The Vital Earth News

Agricultural Edition

Volume XIII, Number 1 | Vital Earth Resources • Gladewater, Texas | Winter, 2006

Life of the Soil – the Wild, Hidden World Controlling the Productivity of Your Fields

By Charles Johnson

[*From* The Furrow *by John Deere Company, Moline, Illinois, March, 2003.*]

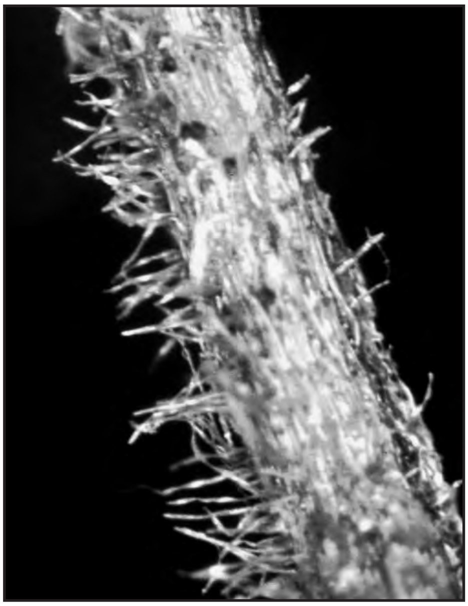
Turn up a shovel full of healthy soil, sink a hand into its richness, and you're venturing into a largely unknown world of microbial interactions. Without them, crops wouldn't grow. People and animals would starve. The earth itself would die. But with them, that soil lives. It breathes, as we do. It generates heat. It moves in water and wind, and changes with time.

A farmer's real job is to protect it, even maximize it. Walking productive soybean and corn fields near Oran, Missouri., Morris Hahn explains his system of building soil organic matter by increasing bacteria and earthworms.

Worm World

"Researchers discovered that what a worm ingested is worth ten to twelve times that in fertility after it's excreted. The earthworm burrows stay intact for three years and the linings are very rich in nutrients. The roots can enter them and go down after moisture," he says.

"Soil bacteria—all those little creatures you can't see—are very valuable, too, just like the worms. They're eating. They're excreting. They're building the soil. That's why more organic soils are more forgiving in what you can use on them."



Root hairs are clearly seen projecting from this plant root. The hairs are barely visible to the naked eye, and cooperate with countless rhizospere microbes.

Don't call Hahn an organic farmer. He isn't even close to that. But he is a dedicated no-tiller, making use of cover crops. He also pays close attention to the pesticides and fertilizers that go on his fields.

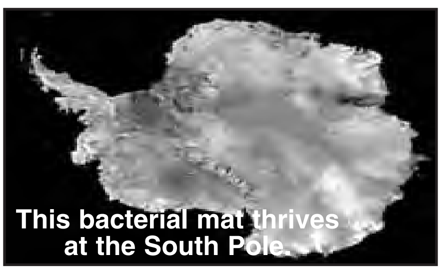
"I want to maintain soil tilth, to reduce irrigation, to allow the plants to have the natural ability to get what they need from nature. It's important to stay away from salty fertilizers and the harsher chemicals. You have to remember that there are living creatures down in that soil, and they're working for you. You want to make their lives just as easy as you can," Hahn says.

Millions of Creatures

Scientists can't even begin to count

See Carbon, the Current Hot, page 2

Those Incredible *Extreme* Bacteria!



This bacterial mat thrives at the South Pole.

***Thermocrinis ruber* loves boiling temperatures.**

By Paul W. Syltie, Ph.D.

Life as humans on planet earth is extremely easy compared to the lives that some micoorganisms must endure ... and these microscopic critters seem to like it. We commonly think of soil and water bacteria, fungi, algae, protozoa, and actinomycetes when we consider the microbes around us, fairly common inhabitants of our ecosphere at the usual temperatures and environmental conditions in which we live.

Yet, there are super-tough microbes — bacteria in particular — that grace the most extreme conditions of our planet. Note this partial list.

Hyperthermophiles grow at > 80^0 C, like *Pyrolobus fumarii*, that thrives at 113^0 C (235^0 F).

Pschrophiles prosper at < 15^0 C, such as some bacteria that thrive in frozen soil by producing enzymes that act as antifreeze.

Deinococcus radiiodurans can live in the radioactive cooling ponds for radioactive fuel rods.

