a plant to its full genetic potential. Humin, the third major component of SOM, contributes little to plant growth. It is basically a semi-inert carbon (think of charcoal) that can take years to decompose completely into soil acids.

SOM can only exist as a result of the decomposition, either past, or on-going, of an organic material. Soil acids give the soil a dark brown color or, in cases of very high carbon levels, almost black. Soils that have lesser amounts of organic carbon are lighter in color. The fact that nitrogen fertilizers and plowing interact with carbon to reduce the carbon storehouses in the soil cannot be disputed or denied. Carbon and nitrogen always interact in the soil. An increase in nitrogen fuels a rapid increase of bacteria that are energized to eat SOM. A good backyard example of this cause and effect can be demonstrated with a pile of decaying leaves, which is basically SOM in the making (the leachate that drips from the pile builds soil acids). Divide a leaf pile in half. Water and turn, as usual, but add a few pounds of nitrogen fertilizer to one pile. The fertilized pile will decompose much more quickly than the non-fertilized pile. While this may sound beneficial, the result is a more thorough release of nutrients in the form of greenhouse gases, nitrogen, methane, and carbon dioxide into the atmosphere. Nitrogen fuels the growth of micro-organisms which devour the carbon elements and turns them into atmospheric gases. It's a simple rule of biology that nature will work to attempt to correct any imbalance in a soil Carbon : Nitrogen ratio.

SOM has been compared to a thick bath towel in the ground. SOM absorbs moisture and holds it in the same manner water is held in a thick towel. Soil with SOM is less susceptible to surface erosion, acts as a moisture reservoir for plants, improves soil workability, increases soil aeration, and provides a moist thermal mass for plants to protect them from extremes of heat and cold. Just as breathable fabrics allow for a raincoat to be water repellent while at the same time allowing a flow of cooling air to permeate the rain ware SOM allows soils to be waterproof and repellent to erosion.As SOM levels are reduced in the soil, a grower sees the need for more water to keep crop moisture levels in good form. It is also not unusual for the grower to attempt to chase the diminishing crop yields, caused in part by nitrogen fertilizer reduction of SOM, with more fertilizer to attempt to maintain the yield of the crop. This nitrogen chase is inevitably a downward spiral as more nitrogen simply accelerates the loss of carbon in the soil. An unfortunate result, in some cases, is that the additional water requirements often bring more salt to the fields than the land can handle and the fields are ruined with salt contained in the water.

In 1840 the father of synthetic chemical fertilizers, Justus Von Liebig, observed that minerals could be added to soils to increase production. Liebig probably would have been both fascinated and horrified by the massive use of N-P-K in the last 50 years. In his letter XI he praises organic fertilizers and makes this statement.

"Can the art of agriculture be based upon anything but the restitution of a disturbed equilibrium?"

Justus Baron Von Liebig, 1856

Do all agronomists understand the nature of carbon in the soil? It does not appear that is the case. At a compost conference in Austin, Texas in the middle 90's the first morning session speaker was an early pioneer in organics, a well-spoken, practical layman who spent his session time carefully building a powerful case for the application of organics to the soil. Those in the audience were astounded as the speaker presented slide after slide that offered powerful vivid demonstrations of the power of soil amended with manure and organics that would become SOM. He was followed by an important agronomist from a prestigious Texas university with a stream of titles and degrees behind his name. The agronomist apologized for arriving late and missing the first session before he flashed a slide on the screen with the letters N-P-K. "That is all we need to grow anything," he stated flatly. A murmur of quiet protest ran through the audience. He then proceeded to illustrate his point, that SOM was not necessary, by showing slides of tests using sand as the medium and only Nitrogen – Potassium – Potash (N-P-K) as the nutrients. Texans are, by nature, a friendly group, and, even though it was easy to sense the ill regard for the agronomist, it is unlikely that he ever realized that the audience, composed largely of serious growers, had already been won by the common sense arguments and graphic illustrations provided by the layman. The worn out N-P-K science was easily identified. Unfortunately, few growers have such black and white comparisons available to them.

Common sense, and the knowledge of the carbon-nitrogen ratio, would tell us that applying tons of synthetic chemical fertilizers to fields cannot restore any disturbed equilibrium. Liebig advocated organic fertilizers and viewed minerals as a supplement to already fertile soles that would increase yields. Over one hundred years later, when mass production of high grade fertilizers have made these fertilizers cheap and readily available, Liebigs' science seems to have been cheapened to only three letters – N-P-K. Now, even fifty years after the agricultural revolution of the 1950's, the great majority of commercial agriculturalists still put their full faith and confidence in N-P-K as the primary growth factors, with little belief in the importance of the other aspects of the soil that are so critical to robust plant growth.

Thankfully, information about soil is now accelerating at a rapid pace. Scientists all over the earth now have the ability to peer into the soil and observe a whole host of micro-organisms that were unknown, even a few years ago. The result of this ability has been to accelerate soil science research to what seems like near sonic speeds.

A lot of worn out science is now being replaced at a rapid rate. The overturn of the "Nitrogen Cycle" is a prime example of the new research refuting old science. The "fact" of the "Nitrogen Cycle", accepted for the last 150 years as an absolute reality, postulated that all plants could only digest inorganic nitrogen. Inorganic nitrogen is, of course, also conveniently manufactured by man. Scientists believed that plants cannot readily absorb organic nitrogen. This was figured out by scientists back in the 1800's, who found a ratio of 70% inorganic nitrogen to 30% organic nitrogen in the lakes and rivers of industrial countries. The nitrogen cycle theory has been a bedrock foundation concept and a driving rationale of the commercial fertilizer industry for over 150 years. Recently, a massive 10 year study in the Amazon basin, (Perakis and Hedin) reported in Nature (415) magazine revealed that the majority of nitrogen in an area, where fossil fuels are not being burned, is actually organic nitrogen. Other studies are now confirming these findings. These studies have brought about a major earthquake in the field of soil science. Thrown out of the window are millions of classroom hours, thousands of little charts showing something that does not and cannot exist naturally, and a century of absolutely-undeniable, scientifically-proven, cannot-be-argued theory that has been used as justification for the application of man-made, nitrogen fertilizers. Scientists have now come to the logical conclusion that the inorganic nitrogen earlier identified from tests of waterways is actually a result of atmospheric pollution from burning fossil fuels.

Despite this new information, do things in the soil world move quickly? No, not really. The gospel of the "Nitrogen Cycle", like the gospel of N-P-K, is still preached in many, if not most of our schools and universities. New science extends slowly into a field with old timers defending turf that they know. Few soil scientists will be quick to replace their theories about the chemical nature of the soil in favor of an organic approach. Clinging to that which they were taught in school, and that which has provided their living, they are understandably reluctant to leave their comfort zone and venture out into a new paradigm of thought that invalidates much of what they believed that they knew. Embracing the new organic theories presents them with the need to reassess their inventories of known, comfortable, tools such as simple soil tests, and large bulk applications of primary and secondary nutrients to correct soil "deficiencies". Instead of being able to rely on their outdated chemical thinking they are faced with realignment into organic thought which relies on tests on microbial populations and the use of balanced nutrition that is aimed directly at microbes.

Thankfully, most of the new research that illuminates correct information about the soil is freely available on the internet. Other specialized articles are available through simple subscription to scientific journals such as Nature and Science. The old ways of soil scientists are being challenged by private industry which now has the same access to knowledge that used to be almost the exclusive domain of universities and professionals in very large corporations.

The new science of the soil is just now being researched and written. The majority of what is known today is of recent arrival. A great deal of the new soil science is less than eight years old. Nobody today seems to know the current doubling rate of soil science. The doubling rate is the rate at which the body of knowledge about a science doubles. In the late 1960's a doubling rate of seven years for biological science seemed reasonable. Now, the doubling rate might be measured in less than a year, as new and astounding information is flowing out from soil laboratories all over the world. These are heady times for soil scientists and, indeed, all those with an interest in the land.

The Worn-out Science of Synthetic Chemical Fertilizers

Synthetic chemical fertilizers are close to having reached the end of their development curve. While there still might be a few twists and turns, mainly with slow-release coatings or other chemical timing agents, the synthetic chemical fertilizer business deals with basic components that are little changed since the 1950's. Most of the chemical approach boils down to a straight N-P-K attitude, as most chemical professionals seem to focus their approach to providing only these key primary nutrients to plants. The industry is so entirely staid that one movement inside the industry to add sulfur as a fourth component to the N-P-K basic formulation, the mainstay of the industry, making it N-P-K-S was recently headline news in trade journals. The step to adopt N-P-K-S as a new industry standard was actually a response to the reality that sources of atmospheric sulfur, normally supplied by polluted industrial emissions, have been reduced due to effective EPA air pollution laws.

While it is easy to jab a fork into the synthetic fertilizer industry, there is no doubt or argument that synthetic chemical fertilizers have made things grow and grow well. Can synthetic chemical fertilizers provide for long-term sustainable agriculture? That possibility had, until the last decade, seemed possible. There are many farmlands that are still productive after decades of chemical fertilization. However, there are too many formally chemically fertilized croplands that are now idle and unable to produce new, economically viable crops. Chemical fertilizer producers may argue that it is the misapplication of these fertilizers that is the problem, not the use. Unfortunately, 'misapplication' seems to be the rule rather than the exception. Synthetic fertilizers can be applied for long periods of time, but ultimately the soil needs the renewal of carbon. Attempts to sustain long-term, high yields with only N-P-K fertilizers facilitated by tillage and pesticides and herbicides have failed in an exceptionally large number of circumstances. The primary damage, as noted earlier, is the result of an upset of the carbon/nitrogen ratios in the soil, which leads to SOM being lost from the soil. There are still some who question the actual mechanism of this loss, but the fact of the loss cannot be disputed. Drive the back roads. There are simply too many once-productive acres of farm land that have now passed into pasture land, with little value for growing crops. There is, as well, too much land with only sand or silt for soil, where there once was rich, loamy topsoil. Such land is simply worn out.

Synthetics and the Environment

In addition to being hard on soils, synthetic chemical fertilizers are hard on our environment. Scientists are pretty much in agreement that mineral nutrients never reach the crops for at least 50% of the chemical-based fertilizer applied to soil. Some scientists believe that even a smaller percentage, perhaps as little as 12%, of the synthetic chemical fertilizers are up-taken by crops. Let's ponder that thought for a moment. The fact that at least fifty percent of applied synthetic based chemical fertilizers never go to the benefit of plants begs a question. If commercial agriculture applies about 50 million tons of fertilizer a year in the U.S. alone, where does 25 million tons of commercial fertilizer go every year? Before we answer that question, let's try to visualize the magnitude of 25 million tons of commercial fertilizer. That amount is, in fact, enough to fill one million tractor trailers with 25 tons in each truck. If all those rigs were stretched in line to enter the U.S., they would reach half-way around the globe. That's a lot of truckloads and a whole lot of synthetic based chemical fertilizer that is going into our atmosphere, ground water, and surface water.

So where do the excess nutrients go? Some leach through the root zone of the plants into the ground water. Others volatize into the atmosphere and some run off in surface water after a rain. This can lead to many problems. Doctors in rural areas surrounded by intensive agriculture are often familiar with the medical term methemoglobinemia. This is a blood disorder often caused when nitrates and nitrites from synthetic chemical fertilizers and, or, raw manure fertilizers interacts with the hemoglobin in red blood cells. Methemoglobin formed in this interaction cannot carry sufficient oxygen to the body's cells and tissues. This blood disorder is often suffered by infants who are fed food or formula prepared with this water. Without adequate oxygen in their blood, they turn blue. Their critical growth and development is impeded. They are, in effect, poisoned by their drinking water. This alarming pollution of ground water is occurring in agriculture areas all over the U.S.

In addition to nitrate / nitrite pollution in ground waters, farming communities often find high levels of phosphorus in their surface waters. The release of the P in N-P-K into surface waters may be a particular problem, as excessive phosphates in the surface water combine with nitrogen to create an environmental condition scientists refer to as eutrophication. This is a term for the nutrient enrichment of surface waters. This over- nutrition leads to an excessive development of vegetation (generally of the microscopic floating plants, algae). Most wetlands are typically able to withstand a substantial increase in nutrient concentrations – in fact, they often can thrive on the condition. Other surface waters such as open lakes, rivers, and coastal waters may not fare as well. A relatively small increase in the concentration of nitrogen and phosphates may be sufficient to trigger an "algal bloom" which can kill fish in ponds, lakes, or coastal waters, as the fast growing algae choke the life out of the waters by depriving it of much needed oxygen and allowing the growth of toxic organisms such as the deadly toxin pfiesteria piscicida. In extreme conditions a eutrophic body of water, typically a pond or lake, may be left entirely devoid of fish. Recent tests revealed a eutrophic plume at the outlet of the Mississippi river that extended for up to sixty miles from the mouth of the river.

\Growers may shrug their shoulders over the loss of a few fish, but fishermen, processors, restaurants, resorts, beaches, and a whole downstream chain of human endeavor and income to families has been and will continue to be deeply affected by over application of synthetic chemical fertilizers. Flying low over beaches affected with red tide and seeing millions of fish dead on the bank for mile after mile gives a new perspective to the problem.

