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August 2022

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REGENERATE YOUR SOIL HEALTH

- ▶ **Dennis Perz Shares How He Revitalized His Pecan Orchard**
- ▶ **INTERVIEW: Jill Clapperton Explores In-Field Testing**
- ▶ **Aaron Weaver Describes Organic Soil Conditioning**

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What's Inside?

August 2022 • Issue #614

FEATURES

ANNUAL HEALTHY SOIL SALE

DEPARTMENTS

▲Strips of mature brassica crops are allowed to flower in order to attract natural enemies that may control pests on the cauliflower and kale plantings next to them. Find the related article on companion planting on page 14. *Photo courtesy Caitlin Tucker*

ON THE COVER

See the related story, page XX.

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ACRES USA

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True Nourishment

Spend enough time typing about farming on a modern computer or phone and sooner or later you'll find that the word "soil" sometimes gets automatically "corrected" to the word "soul." The small amount of annoyance is quickly overcome by the happy realization that there's some real overlap here.

My personal beliefs lead me to maintain a strict distinction between the Creator and the creation — only the former is to be worshiped. Yet the latter was made good — originally, at least — and despite its present brokenness as a result of human actions, the earth remains something that is incredibly important and that needs to be nurtured and protected.

In other words, I don't believe that the soil is actually part of my soul. I prefer to reserve the word "righteous" for spiritual matters. But just as the soul is vital to our entire beings and needs to be cared for and fed — we don't live by bread alone — so the soil must be actively safeguarded and cultivated. It is a common resource that deserves our utmost concern — even if it doesn't rise to the level of eternal importance.

How exactly to fulfill this mission, though, becomes a difficult question. If I were operating a large-scale vegetable or row-crop operation I'm fairly certain I know what I would do: I would hire a consultant, do sap testing every other week and follow the consultant's recommendations for biological amendments, fertigation and foliar application.

On a 10-acre homestead with a quarter acre of vegetables and a couple hundred fruit, nut and berry trees/shrubs, though, my approach can't be as scientific (as much as the engineer in me would like it to be). I firmly believe in the importance of soil balancing, but I'm also placing a lot of hope in eventually being able to nurture enough biology to overcome minor chemical imbalances. I'm blessed with sandy loam and a soil test that didn't indicate any excesses — both great starting points. I am applying purchased liquid macro- and micronutrients in the first few years — along with biological amendments, plenty of molasses to feed the biology, neem oil for insect control and some paramagnetic rock dust — in order to get things going.

Long term, however, my goal is to create enough biology and home-grown amendments to eliminate purchased products. I have faith that the life in my soil will be able to maintain healthy plants and healthy people.

Soil health has perhaps been the key theme of this magazine over the years. We continue that tradition in this issue. Dennis Perz explains how soil health practices revitalized his Texas pecan orchard. Judith Fitzpatrick describes farming methods that are more and less friendly to the microbiology in the soil that make nutrients available to plants. Edwin Blosser discusses humus protein and how it benefits crops. Aaron Weaver examines soil conditioning practices to improve vegetable production. And Harriet Mella dives into the little-understood topic of redox in our soils.

I'm confident that this issue will provide plenty of solid information to nourish your soil/soul. And that's the view from the country.

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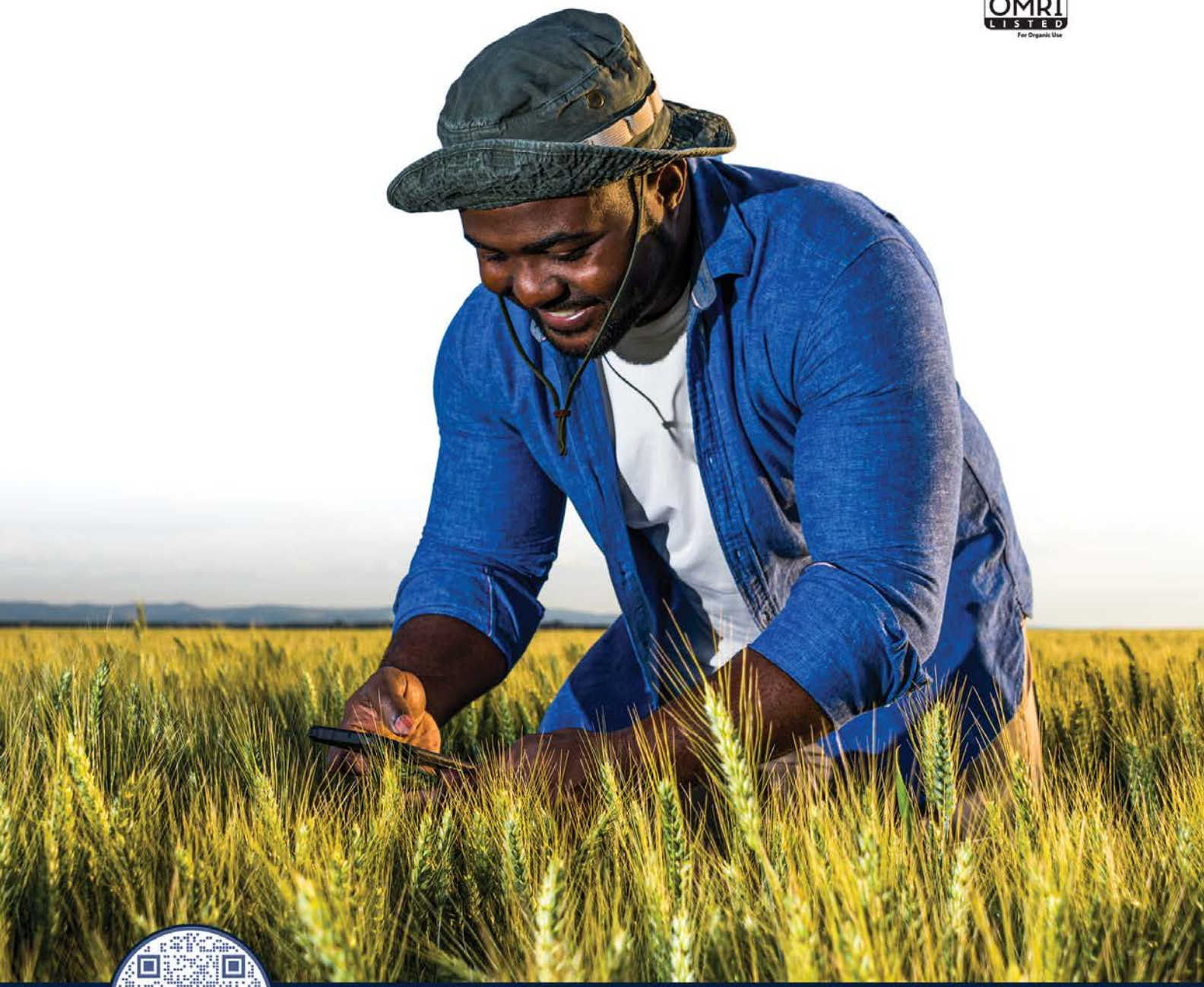

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A New Eye on Plant Nutrition

The mechanisms of plant nutrition are more complex than simple ionic absorption — and are better understood than ever

▲ How plants in wild ecosystems get nutrition can teach us a lot about creating our own soil fertility programs.

BY JOHN KEMPF

How do plants absorb and transport nutrients?

Read any textbook on agronomy and plant nutrition and there is likely to be an opening chapter or paragraph describing how plants absorb nutrition. This section will describe how plants absorb ions (positively or negatively charged atoms) from the "soil solution," transport these ions through the plant's vascular tissue and transfer them into cells using "ion channels" and "pumps."

This model of plant nutrition has been developed with lab research and mathematical modeling, generally without considering the impact of rhizosphere and phyllosphere biology. It is true that plants have the capacity to absorb and utilize nutrient ions as their primary nutrition source. After all, this is how plants are supplied with nutrients in hydroponic environments.

However, it has been obvious to close observers that this model of plant nutrition does not adequately describe how plants get nutrition in wild ecosystems. Unfertilized soils often contain very low levels of soluble ions – not nearly enough to support the nutritional requirements of the abundant vegetation growing on these soils.

And then, of course, there are those plants growing in the absence of any soil. Many of us have observed trees growing out of hard rocks and cliff faces, with zero soil present.

These trees often reach impressive size and can be expected to be decades or even centuries old. Even when we assume they only grow very slowly, the question remains: where do they get access to the substantial quantities of soluble ions of nitrogen, phosphorus, potassium, calcium and magnesium needed to regenerate their leaves each year?

I would propose the answer is: they do not absorb nutrition in the form of soluble ions. Further, I would suggest that **plants in undomesticated ecosystems absorb only a tiny fraction of their nutritional requirements as soluble ions from the soil solution.**

The fundamental problem with the current model of plant nutrition is that it does not consider any possible contributions of soil biology. When we use this contemporary model of plant nutrition for agricultural crops, we are using a glorified hydroponic model, which makes no sense for biologically active soils. It may make sense in the context of soils that are largely biologically dead or inactive. But why would we choose to manage plant nutrition with a model that assumes dead soil? A model that assumes dead soil will create a dead soil.

The textbooks will have to be rewritten. We are living in the moment where science is describing how plants in biologically active ecosystems absorb nutrition from microbes rather than from simple ions.

Science is describing how plant cells can absorb entire microbes and microbial metabolites through endocytosis directly into the cell, without any need for mathematically impossible "ion channels" and "ion pumps." Science is describing how living microbes can be transported through the plant's vascular system to provide microbial nutrition at any location within the plant. We now have the science to describe how plants can absorb the significant majority of their nutritional requirements from microbes and require little or no nutrition in the form of simple ions from the soil solution.

There are two areas of emerging science, and one that is well established, that we now need to be familiar with to accurately describe how we can produce the highest-yielding, best-quality crops with the smallest or no applications of simple ion fertilizers, which depletes a soil of its native biological fertility.

The first area is the work of Dr. James White and his colleagues on **rhizophagy**. They describe a previously unknown mechanism of how plants absorb live bacteria directly from the soil. This mechanism is in addition to the known function of fungi serving as nutrition pipelines and channeling bacteria directly into plants. These mechanisms describe how plants can absorb all of their nutritional requirements in the absence of soluble ions in a water solution. You can find an overview of James' papers and presentations at johnkempf.com/tag/rhizophagy.

The second topic is the work of Gerald Pollack and his colleagues on the fourth phase of water, called **EZ (exclusion zone) water**. This work adds a critical piece to our understanding of microbes as the primary source of plant nutrition, as it describes how plants can transport

live bacteria through their vascular tissue to all locations in the plant. In addition to The Fourth Phase of Water, I highly recommend Pollack's Cells, Gels and the Engines of Life. Pollock's work does not just influence our perspective on plant nutrition – it completely revolutionizes the very foundations of cell biology and is relevant for nutrition management of all organisms.

The third subject is the process of **endocytosis**, which describes how cells can absorb large molecules or entire bacteria by engulfing or enveloping them and utilizing their compounds as a source of nutrition. Endocytosis has been recognized as a foundational aspect of cellular nutrition and biology in animal cells for decades but has historically not been considered an important part of plant nutrition. Understanding that plants can absorb large quantities of living bacteria and transport them to all tissues indicates we obviously need to rethink this.

Crops express themselves quite differently when the majority of their nutrition is coming from microbes rather than from simple ions. The absorption of simple ions actually increases a plant's water requirements and reduces its drought resiliency. As an example, for each nitrate ion absorbed, plants require three molecules of water just to convert nitrate to amino acids.

There are other obvious challenges of relying on water-soluble nutrients. What happens when there is inadequate water? As the water disappears, nutrient availability also disappears. This is mitigated with a biological-based approach to plant nutrition, as it is well established that biology can access thin films of water on soil particles and provide water that plant roots cannot access on their own. When there is excessive water, the water-soluble ions leave with the water and flow into rivers and streams.

Plants that absorb nutrition from microbes require less water, while simultaneously being able to access limited soil water better. This explains why soils with active biology consistently outperform contemporary agronomy management systems in stressed conditions, particularly in drought stress.

The agronomy of the near future will be based on the sciences of rhizophagy, EZ water and cellular endocytosis as the primary mechanisms of plant nutrition, simply because this model delivers consistently superior crop performance.

If you learned about the absorption of simple ions as the primary mechanism of plant nutrient absorption, it would be wise to mentally assign this model to the dustbin – and actively seek to learn about rhizophagy, EZ water and endocytosis.

John Kempf is the founder of Advancing Eco Agriculture and is the executive editor of Acres U.S.A. *magazine.*

COMMON PROBLEMS

Folks, we are going about agriculture all wrong. We are penalizing organic farmers by charging them certification fees. These fees can run in the thousands, and sometimes natural fertilizers cost more than their commercial equivalents. These make the cost of organic crops that are better for you – since they have less residues in them, and they have about the right amount of protein, since the protein in organic fertilizers are in a protein form – cost more. Commercial fertilizer is in a free form, and a 10-year study by Rutgers found that very little to no actual protein was in the commercially raised crops.

Roundup has been found to cause cancer, and yet they are spraying it on wheat to get the grain to ripen, and on rye. Strawberries have been found with 40 different residues in them. Apples have been sprayed 14 times per year and then waxed to make them keep. These are your commercial crops.

We could start by taxing herbicides that cause cancer and other health problems. Herbicides destroy the sugar (food) in the ground and then the bacteria die since they have no food. Bacteria is needed to make nutrients available for the crop you are trying to grow in organic farming.