Acidophiles can multiply at a pH < 1.0, like the algae *Dunaliella acidophila* that pumps hydrogen ions out of its cells.

Halophiles such as *Halobacteriacea*

See Extremophiles, Our Hardy, page 6

Carbon, the Current Hot Topic

Continued from page 1

the number of microbes working in the soil, much less pinpoint their purpose. “There can be millions and millions in one gram of soil, a web of soil fertility,” says Mike Hubbs, Natural Resources Conservation Service (NRCS) agronomist at the Auburn, Alabama, based Soil Quality Institute.

“We know very little about them. They’re more or less a black box even to microbiologists. Ninety-nine percent of soil bacteria cannot be cultured. This is a frontier of science,” says Yucheng Feng, Auburn University soil microbiologist.

“The number is big and we don’t know exactly what all of them are or what they do,” says Bonnie Ownley, a University of Tennessee researcher studying soil-borne pathogens. She thinks farmers might keep soil diseases in check by maintaining a good balance of soil microbes.

“A lot of things we do in agriculture might shift the balance to disease. In nature, disease is the exception, not the rule. I advocate a holistic approach of using proper chemicals and cultural practices, choosing resistant plants, and crop rotation,” Ownley says.

Better Fields

Not all farmers concerned with soil microbes are conservation tillers. Joe Gerber, Millbank, Ontario, moldboard plows his corn and soybean fields. He adds an application of living soil fungi to the soil. It actually involves two products: Step 1, Agri-Remedy, and Step 2, Agri-Achieve, both made by a Minnesota-based company called Farm For Profit.

“With this application, the soil is healthier. It’s more mellow. It plows easier. Plants root deeper. The soil smells like soil should,” he says.

Gerber attributes 5-bushel/acre soybean yield increases to the products. “These are living organisms. We spray them on with water after the crop comes off, then plow them in,” he says.

Tillage Help

Ohio State University scientists found a correlation between subsoiling and soil quality on silty clay loam soils in the northwestern part of the state. Breaking up soil 12 to 18 inches deep allowed increased water movement, better aeration of roots, and access to minerals and nutrients, says Randall Reeder, Extension agricultural engineer.

Fields with plow pans particularly benefited. Conservation tillers could use low-disturbance subsoiling rigs with narrow shanks that hardly moved the soil surface. Compaction can develop naturally in silty clay soils, even without heavy machinery abuse, Reeder says.

At the Auburn University campus in Alabama, a platoon of people works daily on ways to improve soil microbes, structure, and quality. Hugo Rogers,head of the USDA-ARS Soil Dynamics Lab there, says scientists have long been intrigued by the soil’s secret bounty. He likes to quote Aristotle on the subject: “Earthworms are the intestines of the earth.”

Cover crops such as this clover are excellent helps in building and maintaining optimum soil conditions in all climates.

Carbon is the hot topic for soil scientists now. “We’re looking at the whole general practice of rebuilding carbon in soil. There are lots of reasons to rebuild it beyond sequestration. We’re looking at improving water holding and nutrient holding. We’re always dealing with a dynamic situation. The idea is to get more carbon coming in than is going out,” Rogers says.

Farm Help

NRCS agronomist Mike Hubbs and his boss William Puckett, director of the USDA-NRCS Soil Quality Institute, walk a fine line between research and on-farm practicality. When you find them, they might be in a cotton field on their knees with a test kit checking soil respiration.

“Soil breathes. Anything alive will respire CO_2,” Hubbs says.

By testing how much carbon dioxide is released from soil, they can get a good reading about the status of organic matter in the soil. “The more organic material in the soil, the higher the carbon dioxide level. That means there’s more microbial activity going on, more earthworms, more arthropods,” Puckett says. “Tillage can trigger a temporary increase in carbon dioxide and cause a decrease in soil organic matter. Field or farm history is essential for interpreting carbon dioxide measurements.”

Farmers can order the same test kit for their own fields. “I wouldn’t test every field. I’d test systems on particular soil types. You might test a cover crop system in plowed ground, a cover crop system in no-till, and a pasture system. Then you can tell if it’s worth the inputs you put in it. You can go to a conventional field and show the differences in it and the cover crop systems,” Hubbs says.

Coveting Cover

In the cropping and grazing system David Iles established on his farm near Littleton, North Carolina, cover crops are essential.