Another aspect of ground and surface water pollution that cannot be ignored is the question of who will bear responsibility when the EPA ultimately looks for the person or persons responsible for the pollution problems related to a farm. Given the current spirit of pollution enforcement, it is not inconceivable to think that the EPA may want to find the party responsible for the pollution and attempt to gain reimbursement for the remediation of the property. Another troubling aspect of such pollution is the possibility that future land values will be lowered for land with identifiable ground water pollution. Growers who are confident that pollution is not their problem or, that the problem will fall to someone else to handle, should contact the ex-owner of the closest local closed automobile filling station that went out of business due to EPA regulations on possible pollution from underground tanks. In the majority of cases, the EPA knows the names of those responsible for pollution.

In addition to the loss of carbon, it must be recognized that synthetic chemical fertilizers, deliberately designed to be water soluble, are toxic to the soil biosphere onto which they are applied. Question - would you mix a glass of water and add a teaspoon of high nitrogen commercial fertilizer to it before drinking it? Not if you had any sense! The warnings on chemical fertilizer packages tell you not to ingest it. Think about the soil micro-organisms next time you decide to feed the soil with a chemical fertilizer. They don't have any choice but to drink the local water at fertilizer time.

In order to be fair on this question, we must recognize that there is a counter-argument from most chemical fertilizer companies concerning the toxic nature of synthetic chemical fertilizers. Most chemical fertilizer sales folks are armed with a worm test or two showing that applied chemical nutrients have no direct acute effect whatsoever on earthworms. A fair proposal to such a sales person might be to ask him to take you to visit the fields that have been fertilized with synthetic chemical fertilizers over a long term. The likelihood that you will be shown a synthetic fertilized field with an active earthworm population is slim. The next reasonable question that a grower might ask is for the fertilizer sales person to provide a test that shows that non-worm inhabitants of the soil are also not affected by synthetic chemical fertilizers. Scientists are well aware that excessive phosphorus levels are deadly to beneficial mycorrhizal fungi.

A simple worm test to determine how many beneficial earthworms are present in the soil is easy to perform. We recommend that a single, heaping shovel of soil be dug from a field. This should be done once the soil temperature at 1" depth is at least 68 degrees. Spread the dirt out on a plastic sheet. A 100 + worm count (of any visible size) picked out of the pile on the sheet indicates a ve*ry healthy field. Some soils have in excess of 200 worms per shovel full. We grade a worm test just like any school test. Anything less than 60 is a failing grade.*

Synthetic Fertilizers vs. Organic Fertilizers

Organically fed plants have many advantages over synthetically fed. The organic nutrient collection, delivery, and long term storage systems are intricate, effective, and very efficient. Organic plants use symbiotic bacteria and fungi to increase their nutrient supply from surrounding soil through a whole host of functions. These include extensions of root systems, dissolving of soil held minerals, retention of moisture, and retention of the full spectrum of nutritive mineral elements in a moist carbon matrix located in the root zone. This carbon matrix, composed mainly of water with a small percentage of soil acids is rich in nitrates, ammonia, as well as a complete spectrum of other primary, secondary, and trace nutrients. Also stored in the root zone is a substance the USDA has named Glomalin. Glomalin is the result of excessive nutrients created by mycorrhizal fungi. It is a very effective long term storage mechanism for plant nutrients. Microbes that flourish only in an organic environment create antibiotics to keep plants healthy from disease. Beneficial fungi can actively hunt and kill destructive nematodes. The high sugar content of organically grown plants can dissuade attacking insects. Consider the fact that synthetic fertilizers and growing systems have no corresponding mechanisms. It's hardly a contest.

Synthetic fertilizers are at a severe disadvantage when compared with high grade organic fertilizers. All-synthetic nutrients lack the transfer and storage mechanisms that nature has built into soil carbon components. Synthetic nutrients are, by their very nature, designed only to provide a plant with a water soluble nutrient. These soluble nutrients are basically "drive-by-shooters" that are often only able to hold nutrients in the root zone only for a short time. This type of nutrient is extremely subject to volatilization and being lost in ground and surface waters. Organic nutrients use microbial produced weak acids and exudates to break down minerals in surrounding soils into forms that the plant can readily use. These same acids then act as the transfer agents for these minerals to inject them directly through cell walls of roots into the systemic circulatory systems of plants. The collection, transfer, and storage mechanisms are a major difference between synthetic fertilizers and organic fertilizers. High grade organic fertilizers are vastly superior to any synthetic fertilizer made.

The New Science of Organic Fertilizers

Imagine growing excellent crops on land that is completely sustainable. Every year the soil would become more valuable as it is slowly builds into a deep rich growing powerhouse. Imagine harvesting large yields of high valued produce off this soil at the same time as the soil is being built up. Imagine, knowing that every year the soil will grow in strength, capacity to yield, resistance to erosion, and resistance to salt build up as it increases its ability to offer drought and freezing resistance to the plants grown in it. Imagine the hard pan sections of this land becoming softer and sandy sections becoming loamier. Imagine beautiful produce that is grown to its full genetic potential.

Many growers have never seen produce or, for that matter, any crop grown to its full genetic potential. To do so takes fully nutritioned soils. Such soils are, for the most part in this country, only a sad memory of the far past. If you could visualize produce that has reached its full genetic potential, you would imagine produce that is so perfect in perspective that it would almost appear to be made as an artificial advertising model. The size would be large, it would be without blemish. It would be as close to perfect as nature could make it. Such produce would be more resistant to insect attack, and more resistant to fungal disease. Such produce would be remarkable for its visual quality, its shelf-life, its taste, mineral, and sugar content. Such produce would actually have a natural taste and sweetness that hearkens back to an earlier time when farms were small and people were closer to the land and farther away from industrial solutions.

Most commercial growers would be very skeptical when asked to imagine a situation where the soil gets better as it yields full genetic potential crops with high nutritive values. Such almost paradoxical like claims are totally foreign to most US growers who have suffered through decades of top soil loss along with a steady decline in produce nutritional and taste values and the health of their crops and orchards.

Is it possible to rebuild the soil while producing superior crops? The answer is yes if a grower is using a new concept in fertilizers known as a Complex Nutrition Enabling Fertilizer (CNEF). CNEF is a new organic fertilizer that will restore soil mineral values while producing crops that can meet their full genetic potential. The secret of CNEF is both astounding and, at the same time, nothing more complex than good bio-chemistry.

Calcium, Cation Exchange, and Base Saturation Theories

A major group of concepts that have been challenged, uprooted, and largely left on the side of the row to wither by the new biological sciences are large parts of the calcium, cation exchange, and base saturation theories that came into favor in the later part of the 20th century. Some of these theories viewed the soil as a virtual chemistry set with ionic exchange as the driving force. These theories poorly considered the soil foodweb microbes that actually drive the chelation exchange and nutrient transfers. Instead, the theories, for the most part, focused on correcting perceived chemical and electrolytic imbalances. In order to rectify the chemical imbalances their tests showed in the soil, some agronomists embraced theories of base saturation and soil balancing.

We believe that some elements of the theories of base saturation and soil balancing are valid in the recognition of the need by the soil of nutritive elements and the fact of electrically charged soil elements and their interaction. There can be little doubt that cation and anion reactions are critical to basic soil chemistry. However, the actual practice that results from these theories is, such as spreading lime all over a field, is in our opinion, usually biologically harmful in the short term and, more importantly, detrimental to the financial success of the grower. They are biologically harmful from the aspect of the massive kill of microorganisms that can occur when the soil foodweb is blanketed with lime or other so-called balancing additives. The soil is a pH balanced organism that is balanced by microbes. Mess up the pH with a massive assault of lime and you have just unbalanced any active microorganism activity in the soil. The reason that it often takes 2 to 3 years after a lime application for the soil to rebound is simple. A lime application results in a massive microorganism kill. It may take three years just for the soil microorganisms to regenerate and regain their normally dominate role as processors of minerals to plant foods in the soil. Their role as "stomach" for plants is severely impacted and impaired. The financial success of the grower is affected by the impairment and damage of the microorganism driven exchange capacity of the soil that may result of the lime application. If microorganism activity is impaired then a grower will not see the financial gain that results from healthy, robust, soils.

The success of large scale lime applications is often questionable from another aspect. Not only is agriculture lime slowly rendered by soil microorganisms into plant-available foods it sometimes fails all together. Actually, the so-called balance deficits may take many years to rectify, if ever. Even after such an application it is difficult to lift calcium performance in heavy clay or high-magnesium soils. In other soils there still may be poor calcium mobility and the soil may still be calcium deficient even though there are now adequate amounts of calcium according to soil tests. The answer is in the microbes and feeding those microorganisms correctly, not attempting to "balance" a soil chemically.

The new organic Complex Nutrition Enabling Fertilizers (CNEF) take a different approach to achieving a nutrient imbalance. One ton per acre application of a CNEF contains all the calcium, along with all the nutrients, that a soil foodweb requires. Instead of trying to rectify a soil problem with a large amount of calcium, a CNEF provides a smaller balanced application of nutrients, including calcium, in amounts more easily digested by the soil microorganisms. These smaller amounts are balanced in the nutrients that they provide to the soil microbes. They slowly bring the soil back into balance in manner that is both gentle and at the same time faster than any other method. The basic mistake made by the soil balancing concept is that it is not chemical imbalances that render a soil a poor producer. It is instead the lack of a balanced nutrient program that fails to feed and maintain a sufficient population of soil microorganisms. It is the microorganisms interacting with the available nutrients that keep a soils pH at a correct point, not the application of minerals to correct pH in a soil.

The New Complex Nutrition Enabling Fertilizers

Since 2001 a remarkable, but largely un-noted event occurred in the world of fertilizers by the introduction of engineered Complex Nutrition Enabling Fertilizers (CNEF). The organic complex nutrition that is contained in these fertilizers is designed around concepts focusing on two different aspects.

The first aspect is the ability of these fertilizers to contain and transfer a wide range of organic based nutrients that cannot normally be easily delivered to plants. This requires a change in the molecular structure of the feedstock, normally manure, from that of a labile nutrient, a nutrient that readily releases its component elements, into a stable slow release nutrient. Stabilizing the manure at the molecular structure level and slowing down its nutrient release is one of the secrets of the CNEF fertilizers. The CNEF product that is the result of this transformation is vastly different from the raw manure that is the feedstock for these fertilizers. After chemical transformation using a hydrolysis process, the manure base in CNEF is no longer a labile nutrient.

By its nature, manure is an unpredictable unreliable nutrient that can burn crops and lose a majority of nutrients when it is volatized into the atmosphere or lost in surface or ground water run-off. This release of nutrients can occur in only a matter of hours. Manure spread on open ground can lose 25% of its nutrients in 24 hours. Finished CNEF is a stable product that slowly releases its nutrients into the stable form of fulvic and humic molecular structures and retained in the soil until a plant requires its nutrition.

The slow releasing CNEF allows soil bacteria to form complex humic substance molecular structures that actually contain chelated forms of sulfur, nitrogen, phosphorus and the entire range of minerals contained in the enriched CNEF formulations. These newly formed humic substances are primary plant and microorganism foods which do not readily migrate in the soil or waste their nutrients to atmospheric or water release.

The second aspect of nutrition contained in these fertilizers is the complete range of mineral fortification that is added to CNEF to provide it with a full spectrum of organic
mineral nutrition. Minerals are basic elements to our soils. They cannot be created by any organic source or destroyed. They can be removed and taken away when mineral containing crops are harvested. In 1936 the United States Department of Agriculture issued U.S. Senate Document 264 stating "that virtually all soils in the United States were mineral deficient." It is not surprising that some scientists have estimated that U.S. soils are seriously depleted with 85% of essential minerals depleted.

As an example, consider a bushel of grain corn. For each bushel removed, a total of 1.53 lbs of plant food nutrients are removed from the soil. These nutrients include nitrogen, phosphorus, sulfur, potash, calcium, and iron but do not include trace minerals. Corn at 138 bushels per acre would remove 211.14 lbs of nutrients per harvest acre. Over 20 years, a total of 2.11 tons of minerals plus trace mineral weight would be lost from an acre of soil. During that time a farmer might have to put on 40 lbs. of N per acre. That amounts to .4 ton of nutrients back to the corn. Occasionally, the farmer might put a little potassium and maybe a little sulfur back on the soil every few years or so. Even at 10 lbs of each a year, that still means the soil is running a deficit of 1.5 tons a year. It's easy to see how soil minerals play out over a period of time.

Soil microbes require a complete spectrum of natural minerals in order to support a healthy foodweb. Plants draw their nutrition from this foodweb. They too must have a full range of minerals to maintain health and to reach their full genetic potential. How can any grower expect to achieve the maximum potential from his crops without providing the minerals needed by the soil foodweb and the plant?

CNEF fertilizers provide the complete mineral spectrum in proper proportions necessary to replenish minerals drawn from the ground by earlier crops. Continued use of CNEF will result in the gradual replenishment of the mineral content in a soil as sufficient minerals are provided in the formulations for crops and the soil foodweb.