The bacteria feed on crop residue and sugar that are in the soil and make more bacteria, then they die and become organic matter. So the better you do at this (feeding bacteria) the more organic matter you can make, the better the soil gets.

We have known for years that our water level is going down, and the government is paying farmers to put in irrigation. What we need to do is grow cover crops and improve our soil by putting all the right amount of nutrients on at high enough levels (plus what the crop needs for the year) in the form of natural fertilizers, manure and bio-activators. This will help, since the increase in crop residue contains more carbon (one pound of biologically active carbon holds four pounds of water). A cover crop covering the ground helps keep water in the ground since there is less evaporation of water than there is from just ground.

In commercial farming, the fertilizers are highly water soluble, and the nutrients run with the water off the field, down the rivers and into the lake. The same is true for your lawn chemicals. You can get high nitrates in the crop with commercial fertilizer, since it's not done with the bacteria.

We should reward top-quality (high-Brix) regenerative organic farming, since it is the best way to produce food for the health of plants, animals and people. Top-quality beans have two-and-a-half times as many nutrients as poor-quality ones. Brix is half sucrose and vitamins, minerals and more. You can measure Brix with a simple device called a refractometer. They cost about $120 and are real easy to use.

Chris Dietrich
Elmore, OH

SUBMIT A LETTER

Acres U.S.A. welcomes letters from our readers. Please email *editor@acresusa.com* or mail us at P.O. Box 1690, Greeley, CO 80632. Please include your full name, hometown and state.

Reduce Inputs with Regenerative Farming

Using biological inputs enables you to reduce NPK and other synthetic inputs. When done right, crop health improves, soil regenerates and yield and profit can also increase.

Together with progressive consultants, we're reducing synthetics by 40%, ramping up the use of biologicals, fed with Pacific Gro. Over a few years, the NPK budget can be cut even more! But it requires attention to the soil and the system.

Success Story in Rio Grande Delta, Texas
Mike Helle grows corn, watermelons and vegetables in the hot, humid Delta, with sandy, low OM soils. This is not a high yielding corn growing area. They're always challenged by leaf and stalk diseases and insect pressure. Soils are compacted from heavy machinery traffic during vegetable crops.

Mike has been using compost tea he brews, together with Pacific Gro, and other regenerative practices.

He's never grown 200 bushel corn—but this year he's on track for 220 bushel.

The program includes 150 lbs of total N, 50 lb P; 40 lb K, 7 gal Pacific Gro Oceanic, 15 gal. compost tea, and "Whole Shot Starter" from Brad Forkner of NMS

Regenerative grown Corn in Edinburg, Texas. At milk stage, 45 days pre harvest

In 2021 Mike Helle's watermelons were sweeter (11 brix versus typically 9 brix) and matured faster than usual. **Yield was about 40% higher.**

The 2022 crop looks to be as good or better.

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OUR SKIN... & ITS ANCIENT ROMANCE WITH THE SEA

By Stephanie Schneider, Max-Well

"My soul is full of longing for the secret of the sea, and the heart of the great ocean sends a thrilling pulse through me..." – Henry Wadsworth Longfellow

Thalassa, the Greek word for Thalassotherapy, means therapeutic use of the sea. Way back in our ancient history, both the Romans and the Greeks used sea water for not only relaxation, but also for its regeneration and stimulation properties. Writers throughout the ages remark on the healing power of sea water.

Cleopatra and the Dead Sea

The famous Egyptian Pharaoh, Cleopatra VII, was known not only for her beauty but also her clever mind. She passionately believed that the Dead Sea held healing powers! She believed this so much in fact, that she once urged Marc Antony, her close companion and lover, to conquer the regions surrounding the Dead Sea, to attain them for her personal use.

Cleopatra fervently enjoyed using the Dead Sea minerals in her beauty routine and desired to establish pharmaceutical and cosmetic therapies for privileged guests visiting from abroad. Her beautification process not only included the Dead Sea, but also bathing in milk and lustrous essential oils along with skin exfoliation and moisturizing with rich oils such as Olive Oil.

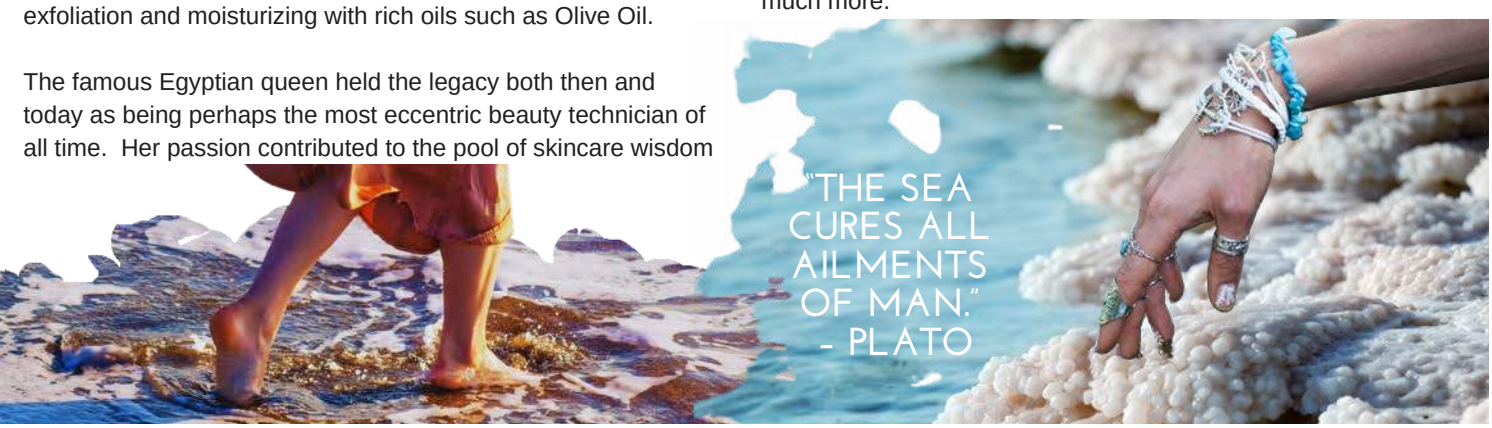
The famous Egyptian queen held the legacy both then and today as being perhaps the most eccentric beauty technician of all time. Her passion contributed to the pool of skincare wisdom we enjoy today and humanity will likely enjoy for centuries to come; yet perhaps most fascinating of all, science shows Cleopatra had discovered the most powerful key to not only physical beauty but also beauty on the deepest cellular level.

Research Proves what the Ancients Knew

Scientists and researchers now concur that there are deep benefits of sea minerals for human health and beauty. But what is it that makes these minerals so wondrous? To find out, we must dive in and discover the reason sea life possesses the longest, disease-free lifespan on planet earth.

In 1904, in the book Seawater Organic Matrix, Rene Quinton wrote about the incredible similarity between the blood nutrient profile and the nutrient profile of micro algae ocean water; the mineral ratios were remarkably alike.

Following this, Dr. Maynard Murray, a researcher in the 1950's, discovered that while land animals were riddled with disease, sea life contained none. He uncovered that the reason for this was due to the perfectly-balanced mineral environment of the sea. Ocean water is overflowing with trace minerals, magnesium, iron, potassium, manganese, iodine, zinc and so much more.



This discovery was phenomenal and unlocked one of the most sacred secrets of the sea. Glorious sea minerals promote tissue healing and anti-aging, and also replenish, moisturize and revitalize the skin. They are vital for the skin's cell metabolism and promote oxygenation and healthy blood flow.

The Healing Benefits of Sea Minerals

As stated earlier, sea minerals influence skin on a cellular level, promoting cell turnover and vitality. This is one of the many reasons sea minerals are so effective at healing skin tissue.

Sunburns can change from a painful red to a warm golden brown overnight. Wounds can heal faster with less scarring. Athletes foot and psoriasis are no match for sea minerals. Users report moles crumbling and falling off, insect stings and bites soothed. Others exclaim that wrinkles lift and dark spots lighten, skin becomes supple and rejuvenated. It is truly no wonder Cleopatra longed for ownership of such a powerful resource. As in so many things, the ancients knew of these secrets long before technology could prove them.

Now knowing the beautiful history and benefits of sea minerals in our lives, the question remains...how do we enjoy these wonderful benefits without building our home in the ocean with our finned aquatic friends?

Be Romanced by the Sea at Home

Max-Well is passionate about bringing natural, holistic health and wellness to our modern world. We truly believe in the all-encompassing health and goodness that sea minerals bring to the body. It's for this reason that they are at the heart of every product we make.

Our concentrated sea minerals are 100 times more potent than those found in the ocean. Not only that, but most of the sodium has been removed during evaporation, leaving behind a very low-sodium, ultra-dense trace mineral solution. Now rain or shine, night or day, your skin can enjoy the holistic experience Cleopatra fought so hard to obtain, and you won't need to journey to conquer the Dead Sea to get it.

We are proud to present our skin care product line: Soothing Sea Soak, Whipped Rice & Coconut Scrub, Milk & Coconut Algae Face Mask and our acclaimed SeaBoost Cream. These luxuriously rich products will give your skin a complete royal experience fit for Queen Cleopatra herself and in the comfort and safety of your own beautiful palace.

Begin your luxurious skin treatment by drawing a warm bath. Add a half to one cup of our Soothing Sea Soak to the water and feel worries melt away in the gentle scents of vanilla, almond and honey. As you relax, soak in the detoxing and rejuvenating wonders of Dead Sea minerals, Epson Salt, Ionic Sea Minerals, a soft milk blend and more. Skin becomes soothed and hydrated, fine lines soften and skin is firmed.

As you soak, it's time to exfoliate the day away. Our Whipped Rice & Coconut Scrub was formulated by bringing together the ancient wonder of rice powder from Asia, the nourishing balm of coconut oil from the tropics, and our acclaimed sea minerals fresh from the Australian shore. This combination offers a royal treatment for tired, dry skin, leaving it exfoliated, soft and clean.

Now that dead skin has been sluffed away, apply our Milk and Coconut Algae Face Mask, also infused with our nutrient-dense sea minerals. Skin will enjoy soaking in a blend of vitamins, amino acids, trace minerals and so much more, which can result in nourished, hydrated, bouncy and youthful skin.

For the icing on the cake, now apply a tiny amount of our intense SeaBoost Cream, an exotic blend of sea minerals, 6 oils including olive oil, sea collagen, papaya, beeswax and many more enriching ingredients. Because our cream is so potent, a light film of it over the skin is plenty to help your skin thrive. Customers have reported wonders from our cream!

The quality of our products is paramount and our desire to spread natural health is the heartbeat of all we do; it has been since our company began over two decades ago. Experience our products for yourself by contacting us below, or visit our website for more information. Unleash the goodness of the sea!

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Eco-Update

News and Analysis on Developments in Agronomic Science

Humans Possess Surprising Nutritional Intelligence

Pioneering research has shed new light on what drives people's basic food preferences, indicating our choices may be smarter than previously thought and influenced by the specific nutrients we need – as opposed to just calories.

The international study, led by the University of Bristol (UK), set out to test the widely held view that humans evolved to favor energy-dense foods and that our diets may be balanced simply by eating a variety of different foods. Contrary to this belief, the study revealed that people seem to have "nutritional wisdom," whereby foods are selected in part to meet our need for vitamins and minerals and to avoid nutritional deficiencies.

The paper, published in the journal *Appetite*, gives renewed weight to bold research carried out in the 1930s by an American pediatrician, Dr. Clara Davis, who put a group of 15 babies on a diet that allowed them to "self-select" – in other words, to eat whatever they wanted – from 33 different food items. While no child ate the same combination of foods, they all achieved and maintained a good state of health, which was taken as evidence of "nutritional wisdom."

Its findings were later scrutinized and criticized, but replicating Davis' research was not possible because this form of experimentation on babies would today be considered unethical. As a result, it has been nearly a century since any scientist has attempted to find evidence for nutritional wisdom in humans – a faculty that has been found in other animals, such as sheep and rodents.

To overcome these barriers, the team developed a novel technique that involved measuring preference by showing people images of different fruit and vegetable pairings so their choices could be analyzed without putting their health or wellbeing at risk.

In total, 128 adults participated in two experiments. The first study showed that people prefer certain food combinations more than others. For example, apple and banana might be chosen slightly more often than apple and blackberries. Remarkably, these preferences appear to be predicted by the amounts of micronutrients in a pair and whether their combination provides a balance of different micronutrients. To confirm this, the team ran a second experiment with different foods and ruled out other explanations.

To complement and cross-check these findings, real-world meal combinations as reported in the U.K.'s *National Diet and Nutrition Survey* were studied. These data demonstrated that people combine meals in a way that increases exposure to micronutrients in their diet. Specifically, components of popular U.K. meals – for example, "fish and chips" or "curry and rice" – seem to offer a wider range of micronutrients than meal combinations generated randomly, such as "chips and curry."

The study's co-author is Mark Schatzker, a journalist and author of *The Dorito Effect* (and contributor to Acres U.S.A.'s *A New Farm Language*),

◄ WHY DOES THIS KNOWLEDGE AFFECT FARMERS?

FROM KATHLEEN DICHIARA

An estimated three billion people from both developed and developing nations have specific nutrient deficiencies. In the U.S. and other developed countries, poor nutrition results in higher rates of infection, increased risks of all types of cancer and an increased risk of obesity. This strain on our health, our economy and our happiness is real.

One of the key drivers for consumers purchasing food is taste. The food industry's biggest obstacle is still the simple fact that people won't buy what doesn't taste good. While taste and smell may seem closely related, they are in fact separate. Receptors on the taste buds of your tongue pick up taste, which comes in five distinct categories: sweet, sour, salty, bitter or umami (savory). Aroma is picked up when volatile chemicals are released into the air or picked up from the back of the mouth into the nose. This close link makes it easy to confuse aroma for taste.