“That’s the engine that drives everything with fertility. Something green and growing all the time keeps the greatest number of organisms working beneath the soil surface. A plant cannot survive without the bacteria. In return, it gives the bacteria one-fourth of all it produces, its precious food supply,” Iles says.

An early no-till innovator, Iles spent the past three decades rebuilding tired old cotton fields on his farm. “I’ve doubled and tripled cation-exchange capacity, and that’s the single most important measure of soil fertility and health,” he says.

Iles keeps a watchful eye on more than microbes. “Earthworms are my most valuable employees. They work 24 hours a day and all they eat is dirt. And ants, believe it or not, move as much soil in a year’s time as earthworms do. Spiders help when you have a good ecosystem. What I have is a managed natural ecosystem,” he says.

Soil System.

See Soil...a Complex, Interacting, page 6

Crop Production Costs Skyrocket

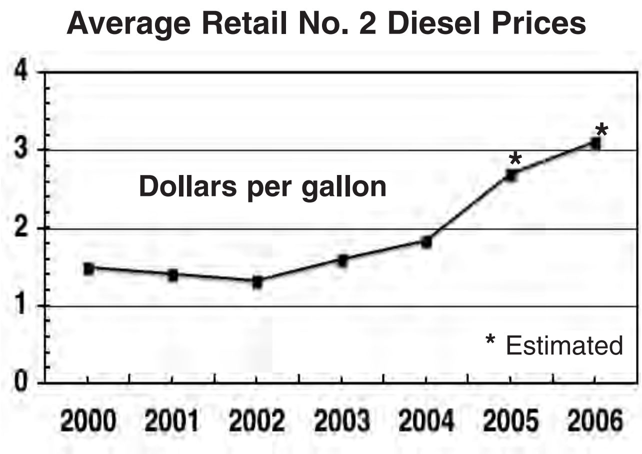
by Paul W. Syltie, Ph.D.

The impact of soaring petroleum prices is having a powerful impact on the profits and decisions of farmers throughout the country, especially for those raising crops where profit margins are already slim. Volatile oil and gas markets are responding to claims of energy shortages and hurricane devastation to offshore wells and refining capacity, as well as war and terrorist threats to oil exporting nations such as Iraq.

What is the present portent? Fuel prices, of course, are directly related to petroleum prices: crude oil comprises 49% of the diesel fuel price and 52% of the gasoline price. Taxes, distribution, marketing, and refining make up the remainder.

Fertilizer prices are also directly impacted by energy costs, especially natural gas, since the cost of natural gas makes up 80% of the cost of ammonia, the chief ingredient of nitrogen fertilizers. According to Joseph Fung, a market analyst for Mosaic Company, a producer and marketer of phosphorus and potash crop nutrients, "Availability of products will be tight for producors .... We are affected by overseas, and their demand and supply. Potash is Canadian supply. Phosphate is the relationship between Brazil not buying and Asia buying more. Nitrogen is all about natural gas prices" (*Iowa Farmer Today*, "Farmers Brace for Fertilizer Price Shock", October, 2005).

In the 1990s the cost of nitrogen fertilizer jumped from a bit over $80 per ton to more than $300 per ton in 2004. This jump moved much of the nitrogen fertilizer production overseas, and now American farmers rely on countries like Saudi Arabia, Qatar, and Venezuela — not always friendly nations and subject to terroriest threats — for their fertilizer.



A single year's increase in fertilizer, fuel, and total production costs were 7.3% in Nebraska: $204,555 in 2004, vs. $189,897 in 2003. In Indiana, a Purdue farm business management specialist, Alan Miller, told farmers to prepare for double-digit cost increases for producing 2006 crops (*Ag Answers*, Sep. 20, 2005). With post-hurricane increases in fuel prices, plus increases in world demand for fertilizers, especially potash, farmers will be squeezed. Seed prices will also likely increase — mostly due to more expensive genetically modified varieties — and interest rates and machinery costs should also rise, according to Dr. Miller.

The remedy for farmers facing such stiff obstacles is not easy, especially considering that grain prices continue to remain low ... so low that even many high-producing Canadian corn farmers in 2005 lost money. Only through government subsidies have American grain farmers been able to sometimes show a profit.

What are the options to still turn a profit in farming for 2006?

1. Switch to higher value crops if possible, such as soybeans instead of corn; soybeans also require no costly nitrogen fertilizers.