Fertilizers that do not replenish the minerals that have been taken from the ground by previous crops are not able to make the soil whole and complete in any manner. As you can see from the above chart, minerals interact with each other. A case in point would be the nitrogenase enzyme reaction that can actually produce nitrogen in the soil. Required in that reaction are bacteria, molybdenum, iron, sulfur, and water. However, if molybdenum is not available then the entire reaction will never occur and the soil is denied additional nitrogen. Use of CNEF result in long-term, sustainable agriculture as these fertilizers can actually increase the amount of SOM in the form of fulvic and humic acid structures and secondary soil structures such as mycorrhizal formed glomalin. Long term use of these fertilizers will actually build soils back to levels of fertility and nutrient content that were once considered long past in agriculture communities.

The fact that these fertilizers are based on manure should not be too startling. The fact that these processed manure based fertilizers are many times more effective than raw manure might be. The difference is in the slow-release nature of the processed fertilizers. Unlike chemical slow release fertilizers, which rely on coatings or bonding methods to attain a slow release, the new Complex Nutrition Enabling Fertilizers rely on the natural progression of organic degradation and the high efficiency building of soil acids to provide a slow release mechanism.

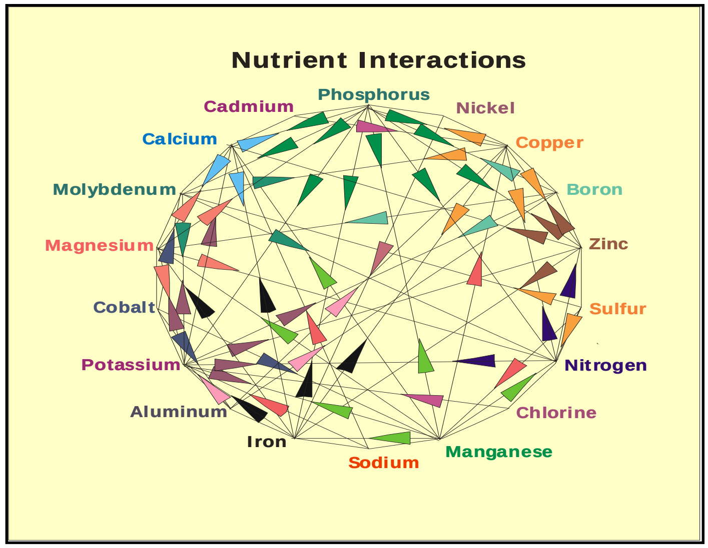
Differentiating between raw manure and this new class of fertilizers sometimes seems difficult to many growers, who are not sufficiently experienced in the unpredictable nature of manure applications. Manure, partially composted manure, dehydrated manure, composted manure and the new class of Complex Nutrition Enabling Fertilizers are all very different nutrients. The manner in which they react, deliver nutrients, pollute, or carry unwelcome problems to fields is different in the case of each of these products and is totally dependent upon the level of processing or the lack thereof. Additional information on the nature of manure is provide later in this text.

The advantage that CNEF has is that it is a product designed to provide nutrition for soil microbes and to create an in-soil mechanism for the transfer of nutrition from the soil into plants.

How Complex Nutrition Enabling Fertilizers Work

Although based on the latest science, much of the knowledge as to how this class of fertilizers really works is still speculative today as field trials and research continues. Many aspects of the workings of the exact interactive biology that underscores the workings of these fertilizers are still being investigated. We believe that decades of research will be necessary to arrive at a complete and absolute understanding of the science of the enabling fertilizers. United Kingdom scientists and major organic growers investigating these fertilizers have postulated that the complex nutrition fertilizers actually increase nitrogen levels in the soil through soil biological and micro-organism activities that result from the increase levels of soil nutrition that is enabled by CNEF. We agree. Complicating our understanding of these fertilizers is the fact that soil science is today a much more complex subject than it was just a decade ago. A wide range of biological and bio-chemical actions and interactions are recently discovered or being re-evaluated under fresh and more knowledgeable science. The research driving the investigation of the workings of the soil is at the same time ancient and refreshingly current. Daily, the subject of soil science grows increasingly complex. Tomorrow, new discoveries may force us to revise our understanding. The following is what we believe today. It Starts With A Tea.

When moisture is applied to the fertilizer a CNEF product slowly enters the soil as a lightly colored liquid which is essentially a tea. Humic substance reducing microbes, both bacteria and possibly fungi, enter into these tea liquids and react with them.



Notice the complex interaction of the soil minerals. An insufficiency of one mineral will affect interactions with other minerals which in turn affect interactions with others.

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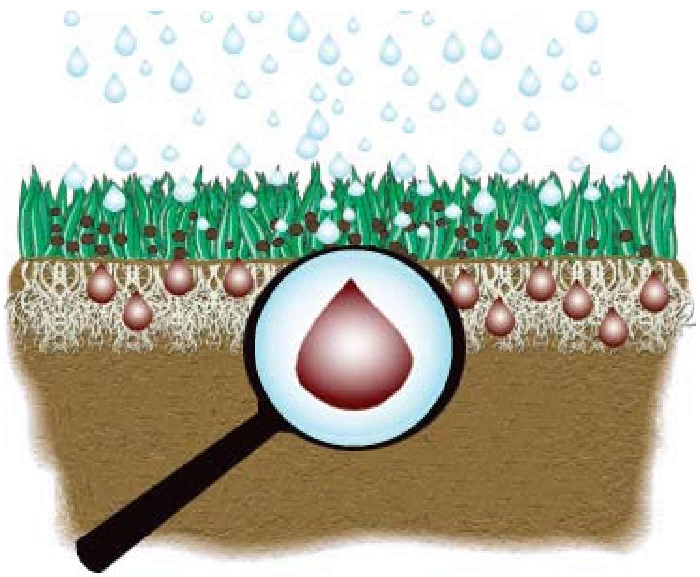
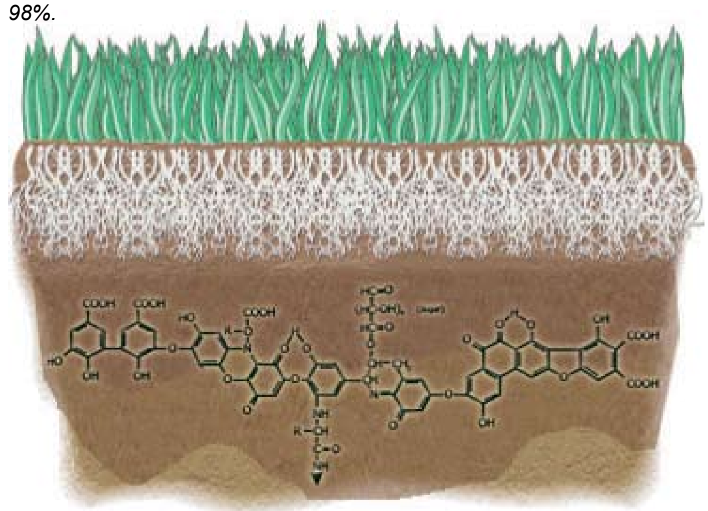


The Tea Naturally Develops Into Fulvic and Humic Acids.

The transformation of the organic CNEF tea into humic substances is a natural phenomenon. Bacteria reacted fermentation begins the process. Some researchers believe that mycorrhizal fungi exuded enzymes strengthen and increase the process. Tea liquids are converted into humic substances in the form of pigmented polymers – both fulvic and humic acids. The pigmented polymers in the plant nutrition productive range are water saturated gel-like substances with moisture contents as high as 98%.



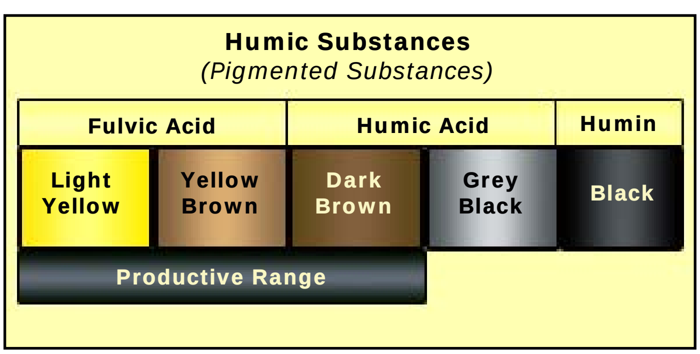
Plant productive humic substances in the form of soil acids are always formed from decomposing organic substances. The non-productive gray substances called humics by some are actually very old humics usually found in hard structures as a powder or rock. The ancient grey humic structures are not involved in growing plants other than as a source of trace minerals. The black structures are usually peat, tar, or petroleum type structures as a solid or a liquid permeated rock that are ancient humic substances.

The Benefits of Soil Acid

What Are Fulvic and Humic Acids?

Fulvic and humic acids are indistinguishable in the soil. Since they are combined within a high moisture matrix with other nutrients we believe that it is best to reference these two acids simply as "soil acids". It is only in the laboratory that the two acids are differentiated. Although science has not yet been able to prove this theory, we agree with some theorists that fulvic acid is the final finished food of the fulvic/humic acid complex as it is the more refined and bio-active of the two acids. The ratio of fulvic to humic acids in the soil is based on soil temperatures so it varies from latitude to latitude. In a northern clime the ratio might be 70% humic to 30% fulvic. In a southern clime, the ratio might be reversed with 70% fulvic and 30% humic. Soil acids are known to scientists as pigmented polymers due to the natural colors and the poly (many connected molecules) structure of soil acids. These gel-like substances are soaked up by soil particles and held in the particles and the spaces in-between. While a lot of work remains to fully understand humic substances, scientists currently describe them as complex aromatic macromolecules that have incorporated amino acids, amino sugars, peptides, aliphatic compounds, and a wide range of chelated mineral substances into the molecular structure or soil acid matrix that is usually found as a gel in the soil. They are incredibly complex and complete organic sources of nutrition. Perhaps the foremost benefit of soil acids as soil nutrients is in the nature of the mobility, or should we say immobility, of the humic substances. Soil acids don't travel very well. In fact, fresh humic substances stay right where they are made, in the root zone, unless they are taken up by plants or literally washed out of the soil by a strong direct current of water. Instead of quickly migrating through the root zone towards the ground water, as water soluble man-made synthetic chemical fertilizers are inclined to do, soil acids tend to stay where they were made. There they stay until plant driven plants or micro-organisms draw upon their reserves of nutrition in order to pass them along to plants.

From a fertilizer viewpoint the tendency of organics to not migrate is a tremendous advantage over chemical based fertilizers. Remember earlier when we discussed the fact that, at a minimum, fifty percent of all chemical fertilizer never reaches the plant and washes out of the soil? While the exact percentage of organic fertilizer that starts as a tea and then translates into soil acids in the root zone has not been firmly established by scientific study, we can measure increases in humic acids in the soil. We do know that levels of soil acids around the base of trees and other plants fertilized by this new class of fertilizers has increased 400% to 600% over baseline levels before fertilizing.



The light yellow through the dark brown ranges are the most productive ranges of humic substances. The grey and black ranges are believed to be less productive for plant growth.

How Soil Acids Transport Minerals to Plants

Soil acids can readily form stable water-soluble complexes with monovalent, divalent, trivalent, and polyvalent metal ions. This aids the movement of metal ions that are normally difficult to mobilize or transport. For that reason, soil acids are excellent natural chelators and cation exchangers. They are vitally important in the nutrition of plant cells.

Humic substances in the form of soil acids are wonderfully made by nature to nutrition plants. They are potent sources of nitrogen, phosphorus, sulfur, and trace minerals in an organic compound nutritional form that is used by both plants and microorganisms. The weak soil acids work on minerals to change them from a solid into simple ionic gel forms through a process of chelation that breaks down the minerals. During this process of chelation metallic mineral ions are firmly attached to organic molecules to turn them into a fully absorbable bio-available form.

The dissolved chelated minerals become a part of the soil acid matrix and are contained within the soil acids in a liquefied gel form that is ready for transport to plants by plant roots.

Soil Acids are Transcellular and Can Inject Nutrients Directly Into Roots

When a root enters the area of soil saturated with soil acids, a portion of the acids, specifically the fulvic acid components, are able to inject the nutrients directly into the plant roots due to the fact that fulvic acids are trans-cellular in nature and easily pass through the outside walls of the plant carrying their mineral components. Once inside the roots the nutrients are quickly passed throughout the plant by the plants systemic circulation system. Valuable nutrients such as iron, copper, and zinc are easily dissolved by the soil acids and transferred to plants. This transfer mechanism is necessary for the transport of minerals from the soil into the plant. The ability of soil acids to effect this transportation of minerals is one of the major differences between an organic fertilizer and a synthetic fertilizer.

Soil Acids Dissolve Silica for Use by Plants and Those Who Eat Plants

Humic scientists believe that soil acids have the ability to inter-react with one another to create new mineral compounds. Soil acids dissolve silica into a form easily digestible by plants. When adequate magnesium is available the vegetal silica and magnesium are transmuted into a form of plant contained calcium that is the most desirable in animal and human nutrition.

Other Nutrients Are Held by the Soil Acid Matrix and Transmitted to Plants

In addition to the dissolved mineral elements, soil acids contain within their matrix dissolved vitamins, coenzymes, auxins, hormones, and natural antibiotics which are a factor in maintaining the health, growth, and well being of plants and the entire soil foodweb.