Beyond the mouth, we have taste receptors throughout the body. Bitter receptors can be found in the lining of the esophagus, stomach, intestines, liver, pancreas and gallbladder, as well as the respiratory and nasal tracts.

Scientists believe that when we are exposed to potentially harmful bacteria and viruses, certain bitter receptors are activated in our mouths and noses, which launch an immune response in the respiratory system. Perhaps Mother Nature has encoded our food with the nutritional data we need to exercise and maintain systemic resilience.

You may be surprised to know that scientists and food companies are exploring ways to use smells — to trick our brains into thinking food contains sweetness and saltiness, even when it doesn't. This is known as "phantom aromas."It makes you wonder if tasting a flavor that doesn't exist has health consequences. If the taste and aromas are "manufactured" in foods we consume and don't come with the broad-spectrum, complementary cargo on board that Mother Nature intended — antioxidants, antivirals, fiber, phytonutrients, enzymes, beneficial microbes and more — we may be left overfed and undernourished, and potentially chronically ill. But farmers have an advantage that flavor scientists will never be able to compete with: the complex nutritional intelligence within food that accompanies the naturally occurring flavor of each ingredient. Most people want to eat healthier. Research supports emphasizing taste, and positive experience could help shift dietary habits. It may be time to expand our language of food and stimulate some appetites in favor of nutritional wisdom.

who is also the writer-in-residence at the Modern Diet and Physiology Research Center, affiliated with Yale University. Schatzker noted that "The research throws up important questions, especially in the modern food environment. For example, does our cultural fixation with fad diets, which limit or forbid consumption of certain types of foods, disrupt or disturb this dietary 'intelligence' in ways we do not understand?

"Studies have shown animals use flavor as a guide to the vitamins and minerals they require. If flavor serves a similar role for humans, then we may be imbuing junk foods such as potato chips and fizzy drinks with a false 'sheen' of nutrition by adding flavorings to them. In other words, the food industry may be turning our nutritional wisdom against us, making us eat food we would normally avoid and thus contributing to the obesity epidemic."

Nature Restoration: Soil Networks Connect and Take Up More Carbon

Soil organisms have an important role in aboveground community dynamics and ecosystem functioning in terrestrial ecosystems. However, little is known about entire soil networks.

A study published in *Nature Communications* shows that **during the course of nature restoration on abandoned arable land, a compositional shift in soil biota – preceded by tightening of the belowground networks – corresponds with enhanced efficiency of carbon uptake**. In mid- and long-term abandoned field soil, carbon uptake by fungi increases without an increase in fungal biomass or a shift in bacterial-to-fungal ratio.

The diagram demonstrates interaction strength between the species subgroups (a) and main species groups (b) in seminatural grasslands on recently, mid-term and long-term abandoned agricultural fields. Line width is proportional to the number of correlations. Line color and transparency is proportional to the interaction strength. The size of the circles is proportional to the number of species/taxa in that group; red-filled circles are bacterial groups, blue-filled circles are fungal groups and filled circles of other colors represent other taxa.

The implication of this study is that during nature restoration, the efficiency of nutrient cycling and carbon uptake can increase by a shift in fungal composition and/or fungal activity.

Virus Tricks Caterpillars into Climbing by Altering Their Vision

Baculoviruses can induce climbing behavior in their caterpillar hosts to ensure that the caterpillars die at elevated positions on plants. This improves the probability of virus transmission, since it enhances the ability of the virus to spread over the adjacent foliage.

A team of researchers from China Agricultural University has recently discovered how this happens: the virus changes the expression of genes associated with the insect's visual system, particularly the genes that perceive light. The findings were recently reported in *Molecular Ecology*.

The team infected a species of cotton bollworm larvae with a virus

▲ WHAT DOES THIS MEAN FOR GROWERS? FROM DR. ROBERT KREMER

This study by Morriën et al. offers new information on how soil food webs (SFWs) develop in fields during transition from previous intensive cultivation to conversion toward a more natural state of perennial vegetation. The authors report during the "nature restoration" on several fields studied in the Netherlands that soil fungal components, including mycorrhizae, increased their efficiency in C uptake, but this was not due to C inputs by plant roots. Simultaneously, predatory components of the SFW — including nematodes, mites and Collembola — increased, resulting in C released as they consumed bacterial and fungal prey, which apparently was metabolized preferentially by fungi.

An unexpected finding was that despite fungi dominating C uptake in the SFW, no increase in fungal-to-bacterial ratio (F:B) was detected. Ecological agricultural farmers often consider F:B an important indicator of ecosystem functioning and recognize that higher values reflect optimum soil health properties, including C cycling, decomposition and storage, and soil structure. However this study suggests that F:B values may be influenced by the efficiency of C metabolism and microbial uptake in the SFW. Unfortunately, no indicator of metabolic activity such as CO2 respiration was presented to confirm C uptake efficiency by fungi.

Although this study presents new and interesting soil health information based on SFW interaction analyses, astute ecological farmers should consider the context of this information and realize it may not apply to their particular farming system. Soils at all study sites were sandy texture and the successional grassland was a mixture of two cool-season grasses (bent grass and tufted grass) and a plantain species. Actual values of soil chemical and physical properties were not presented, only shown in correlation analyses. Thus, the study was limited to a soil type that likely lacked good aggregation and we have little notion of reference values on soil organic matter, pH, etc. — all important in understanding the SFW environment.

Furthermore, the grassland was mowed and grazed annually, which does not represent a "natural landscape." This management would obviously affect C inputs by the vegetation (i.e., root exudation), as well as the overall SFW composition, and confounds the findings of the study. Many other factors affecting the study outcomes, such as the level of mycorrhizal infection/colonization of the plant components, are too numerous to detail given the space for this commentary.

In summary, the study is important to growers because it demonstrates the dynamic and potential variations in SFW functions; however, one also should be aware that variations in microbial C uptake and F:B are likely not constant across all agro-ecological systems. More research is needed.

called nucleopolyhedrovirus (NPV) and set placed them near plants with lights at different heights. For the systems with higher lights, infected larvae tended to climb much higher before dying. They also died closer to the lights – no matter the height of the lights.

The scientists hypothesized that the virus was altering the visual signaling pathway of their hosts. They confirmed this by analyzing the genomes of healthy and infected larvae and identified between 2,700 and 3,500 genes that differed between the groups. From these they found three that were significantly upregulated after the viral infection, each of which was related to light detection.

Finally, the team genetically modified larvae using CRISPR/Cas9 to lack each of these three genes; the resulting larvae lacked the ability to respond to light and died at a lower height when infected compared to a control group.

The method the virus uses to alter the genes remains a mystery – one of the many examples of the extreme complexity of the natural world.

▲A bollworm. Researchers are trying to figure out why a virus can induce climbing behavior in caterpillar hosts.

Non-Profit Support for Cover Crops

The National Fish and Wildlife Foundation recently announced $2.6 million in grants to enable Midwest farmers to establish cover crops on over 500,000 acres.

The Midwest Cover Crop Initiative is a public-private partnership that accelerates large-scale, voluntary adoption of cover crops across several midwestern states. The initiative awards grants to provide outreach and technical assistance and to facilitate multi-year financial assistance contracts with farmers. Through this support, the initiative aims to enhance soil health, reduce atmospheric greenhouse gases and improve water and wildlife resources while providing economic benefits to participating farmers.

Cover crops are grown between harvested crops to protect soil from erosion, store nutrients, increase water infiltration and improve soil structure. The conservation impact of cover cropping systems is significant – improved water quality, reduced atmospheric greenhouse gases and even habitat benefits for pollinators or other wildlife. Farmers who implement a cover cropping system often see economic returns with reduced input costs and higher crop yields. It's a major win-win conservation opportunity.

The Midwest Cover Crop Initiative is implemented with support from ADM and NRCS. Launched in 2022, the initiative awarded approximately $2.6 million to grants that: 1) conduct targeted outreach and provide technical assistance to farmers; 2) develop multi-year contracts with farmers for cover crop plantings; 3) coordinate ADM incentive payments to farmers and facilitate enrollment in Farm Bill cost-share programs; and 4) monitor and report environmental and economic outcomes.

Funding availability is limited to cover crops on active corn, soybean, and/or wheat production systems in Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota and Ohio, with an emphasis on projects that deliver large cover crop acreages (tens of thousands to hundreds of thousands of acres) on a cost-competitive basis.

Improving the Regenerative Supply Chain

This past Earth Day (April 22), Kocher Foods International opened Regenerative Mills, a $250,000 flour mill, in an effort to drive market expansion of regenerative agriculture.

Regenerative Mills will process gluten-free grains that come directly from regenerative farms. In turn, this flour will be used in all of their pizza crusts and products. Around the World Gourmet, also owned by Kocher Foods International, is a leading

producer of gluten-free, allergen-free, plant-based, vegan pizza crusts and other products that are sold to restaurants, groceries and other locations around the United States, including Pizza Joe's, a 42-unit chain in western Pennsylvania.

Jennifer Kocher, founder and president of Kocher Foods International, says that **her mill will solve a problem in the supply chain for companies desiring clean, regenerative products**. She believes that regenerative food is the next step in the future of the food industry, giving consumers a sense of connection to the foods they eat and give to their children. She also states that regenerative farming and bringing regenerative foods to market can help battle climate change, all while bringing a more nutrient-dense product to the consumer.

Kocher says that the very first flour to be made will be from both brown and white rice and expand to regeneratively grown grains including millet and sorghum, as well as vegetables such as cauliflower and mushrooms. •••

Organic No-Till Financial Planning

BY JEFF MOYER

Editor's note: This is an excerpt from Jeff Moyer's *Roller-Crimper No-Till* (2020).

An organic no-till operation involves considerable planning, as we've already discussed. If you are currently farming no-till, the financial investment in converting to organic no-till is fairly minimal. If you currently use conventional tillage but want to experiment with no-till, the investment is more extensive. Of course, the amount of money needed will depend on the size of your farm operation. By giving you as much information as possible about costs, we hope to help you get started with your financial planning. Although you can't expect to become a millionaire farmer overnight, you should be able to save some money and improve your bottom line with organic no-till.

COSTS

Equipment will be your biggest start-up cost – especially if you are using conventional tillage. The following is an outline of the equipment needed and the approximate costs:

- Roller/crimper: $3,000-$15,000 (depending on width)
- Front 3-point hitch: $3,000 (approx.)
- No-till planter: cost will vary depending on size, but it is worth looking to pay more for a quality planter in good condition as you'll be expecting a lot from it.
- Planter modifications: The costs will depend on the number of planter units and the modifications required. Allow anywhere from $100 per row and up.
- Tractor: The tractor size will be governed by the planter size. The tractor must be of suitable size to pick the roller off the ground for turning. Actual operation of the roller (pushing or pulling) takes very little energy since it simply rolls over the surface of the ground.

Here's how much Rodale spent on our start-up costs for the roller/crimper system. This might be what someone might spend for a medium-sized operation.

▶ SAMPLE EQUIPMENT BUDGET

Equipment	Cost
Roller/Crimper	$3,200
Front End Hitch	$2,500
No-Till Planter	$20,000
Planter Modifications	$460
Total cost:	$30,600

You will probably pay more money for seed with the organic no-till system. With organic no-till, the cover crop is extremely important, and it pays to invest money in good seed. Locally sourced organic seed may be more expensive, but it's worth the cost. Seeding rates are higher in this system, so make sure to allow enough in your budget to cover these costs. The cash crop will have a higher seeding rate, as well to compensate for seedling loss due to the heavy mulch.

SAVINGS

FUEL. After a conversion to no-till, you can expect to cut your fuel costs by 50 percent or more. The number of field operations will decrease considerably. The table shows the energy used in different kinds of corn production systems. It represents all costs converted to diesel fuel equivalents and includes fuel costs.

HERBICIDE. Since herbicides are not needed in this system, you can count that as a savings. Conventional farmers may still want to budget some money for an herbicide application to take care of the few weeds that may break through the mulch.

INSECTICIDE. You should save money on insecticide costs, but you

▶ COVER CROP SEED COSTS

	Rye	Vetch
Normal seeding rate	60 (drilled) -160 (broadcast) lbs./acre	15-20 (drilled) lbs./acre
Organic no-till seeding rate	120 (drilled) -240 (broadcast) lbs./acre (Rodale uses 150 lbs./acre)	15 (drilled)-40 (broadcast) lbs./acre
Organic seed cost	$14.50/ 50 lbs.	$92.50/ 50 lbs.
Conventional seed cost	$7.50/ 50 lbs.	$75.00/ 50 lbs.