2. Reduce tillage and trips across the field by doubling up on operations to reduce fuel consumption.

3. Keep equipment in top repair to reduce down time.

4. Reduce fertilizer imputs while not reducing yields. Use Vitazyme, for instance, along with a 20 to 40 % nitrogen reduction.

In Texas, the cost of urea in mid-2004 was $180 per ton ($0.20/lb of N). Today it is $360 per ton. ($0.40/lb of N). Diesel fuel has shot up to over $3.00 per gallon. These basic inputs must be limited as much as possible while we all hope for reasonable prices for our hard-earned production. One thing is certain: Americans and all people must eat, and the farmer is the most critical cog in the nation's economy ... and always will be.

Are GM Crops On the Way Out?

By Paul W. Syltie, Ph.D.

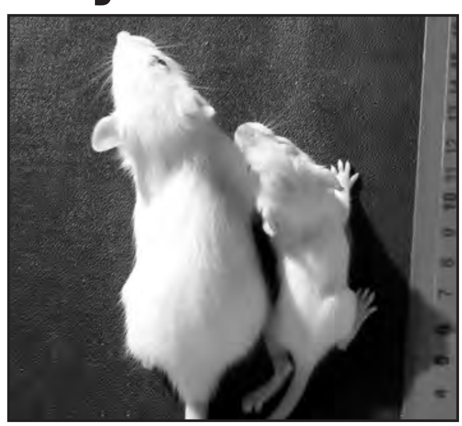
How easy and novel it is for a corn or soybean farmer to allow the weeds to grow up with the crop for a few weeks, and then to "nuke" the weeds with Roundup herbicide. These corn or soybean varieties have the genes of specific soil bacteria injected into their DNA so they can withstand the onslaught of the herbicide that normally would kill them along with the weeds.

In 2005 farmers upped their plantings of genetically engineered acreages to 52% for corn, 79% for cotton, and 87% for soybeans. These values include both herbicide tolerant and insect-resistant varieties, which in some cases save the farmers in chemical costs but also increase environmental pollution (with additional glyphosate sprays), and affect crop nutritional quality. It is this last concern that may spell the death knell of genetically modified crops during the next few years and force the companies that have spent billions of dollars on GE research to write off huge losses.

A Small Russian Study On Rats

Just as a tiny spark can set a forest afire, so a small study by a leading scien-

See Rats Died With GM Soy, page 7



The rat on the right is an offspring of a GM soy fed female; control is on the left.

15-Minute Soils Course

Lesson 22:

The Critical Oxygen-Ethylene Cycle

A major symbiotic association occurs along the root surfaces of all plants, called the ***Oxygen-Etheylene Cycle*** [O-E Cycle] ... so-named because of the two major gases involved in its operation. It is a critical cycle by which plant roots are able to extract nutrients from the soil.

The O-E Cycle occurs on, and a millimeter or two from, actively exuding root surfaces. In brief, the plant exudes carbohydrates and other energy-rich compounds from the root surfaces. Microbes feed vigorously on this exudate and multiply, using up oxygen in the vicinity to create an ***anaerobic microsite***, a small area on the root surface having a low oxygen level. Since most soil microbes are aerobic — they require quite a lot of oxygen to function — they slow down or stop their activity as the oxygen level drops. At the same time, a gaseous growth regulator called ***ethylene*** is produced by complex reactions with reduced iron ($Fe^{+}2$) and organic compounds in the microsite. Ethylene is an anesthetic to microbes, so they slow down further. The effect of reduced oxygen plus ethylene is to modulate the activity of the microbes so they do not get out of hand, but maintain a fairly constant rate of activity. As the microbes slow down, they use less oxygen and more flows back into the microsite, as ethylene diffuses out, allowing activity to increase.