Soil acids can complex vitamins into its structure. Since it has a transcellular nature, it can transfer vitamins into the cell along with complexed minerals. In this perfectly natural process vitamins can be catalyzed and utilized or stored within the cell.

Soil Acids Provide Food for Soil Microbes

Soil acids provide a prime food for mycorrhizal fungus. The exudates of the fungus in turn are believed to help produce fulvic acid. A functional nutritional benefit of mycorrhizal fungus is the manufacture of plant and human effective antibiotics which are untaken and stored by plants. Soil acids are also prime food for some bacteria which then in turn become prime food for beneficial nematodes that enrich the soil with high levels of natural nitrogen. These nematodes in turn render the protein from bacteria into a high grade form of nitrogen from their manure and the decomposing structures of their bodies.

Soil Acids hold Very Large Amounts of Moisture in the Soil Acid Matrix

Soil acids contain a large portion of the world's carbon. In fact, they are the predominating form of carbon on the planet as they contain more carbon than all living things. (Ghabbour) Inside this carbon is a very high level of moisture, as much as 98%, that is held in the soil acid matrix.

When a grower adds a ton of a high efficiency organic material, such as a CNEF, it is actually building a soil sub-mass that is much greater than the ton of materials added to the soil. The reason for this is simple. When soil acids are formed as a gel, the gel is moisture saturated as it collects surface applied moisture and incorporates it into the soil matrix.

A ton of CNEF, with an 80% efficiency of transformation and a 98% moisture content could possibly form in the soil over 39 tons of soil acids once the gels are formed by the addition of moisture. In a one-acre area that would amount to about 1.79 lbs of soil contained soil acids per square foot. Soil acids work as a polymer to gather and hold moisture inside its structure.

Soil Acids Take the Toxic Out of Toxic Pesticides and Herbicides

Soil acids gradually destroy toxic pesticides, herbicides, and other forms of toxic compounds through a natural process of bio-chemical degradation into harmless elements along with a sorptive action that occurs when these organic toxins come into contact with soil acids. A toxic herbicide such as Paraquat is quickly detoxified by fulvic acid. These reactions can occur before or after the toxins reach concentrations that are toxic to living organisms.

Soil Acids Result in Higher Systemic Levels of Plant Copper to Eliminate Disease

Many agronomists who have scoffed at the ability of CNEF to eliminate many plant diseases are unaware of some of the newer theory as to the nature of plant pathogens. These theories hold that plant pathology, including attack by fungi, basically have two primary causes.

These causes are:
1) A weakness of the plant and its immune system stemming from a deficiency of proper nutrition.
2) A weakness of the plant and its immune system stemming from toxic overloads. Basically, the concept most important to growers is that symptoms of plant disease including a susceptibility to the disease or observed symptom of the disease are the result of the entire systemic weakness of the entire plant resulting from a nutritional deficiency. These theories are derived from similar theories developed for humans. Most plant pathology is visible by long identified symptoms that are well known by most growers. Growers have grown accustom to treating symptoms, not overall nutritional deficiencies. For lack of a better term, these symptoms are often labeled as a "disease". Treating those symptoms usually requires the addition of an additional element or nutrient along with an effective transform mechanism, such as soil acids, to assure that the plant uptakes the mineral elements.

A case in point would be the use of copper compounds to defeat fungus molds in grains, grapes, and other crops. A question might be asked – when is a copper compound a "cure" and when is it simply an increase in a deficient mineral? Copper compounds have been in agriculture used since at least 1761 to cure fungal infestations in grain. Such use begs the question – "If grain was grown with adequate copper nutrition would it have been susceptible to the fungus attack in the first place?" Likewise, wine grapes were first treated with copper compounds in 1880 to defeat downy mildew. Grains and grapes grown with CNEF type products have repeatedly shown little evidence of downy mildew, powder mildews, or fungal diseases such as club root, black fungus, and white fungus. CNEF not only provides copper and zinc, both recognized mold fighters, it also provides the transfer mechanism in the form of a high efficiency organic base that transforms into soil acids that render the copper into a form easily taken up by the plant.

Spray copper compounds or provide them systemically through the plant from the mechanism of the soil? Which makes the more sense? Many agronomists will readily tell you that simply adding copper to a synthetic fertilizer does not assure transfer to a plant. From the experience of synthetic fertilizer producers this is absolutely true. It is not true with organics such as a CNEF product. CNEF has the organic transfer mechanism lacking in synthetic fertilizers.

Soil Acids Increase Plant Sugars

Fulvic acid easily penetrates root cell walls. Plants grown in high soil acid soils are exposed to a constant fulvic acid driven mineral and metal complex exchange between the stored fulvic acid nutrients in the soil and the plant. This results in increased oxygen to the plant, an increase in the vital activity of plant cells, and an increase in carbohydrate metabolism which in turn increases the accumulation of soluble sugars in a plant. The increase of soluble sugars in a plant increases the pressure of osmosis inside plant cell walls and enables plants to withstand wilting, which in turn enhances growth stimulation and the immune system.

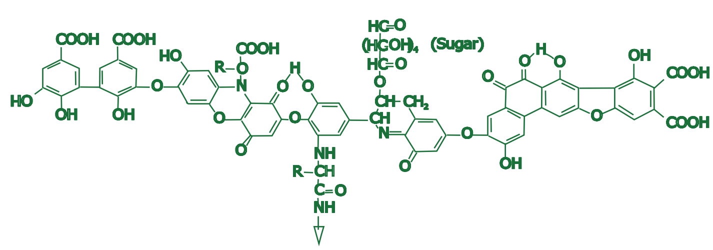
When "Humic Acids" are not Soil Acids

Often when we start to talk about fulvic and humic acids we draw a blank look until a mental light-bulb goes off in the listeners head and we get a response something like "tried humics and fulvics and they don't work!" What!
Then the light bulb goes off in our head. The person we are speaking with is talking about man-made reconstituted humics or man-made fulvics. About that time we call a time out and go
into an educational mode.
The fact of soil acids being only manufactured in the soil does not prevent the sale of agriculture additive products labeled as fulvic acid and humic acid. Grey and black forms of petrified humic acid are often thousands of years old and are typically found right where they were made. Mined and sold as soil supplements, they are probably of little use to the plants except to provide trace minerals to the plant. Growers with experience in these types of humic substances generally have seen the benefits from the trace minerals contained in these ancient humins but cannot from these products experience the benefits of biologically active soil acids.
Soil acids are by their nature and definition alive in the same manner that wine is a living liquid. The soil is the only place where complex molecular structure fulvic/humic acids are manufactured. Those manufactured from dead humics are not reconstituted by the addition of an acid. Other "fulvic acids" made from bacterially deteriorated green waste do not offer the active bacterially components provided by soil manufactured fulvic and humic acids.

Despite extensive US government funding, researchers have been unable to successfully build complex molecular structure soil acids in the laboratory or to synthesize them. The molecular structures are simply too complex. The manufacturing process in the soil is entirely by bacteria, fungi, and possibly other soil microbes. The manufacture of fulvic / humic acids takes place in a complex living foodweb that is interactive with the soil, the atmosphere, and other microbes. The result of this interaction is the construction of a living fulvic / humic acid matrix in the soil. Some scientists believe that plants, if available, may play an important role during the manufacturing process. Plant roots act as two way highways bringing atmospheric gases CO2 and N2 down to microbes. The gases are used by microbes, specifically mycorrhizal fungi, in their process of collecting, converting, and transporting mineral nutrients into the plant roots for use by the plant. The nutrients then flow back up the plant into the stems, leaves, flower, and fruit. While the plant benefits it must also be considered to be an active participant in the total process. The soil acid matrix will be built with or without plants.

Soil Acids Are The Ultimate Nutrition Storehouse

The soil acid matrix, with moisture content up to 98%, provides a stable long term storehouse of nutrition and moisture for the plant. Within it, fungi manufactures antibiotics to keep the plant healthy. Other fungi capture and kill soil dwelling predatory microbes. The nutrition created by this soil foodweb raises the soluble sugar and minerals in the plant which in turn repels insects. From the soil foodweb a whole host of benefits arise that are vital to the health of the plant and its ability to reach its full genetic potential.



The complexity of this humic acid molecule is astounding! This is a high quality plant food with abundant nutrition.

How Growers Can Build Soil Acids in Their Soils

Scientists know that all things organic that are left to deteriorate on the surface of the earth will eventually become some form of a soil acid. The more important aspect of this concept is the fact that organic materials are not universally efficient in the building of soil acids. Soil acids have an infinite number of molecular structures. Some are very complex and contain a high level of N-P-K, secondary, and trace minerals. Others are simpler and may contain only a small amount of a lot of nutrients or even of a single nutrient. Three basic factors are critical to conversion from organic material to soil acids. These are:

1. The mineral content of the organic material.
What is the mineral content of the material that is being converted? Much organic material is exhausted through natural process. Fallen leaves, for instance, are basically exhausted organic materials. Most of the systemic nutrition contained within the leaf has been returned to the tree. In a like manner, compost has often been exhausted of the initial value of its nutrition during the composting process. The majority of composting programs work with an active phase, to eliminate weed seeds and insect spores, where the compost temperatures are heated from 135 ° F. to 155 ° F. temperatures over a period of four to six weeks. Contained nutrients in most compost are lost to the atmosphere in the form of CO_2, methane, and ammonia or leachate and are not available for transformation into soil acids.

2. The stability of the organic material.
The stability and nature of the organic material is critical. If an organic material is a fast deteriorating material then valuable nutrients are often consumed by bacterial action or lost to the atmosphere before the nutrients can be transformed into soil acids. A prime example of this type of loss is manure. Manure is prone to quickly lose its nutrients through rapid deterioration due to many factors, including temperatures, sunlight, soil types, and wind. As a result of rapid deterioration the full level of contained nutrients do not make into the bacterially and fungi formed soil acids.

Manure left on the surface of soil will deteriorate rapidly. One university research study found that 25% of the nutrient value of manure deteriorated in 24 hours. By the end of several days the nutrient values are less than 10% of the original values. Manure incorporated into the soil will more often effectively transmit its nutrients into soil acids. However, such manure is often prone to putrefying as its bacterial content may overcome the existing soil bacteria responsible for transformation into soil acids. When this occurs, the manure can produce potentially harmful putrefactive soluble metabolites which can actually harm plant growth. Application of raw manures that putrefy can kill aerobic organisms that that form beneficial soil aggregates. (Byers) Should this occur the soil structure can collapse. Soil clays can de-floculate and the soil will seal. The result is that the soil is then subject to a high degree of erosion. The more detrimental result of in-soil putrefying manure is that eventually the grower will lose the beneficial aspects of the soil foodweb as it is turned into an anaerobic environment where injurious microbes in the form of pathogens and anaerobes become the dominate life form. (E. Ingham)

3. The pH of the organic material.
Organic materials will convert to soil acids over a wide range of pH values. However, the most efficient conversion pH is between 6.0 to 6.2 Organics with higher or lower pH values are not as efficiently converted. Manures and manure composts are often high pH organic materials that convert poorly into soil acids.

4. Prior chelation.
Organic materials that have been chelated prior to application are much more efficient in their transformation into soil acids. Prior chelation means that the minerals contained in the organic matter are more easily and efficiently converted.

CNEF is Manufactured to be A High Efficiency Conversion Organic Material

The efficiency of transformation from provided nutrient to soil acids acid is what differentiates one organic supplement from another. In order for an organic supplement to have a high efficiency of transformation it must have;

1. A CNEF must have a complete Formulation.
An organic based or a 100% organic fertilizer must have within each granule a complete nutrient package that contains all primary, secondary, and trace nutrients. As a result, each drop of infusion (tea) into the soil will carry the complete nutritional elements necessary to build high quality fulvic and humic acids with complex and complete molecular structures.

2. A CNEF must have a homogenous nature.
Blends of mono-organic nutrients are not as effective as a homogenous product for the simple reason that different mono-ingredients deteriorate at different speeds. A blood meal, bone meal, feather meal blend may appear to have the right N-P-K levels but will convert poorly in the soil.

3. A CNEF must have the correct pH level.
CNEF is pH adjusted to a 6.0 - 6.2 pH. The organic segment of an organic based fertilizer must be at this pH for maximum efficiency of transfer.

4. A CNEF must be process sterilized.
In order to have a high efficiency of transformation, a fertilizer must be process sterilized at temperatures that do not damage the nutritional aspects of the fertilizer but does remove all weed seeds, spores, virus, and bacteria. This is done to remove possible competing pathogens. Applied fertilizers rely on existing soil pathogens which regenerate and explode in numbers when provided a high quality source of microbial nutrients. Competing deterioration pathogens carried within the product before application can overwhelm soil bacterial responsible for converting a fertilizer into soil acids turning it from a slow release product into a lowered efficiency labile type organic material instead of an efficient and slow converter.

5. A CNEF must be hydrolyzed.
An organic base must be precisely hydrolyzed to alter the nature of the molecular structure of the organics to alter it from a labile nutrient into a stable nutrient that will enter the soil correctly.

6.A CNEF must be fortified with living organic organisms
The best organic based fertilizers are inoculated with mycorrhizal fungus and sometimes bacteria depending upon existent levels of soil bacteria and fungus. These microbes can accelerate the restoration of microbial levels in soils that have been stripped of most of the microbial life through soil sterilization, over application of phosphates, and, or, poor tillage techniques. Is should be evident that CNEF type products are carefully engineered to achieve one goal. That goal is, of course, the building of a high quality soil acids matrix in the soil to which it is applied.