▶ COVER CROP SEED COSTS

	Corn	Soybeans
Conventional seed cost	$107-$196/50 lbs.	$24-$40/50 lbs.
Organic seed cost	$118-$137/50 lbs.	$21-$29/50 lbs.
Conventional seed rate	20,000-40,000 plant population	120,000-190,000 plant population
Organic seed rate	30,000 plant population	200,000 (30 inch rows)
No-till organic seed rate	32,000/ acre	220,000/ acre

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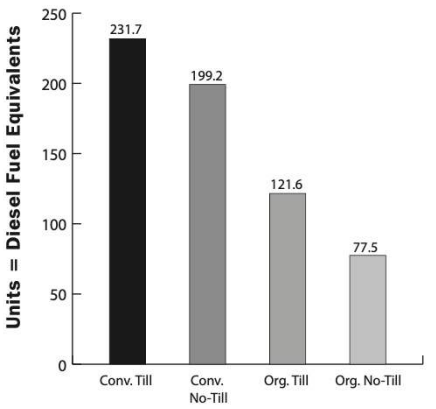
▶ **ENERGY USED IN DIFFERENT CORN PRODUCTION SYSTEMS**



▶ **FUEL COSTS ESTIMATES**

Field Operations	Traditional Organic (per acre)	Organic No-Till (per acre)
Cover crop: Planting	$3.30	$3.30
Cover crop: Disking & incorporating	$2.40	N/A
Seedbed preparation	$2.30	N/A
Planting (and rolling)	$3.30	$3.30
Rotary hoeing	$2.30	N/A
Cultivation	$2.30	N/A
Combining	$11.00	$11.00
Disk crop residue	$2.40	$2.40
Total costs:	**$29.30**	**$20.00**

Your fuel costs will vary, but they'll always be less for organic no-till, because there are fewer operations per acre each season.

may have new pests to deal with. Conventional farmers will want to spray, and organic farmers may want to think through other strategies such as delayed planting, or field border plantings that encourage beneficial insects.

FERTILIZER. You save here too, because in most cases you are growing your own fertilizer (nitrogen) with the cover crops. If you are transitioning to organic, you may still need to budget some money for fertilizer since it takes a while for nutrients to start cycling. In other words, most of the nutrients from the cover crops won't be available for crop use the first year. As microorganisms break down the cover crops and your organic matter goes up, you can cut back on fertilizer and achieve the same crop yields.

ROW SPACING. You might experiment with narrower rows as a way to boost yields. Since organic no-till is a one-pass system for planting with no cultivation needed, you can narrow those rows from 30 inches to 20 inches or 15 inches and even consider using a grain drill for crops like soybeans and plant on 7-inch or 8-inch rows.

The Crop Conversion Calculator is a free tool that you can use online at the New Farm website, *www.newfarm.org.* You can use it to compare costs for your current farm operation and an organic no-till system. To get you started, we have included two sample budgets for different farms.

Iowa State has also developed a web page for Organic Crop Production Enterprise Budgets. The worksheets can also be helpful in figuring out your budget. The website can be found at *www.extension.iastate.edu/agdm/crops/html/a1-18.html.*

Save money with low-cost tools or sharing tools:

- Rent a no-till planter
- Share a roller/crimper and a front end hitch with a neighbor
- Build a roller/crimper yourself

ON-FARM RESEARCH

Trying a new technique in a small area is one of the easiest ways to minimize your risk. In order to have a representative trial, it's important that the plot is similar to other areas on your farm and to have the same growing conditions. You'll need to have a control plot with the same conditions. For information on how to conduct on-farm research you can visit the Organic Farming Research Foundation (OFRF) website at *www.ofrf.org* or request the publication *On-Farm Research Guide.* Rodale also publishes a similar guide called *A Farmers Guide to On-Farm Research.* Here are a few tips for on-farm research:

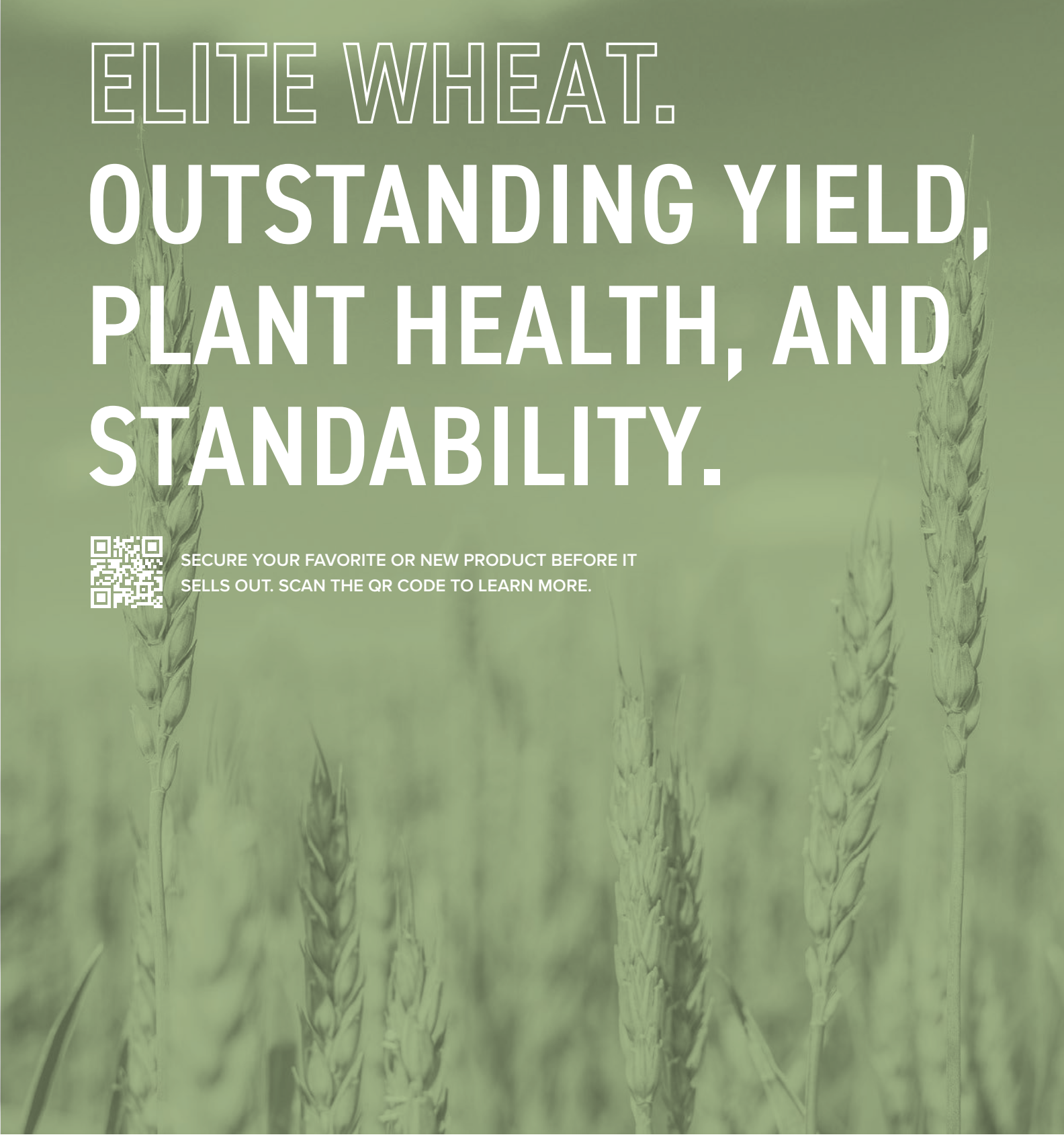
- Consult with someone experienced in designing experiments, such as your extension agent.
- Conditions within your experiment should be as uniform as possible.
- Design plots that are easy to maintain.
- Keep a notebook dedicated to the research project. Document as much as possible as you go along.
- At harvest, measure yields from each plot, and document which plot each sample comes from.
- Design your experiment so that it has between four and six replications. This will eliminate much of the natural variation.
- Randomize your plots to eliminate any other sources of bias.
- Use a control that receives your normal practice or variety. This will give you a comparison to measure your experiment against.

Even if you don't do an official on-farm experiment, nothing is more important than good record-keeping. Recording field operations and yield is important, but you'll also need to return to the field often to check the planting for crop quality. Digital photos are an excellent way of recording visual observations that don't translate well to written information.

SHARING INFORMATION

Form a local group of farmers who are interested in pooling information. Although everyone will have different opinions about what will work on their farms, you may come up with some useful tips. Also check out the wealth of information online, including the New Farm forums.

Jeff Moyer is a world-renowned authority on organic agriculture and CEO of Rodale Institute. Jeff is perhaps most well-known for conceptualizing and popularizing the No-Till Roller Crimper for use in organic agriculture. In 2011, he wrote *Organic No-Till Farming*, a book that has become a resource for farmers throughout the world.



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BECK'S

FROM MOSES ...

Marbleseed is a prairie plant native to the Midwest. It has a deep taproot and thrives in areas grazed by cattle and is one of the first to return, resilient after fire. This drought-tolerant, perennial plant is often used in prairie restoration efforts, providing nectar and pollen as rewards for bumblebees, butterflies, and other insects.

... TO MARBLESEED

In 2021, The Midwest Organic and Sustainable Education Service (MOSES) received a grant from McGuffin Creative Design, a Chicago-based creative services firm, in support of the organization's long-desired quest to rebrand. After deep conversations amongst the staff and Board of Directors, "Marbleseed" emerged as the new name for MOSES, along with the tagline farmer-led, rooted in organic.

"Marbleseed's self-seeding nature speaks to the resiliency, adaptability, and strong community networks needed in the organic farming movement today," says Lori Stern, Executive Director of Marbleseed. Buoyed by success in reaching unanimous consensus, the MOSES team set about the task of creating a new logo.

MOSES was first incorporated in 1995, after six years of growing what has since become known as the MOSES Organic Farming Conference, the largest organic farming conference in the United States. With the Organic Food Production Act (OFPA) authorized by the 1990 Farm Bill, there was a great need for farmer education and technical assistance.

Increasing use of production methods that improved soil health, along with an emerging certification process created a dynamic and exciting environment for farmers who were on the frontline advocating for organic standards that could support the burgeoning organic movement. Today, that need for farmer education and technical assistance continues, and so does Marbleseed's commitment to provide it—but there's no doubt that the organic farming landscape has changed greatly in the past three decades.

Today, environmental awareness and consumer demand for organics has continued to grow, but market capture by industrialized food and agriculture means little of that demand is reaching small and mid-scale farmers.

Instead, the barriers to enter into organic farming–let alone to stay in business—have remained prohibitively high for small and mid-scale farmers, especially farmers of color, veteran farmers, and LGBTQ farmers.

"When we set about the work of choosing a new name and logo, we sought a name that could reflect not only the founding of the organization, but its future and place in a broader and more inclusive organic farming movement," says Stern. "As the organic food and farming landscape continues to evolve, we remain committed to supporting the success of small and mid-scale, organic and sustainable farming operations." And the success of those farms is critical. As Lori explains, "The future of these farms represent an important piece of a more holistic puzzle—one that holds the power to feed communities and address food insecurity; provide economic justice through parity pricing for farmers and fair wages for farmer-workers; and pull CO2 back into the soil."

With a new name and logo, a lot is changing at Marbleseed, but Lori makes clear that the core of its work remains the same, "Marbleseed remains committed to our organization's founding mission: to support farmers in making the transition to organic and sustainable farming systems that are ecologically sound, economically viable, and socially just through farmer-led events, educational resources and community connection."

Find out more about Marbleseed's transition and explore the new website at marbleseed.org and on social media, @marbleseedorg.

▼ Betsy Ross Builta, 1937-2022. *All photos courtesy of Betsy Ross and Dennis Perz.*

REGENERATING SOIL WITH BETSY ROSS

How we learned to grow pecans together

BY DENNIS PERZ

I FIRST MET BETSY ROSS BUILTA at a farmers market in Georgetown, Texas in 2001 or 2002. My wife, Marilyn, and I were still in the lift-off of our new pecan careers and knew little about either growing or selling pecans. Betsy was selling her grass-fed beef and had some big ideas.

Betsy talked to every grower in the market touting the benefits of soil microbiology – the soil food web. My response to her overture was the same as all the others. "I don't know why I need that." This was a true statement firmly rooted in ignorance rather than any horticultural prejudice.

Prior to meeting Betsy that first time, I had taken the pecan short course at Texas A&M on the advice of our county ag agent. He had advised against trying pecans as the soil and location were both unsuitable for commercial pecan production. A true statement. At the first day of the short course, I asked the head of the pecan program if he would help me restore my dilapidated orchard. He asked its location and, when told, assured me I was wasting my time. And he would not waste any of his. The problem was the shallow, blackland clay soil, which is a far cry from the deep, well-drained, mineral-rich alluvial soils recommended for pecans.

But another (successful) local grower was more positive and advised that "hard work and diligence" would lead to pecan crops. We listened to our neighbor and persisted. But after a few years of following the standard advice offered by the Extension Service, it became clear that we could not achieve financial success. I decided that we were wasting

our time – using the recommended management system. Rather than giving up, we needed to find a better way.

One Saturday in 2004 we stopped by John Droomgle's Natural Gardener Nursery in south Austin. John came by, and I started asking questions about my trees' chronic foliar scorch. John admitted he didn't know enough about pecans but directed me to a flyer on the shop door announcing a week-long seminar being offered by Elaine Ingham, founder of the Soil Food Web organization. I was determined to find a better way and paid $425 to attend Elaine's seminar.

Elaine continually emphasized that a healthy soil food web would lead to healthy soil and healthy plants. At one point in her lectures, Elaine advised that growers needed at least 5 percent organic matter (OM) in the soil. I had been discussing with Malcolm Beck (another of my heroes) the merits of the 1.5 percent OM in my orchard soil.

At Elaine's assertion, I rolled my chair over to where Betsy Ross was sitting and asked her if she had 5 percent OM in her pastures. She said, "Yes." And I said, "We need to do some business together." That's how our 18-year collaboration began.

From day one, Betsy's goal was to make the orchard organic. My goal from the very beginning was to make the orchard profitable. There was always this healthy tension between us as we pursued learning together and finding the path to "better."