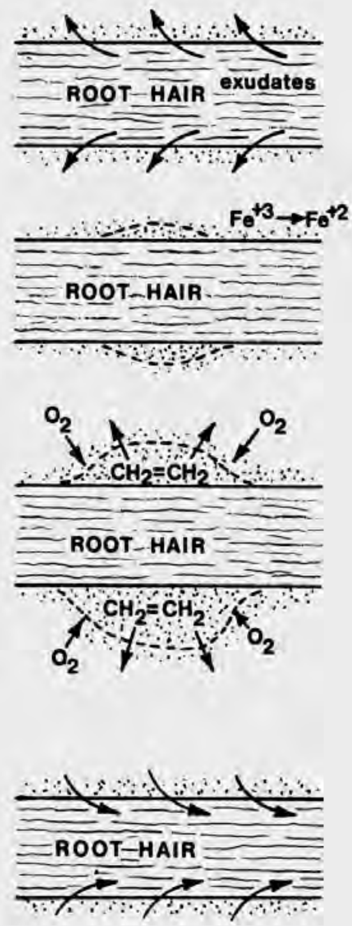
A ***change in the oxidation state of iron*** is another major aspect of the O-E Cycle. Iron is normally in the more oxidized, crystalline Fe^{+3} state, but within the low oxygen microsite the state changes to Fe^{+2}. Fe^{+2} is soluble in soil water. When the iron crystal breaks down and the counterbalancing ions like PO_4^{-3}, HPO_4^{-2}, $H_2PO_4^{-1}$, SO_4^{-2}, BO_3^{-3}, and others are released, then plants are able to take up these released nutrient ions. Moreover, the released, soluble Fe^{+2} serves as a replacement cation on the exchange sites of clay and organic matter, and

Soil microbes (bacteria, fungi, actinomycetes, algae, etc.) grow rapidly on root exudates in the rhizosphere. These exudates originate from photosynthesis in the leaves, which are translocated into the roots.

In these microsites the microbes rapidly deplete the oxygen, allowing ethylene to be formed (nitrate inhibits the process). Iron must be reduced for ethylene to be produced in a nonbiological reaction.

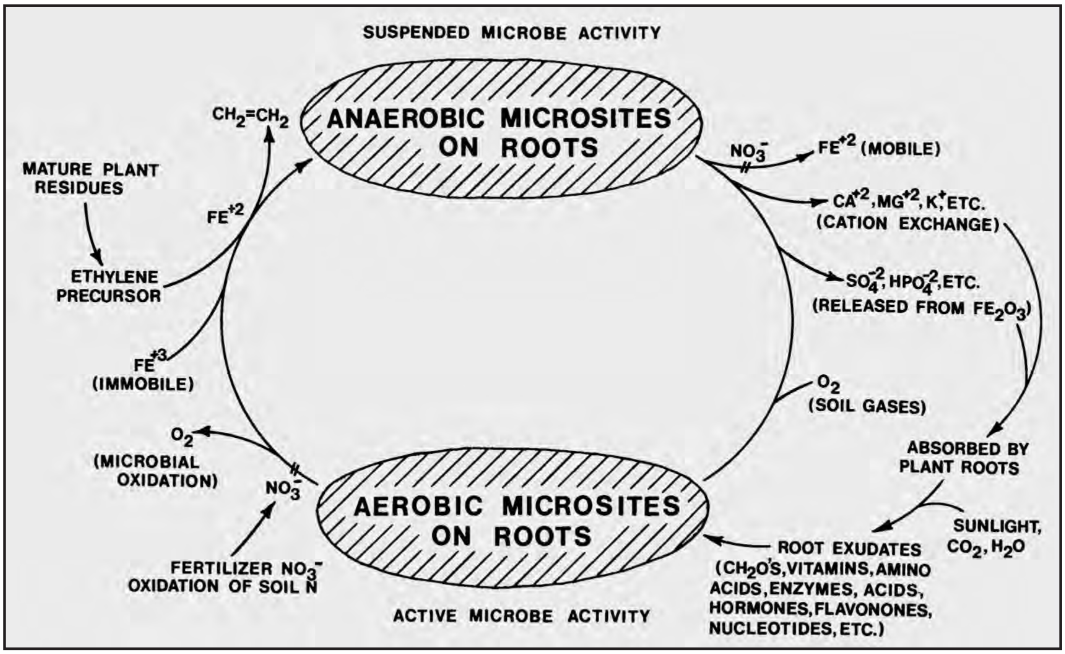
Ethylene, a gas, diffuses into adjacent soil and deactivates microbes, creating anaerobic microsites. Lowered oxygen demand allows oxygen to reenter microsites.

Photosynthesis and metabolism are enhanced, leading to more light energy and CO_2 trapped in carbon compounds, with greater translocation and exudation of compounds into the rhizosphere. Also, metabolites and decomposition products from microbes are available for root uptake. These include vitamins, antibiotics, enzymes, nucleic acids, regulators, and other substances. Acids produced by microbes dissolve minerals.