Additional Attributes of a CNEF Type Organic Fertilizer

Other mono-ingredient organic sources are not nearly as efficient. Some, such as feather meal and bone meal are slow reduction organics that take a long time for bacteria to break down. They often fail to capture and store accompanying labile nutrients. Others, such as blood meal are more efficient, but carry the possibility of dangerous pathogens. Most organics, such as raw or dehydrated manures, are simply too labile in nature as they deteriorate faster than the soil bacteria can convert their nutrients into fulvic/humic acids.

Synthetic / Organic Convergence - Long term nutrition for soil and humans

Soils treated with synthetics should be treated with high efficiency organics to build back soil components. Such programs will use much lower rates of synthetic fertilizer as the organics provide a capture and transfer mechanism which synthetics alone do not have.
The effectiveness of milder synthetic formulations is accelerated by an organic base that is efficiently capturing and storing the synthetic mineral component. Too much synthetic is not only overall detrimental to the soil food web, it is wasteful, and actually can kill off mycorrhizal fungi which are providing increased nutrition to the plant, protecting it with antibiotics, and protecting if from harmful nematodes.

Many growers, in real life applications, using modern, full-nutrition organic fertilizers have found that if their crop requires high nitrogen levels it is better to apply more of a low-nitrogen fertilizer, one which converts directly and quickly into balanced fulvic and humic acids, than to attempt to use a synthetic fertilizer with higher nitrogen content. In nature, there are few full strength "hits" of nitrogen. Nitrogen and some forms of phosphate are simply too volatile to be highly efficient.

To be practical, it is unrealistic to believe that mono-culture farmers want to do anything that is not simple, effective, and with the least applications. Given the nature of the soil, we have observed that two annual applications of low nitrogen organic fertilizers on a single rotation crop can easily outperform repeated applications of a high nitrogen fertilizer even if the synthetics are applied at double or triple the amount of nitrogen. Soils on which high rotation crops are grown will actually rapidly increase in strength with repeated applications of a CNEF fertilizer.

Observed Plant and Soil Response to CNEF

Root System Size Increases When Supplied With Ample Soil Acids.

High levels of complex nutrition soil acids in the soil naturally result in an increase in the size of root structures. Soil acids, specifically fulvic acid, can easily cross directly into the root structure to provide food directly into the plant roots. These substances also provide food for bacteria and mycorrhizal fungi to grow and build aggregate structure in soil breaking up compaction zones getting air deeper into the soil and allowing roots to grow out seeking moisture and additional nutrients. Soil acids manufactured in the root zone of a plant and stored in the place where they are manufactured are the ideal source of nutrition for an increased root mass. Dr. Elaine Ingham of Soil Foodweb, Inc. states that there is a direct correlation with the addition of humic substances in the root zone and an improvement in plant health. Dr. Mike Amaranthus, of Mycorrhizal Applications is quick to explain the mechanism.

"We know that a healthy mycorrhizae fungi colony in a plant actually induces additional growth of the smallest of secondary plant roots. This growth is in addition to the growth of the mycorrhizal hyphae extensions on the plant roots that increase the effectiveness of the roots by a factor or perhaps 10 fold. Fulvic acids are the ideal food for a colony of mycorrhizae."

Plants fed with Complex Nutrition Enabling Fertilizers always respond with significant new and increased growth in the root zone. The function of soil acids providing foods for use by symbiotic mycorrhizal fungi is a reason for this reaction.

We have observed the fact that plants fed with CNEF almost always increase the size of their root mass. It is not unusual for a plant to double its root mass or even increase it by a factor of four times or more its original size. Considering the inability of synthetic chemical fertilizers to remain in a root zone, it is easy to believe that most plants fed with chemical fertilizer systems are hungry a majority of the time.

Increased Root System Size Enables The Growth of a Balanced Stem and Foliage.

When humic and fulvic acids are manufactured and stored in the root zone of a plant a plant responds with an increase in growth of its root system. The next response is the growth of a balanced stem & foliage. Without the balanced stem and foliage the next step, that of flower and fruit, will not be enabled to the full genetic potential of the plant.

A Balanced Stem and Foliage Will Allow The Development of The Full Genetic Potential of the Flower and Fruit.

An increased balanced stem and foliage will provide nutrients for full genetic growth of the flower, and fruit of the plant. Fruit grown with CNEF typically is sweet with a firm flesh. This is due to the fact that most plants grown with CNEF typically have a higher Brix content (measure of sugar content) than plants fertilized with synthetic N-P-K fertilizers. An important secondary benefit to this increased Brix content is the added resistance to plant attacking insects who find it more difficult to suck or eat plant juices that are sticky due to the higher sugar content. A healthy plant, with higher Brix levels, is always more plant insect infestation resistant than an unhealthy plant with lower sugar contents.

Benefits of Using A Complex Nutrition Enabling Fertilizer

The benefits of using CNEF are easily demonstrated. Almost five years of observed experience with Perfect Blend Organics, a CNEF type product, has provided growers with a eye opening appreciation of the benefits of a CNEF program. These growers are benefiting from advanced soil nutrition that allows their plants to reach their full genetic potential while naturally protecting their crops from insects and disease.

- Orchard growers using Perfect Blend have consistently found themselves at the top of the pool in their pack-out for quality and size. Along with outstanding and consistent balanced growth they report the ability to harvest a high yield, high quality commercial crop off of second leaf trees – an almost unheard of possibility.

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- Salad greens growers report that the use of Perfect Blend has eliminated downy mildew in their high rotation crops. Growers are using as much as 3 tons of Perfect Blend per acre per year to achieve high quality, high yield greens.

- Truck farm growers use Perfect Blend to grow direct-to-restaurant vegetables and greens that are remarkable for their taste, shelf-life. high quality, high mineral, and high measurable Brix indicating a high sugar content. They report excellent visual quality, size, and yield across a wide range of vegetables.

- Growers have reported that Cruciferae family vegetables such as cabbage, cauliflower, brussels sprouts, broccoli, and Chinese cabbage are less susceptible to a fungal disease known as club root when fertilized with Perfect Blend.

- Organic wheat growers, drilling Perfect Blend in with dry winter wheat seed, report the highest Brix levels ever observed along with increased yields. They believe that higher Brix levels are an indication of the resistance of their crop to sucking insects. Their average Perfect Blend application rate is approximately 500 lbs / acre.

- Walnut tree growers applying ½ ton of Perfect Blend per acre report four to six feet of growth and high quality walnuts from two year old trees that were fertilized at the end of their first year with Perfect Blend. They also report a decrease in the incidence of soil borne pathogens such as Phytophthora.

- High application growers observe immediate changes in their soils. One grower observed that his 300 acre field had originally had sections of sand along with hard pan. After a year of intense application, his soil had become much more uniform with the hardpan becoming softer and the sandy soils loamier. Now, he states, his soil is amazingly uniform. Multiple growers have reported soil changes with repeated use of Perfect Blend CNEF.

- Growers report less insect problems with Perfect Blend grown potatoes. Fields may show insect damage on the outer margins of their fields but the damage does not extend past the first row or two into the field.

- Onion and garlic growers repeatedly report major increases in the percentage of colossal and jumbo sizes in their crops.

- Alfalfa growers report higher protein content and increased TDN and RFV values with Perfect Blend CNEF type products.

- Several growers have reported a decrease or complete cessation in attacks by slugs on plants fertilized with Perfect Blend organics

The Nitrogen Question - Why organic N units and N values are often wrong

There can no longer be a debate over whether organic fertilizers are just as good as synthetic fertilizers. Organic fertilizers are greatly superior. Science is slowly producing a clear and concise understanding that the benefits of organic fertilizer far outweigh the quick labile nutrients of synthetic types encompassing man-made nitrogen. Organics, are being revealed by new science to be not only more efficient, they are superior in every manner from conservation of fertilizers, soil sustainability, environmental pollution, storage of nutrients, transformation of minerals, sustainability of soil, along with increasing the vigor, yields, and health of plants.

To illustrate the problems with trying to compare N values consider that recently, a leading manufacturer of organic fertilizers subjected their products to a side-by-side turf trial by a major university. The 100% organic product with 4% guaranteed nitrogen (3.5% organic - .5% inorganic) actually out performed a synthetic – organic mix with 8% guaranteed nitrogen (3.5% organic and 4.5% inorganic). How did this happen? Conventional wisdom says the higher the guaranteed nitrogen the better the performance. The truth is that the organic product is more efficient at conversion, delivery, storage, and slow feed than the higher nitrogen product.

One of the more troubling aspects of such a comparison might focus on the use and concept of nitrogen units. Many organic growers attempt to use the model of nitrogen units that were invented in the synthetic nitrogen fertilizer industry. Applying this concept to organic nitrogen, they attempt to calculate their nitrogen needs based on measures provided by synthetic units. Synthetic units are much more easily calculated than organic N units which face many subjective forces that may, quickly in some cases, alter their value. Even with that understanding many growers do not acknowledge that there is a great difference between the nitrogen contained in a pile of manure and the granulated nitrogen from a urea granule. Organic growers who attempt to calculate their organic nitrogen needs by use of synthetic units are condemned to getting it wrong and either overpaying or underpaying for fertilizers most of the time.

The reasons for these miscalculations are simply stated:

1.The labile nature of synthetic nitrogen invites over application as a practice.

Synthetic nitrogen is a labile nutrient. It seeks quick release into the atmosphere, ground, and surface water. As a result, most growers over apply in order to compensate for its nature. From this practice has grown a large body of practice that advocates calculated nitrogen units that are universally at least 50% if not 80% in excess of what plants can actually use. Such baselines are universally used with synthetic fertilizers but are very inappropriate for organic fertilizers. Growers who attempt to use synthetic N values, or N units, in calculating the needs for their organic crops will spend a lot of extra money for nitrogen that their plants cannot use.

2.Organic nitrogen is much more efficient in delivery to plants than synthetic nitrogen.

Synthetic nitrogen sources are very inefficient in remaining in the root zone for any length of time due to the fact that they do not have any type of storage mechanism that collects and stores nitrogen. High quality organic fertilizers, such as CNEF have the ability to store nitrogen in the soil acid matrix.

The net result is that synthetic nitrogen sources tend to provide plants a quick hit of nitrogen while organic nitrogen sources provide a slow steady feed of nitrogen and other mineral elements to the plant.

3.Many agronomists still believe that plants can only uptake inorganic nitrogen.

Despite recent science that clearly shows that organic nitrogen, not inorganic nitrogen, is the dominate form of plant nutrition some agronomists who don't keep up their reading still believe that nitrogen in organic materials must be "mineralized" to nitrate or "exchangeable ammonium" before it can be taken up by a plant. This misconception is a base cause behind the need by some to continue to attempt to express organic nitrogen in measurable units.

With the concept of nitrogen "N units" clearly not working, some soil scientists have grasp onto the concept of measuring carbon to nitrogen ratios in the soil. Now a new body of conceptualization, based largely on faulty science of inorganic nitrogen being the predominate form of nitrogen, is being tried by some soil scientists.

In time, we predict that these theories will ultimately fail due to the lack of understanding of the way manure and other organics deteriorate. However, we are pleased to note that these scientists have finally realized that the concept of "N units" is largely a defective means of nitrogen measurement and are at least attempting to bring scientific measurement to nutrients of a highly subjective nature.

4.Measurement of nitrogen in organic materials is a highly speculative business.

Many times, we could have won a wager with growers over the nitrogen content of organic materials. Along with a grower armed with a two week old test showing 4.2% nitrogen in a supplied manure we might arrive at a pile of manure at the edge of a field awaiting spreading. The grower was absolutely convinced that the pile of manure had the same percentage nitrogen as shown in his report. We knew otherwise. There are too many factors that work against a manure holding nitrogen values before and after incorporation into the soil.

These factors include

A. Sunlight

B. Wind

C. Ambient soil temperature

D. Bacteria count – putrefying bacteria

E. Presence of shavings or other litter that can bring about nitrogen immobilization

F. Presence of dead animal carcasses which might accelerate putrefying bacteria

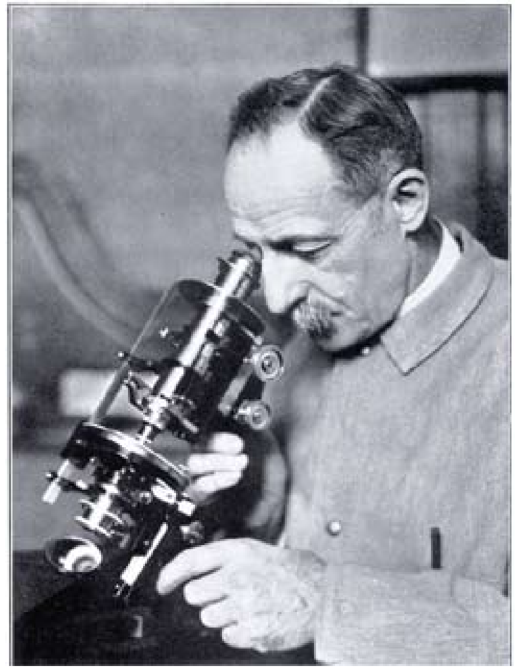
G. Heath of animals that are the source of bacteria – sick or dying animals are often the source of putrefying bacteria in nitrogen source.