Betsy and her son, J.R. Builta, began applying her liquid biological amendments to the orchard floor several times a year. By 2005, three applications per year were being made. I always thought of these amendments as dormant compost tea. Betsy started with the best fungal compost she could find (not from Texas) and used a patented extraction process that is much faster and easier than compost tea brewers. This gave us microbial inoculants, and to these she added foods for the microbes, along with

small quantities of minerals. These latter were in the form of seaweed and other materials, all obtained from trusted organic sources.

On her insistence, we stopped using conventional fertilizers and ended all use of herbicides. Of necessity, I continued the foliar zinc sprays and synthetic agents to control pecan nut case bearer – an annual spring threat to the new crop. We did try organic means for crop protection, but they proved less effective.

Within two years, the foliar scorch started to recede and then disappeared completely. At the time we did not understand how this occurred, but we were certain that the biological amendments were the cause. Only later did we learn that we were taking the most important step in all our efforts over the next many years. The soil biology improved the structure of the heavy-clay, severely compacted, poorly drained soil. By aggregating the tiny clay particles into clumps, open spaces were created that improved drainage in wet periods, increased drought tolerance in dry periods and increased air in the soil. **Air brings oxygen for root and microbe respiration** and atmospheric nitrogen for sequestration by multiplying bacteria. Restructuring reduced compaction, improved tilth and enhanced uptake of mineral nutrients. The foliar scorch was caused by shortages of phosphorus and potassium. The trees started to grow faster, and larger crops started to appear.

We were no longer "wasting our time."

As time went on, I decided that we needed to do more. For many years, foliar nutrient data from the labs showed that the major mineral nutrients (phosphorus, potassium, magnesium and sulfur) consistently measured below the "sufficiency" range. They were not "deficient"; I called them "insufficient." I suspected the orchard had been planted on a rundown cotton field years before we bought the property. Cotton can severely deplete mineral resources from the soil.

▲Bio-stimulants being sprayed on the orchard floor. *Photos courtesy Betsy Ross.*

▲The picture on the left was taken immediately after three-day, 6-inch rain. The photo on the right was taken 24 hours after the first photo.

I decided in 2012 that amending with ammonium phosphate and K-Mag was worth a try. I would apply a few tons of each rather than a few pounds. Most of the orchard was amended with MAP (11-52-0), K-Mag (0-0-22-11Mg-22S) and ammonium sulfate (21-0-0-24S). We tested this step by leaving one acre untreated.

The response was immediate, and I've said for many years that "I could not have done better with a magic wand!" Improved canopy growth and health were apparent to all. I viewed this as fixing a defined problem. As the foliar results improved, we ended these amendments.

The orchard endured a severe drought from 2008 to 2012. As it receded, the trees thrived. In 2014, I sent two soil samples to Soil Food Web New York – one sample from the area treated with the mineral amendments and one sample from the untreated area. The treated area had better biology, despite the synthetic amendments. In retrospect, this result was predictable. **Better mineral resources significantly accelerated canopy growth, which in turn increased photosynthesis and food production.** Much of this food increase goes down the trunks to the roots and then out to the soil and the microbes. Tree root exudates feed the microbes and increase their populations.

After starting with the synthetic amendments, I discovered Bill McKibben's book *The Art of Balancing Soil Nutrients* and Bill McKibben as a resource. Bill is a soils consultant working in northwestern Ohio. He knows little about pecans but a great

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deal about balancing mineral nutrients. His book explained why the foliar scorch went away. Compacted soils inhibit uptake of needed minerals, including P and K. Around that same time, Dr. Michael Smith, a pecan researcher at Oklahoma State University, presented data on curing foliar pecan scorch with mineral amendments of phosphorus and potassium. **We cured our scorch problem much earlier with soil biology and improved soil structure.** Our later amendments of P and K served to further correct the mineral imbalances and improve tree vigor.

When the drought ended (based on annual rainfalls in our orchard), I decided it was time to invest in more irrigation. The biology had improved the soil structure, and the mineral balancing ensured the trees could get the mineral nutrients needed to prosper. Growing trees need more water. The irrigation upgrade came in three parts:

• In 2012 we added a second well and increased our pumping capacity from one 5 horsepower (HP) pump to one 5HP and one 7.5HP.

• In 2013 we replaced all the old, undersized field piping with new, including a 4-inch main header and a 7.5HP irrigation pump.

• We also reinstalled tensiometers for soil moisture sensing and began tighter control of moisture with these in-the-ground sensing devices.

In recent years, Betsy talked less about organic and more about natural, sustainable systems. Together, our management system has evolved to four key elements:

1. Soil microbiology – easily the most important – the "enabler" for everything else;

2. Structure coming from the microbes;

3. Mineral balance; and

• Water management.

This comes close to the definition of regenerative agriculture. Only the livestock are missing. With these in place, both the quantity and quality of our production have increased. The orchard is consistently profitable. And our management practices are increasingly sustainable.

Other value-adding practices include:

• Mid-season crop thinning to avoid overloads and reduce alternate bearing. I learned this from Dr. Smith at OSU.

• Tree removal and chipping to avoid crowding and tree deterioration. From AgriLife.

• Composting the wood chips mixed with other organic matter and then spreading back to the orchard floor. From Betsy and Dennis.

• Solid ground covers, including mostly volunteer legumes. From Betsy Ross's prohibition of herbicides.

• Grafting and topworking. From local teachers.

As time goes by, tree health and production continue to improve. We're moving toward Betsy's goal of 100 percent sustainable inputs as we find that soil biology can provide more than enough nitrogen in the biomass to drive excellent canopy growth. Soil organic matter from multiple labs comes in at 4-7 percent.

Steve Diver (*find Steve's latest article in the June 2022 issue*) worked for Betsy in the early years of our collaboration. Steve earned a master's degree in pecan horticulture under Dr. Smith's supervision at OSU. Steve combined practical advice

◀ Fresh wood chips in foreground. Older compost windrow behind.

▼ Ample biomass nitrogen can drive over a foot of secondary growth beyond the point of pollination (empty shucks).

with the most visionary view of horticulture I have encountered from anyone. Before he left to direct a horticultural research program at the University of Kentucky, he advised me to start thinking of the orchard as an ecosystem. The five years of drought brought that into focus as I watched the trees decline from the stress and then come back. But I also saw the same for the birds, critters and insects. The unusually high organic matter (for central Texas) is a product of our attention to the soil biology, ground covers without herbicides, gradual reduction of synthetic inputs and recycling trees we have removed. Our orchard serves not only to produce edible pecans but also as a carbon sink, doing its part in removing atmospheric CO_2.

Betsy has left us, but her influence sustains us:

• Over the last several seasons we have discovered pecan truffles during our harvests. Truffles are the flowers of a strain of mycorrhizal fungi. Mycorrhizae are of particular value because they form a symbiotic relationship with tree roots, extend the reach of the roots in gathering soil nutrients and are particularly noted for bringing in phosphorus. At the suggestion of a professor at Texas Tech University, we have begun injecting the truffle material into the soil. Our goal is to deposit the fungal spores into the soil, propagate the mycorrhizae, aid the trees and eliminate future amendments of 11-52-0.

• We have purchased a refractometer and are beginning to take Brix measurements to judge tree health.

• Similar efforts will be pursued to further reduce synthetic inputs. This entire process has focused on measurements, data collection and objective evaluation of results.

As the pecan industry leadership increases our focus on food safety, nutrition and sustainability, the regenerative management system that has evolved in our orchard is attracting the attention of other growers. At least one other is already engaging Sustainable Growth Texas to apply Betsy's biological formulations to their orchards. We hope that will expand. As it does, Betsy's legacy will go on.

For both Betsy and I, our eighteen-year collaboration was a continuous learning process, and the results have been rewarding.

Dennis and Marilyn Perz own and operate the Georgetown Pecan Company, a 25-acre orchard just north of Georgetown, Texas. Dennis worked for 32 years as an engineer at NASA and at the Dow Chemical Company. Georgetown Pecan Company was recognized by the Texas Pecan Growers Association as winner of their 2022 Small Grower Award.

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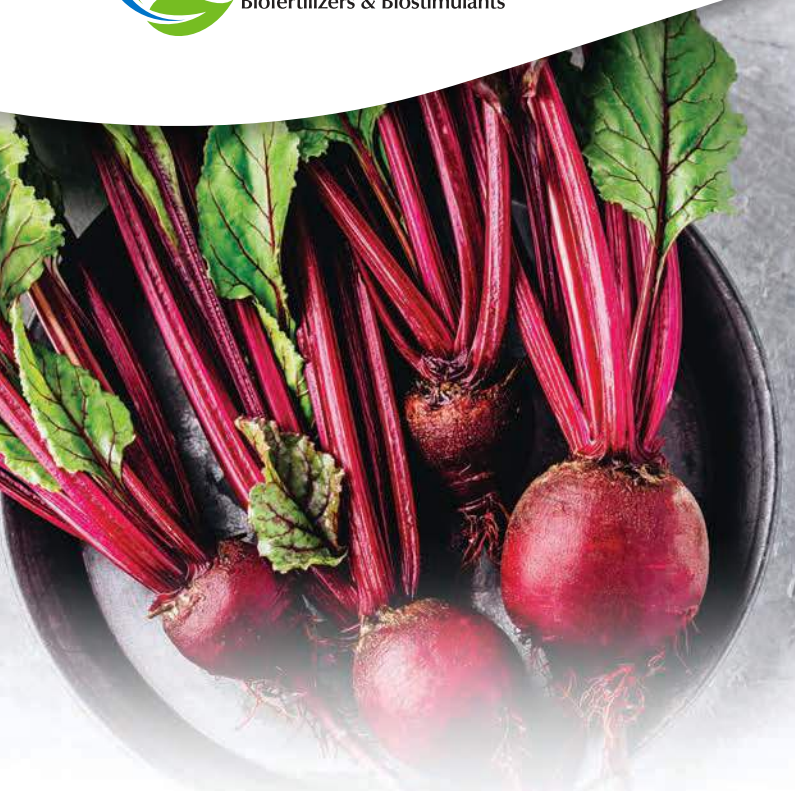

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Richard Marolda Jr, Marolda Farms, Inc, Vineland, NJ

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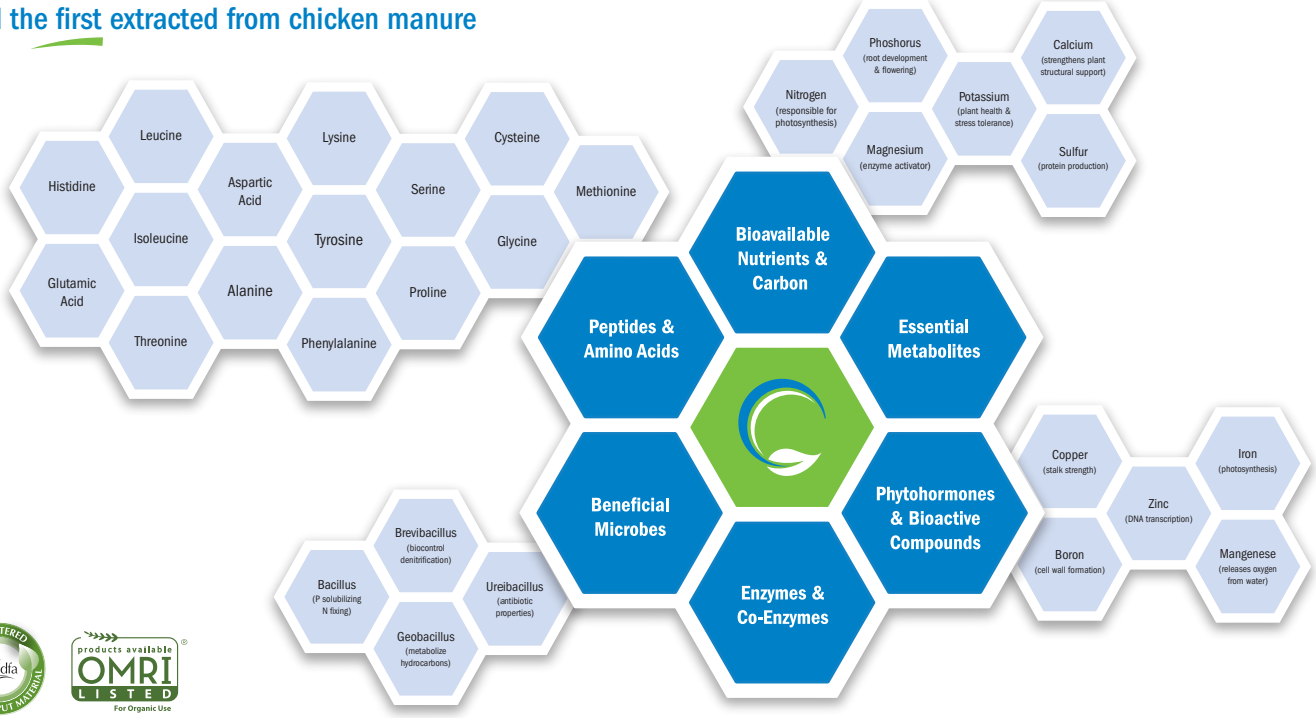

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Soil Conditioning for Organic Vegetables

How to recreate an old pasture field ... without cattle or horses

BY AARON WEAVER

The best-conditioned soil for growing organic vegetables is an old pasture field where cattle and horses have grazed for twenty years or more. It has received manure from these animals over the years and possibly some lime or gypsum. Most of these fields have a high total exchange capacity, good organic matter and good water drainage, but the soil can hold moisture during dry periods.