Continued on the next page

15-Minute Soils Course



cations such as Ca^{+2}, Mg^{+2}, K^{+2}, K^{+1}, Zn^{+2}, and others are kicked off into the soil solution for root uptake. Thus, the change in oxidation state of iron within the anaerobic microsites is instrumental in bringing key nutrients into the plant.

See How Much You Learned

1. The Oxygen-Ethylene Cycle is critical for plants becuase it ...
   a. enhances nutrient uptake.
   b. changes the oxidation state of iron.
   c. inhibits root growth.
   d. prevents calcium uptake.

2. The O-E Cycle creates small regions of low oxygen in roots called ___________________________.

3. The change in oxidation state of iron from Fe^{+3} to Fe^{+2} is critical for the O-E Cycle. T or F

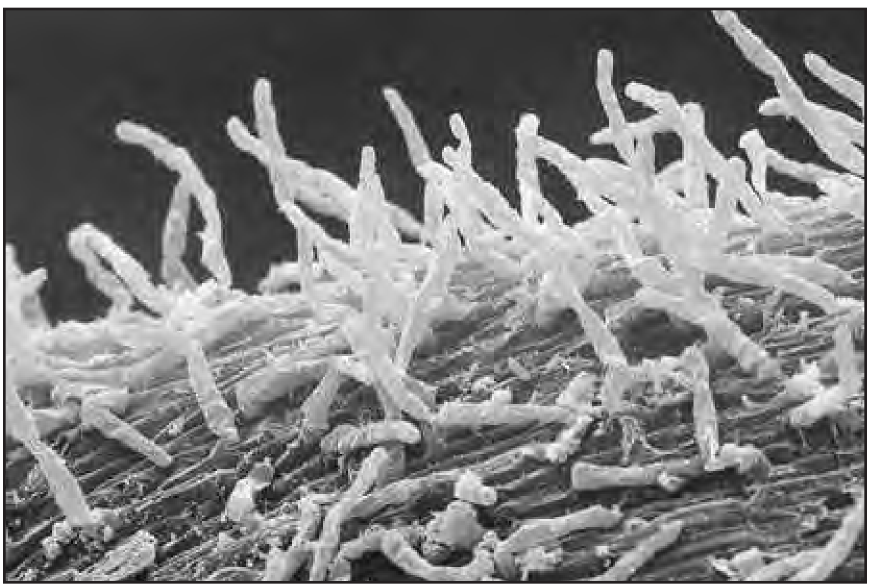
4. Ethylene ____________________ the activity of rhizosphere microorganisms.

5. Which of these anions and cations are released when iron changes to Fe^{+2} in the O-E Cycle?
   a. $H_2PO_4^{-1}$
   b. BO_3^{-3}
   c. SO_4^{-2}
   d. HPO_4^{-2}

6. Root exudates from high energy compounds synthesized in the leaves are essential for the operations of the O-E Cycle.
   T or F

7. The O-E Cycle is another example of a ______________ cycle so critical throughout the natural world.

Answers: 1. a,b. 2. anaerobic microsites. 3. T. 4. slows down or governs. 5. a, b, c, d. 6. T. 7. synergistic or mutualistic.



The Oxygen-Ethylene Cycle occurs within anaerobic microsites that form along root surfaces, where energy-rich exudates are being secreted from roots. The zone of root hair formation shown here would contain many such microsites.

Extremophiles: Our Hardy Friends

Continued from page 1

can endure highly saline invironments, like the Dead Sea.

Xerophiles such as *Artemia salina* enjoy extremely dry environments, such as in the Sahara Desert.

Piezophiles can endure enormous pressures deep within the earth, up to 10 tons/cm^2.

Microzymas and Bions, smaller than bacteria, were claimed to exist by early researchers such as Bechamp (a contemporary of Pasteur), and Reich, who said they could survive direct flames.

Extremophiles survive by producing "extremozymes", enzymes that are specially fabricated to work at the extreme conditions the microbes experience.

Morning Glory Pool in Yellowstone Park contains prime examples of hyperthermophlies, bacteria that thrive at temperatures above 80º C. The most heat tolerant grow in the hot center, and less heat tolerant species of different colors live in concentric cooler zones further out from the center.