5. Many laboratories test nitrates and ammoniacal nitrogen and do not test for other nitrogen sources including water soluble nitrogen and water insoluble nitrogen.

Many laboratories operate under a simple theory – why test for something that they believe does not affect plants. Such labs are operating on the same theory that many agronomists still operate on, the belief that inorganic nitrogen is the only nitrogen that be taken up by a plant. As a result, they are under testing most nitrogen sources and sometimes over applying fertilizers. The science of the synthetic chemical fertilizer industry trains agronomists and farmers to think in easily applied highly mobile units of chemical nutrition. As a result synthetic chemical nutrients are deliberately over-applied to compensate for the labile release nature of the synthetic chemical fertilizers. It is only logical to conclude that if you know you are going to lose 50% or more of the added nutrient then you have to add twice the amount your plants actually need. Can any mono-culture really use the total "units" of nitrogen / acre proposed by most scientific literature or manufacturers indications? The answer is probably not. Plants are limited as to the amount of nitrogen they can uptake. The greater majority of plants can uptake less than 5% total nitrogen. Frequently, the "units" of required nitrogen are calculated on agriculture lands with low or exhausted levels of SOM. Many growers believe that higher nitrogen levels are required to compensate for SOM exhausted land. As such practice continues, word of mouth passes between growers and high nitrogen levels are topped with higher levels. With this knowledge, it is instructive to check with past fertilizer practices on a piece of land. Usually, over a period of decades, one can observe an annual increase in the amount of nitrogen needed to achieve a stated yield. Unfortunately, these increased application rates are often, and without any official sanction or justification, the basis for application rates on an industry wide basis, thus accelerating and perpetuating the amount of nitrogen being placed on agriculture lands. Dr. H.J. Kronzucker of the University of Toronto addressed the problem of nitrogen uptake in conventional crops. His studies revealed that only about 50% or less of applied nitrogen was actually taken up by plants. Other studies have indicated that up to 80% of the nutrients were never taken up by the plant. Nitrogen nutrients are lost in the soil or atmosphere in the form of ammonia volatilization, leaching, nitrification, and denitrification. If valid, these studies alone would indicate that we need to cut in half the amount of organic fertilizer necessary. Trying to adapt the standards of the chemical industry to organic based CNEF applications will almost always result in over-application of a CNEF fertilizer. That said, the good news is that over application of a CNEF will not usually result in any real loss as the nutrients are retained in the soil and available for next years crops.

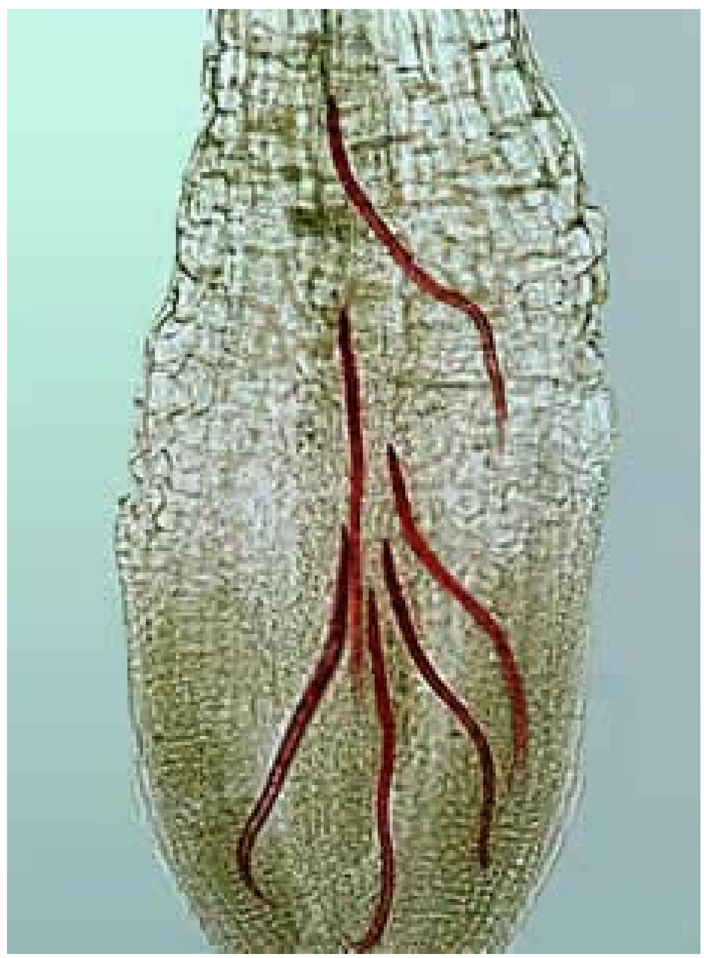
What does work in assessing nitrogen needs? Unfortunately, there is currently no simple test to assess real nitrogen retention in the soil and real nitrogen values for application to the soil.

There are standard tests for nitrogen content in the soil. Unfortunately, these tests are usually focused on nitrate and ammoniacal contents and largely ignore organic nitrogen or calculate the availability of organic nitrogen over a period of months or years. Once again, these concepts ignore the availability of organic nitrogen and focus on the conversion of the organic forms into inorganic forms. If this was truly the case, organic fertilizers would not be able to perform in the manner that is easily observed. Properly taken leaf sample nutrition tests taken over a number of years, analyzed for nutrient values, and correlated back to the yields and quality scores of a crop can be effective roadmaps.



"If all the matter in the universe except the nematodes were swept away, our world would still be dimly recognizable..."

N.A. Cobb, 1914



Manure, Dehydrate Manure, Compost, & Other Forms of Organic Nutrients

A Quick Primer on Manure

Raw manure is the oldest known fertilizer on the planet. It has many excellent properties however commercial monoculture growers frequently find it problematic. In addition to often being full of active weed seeds, spores, and pathogens, nutrients in manure are easily lost. Most of the nitrogen in manure is in the form of urea and NH4 (Ammonium) depending on conditions in the animal. The NH3 (Ammonia) contained in manure easily volatizes into the atmosphere once manure lands on the ground. Other nitrogen nutrients, NO2, nitrogen dioxide, N03, the nitrate ion, and NH4 the ammonium ion will easily leach into surface and ground water if given the opportunity. If the manure remains anaerobic, NH4 and N03 will be reduced to NH3 and will volatize as a gas. Over twenty-five percent of nutrients in fresh manure can be lost in the first 24 hours after manure is spread on a field if the manure is left uncovered. Fifty percent of the nutrients may be gone within two weeks.

Manure is an unpredictable and unreliable fertilizer. Soil loves manure, but the nutrients in fresh untreated manure do not hang around long enough to provide the soil food web with the full range of nutrients that it could provide if it were more stable.

Manure can be a good soil nutrient. Many growers have developed a practice that serves them and their soils well. It can also be a catastrophic nutrient, destroying fields and stunting crops. CNEF was developed specifically to provide a treatment for manure to render it into a high quality nutrient. Most growers do not know the full range of the downside of using manure. The following is a discussion of some of the known problems with manure.

1. Some poultry manure contains Arsenic V – a very labile form of arsenic

An organic arsenic compound called Roxarsone is frequently added to poultry feed to control coccidial intestinal parasites. This compound is made up of Arsenic V – a very labile form of arsenic which can spread to ground and surface water. Many growers believe that this compound has a toxic effect on their crops and can slow growth and stunt development phases in crops.

2. Putrefying manure can cause major damage to soils.

Manure incorporated into the soil will more often effectively transmit its nutrients into soil acids. However, such manure is often prone to putrefying as its bacterial content may overcome the existing soil bacteria responsible for transformation into soil acids. When this occurs, the manure can produce potentially harmful putrefactive soluble metabolites which can actually harm plant growth. Application of raw manures that putrefy can kill aerobic organisms that that form beneficial soil aggregates. (Byers) Should this occur the soil structure can collapse. Soil clays can de-flocculate and the soil will seal. The result is that the soil is then subject to a high degree of erosion. The more detrimental result of in-soil putrefying manure is that eventually the grower will lose the beneficial aspects of the soil foodweb as it is turned into an anaerobic environment where injurious microbes in the form of pathogens and anaerobes become the dominate life form. (E. Ingham)

3. Crop burns kill young crops.

The fact that non-composted and partially composted chicken manure in high concentrations can kill young crops and burn more mature crops is well known by most growers.

4. Nitrogen immobilization stunts crop growth.

Broiler house manure concentrates sometimes have with high levels of wood shavings, rice hulls, or some other form of carbon mixed with in with the manure. In these circumstances spread or incorporated manures may actually have a carbon : nitrogen ratio that results in overly high carbon contents. Soil microbes will actually compete with plants for available nitrogen. When this occurs, soil microbes will prevail and plants will receive insufficient nitrogen.

5. High salt levels damage soils.

The University of California has warned growers that "the material that remains after we subtract out the nitrogen, phosphorus, and potassium is for the most part undesirable salts which can prevent seed germination and burn plants." Another University of California Extension Agent explained. "Manures commonly contain 4% to 5% soluble salts on a dry weight basis and may run as high as 10%. To illustrate, an application of 5 tons of manure containing 5% salt would add 500 lbs of salt. Normally, irrigation and rain water will sufficiently leach well-drained soils to prevent damaging salt accumulations. However, one should be cautious with poorly drained soils, soils with existing salinity problems, or unusually high application rates, especially when concentrated near young plants."

6. High carbonate levels can destroy productive soils.

We regularly see high pH compost and manures. The damage that these nutrients can cause is sickening as it can render soils useless for decades. The Vermont Intervale Foundation warning about high carbonates is instructive. "Using an overly acidic compost won't usually do any long-term damage to your soil, but using one that's too alkaline might. High-pH composts often contain carbonates, usually in the form of lime (calcium carbonate). If you have naturally alkaline soil (most common in drier regions) or if your soil is acidic and you already apply lime to reduce the acidity, you should avoid using a high-pH compost. Once a soil contains too much carbonate, other nutrients, such as phosphorus and zinc, will become unavailable. There is no easy way to bring the soil back into balance".

7. Pathogens

Manures can easily contain pathogens dangerous to humans. A Colorado State University Cooperative Extension Agent Dr. Curtis Swift commented on these pathogens. "Animal manures and composted animal wastes are reported to harbor disease causing microorganisms. Even after composting, manure mixes have been shown to harbor such disease causing organisms. Animal wastes contain pathogens to which humans are vulnerable including Salmonella and Cyptosporidium.

8. Weed seeds and spores are often carried in manures.

Much of the "composted" manure we see is littered with bedding and occasionally the visible carcass of a dead animal, such as a chicken. This indicates that the manure has not been properly composted. In such circumstances, there is a large likelihood that the "compost" still contains live weed seeds and insect spores. The viability of weed seeds is effectively reduced by complete composting.

In addition to being unpredictable, raw manure applied in large quantities is also a major environmental problem. Instead of nurturing the soil, nutrients from unstable raw manure piles enter the atmosphere in the form of greenhouse gases; methane, CO2, and ammonia.

If you can smell manures after they have been land applied then you know that they are releasing large amounts of their nutrients into the atmosphere. Often unobserved, is the pollution of ground and surface waters with nitrates, nitrites, and phosphates from labile manures.

Many growers have ruined their fields with manure. Some discover, too late, that the pH of the manure that they were applying was extremely high due to elevated calcium levels in the manure. Others, mainly in low rain fall areas, discover too late that excessive salts in manures, compost, or partially composted manures have rendered their soils useless for commercial agriculture.

Current worldwide attempts to stabilize manure to render it into a useful, predictable source of nutrients and to reduce its negative impact on the environment by piling manure to decompose or machine dehydration of manure will probably, at some point in time, be recognized for the half measures that they are. Many of the current methods of composting, such as simple waste-reduction type piling of manure, do not allow aerobic decomposition to occur and as a result are wasteful and destructive of organic nutrients. Unless, properly composted under controlled scientific practice, the final manure products that result from these programs is neither environmentally friendly nor is their end product effective from the concept of an enabling fertilizer.

Dehydrated Manure

Dehydration and the rendering of dehydrated material into pellets do not, in any real manner, alter the physical nature of manure except, of course, to shut down microbial processes while the material is dry and make it a more easily handled product. Once wetted, dehydrated manure products suffer from most of the same problems that are associated with fresh manures including quick and unpredictable release of nutrients. Perhaps the only one advantage that dehydrated manures often have over fresh manures is that some dehydrated manures are steamed during the pellet extrusion process to kill pathogens, weed seeds, and spores. However, even this process has a downside when you consider that the heating process may also kill beneficial organisms.