Not all farmers are able to have old pasture fields to grow vegetables in, but even with other fields it is possible build up humus and microbes and have healthy soils.

Taking a soil sample is one of the most important steps in building soil health. It will show us what type of soil we have (sandy loam, clay, etc.). The total exchange capacity will tell you what the nutrient holding capacity is. You will be able to see where the levels of your main minerals are at (phosphorus, calcium, magnesium, potassium, sulfur, trace minerals, boron, manganese, copper and zinc).

Sometimes the farmer is ahead by not trying to grow vegetables the first few years after buying a farm or acquiring some land. Consider incorporating cover crops or pasture mix and grazing the fields for a few years. If your soils have poor drainage, contact somebody to run drainage tile in the fields. Poor drainage slows down plant growth and promotes diseases, and insect pests love plants that are stressed. Running drainage tile is expensive but pays for itself in a few years with the good, quality crops that you will then harvest. This is especially important for heavy clay soils.

Clay soils can hold more minerals but need to be worked differently from sandy loam soil. Rule number one is to never work the soil when it is too wet. Working the soil when it is too wet kills the microbes and creates a hard pan; it takes several years to get it back to where it was.

Our farmers use old-time methods of tillage – moldboard plows, harrows with culti-mulchers and cultivators for weed control. No-till practices are better for the soil but are not practical for a farmer that makes a living growing organic vegetables. So, our farmers use minimal tillage, being conscious about the microbial life in the soil. They set the plow depth just deep enough to turn the cover crop over.

On clay soils, start balancing the soil by applying the minerals to work toward ideal levels, which are 68 percent calcium, 12 percent magnesium and 5 percent potassium. This will take a few years to accomplish, but you will notice it getting better each year. Adding sulfur, humates and boron will help make these minerals available to your crop. Phosphorus levels are often low in these soils and can be raised by applying rock phosphate. If you have your own

▲ *Photos courtesy Aaron Weaver.*

bedded pack manure or compost, this will help raise your phosphorus and potassium levels.

Manure has more value today than it ever has had, with the high fertilizer prices. Doing cover crops, along with applying these minerals, will help create a nice texture and help break up hard pan.

Nutrient transport can be visualized as a wagon with a horse hitched to it – Dad and Mom on the front seat with the children on the back seat. Being calcium, the king of nutrients, Dad determines how many children go along and where they will go. Mom is phosphorus –reproduction, for rooting and fruiting. The children on the back are the trace minerals. The horse is boron; the family isn't going anywhere till he starts walking. Running along beside the wagon is a dog, which is sulfur – he will keep things stirred up.

Here in our area, we have a silt loam soil that is generally high in calcium and magnesium but low in potassium and phosphorus. By not working the soil when it is wet and applying sulfur, humates and trace minerals, the other minerals become plant available. The farmers can grow very good, quality crops. They are also doing cover crops. The produce fields are done in zones, with permanent drives that are seeded with clovers and grasses for our pollinators.

Crop rotation is also very important to help with disease control. Some farmers are leaving zones fallow for a year, growing different species of cover crops to help revitalize the soil. Mulching between rows with hay or straw also helps build up microbial activity and keeps the soil nice and cool. It also keeps water from splashing on the lower plant leaves for disease control.

Sandy loam soils have a low total exchange capacity, which means to balance the soil you must use spoon-size servings instead of cup size. Minerals need to be supplied small amounts at a time or they will leach away. By incorporating humus compost, compost or manure and by cover cropping, you will be able to hold the nutrients better and build organic matter. Irrigation is a must in light soils. It works well to spread a dry crop food with nitrogen, plant-available phosphorus, potassium and food for the microbes. This builds a hot bed of biology right where the crop is planted. It is also good to feed liquid crop food through the drip irrigation. This would be considered spoon feeding. It is also good to apply minerals for balancing the soil twice a season, rather than then just once.

Try to seed cover crops as soon as you have cash crops harvested. On fields that have early harvested crops you have the opportunity to

can be worked into the soil in the spring.

For late-season crops you can do a cover crop in the spring like buckwheat, which will aid in making more phosphorus plant available to the soil. Plow it under in the summer for your fall squash crop. Mustard is also a good cover crop. It helps to fumigate the soil of some soilborne diseases like Phytophthora. Cereal rye is used as a cover crop mostly on the late-harvested crops.

Be diverse with cover crops and try different species. Diversity builds immunity. When we are harvesting crops every season, we are taking minerals out of the soil, so we need to be putting them back in.

Aaron Weaver is the field coordinator for Green Field Farms, a farmer-owned co-op that markets products from Amish and Mennonite farms in Ohio. Find out more about Green Field Farms at 330.263.0246, info@gffarms.com, or 6464 Fredericksburg Road, Wooster, Ohio 44691.

Practical Advice for Preventing Foxtail

From Dr. Adam Davis of the University of Illinois:

1. **Foxtail is very susceptible** to weed seedbank control: A lot of different granivores, including mice, ground squirrels, birds, crickets and ground beetles, like to eat giant foxtail seeds. If we provide habitat/shelter (mulch, living cover, crop residues) for those granivores during the August through November time period, they can eat up to 90 percent of the newly produced seed.

2. **Primary tillage timing**: Fall tillage vs. spring. Keeping giant foxtail seeds on the soil surface for as long as possible (delaying primary tillage) can maximize seed predation benefits. However, tillage timing considerations are clearly linked to a lot of other factors: soil type (Is the soil heavy enough to require fall tillage to allow for mellowing over the winter? Is the clay content low enough and drainage good enough to permit primary tillage in the spring?), crop rotation (does a following cover crop or primary crop require fall seedbed preparation?) and soil quality goals (do you even include primary tillage or go for some form of limited tillage?).

3. **Cover crops**: I've noticed that legume cover crops do considerably better than grass covers in suppressing giant foxtail. There's a large allelopathic impact of red clover, alfalfa, birdsfoot trefoil and medics on giant foxtail seedling recruitment. I haven't seen much impact of rye or other cereals on giant foxtail germination and establishment. During the seven years that I ran a roller-crimper study in soybeans, the weed community went from being dominated by common waterhemp to being dominated by giant foxtail.

4. **Rotations**: It's good to get a winter annual in there to interrupt giant foxtail's summer-annual life history. For organic grains, corn-soybeans-wheat/red clover is nice, or corn-soybeans-oats/alfalfa-alfalfa.

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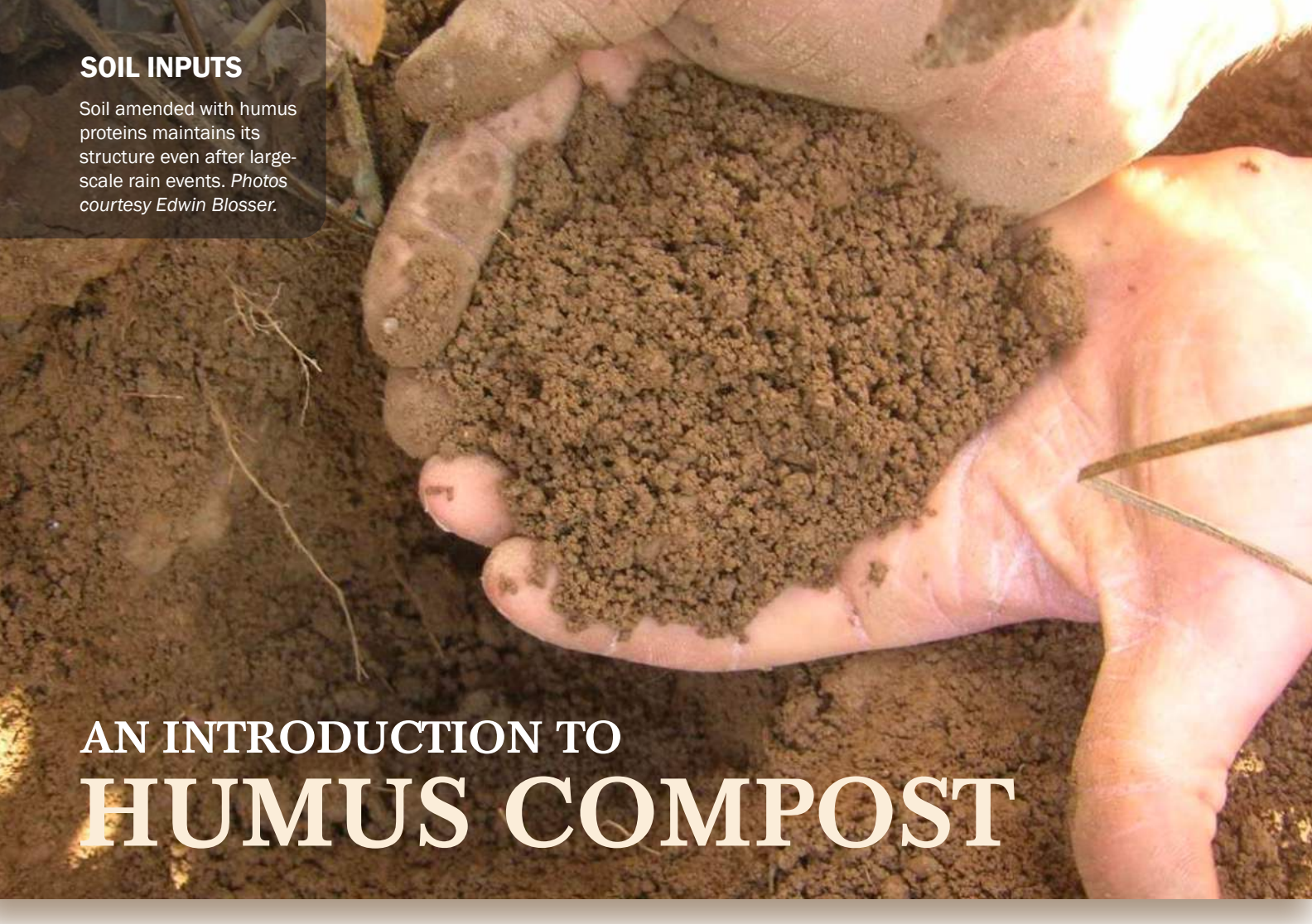

SOIL INPUTS

Soil amended with humus proteins maintains its structure even after large-scale rain events. *Photos courtesy Edwin Blosser.*

AN INTRODUCTION TO HUMUS COMPOST

BY EDWIN BLOSSER

HAVE YOU EVER LOOKED OUT at your fields in the middle of the summer and been really pleased with how green everything looked?

What if everything that was green was a weed, though – grasses and pigweed and bindweed?

I have had this happen in my own fields way too many times. It's embarrassing. Beyond that, it's frustrating. And, of course, the financial return on investment for such a field is not good.

Humus compost offers another way. It's a tool to help us with profitable farming.

Humus compost is applied in two different ways: as a solid mixed with minerals or as an extract liquified into water and applied through sprayers and planters. Based on having done this since 1993, I will tell you that the liquid by itself is not as effective as the solid humus compost mixed with minerals; however, using both has a much greater impact than just one or the other. The synergistic effect is amazing.

Humus compost is actually compost with a humus protein. I would not make compost if it did not have humus in it. And what is humus? Most people think organic matter and humus are the same thing; they are not. Are wheat and bread the same thing? Well, the bread has wheat in it, but it's no longer wheat; it's wheat bread. The same goes with organic matter: humus came from organic matter – it was derived from it – and yet it is no longer organic matter.

When you're sitting around the fireplace on a cold winter night, what are the sounds coming out of the fireplace – the snapping and crackling and popping? Each noise accompanies a release of energy. As a matter of fact, that's the sun's energy being released. It's not organic matter being released. When the tree that grew the wood that you're burning in your fireplace was growing, it was capturing sun energy through photosynthesis and storing it in its wood. In the fireplace, it's releasing that energy.

Now imagine a windrow of compost. You can't hear that snapping and popping and crackling in the compost windrow, but it's happening. The sun energy is being released up into the air, just the same as in that fireplace. But instead of allowing that energy to be released into the air, we want to capture that sun energy and put it into humus protein.

Most people make compost by decaying organic matter until it becomes dirt and soil. That's not what I'm interested in. I want to make a compost that becomes a valuable tool in helping farmers become more economical.

Humus compost is a tool for profitable farming

Making Humus Compost

When we make compost, we start by putting carbon-based materials into the beginning of a windrow and we thoroughly soak it with water, along with an inoculant designed to limit evaporation of the volatile compounds. On the second day we incorporate clay into the carbon along with the nitrogen-heavy materials. The clay helps capture the sun's energy – it doesn't allow things to volatilize; we've learned that we have to coat our organic matter well with clay.

Every little cell of organic matter is very small. And inside every cell there's a whole lot of stuff that wants to evaporate. Why? Because it's lighter than air, like a hot air balloon. One mature oak leaf has seven to ten billion cells, and every cell contains energy that came from the sun. As soon as it rots – unless you do something about it – that energy is going to escape. The clay is a negatively charged ionic material that causes the evaporative material to get sucked to it instead of to evaporate.

We then incorporate microorganisms that do not survive in the gut of an animal but that do survive out in the undisturbed forest floor. These microorganisms assemble things – instead of disassembling/decomposing them. They actually assimilate and assemble the volatile compounds into bonds of carbon called links, and from there they are able to create a carbon chain with 45 links or more – that is called a humus protein.

We do our turning based on windrow temperature readings. We apply water to make sure the organic matter starts to decay. We use mixers to make it all happen faster.

Benefits of Humus Compost

We have a client in Lancaster County who sells humus compost for $220 a ton – in an area where there's an excess of manure. How is this possible?