The world would be a very different place without these organisms, and we probably have not suspected their presence all around us. Some of these occupy major niches in soils and are very valuable to farmers by slowly breaking down residues in cold soils and making nutrients available under dry, acidic, or alkaline conditions.

They can break down rocks and destroy toxic pesticides in soils ... or remediate petroleum spills. Let's appreciate these unseen heroes of the wild and wooly world around us, and understand how diverse and amazing creation is.

Soil ... a Complex Interacting Food Web

Continued from page 2

It's important to see the soil as part of a system, says Jay Hardwick, Newellton, Louisiana., farmer. "We have the protozoa, the earthworms, all those creatures, parasites and predators, in the soil, working in cooperation with each other. I've come to see the one that's after my plant, like a nematode, as having kind of a minor role. Maybe by using aggressive tillage and monocropping we've selected for it. Maybe something we do has decimated the beneficial nematodes."

Balance is important, Hardwick says. "What I'm trying to do is get all these things in balance, the protozoa, the microbes, the arthropods, the worms, and whatever else is out there. All those things help us. The farmer has to ask, "What's the cost of getting there?'"

Benefit analysis

Inspecting his fields near the Mississippi River, Hardwick has time to mull over just exactly what he gets from no-tilling this nearly flat ground.

"I think it's a long-term thing. It took these fields a long time to get to an unproductive state. The writer and naturalist Aldo Leopold said that the less aggressive man-made activity is, the greater ability nature has to overcome it," he says.

Over the past decade or so, he's learned a few things about his system. "Organic matter becomes the energy. Without it, the soil microbes and worms don't have a food source. Then they turn it all into chemical properties a plant can use. You have to look at it and ask, 'What's going on down there? How can it help us? How can we help it?'" Hardwick says.

And what, after all, is going on down in that shovel full of soil? Scientists may not have a name for every organism or know exactly what it does, but they see it all as a complex, interacting food web. Simply decomposing a small piece of rye-grass stem may involve several organisms.

It's easy to pick out the bigger creatures, the worms and ants, the beetles and mites. The microscopic creatures, though, live in a world of heterotrophs that break down organic compounds, phototrophs that live on light, and chemotrophs that oxidize inorganic compounds like nitrite, sulfur, and ammonium.

A million one-celled bacteria may fit in a teaspoon but can be a key factor in stimulating root growth and nutrient uptake. Long, thin mycorrhizal fungi live on simple carbon compounds and release acids that make phosphorus more available to plants. Nematodes measuring one millimeter in length help control disease-causing organisms. Tiny arthropods like springtails, millipedes, and spiders break down plant residue to make it more accessible to the microbes, and their burrows improve soil structure.

The rhizosphere surrounding each root teems with activity. It's a dynamic system of life, change, struggle, and death.

We may not understand it completely, but in its own way that soil is just as alive as we are.

FORGET YOUR FAILURES

Most people who attain success have learned to forget past failure and concentrate on present goals. Babe Ruth was once asked what he thought about when he struck out. "I think about hitting home runs", the Babe answered.

When the average person "strikes out", he often feels hurt and ashamed. Yet, as Teddy Roosevelt observed, "Show me a man who makes no mistakes and I will show you a man who doesn't do things".

Failure is often the first step to success. Pick up your pride and keep going.

Bits and Pieces, March, 1973.

Rats Died with GM Soy!

Continued from page 3

tist at the Institute of Higher Nervous Activity and Neurophysiology of the Russian Academy of Science, Dr. Irina Ermakova, may have set the stage for a firestorm of publicity and renewed research that could demonstrate the inherent dangers of genetically modified food crops (J. Smith, *GMWatch.com*, Oct. 31, 2005). Amazingly, since the advent of these new crop varieties in the early 1990's, less than 20 published, peer-reviewed animal feeding safety studies have been produced, and there have been **no** human clinical trials conducted. The Food and Drug Administration does not require safety tests on genetically modified foods to bring them into use. Companies like Monsanto merely declare their foods as safe, and no regulatory action ensues, based on a 1992 FDA policy that states, "The agency is not aware of any information showing that foods derived by these new methods differ from other foods in any meaningful and uniform way" (*Federal Register,* May 29, 1992). This statement, however, is deceptive because years later the FDA's own experts agreed that GM foods are different and might lead to hard-to-detect disease or nutritional problems.