Composting (Static Piles) Manure

Raw manure is the oldest known fertilizer on the planet. It has many excellent properties however commercial monoculture growers frequently find it problematic. In addition to often being full of active weed seeds, spores, and pathogens, nutrients in manure are easily lost. Most of the nitrogen in manure is in the form of urea and NH4 (Ammonium) depending on conditions in the animal. The NH3 (Ammonia) contained in manure easily volatizes into the atmosphere once manure lands on the ground. Other nitrogen nutrients, NO2, nitrogen dioxide, N03, the nitrate ion, and NH4 the ammonium ion will easily leach into surface and ground water if given the opportunity. If the manure remains anaerobic, NH4 and N03 will be reduced to NH3 and will volatize as a gas. Over twenty-five percent of nutrients in fresh manure can be lost in the first 24 hours after manure is spread on a field if the manure is left uncovered. Fifty percent of the nutrients may be gone within two weeks.

Manure is an unpredictable and unreliable fertilizer. Soil loves manure, but the nutrients in fresh untreated manure do not hang around long enough to provide the soil food web with the full range of nutrients that it could provide if it were more stable.

Manure can be a good soil nutrient. Many growers have developed a practice that serves them and their soils well. It can also be a catastrophic nutrient, destroying fields and stunting crops. CNEF was developed specifically to provide a treatment for manure to render it into a high quality nutrient. Most growers do not know the full range of the downside of using manure. The following is a discussion of some of the known problems with manure.

1. Some poultry manure contains Arsenic V – a very labile form of arsenic

An organic arsenic compound called Roxarsone is frequently added to poultry feed to control coccidial intestinal parasites. This compound is made up of Arsenic V – a very labile form of arsenic which can spread to ground and surface water. Many growers believe that this compound has a toxic effect on their crops and can slow growth and stunt development phases in crops.

2. Putrefying manure can cause major damage to soils.

Manure incorporated into the soil will more often effectively transmit its nutrients into soil acids. However, such manure is often prone to putrefying as its bacterial content may overcome the existing soil bacteria responsible for transformation into soil acids. When this occurs, the manure can produce potentially harmful putrefactive soluble metabolites which can actually harm plant growth. Application of raw manures that putrefy can kill aerobic organisms that that form beneficial soil aggregates. (Byers) Should this occur the soil structure can collapse. Soil clays can de-flocculate and the soil will seal. The result is that the soil is then subject to a high degree of erosion. The more detrimental result of in-soil putrefying manure is that eventually the grower will lose the beneficial aspects of the soil foodweb as it is turned into an anaerobic environment where injurious microbes in the form of pathogens and anaerobes become the dominate life form. (E. Ingham)

3. Crop burns kill young crops.

The fact that non-composted and partially composted chicken manure in high concentrations can kill young crops and burn more mature crops is well known by most growers.

4. Nitrogen immobilization stunts crop growth.

Broiler house manure concentrates sometimes have with high levels of wood shavings, rice hulls, or some other form of carbon mixed with in with the manure. In these circumstances spread or incorporated manures may actually have a carbon : nitrogen ratio that results in overly high carbon contents. Soil microbes will actually compete with plants for available nitrogen. When this occurs, soil microbes will prevail and plants will receive insufficient nitrogen.

5. High salt levels damage soils.
The University of California has warned growers that "the material that remains after we subtract out the nitrogen, phosphorus, and potassium is for the most part undesirable salts which can prevent seed germination and burn plants." Another University of California Extension Agent explained. "Manures commonly contain 4% to 5% soluble salts on a dry weight basis and may run as high as 10%. To illustrate, an application of 5 tons of manure containing 5% salt would add 500 lbs of salt. Normally, irrigation and rain water will sufficiently leach well-drained soils to prevent damaging salt accumulations. However, one should be cautious with poorly drained soils, soils with existing salinity problems, or unusually high application rates, especially when concentrated near young plants."

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Nature normally composts in thin layers of leaves on the ground or in exposed droppings of manure. Man-effected composting is more akin to a reduction of materials by use of a controlled furnace. Composting in large piles that are either infrequently turned, or not turned at all, require mechanical turning and additional wetting is a process invented by man that has little semblance to the natural cycle of decomposition found in forests and grasslands. Despite claims to the contrary, that composting is a natural process, the only occurrence in nature that even remotely resembles man-made composting can be found in a swamp or in a location where a catastrophic event, such as a flood or avalanche, has piled up large amounts of organics. The large amounts of compost which have entered the U.S. marketplace in the last decade are due to the clean water laws which mandate land-fill use which resulted in a subsequent effort to keep green-waste out of the landfills. The composting business is being driven by efforts to eliminate waste, not demands by farmers for the beneficial effects that green-waste compost can provide to their fields. The reason for this is simple. Most urban green waste is contaminated with a fraction of plastic, glass, and other enduring contaminates that are close to impossible to remove from the green-waste stream that are visible in a farmer's fields after the organic compost has been reduced into soil components. Most farmers are reluctant to allow this type of contamination of their fields.

During the process of static pile composting most of the valuable nutrients contained in manure are lost during the sustained heat phase of the semi-composting that they undergo. Scientific composting does largely eliminate weed seeds, spores, and pathogens that are contained in manure. Composting in large piles may or may not achieve this natural cleansing. This process of composting results in cooking compost for a number of weeks at a temperature that may vary from 135° F. up to temperatures that exceed 165° F. converts nutrients into forms that are lost through gaseous emissions. Component nutritional levels may drop 90% or more during composting. Even more critical are complex carbohydrates, amino acids, peptides, enzymes, vitamins, and other nutrient components that are lost during the composting process. Read the labels on your vitamins and concentrated sources of nutrition. None of those labels say store in an oven at 150 °F. That's a sure formula for total degradation of nutrients. Most of the nutrients lost during composting volatize into the air in the form of greenhouse gases that include carbon dioxide, methane, and ammonia. Other nutrients are leached out into the soil under the static compost pile or are simply destroyed by the intense heat of the process.

Can static piled compost provide some carbon? Yes. However, if the compost is thoroughly cured the nutritional values of the compost are very low as most of the carbon is in the form of humin which is of little reactive value in the soil. The drawback to a static pile of compost that has not aged is that the "compost" has much the same nutrient levels as raw manure, and will release those nutrients in a labile manner in the same way as fresh manure.

The composting process concentrates salt contents in the material through the reduction of large amounts of materials into small amounts of compost. For every 100 tons of manure that is composted, only about 25 to 30 tons, or less, of finished dry compost is produced. Compost is not dried in the manner of a commercial product down to about 10% moisture. Instead, most compost programs add as much water as possible before shipping. An additional 15 to 25 tons of water weight remain bound up in the compost for gross weights of 40 to 50 tons of finished product. A grower always pays for the cost of the water weight in composts.
The effect of this remarkable reduction, from 100 tons down to 25 or 30 tons, is especially evident in salt concentrations. Growers in many parts of the country, especially in drier areas, have experienced severe damage to their fields through the accumulation of
compost derived salts.

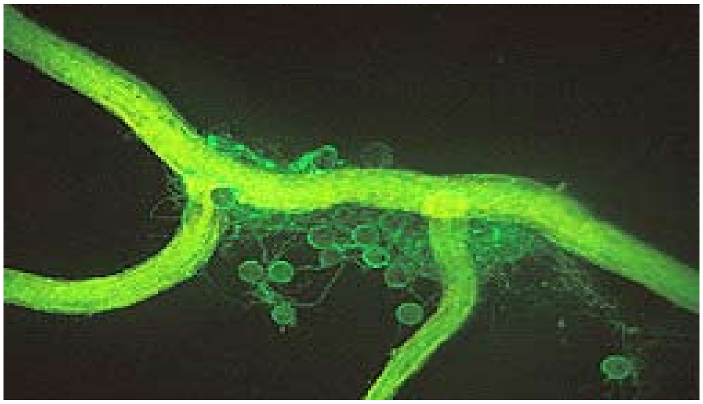
Composting (Scientific) Manure

Manure that has been properly composted using modern-day scientific methods is a totally different material than compost that has been piled to deteriorate. The temperature, oxygen levels, and moisture of this material have been scientifically monitored as the deterioration progresses. While it still shares some of the disadvantages of a piled composting approach, such as buildup of salts, scientifically composted manure is cleansed of weed seeds, spores, and dangerous pathogens by the scientific composting process.

The greatest advantage of this material is as a conveyor of a rich variety of soil microorganisms. Either as a tea, or as in a solid form, scientifically composted manure, which is composted along with an organic lignin source such as green waste, hay, or other plant waste, these composted products provide soil with a tremendous range of beneficial microorganisms to the soil.

We believe in these products as a supplement to CNEF products. It is our opinion that additional microorganisms can only benefit a soil. However, we are also of the opinion that these composts offer a "thin" nutrition to the soil as most of their nutrients have been exhausted by the composting process. Basically, compost that is rich in microorganisms may not always have the nutrients to maintain those levels in the fields.

We like to illustrate this concept to growers who are using compost teas with the idea of sending an army in to do battle with a foe. The microbes contained in teas are formidable. However, we would not send an army to some part of the world without sufficient food to keep them alive and fighting. Likewise, a grower must provide sufficient nutrition to the microbes that he deploys to affect change in his fields. This nutrition must come from a balanced blend of nutrients that supply the microorganisms with the nutrition they require to effect change. Otherwise, a grower must continually replenish the microorganism population. It is far better to provide them the energy to replenish their own ranks than to have to continually have to supply their ranks with replacements.



Mycorrhizal fungal spores are clustered around the bright fluorescent green glomalin. Photo: USDA

Other Organic Fertilizer Manufacturers

Out of all the companies that are building organic fertilizers there are only a very few that really seem to understand the new science of organic based fertilizers. Many organic fertilizer manufacturers are blending fertilizers in the same manner as synthetic chemical fertilizers are blended. Emulating chemical fertilizer formulations, in a higher-octane type race, they try to obtain high nitrogen levels by the use of higher protein, organic materials. The chemical fertilizer model is a blend, or mix, of simple nutrients. Many organic fertilizer manufacturers follow this model blindly. Throwing a bunch of nutrients in a mixer and dumping them into bags or bulk trucks is an old, worn-out way of making fertilizers. It is usually easy to identify these fertilizers as they will contain partial nutrition formulas and typically use a product like non-hydrolyzed feather meal or blood meal in an attempt to emulate the higher nitrogen levels used in synthetic chemical fertilizers. Contrary to that thinking, we have found is that a properly manufactured organic fertilizer does not need high nitrogen levels. Organic growers are reporting sustained nitrogen levels in well nutritioned soils in a manner that does not correlate with the "economist" concepts of nitrogen which have been propagated by suppliers of synthetic sources of nitrogen.
The concept of "X" units of nitrogen into the soil and "X" units taken up by the crop leaving "X" units in the soil has been profoundly shaken by tests run by some of the nation's largest organic farmers. They are finding that well nutritioned organic fed crops actually have higher residual nitrogen and mineral values than might be expected if going by measurable units of nitrogen.
Why would this be the case? The binding action of the humic and fulvic acids in their ability to capture nitrogen along with other primary, secondary and trace nutrients within their structures and the retention of these nutrients within the reach of a plant's roots may be a factor. In order to discuss organic transfer mechanisms, it is important to understand the nature of fulvic/humic acids.

The Nitrogenase Enzyme Reaction – A Miracle in The Soil

Scientists know that ammonia, an essential plant nutrient, can be manufactured in the soil by a process that takes the atmospheric gases dinitrogen in through plants. In the root zone nitrogen fixing bacteria convert it into usable protein. Essential to this conversion process are the minerals iron, sulfur, and molybdenum in a form accessible by bacteria. In addition, the conversion process requires moisture and bacteria. There is ongoing scientific controversy over aspects of this reaction coupled with intense research by private and publicly funded researchers. There is no doubt, however, that this process is a powerful source of plant nutrition. This process will not occur in soils deficient in the minerals iron, sulfur, and molybdenum. Can a grower initiate or accelerate this process in the soil? We believe that by providing the trace minerals necessary for this process, in unbound forms along with a slow nutrient release form of organic nutrients which efficiently form soil acids, that the nitrogenase process can be accelerated in soils where the level of this reaction have been reduced by a lack of ingredients. CNEF contains all of the necessary trace minerals, amino acids, and other nutrients required in this process.

Increased Root Mass Provides A Hospitable Domain For Mycorrhiza Fungus.

According to Dr. Mike Amaranthus of Mycorrhizal Applications, Inc. scientists estimate that up to 95% of higher land plant species used by man have symbiotic relationships with mycorrhizae. First described in 1885, by a German pathologist, the mycorrhizal fungus and plant root symbiotic connection to robust healthy plants is the rule, not the exception in the plant world. Mycorrhizal fungus invades the root system of the host plant and lives off nutrients provided by the plant. In return for a food source, the mycorrhizal fungus extends tiny nutrient pathways (hyphae) off of the plant roots. How small are the hyphae? A single thimble full might contain miles of these minute filaments. This increases the effective absorption surface area of the plant and makes the plant more efficient in the intake of nutrients from the surrounding soil. Mycorrhizal fungi play a critical role in plant growth by dissolving soil bound nutrients, such as phosphorus and iron. The tiny mycorrhizal filaments improve soil structure, protect plants against pathogens, and increase the reproductive viability of plants. Mycorrhizal fungus is more interested in forming on and around new root growth but, the mechanism of that action is still unknown. We know that plants, fed with CNEF evidence a large increase in mycorrhizal fungus growth. This seems to occur simultaneously with an increase in root mass. The mycorrhizal hyphae, the tiny fungus root hair extensions that provide increased nutrition to a plant are able to keep up, or even exceed the spread of the nutrient depletion zone that can develop around a plant's roots as a plant accelerates in growth, a phenomena often observed in synthetic chemical fertilization. Dr. Elaine Ingham of Soil Foodweb, Inc. explains this happening by pointing out that when microorganisms are provided proper organic based nutrition they can easily replenish these available nutrient pools through their actions. We suspect, but cannot scientifically prove at this time, that the increased growth of mycorrhizae and root mass due to increased organic nutrition is one of those serendipitous occurrences in nature where both the mycorrhizae and root mass respond to the increased nutrition and simultaneously work together in mutual harmony and benefit. We believe that science may one day prove that depletion zones are largely a phenomenon that occurs only when plants are fed chemical nutrients and are not a factor in organic nutrient rich soils.