This client used to have sticky red clay soil. I was walking out in his field once, and it had rained three tenths of an inch the night before, and my shoes had an inch to two worth of soil on them. Two years later, after using humus compost, he got eight and a half inches of rain, and at six inches deep his soil was granulated and nice and mellow – not sticky red clay. The reason people buy humus compost in Lancaster County instead of the excess manure is because it does things like this.

Humus compost also helps us with our mineral nutrients. Humus has a powerful magnetic attraction – it has a CEC of up to 300, compared to 15 to 30 for clay and just 1 to 5 for sand. Yet humus interacts well with the root rhizosphere and easily releases the bound-up minerals in the humus upon demand from the exudates from the root rhizosphere.

Humus compost is also extremely helpful for soils that are too tight. Many farmers have "24-hour soils" – in a 24-hour period they can go from being too wet to work to too dry. Tight soils have a base saturation that's wildly out of balance. Humus compost can help fix this.

When minerals are applied by themselves – without humus compost – there are certain limitations growers should be aware of. First of all, many minerals are attracted to other minerals, and they tie each other up and become unavailable to plants. Imagine a bunch of magnets sitting on a table, not quite touching each other. What happens when you bump the table? All of those magnets snap together. This is what happens when you add certain minerals to your fields. How do you know, when you put out phosphorus or potassium or lime or gypsum, that that does not happen with the minerals in your soil?

That is the dilemma. I call it the paradox of minerals. There are also losses of minerals due to evaporation and leaching. We would like to prevent these losses.

It's very difficult to apply minerals so as to make a long-term change. A question I often get is, "Why am I putting all of these minerals out there

year after year and nothing changes? In fact, the levels either remain the same or even go lower. Do you believe that balancing the base saturation, such as Dr. Albrecht taught, is either economical or effective?"

My answer is, "It depends." If you can utilize a carbon-based mineral system, where the minerals are attached to long-chain carbons first – as with humus compost – it absolutely pays big dividends. This is based on thousands of examples on farms in the U.S., Australia, New Mexico, Colombia, Ecuador, Paraguay, etc.

Minerals are magnetic in nature – it doesn't matter whether it's potassium sulfate, elemental sulfur, potassium chloride, brown rock phosphate, etc. Every mineral has a positive and a negative end to it, and given the opportunity to attach to another magnetic positive and negative, it will. That's why a lot of people are frustrated about applying fertilizers – because they really want to see good results, but their minerals are just being tied up and aren't available to the plants.

However, if a mineral is adequately coated with humus, it will not be attracted to other things in the soil that want to bind to it.

Utilizing humus, our goal is to see a permanent change in the base saturation mineral balance. I'm not discounting the need for minerals. I'm saying that humus compost is a tool to make your minerals more effective.

The compost we make is full of humus protein. A lot of people ask me what's in it: "How much nitrogen? How much phosphorus? How much potassium?" It's not what's in it in terms of content – it's what it functionally does in the soil. That is what I am concerned about. It's about nutrient cycling, not nutrient content; it's about what it will do to the soil, not how much it will add in terms of nutrients. We use humus compost as a tool to coat minerals with and as a tool to elongate the rootlet in the rhizosphere. We make a liquid extract out of it. We use this product as a tool for the farmer to become more

economical. When we blend minerals in with humus compost, we can balance our base saturation ratios, and there are long-term benefits – we get those ratios to stay there.

An Economical Tool

Here's an example. In the late eighties I did a research project with a soil that was at a pH of 8.3, and my goal was to get it down to 7.7. I applied two tons of gypsum for five years – a total of 10 tons. At the end of five years, the pH of the soil averaged 7.6. I had achieved my goal. At the end of that five years, however, I had started making humus compost. On another part of that field that I had not treated – that was still pH 8.3 – I mixed up 1,500 pounds of gypsum and 2,000 pounds of humus compost and applied half of that mix in the fall and half in April of the next year. By that summer, the pH had gone from 8.3 down to 7.3. Three years later, the pH was around 7.6; the area where I had applied 10 tons of gypsum had risen from 7.6 to 7.9.

So, how economical is humus compost? In this example, it meant that I only had to apply 15 percent as much to achieve a better and longer-lasting benefit. Humus compost is an incredible tool. Humus compost also prevents plants from taking in an excess of nutrients. Plants become healthy and optimize their growth when they can dictate in advance to microbes the nutrients they need. This prevents plants from taking in excess nutrients. The number one reason for plant disease is one or more nutrients being present in excess. By having the plant dictate its needs to microbes via its exudates – via the liquid coming out of the root – you can lower your fertilizer needs.

When the plant is in charge of and can direct its own growth, the plant will grow with much less water and fertilizer. We have documented between 60 and 80 percent less water being required in a healthy plant versus an unhealthy one. When a plant is out of balance, it is going to require more water. That automatically dilutes the energy and then requires more fertilizer. That gets you into a no-win situation.

▲Making humus compost requires, among other elements, timely turning.

In summary, humus protein is sun energy, captured and built into it. It is accomplished by utilizing a special process of capturing the sun energy that normally escapes from decomposing organic matter (often taking from four to six weeks) and then building those compounds into a protein substance (often taking from six to eight weeks, for an average total process of 10 to 12 weeks.) The final humus compost really enhances soil structure, enables one to economically balance soils and allows the plants to direct their own growth, resulting in healthier and more nutrient-dense crops and produce!

Edwin Blosser is the founder of Midwest Bio-Systems. He has attended nearly every Acres U.S.A. Eco-Ag Conference since 1986. This article is an edited transcription of his presentation from last year's conference.

MICR☺BIALLY FRIENDLY FARMING

Controlling plant pathogens and increasing plants' ability to withstand stress

▲Parsley roots. *(Canva)*

BY DR. JUDITH FITZPATRICK

Imagine that you were intelligent enough to diagnose a disease, proscribe the correct antimicrobial and manufacture it. Plants with a healthy microbiome do this!

In this article we will explain how the plant and microbe work together to perform this miracle and why organic farmers use 97 percent less of any kind of pesticide than those using mineral fertilizers, which are genocidal for the soil microbes that protect the plant from pathogens and adverse conditions, produce nutritionally deficient food, and pollute the environment.

In organic or regenerative farming, which we will refer to as Microbially Friendly Farming (MFF) – in which growers seek to maintain microbial populations above 250 ug microbial biomass carbon per gram of soil and a F:B (fungal to bacterial) ratio above 0.5 – the plant secretes about 30 percent of its photosynthate to generate the specific microbial population that it requires for nutritional needs and health. The major stimulation for the plant to build this population is the plant's hunger for the N, P, K and other soil minerals that the microbes can deliver. When the plant is provided mineral N, it does not nourish this microbial population, and the plant loses the ability to protect itself from pathogens and stresses such as drought.

The microbial population in the rhizosphere is controlled by the organic molecules that the plant exudes and the nutrients available in the soil. Microbes are the pickiest of eaters – they can only dine on very special diets and require the support of a population of other microbes that supply some of their dietary needs. This is why we can only grow about 1 percent of soil microbes in the lab – we know about the other 99 percent only because we can detect their DNA, see them microscopically and measure some of their metabolism.

Like us, plants receive their initial microbiome from the seed of the mother plant. It is as important for a plant to establish a healthy microbiome as is it for us; children born by caesarian birth have different microbiomes than those born vaginally and have immune deficits that are attributed to not being inoculated with their mother's vaginal and fecal microbes.

The microbial population in the rhizosphere descends from the seedling population and expands with plant/root growth and recruitment from the surrounding soil. The seedling feeds the microbes with root exudates, and the microbes send chemical growth molecules to stimulate plant growth; these microbes are therefore called "plant-growth-promoting bacteria." As with humans, the overall health of the plant is a critical component of disease resistance.

The interaction between the microbes and the plant is very similar to how the microbes in our guts stimulate our immune system, which also doesn't develop in the absence of microbes. **Microbes enter the plant through root tips via a process called rhizophagy.** The plant extracts 40 percent of the N it requires, as well as other nutrients, before it releases these microbes back into the soil via root hairs. Some of these microbes enter the plant's circulation system and interact with receptors that appear on all plant cells called Microbe Associated Molecular Patterns (MAMPs), which recognize and bind to common structures on

> "The soil microbial community and economy has thrived for 3 billion years."

the surfaces of microbes. This binding leads to an intracellular molecular chain reaction that stimulates the cell to produce more MAMPs and many protective antioxidants. Thus, it produces a cell that is more alert to microbes and is more prepared to respond to infection.

In addition to MAMP receptors, the plant has Pathogen Associated Molecular Patterns (PAMPS) that recognize and bind to structures that are unique to pathogens. Binding to a pathogen receptor stimulates the cell to make more PAMPs, making the plant more sensitive to the pathogen and producing large amounts of antioxidants that are harmful to pathogens; it also sometimes causes the cell to commit suicide (apotosis) to save the spread of the disease.

This exposure to pathogens also stimulates the plant root to up the production and secretion of the foods that attract the microbes that make the antibiotic to combat the particular pathogen. The microbes making this antibiotic then multiply in the root area, making the antibiotic available to the plant. Thus, with MFF, a plant in partnership with microbes develops a strong immune system by upping the number of MAMPs and PAMPs and is more resistant to disease and requires much less pesticide.

Perhaps the biggest wins for MFF is that these healthy plants produce thousands of essential nutrient antioxidants, which are not plentiful in conventional farm produce and are not currently listed as nutrients by the USDA. These antioxidants provide protection against cancer, inflammation, etc., and they are what give fruits and vegetable texture and flavor, leading to better eating habits.

Microbes also stimulate the production of Damage Associated Molecular Patterns (DAMPs), which recognize and bind components of damaged cells, especially those of leaves, and promote healing. Moreover, it has been demonstrated that the chemical odors produced by these damaged cells are specific to the insect causing the damage and that these odors attract insects that antagonize the attacker.

Microbes make antimicrobials in large part to protect their territory from other microbes. So, the microbes surrounding your plant are big defenders against pathogenic soil bacteria – e.g., good nematodes are the best protectors against pathogenic nematodes. Interestingly, it has also been observed that a proper F:B ratio results in a bacterial population that is more prepared to defend itself from predators. The proper ratio varies depending on soil and crop; for agricultural crops it is usually between 0.4 and 1. The proper ratio also tells you that you are not decreasing your soil fertility (organic carbon).

Mycorrhizal fungi, which colonize approximately 90 percent of all plants, are fungi that are totally dependent on the plant for nutrition. A plant root exudate awakens the fungal spore that has only a day to grow to the plant, where it enters a cell and is fed. When established, the fungi

> "The current best indicator of a healthy soil microbial community is a healthy microbial biomass and F:B ratio."

send out hypha to collect P, N, K, S, and water, which it brings back to the plant cell and trades for carbon and amino acids. The fungal hypha of a colonized plant can increase the root area as much a 1,000 percent, making significantly more water and nutrients available. The hyphae are also able to form a network connecting trees and are known to send immune signals from diseased trees to other trees in the network to up their resistance to the disease. These fungi also very efficiently protect plants from drought by modifying the root structure, allowing it to absorb more water. Protecting a plant from the stress of drought makes a plant that is more disease resistant and increases yield.

The soil microbial community and economy has thrived for 3 billion years. It has checks and balances and has adapted to soil and water conditions all over the globe. Like our own society, it contains opportunists who take advantage when a defense system is poor and/or the society is weakened. The current best indicator of a healthy soil microbial community is a healthy microbial biomass and F:B ratio: it tells the nutrient level and nutrient balance of the soil and can tell if it is improving. It provides information that chemical tests cannot; e.g., most soils have plenty of P, but it is in a form that only fungi are able to make available to the plant.

A soil test tells you N is low, but it doesn't tell you that MFF can increase the number of microbes that can deliver N and fix N from the air.

As you can imagine, creating and maintaining a healthy immune system requires plant energy – which is probably why the yields of MFF practices are on average about 10 percent less than those of mineral fertilized farming. But studies show that when microbially friendly farming is optimized, the yield loss is compensated for by tastier produce; lower fertilizer, water and pesticide costs; and better resistance to drought.

MFF also offers the potential to increase financial return by building soil structure, which increases water holding capacity, decreases erosion and water costs, increases drought resistance and increases soil carbon; these benefits have in turn has been shown to increase yield and, over time, decrease fertilizer needs. Understanding the plant health microbial synergy is even more critical now that the cost of mineral N is up as much as 400 percent and pesticides costs are also rapidly rising.

Dr. Judith Fitzpatrick is a microbiologist who has designed a number of on-site diagnostic tests and who holds 13 patents. She is a founder and principal scientist at microBIOMETER.