Dr. Ermakova added GM soy flour, from a Monsanto variety, to the diet of female rats two weeks before conception, and continued the diet at 5 to 7 grams per day through pregnancy and nursing. A second group of females received non-GMO soy flour, and a third group no soy at all. She was surprised to discover that some of the pups from GM-fed mothers were quite small, and at 2 weeks 36% of them weighed less than 20 grams compared to only 6% from the other groups.

This result was startling enough, but the real shock came within three weeks when 25 of the 45 rats (56%) from the GM soy group died, compared to only 3 of the 33 (9%) from the non-GM soy group, and 3 of 44 (7%) from the non-soy controls. Dr. Ermakova unfortunately ran out of funds so could not complete organ analyses and a repetition of the study, but she was able to present her results at a major symposium ... much to the chagrin of GE industry promoters.

The recent results are not unexpected considering that Roundup Ready soy and other GM soy products produce misshapen liver nuclei and other cellular anomalies (M. Malatesta, et. al., *Cell Structure and Function* 27:2002). This change indicates increased cellular metabolic activity and a major insult to the organ, but changes in the pancreas were also noted. These included a huge drop in the major enzyme a-amylase, which could impact food digestion. Cooked GM soy also contains twice as such soy lectin, which blocks nutrient assimilation (S Padgette, et. al., *Journal of Nutrition*, 126:1996). Monsanto's own feeding studies have proven to be severely lacking in credibility, with older, mature animals used rather than young and sensitive ones, starting weights having great variation, and too much protein and too little soy flour used. The most incriminating data from these studies was even omitted from the final reports (Smith, 2005).

The National Institutes of Health in the U.S. is ready to sponsor immediate, independent follow-up studies to Dr. Ermakova's work. Yet, it will be difficult to exactly duplicate her work because the inserted genes tend to rearrange within the DNA over time, giving a slightly different genome. Such rearrangements will give somewhat different responses in test animals, showing that these GM varieties in many ways are not trustworthy. Their genomes cannot be controlled, leading to possibly more serious nutritional effects.

Other nutritional effects of GM varieties include sterility in pigs, false pregnancies, or birth to bags of water. A German farmer lost 12 cows to GM corn, and others became ill, while in the Philippians people living near a GM corn field developed skin, respiratory, and intestinal problems, and fever when the corn was pollinating (J. Smith, *seeds of deception.com*, 2005).

As research results on test animals and humans become available, it is likely that Monsanto and other players in the genetic engineering drama will be forced to withdraw engineered varieties from the market. If they are, then a major victory will have been achieved by consumers across the world because, after all, food crops are produced to foster health, not disease. Industrial agriculture must face its collateral effects and eventually recognize that natural laws within God's universe cannot be circumvented without automatic kickbacks. Conformity to natural laws will bring mankind healthful, abundant living.

Statement of Purpose

Vital Earth Resources is a for-profit private corporation dedicated to the development, production, and sale of top-quality, ecologically sound horticultural and agricultural products. *The Vital Earth News* is a periodic publication of Vital Earth Resources to inform customers and other interested parties about our products and programs, and to educate our readership on critical issues facing growers today and in the future. If you would like to receive future issues of this newsletter or product information, simply fill out the form on the right and mail it to us.

Yes! Send me a subscription to _The Vital Earth News_ and/or product information!

- ❑ *The Vital Earth News Agricultural Edition* (two issues per year)
- ❑ Carl Pool water soluble fertilizers
- ❑ Potting soils, mulches, and compost
- ❑ Vitazyme, Aqua-Min, and Odor-X
- ❑ I am an ( ) individual, ( ) retailer, ( ) grower.

Name ______________________________________

Address ____________________________________

City/State/Zip _______________________________

Telephone and/or fax (optional) ________________

Mail to: **Vital Earth Resources, P.O. Box 1148, Gladewater, Texas 75647**

Vitazyme **will improve both raisin and wine grape yields and quality. A three-year raisin grape study near Madera, California, showed that net raisin yield was increased by 16%, 27%, and 20% above the standard Ethrel treatment for 2003, 2004, and 2005, respectively.**

Three foliar Vitazyme applications at 13 oz/acre helped produce these magnificent, high sugar Cabernet Sauvignon grapes in the San Miguel area of California.

Vital Earth/Carl Pool logo and return address