We receive many questions about the effects of synthetic chemical fertilizers on mycorrhizal. Dr. Mike Amaranthus of Mycorrhizal Application, Inc. believes that excessive levels of phosphorus will cause fungi spores to over expand and self-destruct. This might explain why over fertilized ground may often be lacking in what would be normal levels of mycorrhizal fungi. Excessive disturbance of the soil, as occurs in plowing operations, is also believed to be a cause of destruction of mycorrhizal fungus in the soil.

Mycorrhizal Fungi Produces Glomalin.

In addition to extending the effectiveness of roots, mycorrhizal fungi also play a vital role in soil health by producing glomalin. Discovered in 1996, glomalin is a material manufactured by the hyphae of an arbuscular mycorrhizal fungus (a common form of mycorrhizae). Even as scientists still research glomalin, they have identified the fact that glomalin plays at least two important roles in the soil. The first role glomalin plays is that of storage of carbon nutrients in the soil.

Scientists have estimated that as much as one-third of the total carbon stored in the soil is stored as a result of the mycorrhizae – glomalin conversion and storage of organic nutrients. Mycorrhizal fungi convert atmosphere gases and soil nutrients into stored glycoprotein which includes both protein and carbohydrate subunits. These are intense storehouses (30% - 40% carbon) of organic nutrition which can be readily accessed by a plant when needed. Most of the glomalin seems to bind iron and other ions to it. This fact is important to recall when we look at the nitrogenase enzyme reaction later in this essay. Carbon dating has shown that glomalin can remain in soils as a potent source of nutrition for a time period that ranges from seven to forty-two years depending upon soil conditions.

The second role glomalin plays is that of a super soil adhesive. As the mycorrhizal hyphae grow, they slough off glomalin to leave behind in the soil. The glomalin adheres to the soil particles and binds them together to form particle aggregates. These aggregates stabilize and moisturize the soil. The "stickiness" nature of the glomalin welds humic substances to soil particles which prevents the carbon from easily escaping either to migrating water or to the atmosphere. Scientists credit glomalin with providing soil greater levels of water infiltration, more permeability to air, better root development due to looser soils, higher microbial activity given increased nutrition, resistance to surface sealing (crusts), and much greater soil resistance to erosion.

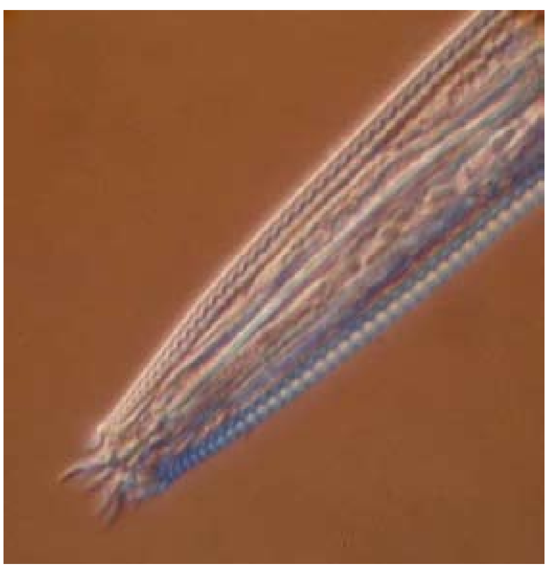
This microscopic view of mycorrhizal hyphae shows the tiny extensions of nutrient intake pathways that extend from a plant's roots. These fungi can greatly extend plant nutrient uptake efficiency.

Beneficial Nematodes - Nitrogen Producing Microorganisms

The availability of increased levels of complete organic based soil nutrition provide nitrogen producing organisms such as nematodes and other soil micro-organisms with a large increase in bacteria – their primary feedstock. We humans have long considered ourselves the dominate species on earth. It is humbling to consider that if all the lower species on earth were weighed then that total would out-weight the entire human race by factors that might measure in the millions. Nematodes are by and far the most numerous multi-cellular organisms on earth. Bacteria are high in protein that in turn is high in nitrogen. When these types of nematodes eat bacteria they digest the protein and convert it to nitrogen that is excreted as a body waste product back into the soil in a form that becomes available to plants.

A cup of healthy soil contains billions of the tiny worms, many of them predators of bacteria, insects, plants or animals. Nematodes these worms are generally beneficial as the beneficial organisms vastly outnumber the non-beneficial in healthy soil. How do nitrogen producing nematodes benefit the soil? It appears basically very simple. Many types of beneficial nematodes have a relatively short life – typically 12 to 18 days. They reproduce in about three to four days. A soil rich in beneficial bacteria-consuming nematodes contains an uncountable host of tiny manure producers. Think of the high speed of reproduction and death of bacteria and consider that nematodes add plant available nitrogen to the soil each time one excretes and each time one dies. These plant available nitrogen producers fixing nematodes provide the soil an incredible service by converting organic nutrients into forms that a plant can absorb.

Create the right environment for bacteria, fungi, beneficial nematodes and other beneficial soil micro-organisms in your soil and they will go to work by retaining nutrients when needed and making nutrients plant available when plants signal that they need nitrogen, phosphorus, sulfur, or another nutrient. The right environment, or soil-biosphere, is a top section of soil that is rich in organic material and contains all the nutrients and minerals necessary for soil micro-organisms to thrive.



This is an example of a species of beneficial nematode that feeds on bacteria and not plant roots. Photo by Dr. Elaine Ingham. www.soilfoodweb.com

The Brix Indicator of Success

Growers attempting to increase quality of their crops are often faced with the need to find a method to quantify progress. Some periodic tests, such as the soil microbial tests, such as offered by Soil Foodweb of Corvallis, OR, are essential for a base line and periodical comparisons of microbial life. The health of microbial life is an excellent indicator of overall soil health.

Conventional soil testing is not always a reliable method due to the simple fact that most conventional soil tests use strong acids to determine mineral content of a soil. These tests reveal what minerals are in a soil and do not differentiate as to what minerals are available to plants. Soil tests using a Morgan Solution, a weak acid solution that mimics the strength of soil acids, is actually a much more reliable test. A Morgan Solution test will more closely reveal what minerals may actually be available in an ionic form after being chelated by soil acids. A soil may conventionally test as being rich in minerals but may actually lack the necessary driving microbial engines and nutrition for such engines that will allow the microbes to chelate and transfer the minerals to the plant. While a Morgan Solution test is an improvement over conventional soil tests, there are still large gaps in the information that they may provide. Like conventional soil tests, Morgan Solution tests completely ignore the presence or absence of organic nitrogen sources or stored organic nutrients.

Traditional soil tests measure in-organic nitrogen and do not measure organic nitrogen levels which may be stored in fulvic and humic acids, in glomalin, and in other forms of resident humic substances. Up to early 2000's, most soil test operations routinely threw away organic soil elements as "un-testable elements". Unfortunately, most still do. We like to point out that there are many soils rich in minerals but completely unsuitable for growing crops due to out of balance pH, absence of SOM, soil compaction, hardpans, or other problems not identified by soil tests.

A good alternative to soil testing is to test the plant itself by use of a Brix test. A Brix test is a measure of dissolved soils in fresh plant sap or juice. These tests, using an inexpensive hand held refractometer can be performed in the field, by a grower, in less than a minute or two. There is little or no cost other than the initial price of the low cost refractometer. Our experience with over 400 growers has indicated that the higher the Brix reading, the higher the quality of the plants. Old time organic growers will tell you that insects, virus, bacteria, and fungus only attack low Brix plants. Higher Brix levels also correlate to lower freezing temperature, providing plants with greater resistance to freezing temperatures and extended production seasons.

The complex nutrition enabling type fertilizers have constantly been shown to build high Brix levels in plants. We urge those using our program to download the excellent 44-page introduction Brix book by Rex Harrill at www.crossroads.ws/brixbook/BBook.htm and to consider using Brix levels as an indicator of soil health as any excellence observed in a Brix tested plant is directly correlated to the soil in which it is grown.

The Symphony of the Soil

The soil is alive with an unbelievable number of a huge variety of micro-organisms that interact with each other in manners that are only now becoming understood. Microbes are the self-renewing engines of the soil with an ability to reproduce in astounding levels. An acre of healthy organic soil can contain tons of microbes and microbe produced structures which do work equivalent to that to tens of thousands of man hours.

We believe that the only logical conclusion that can be reached, given the current level of knowledge, is that a plant provided with adequate organic based complex nutrition will benefit from a multiple of micro-organism driven reactions that will provide extraordinary growth and health benefits to plants. In the total, these benefits greatly outstrip the benefits provided by current technologies of N-P-K synthetic chemical based technologies that are oriented mainly towards providing simple plant nutrition of a largely transient nature.

The information discussed in this essay offers only a glimpse into the intricate workings of the soil. Despite the current levels of research, we are only scratching the surface of the science of the soil-biosphere. What we see, at this time, is truly amazing and is perhaps a good reason for a pause and reflection on how mankind has treated plants and soils in the past. The simple nutrient science that has focused on N-P-K was, frankly, much easier to believe, cheaper, and easier to apply. But, even as it is being applied it is fouling the nest that we know as earth. It is destroying the habitat that humans need to have in order to stay healthy.

This situation will change as additional Complex Nutrition Enabling Fertilizer production facilities have are now being planned and will be built over the next decade. As this occurs, the price of these fertilizers will gradually decrease to levels below that of synthetic chemical fertilizers.

As we noted earlier, in 1936, scientists from the USDA stated that most of the soils and foods grown in the US no longer contained many essential minerals and vitamins required by human beings. Recent studies have shown that for the most part, vegetables and other edible foods, with few exceptions, continue to test lower in offered vitamins and nutrients. The fact that healthy plants also require many of these same minerals and vitamins has been largely ignored by many segments of industrial agriculture.

For the first time, in the history of fertilizers, it appears that the new classes of Complex Nutrition Enabling Fertilizers coupled with the fresh understandings of how these fertilizers work in the soil will, at some point, bring about a new era of sustainability to agriculture and horticulture. The process of switch over from chemical to organic based fertilizers will not be immediate, or even occur in our lifetimes. Nor, will the science behind these fertilizers be universally acclaimed or even easily accepted by those with vested interests in the production and sale of chemical based fertilizers. Existing manufacturers of chemical based fertilizers have invested large sums in infrastructure as well as marketing and distribution enterprises. The fact that there have been dramatic losses of and changes in the amount and nature of the topsoil in the US have been well documented by the USDA. The interaction of carbon and nitrogen in the soil is an established and accepted fact of science that is easily illustrated by scientific experiment. The fact that the present fertilizer programs used in agriculture along with poor farm practice have, in many locations, rendered vast areas of formally rich farm lands useless may be argued. However, for thoughtful growers the debate is over. Thousands of square miles of pasture lands, which were once productive farmlands, are now a powerful mute testimony to the sad failure of chemical fertilization.

Now that we understand more about the world beneath our feet, we will all treat soil with more care and understanding in the future.
With our new understanding and process, the concept of sustainable soils for untold generations of use is now a reality.

Symphony of The Soil

Concepts & Science

Brix – Using A Refractometer to Test The Quality of Fruits and Vegetables by Rex Harrill
www.crossroads.ws/brixbook/BBook.htm

Fulvic & Humic Acids – Dr. Jerzy Weber, professor of soil science at the Department of Soil Science & Agricultural Environment Protection, of the Agricultural University of Wroclaw, Poland.
http://www.ar.wroc.pl/~weber/humic.htm#start

Glomalin – Glomalin: Hiding Place For a Third of the World's Stored Soil Carbon
www.ars.usda.gov/is/AR/archive/sept02/soil0902.htm

Methemoglobinemia - Nebraska Cooperative Extension G98-1369 Drinking Water: Nitrate and ("Blue Baby" Syndrome) Sharon Skipton, Extension Educator, DeLynn Hay, Extension Water Resources Specialist Mycorrhizae – Mycorrhizal Applications, Inc. – Dr. Mike Amaranthus
www.mycorrhizae.com

Nematodes - University of Nebraska at Lincoln – Nematology www.nematode.unl.edu

Nitrogen Cycle - Understanding of Nitrogen Cycle Called Into Question, February 07, 2002 – David Suzuki – http://www.davidsuzuki.org
Nitrogenase – Nitrogenase www.geocities.com/nitrogenase653/Nitrogenase.htm
Soil Micro-Organisms – Soil Food Web Incorporated - Dr. Elaine Ingham www.soilfoodweb.com

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