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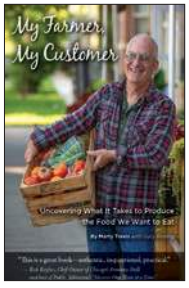

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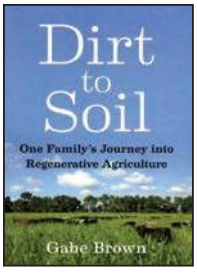

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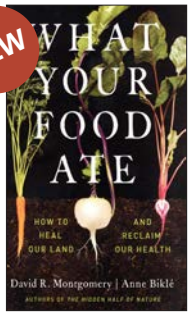

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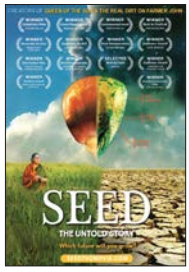
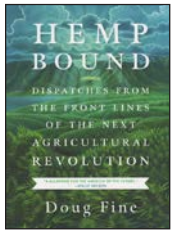


Few things on Earth are as miraculous and vital as seeds. Worshipped and treasured since the dawn of humankind. In the last century, 94% of our seed varieties have disappeared. As biotech chemical companies control the majority of our seeds, farmers, scientists, lawyers, and indigenous seed keepers fight a David and Goliath battle to defend the future of our food. In a harrowing and heartening story, these heroes rekindle a lost connection to our most treasured resource and revive a culture connect to seeds. SEED features Vandana Shiva, Dr. Jane Goodall, Andrew Kimbrell, Winona Laduke and Raj Patel. **#7448DVD • 1 Disc •** ~~$19.99~~ **SALE: $4.98**



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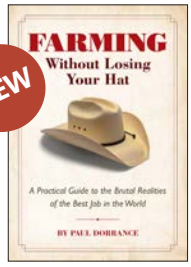

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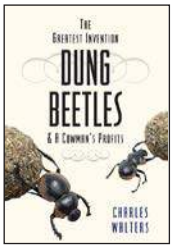

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Charles Walters digs deep into modern science and ancient history, traditional folklore and the best practical advice to resurrect the lowly dung beetle, exposing farmers and ranchers – and anyone with a desire to work more closely with nature – to this amazing creature. Anyone interested in organic forms of farming will be enchanted by the intriguing tale of the dung beetle. **#6852 • Softcover • 215 pages • ~~$32.95~~ SALE: $22.95 (SAVE $10)**

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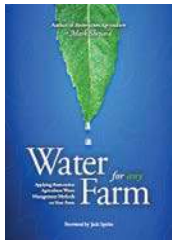

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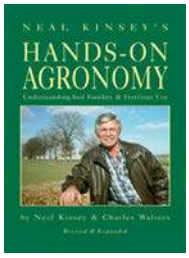

Hands-On Agronomy

NEAL KINSEY & CHARLES WALTERS

An ecologically balanced soil system is essential for maintaining healthy crops. This is a comprehensive manual on effective soil fertility management. The function of micronutrients, earthworms, soil drainage, tilth, soil structure, and organic matter is explained in thorough detail. **#4120 • Softcover • 391 pages • ~~$35.00~~ SALE: $24.50**

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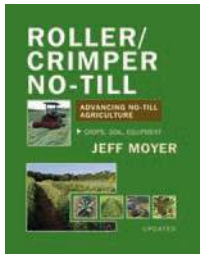

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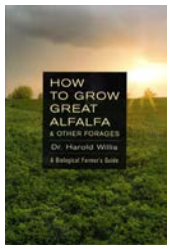
The roller/crimper is surging in popularity as farmers around the world are looking for ways to decrease their need for synthetic inputs and replace them with the nutrients nature can more affordably provide. Written by the inventor of the roller/crimper Jeff Moyer, *Roller/Crimper No-Till* is an expanded update of the groundbreaking work *Organic No-Till Farming*. This book presents farmers with a proven system that limits tillage, reduces labor, cuts toxic inputs and improves soil structure. **#7633 • Softcover • 260 pages • ~~$30.00~~ SALE: $21.00**



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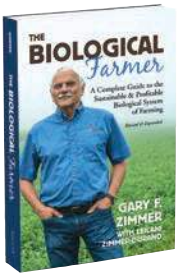

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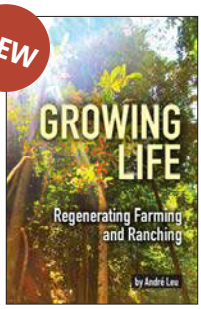

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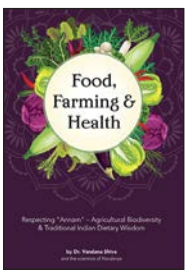
André Leu, author of *The Myths of Safe Pesticides* and *Poisoning Our Children*, writes five chapters that define the regenerative agriculture movement through real tactics farmers and ranchers can use in their operations. In a regenerative farming operation, the mindset involves thinking of our jobs as establishing, and feeding, a natural system that provides healthy, nutritious food and ecological health. This book will finally give a common language to the movement that now spans the globe and promises to revolutionize our agricultural industry. **#7688 • Softcover • 248 pages • ~~$35.00~~ SALE: $24.50**



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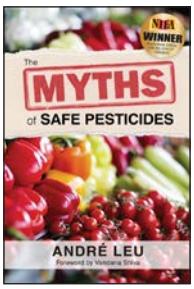

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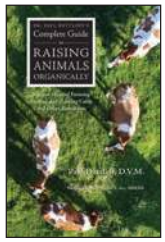

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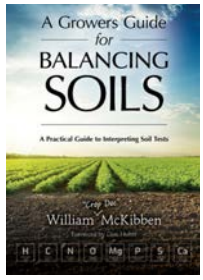

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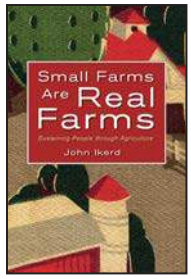
Whether you're a serious home gardener or a full-time farmer, this will help you expand your understanding of the science behind plant nutrition. Drawing on 40 years of experience using the Albrecht philosophy of balancing soils, William McKibben will walk you through a data-driven, time-tested process that starts with soil analysis, but doesn't stop there. With a foreword by Dr. Don Huber. **#7625 • Softcover • 284 pages • ~~$25.00~~ SALE: $17.50**



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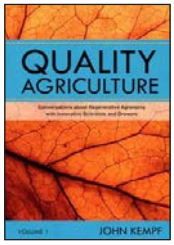

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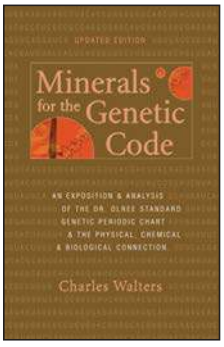

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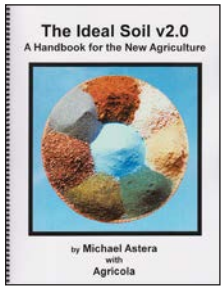

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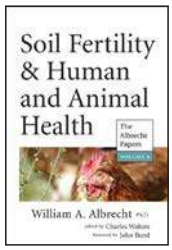

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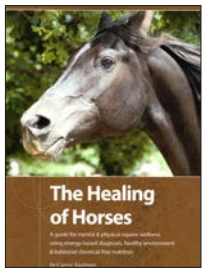

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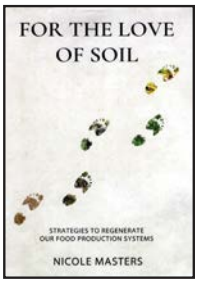

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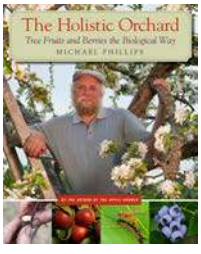

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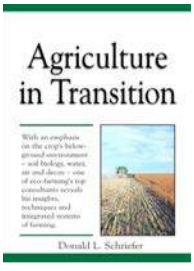
A holistic grower knows that producing healthy fruit is not about manipulating nature, but about supporting a balanced orchard ecosystem. *The Holistic Orchard* provides all the basic information needed to create and maintain a living orchard with insights into design, choosing varieties, and a step-by-step instructional calendar for the entire orchard year. **#7116 • Softcover • 432 pages • ~~$39.95~~ SALE: $27.97**



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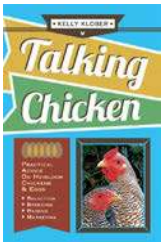

Talking Chicken

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A resurgence of interest in heritage poultry breeds has invigorated poultry raising on family farms. These are the birds that can and should be producing for today's marketplace – for consumers that have come to value locally bred and grown, historically significant agricultural food. **#7067 • Softcover • 396 pages • ~~$28.00~~ SALE: $19.60**

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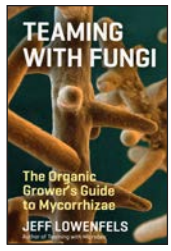

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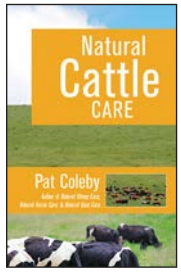

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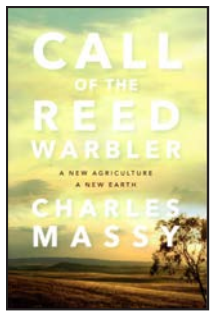

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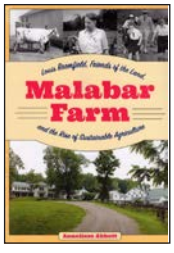

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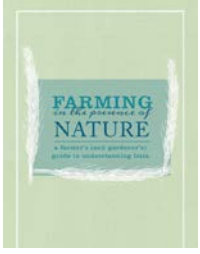

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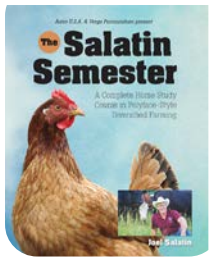

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JILL CLAPPERTON is the principal scientist and CEO of Rhizoterra Inc. and the founder of the Global Food & Farm online community. Jill has decades of experience helping farmers and food companies solve problems. She has a Ph.D. in plant ecophysiology and is a leading researcher in measuring the nutrient density of food, helping farmers to improve soil health through regenerative farming principles.

Rhizoterra Inc. is an international food security consulting company guiding people, organizations and corporations as they create healthy, productive soils that grow nutrient-dense food in a way that honors our farming culture, regenerates arable lands and sustains environmental integrity. In this interview, Dr. Clapperton discusses her work with x-ray fluorescence – a handheld technology that could enable growers to receive real-time information about the nutritional characteristics of the plants they're growing. She also goes in depth on the soil food web and its importance, and how agricultural policy can affect soil health. And she discusses the role of researchers in agricultural progress – how both farmers and scientists can listen to one another and support one another better.

Dr. Jill Clapperton discusses measuring nutrient density, soil health and agronomic research

CREATING A BENEFICIAL Rhizosphere

ACRES U.S.A.: You've done some work with an x-ray fluorescence device to test crops in the field – to help growers know whether their management strategies are working or not. Can you describe your work in this area?

CLAPPERTON: We are going for what you, as a farmer, can measure in the field. It's not that we want to take labs out of business or anything like that. Sometimes you see things in the field and think, "This is X," or, "I think this is a calcium toxicity, or a calcium deficiency."

Well, with a handheld XRF or a handheld instrument, you would be able to say yes or no. Then you would be able to adjust immediately. Whereas if you had to send leaves to a lab, you'd get them back in two days' time. Then you'd adjust. You may have lost some things by then.

I think we've always thought that plants don't require us to be on top of it – like with animal husbandry. But that's not really the case. I think that we do need to have more instantaneous analytics for plants too.

"The microbes are going to make [nutrients] available to the plant, but the plant drives it all. The root exudates are what attract the microbial community to that root."

ACRES U.S.A.: How does the XRF work? How accurate is it compared to lab measurements?

CLAPPERTON: I'm using a Bruker TRACER 5i, but they also make what's called a 5g. The 5g has a graphing window. It makes it more accurate on magnesium. So, on the lower end, what we'll call the lighter metals – magnesium being a lighter metal, sodium being a lighter metal – the TRACER XRF analyzes any minerals from sodium to uranium. It is fully calibratable. In other words, a lot of the other instruments out there have factory calibrations, but this one allows for custom calibration. It's a research instrument. It's every bit the research instrument of a desktop.

That means that you can point and shoot. We do that on twigs, on vines, on tree limbs and things like that. In one pass – set up correctly, with the right voltage and the right amount of current – you can run sodium to zinc in one pass. In anywhere between 30 seconds and 90 seconds, you will have a spectrum that shows you everything that's there in amounts that are measurable.

You'll be able to make a decision. For example, maybe you have no zinc – you're flatlining on zinc. Or you have no copper. Well, then you know that you have some issues that you need to address.

ACRES U.S.A.: Will it show it in all molecular forms? If you have zinc oxide versus zinc sulfide, will it show the total amount of zinc regardless?

CLAPPERTON: It will not show molecular forms. It does total elemental analysis. You could think about it as an atomic analyzer. It analyzes atoms. Let's say you were looking at a fertilizer that was zinc sulfate. You would see a sulfur peak and you would see a zinc peak. You could put two and two together quite easily because of the proportions – that you had zinc sulfate.

It doesn't measure molecules; it measures atoms and elements.

ACRES U.S.A.: But if there was zinc sulfate and there was also zinc oxide, you would get zinc and sulfur – you see the zinc from both molecules – but you don't see oxygen, because the XRF doesn't go down that far on the periodic table, correct?

CLAPPERTON: Right. You'd get zinc and you'd get sulfur. Then, you'd look at that and you'd say, "Well, there is a little extra zinc in there." That would be the zinc from the oxide.

There are calculations you can make. My calibrations give you concentrations. Without the calibrations, you can't get concentrations; all you would see would be the elements that are there. For some people, that's adequate.

You need to calibrate for a matrix. What do I mean by matrix? Soil is a specific matrix. Flower is another matrix. Dried plant leaves are a different matrix. Does the material you're testing look like cookie crumbs? Does it have a high amount of carbon in it? If it's very high in carbon, then that's one matrix. If it's very water-like and it doesn't have any carbon in it, then that's another matrix. If it's liquid, it's another matrix. You end up having quite a lot of calibrations.

It's a very good tool if you're interested in heavy metals, because the TRACER has been used for a very long time in mining. It's also used in art. Every one of the great masters had their own unique black, and their own unique white, and their own unique reds. They are a signature for that particular painter.

Acres U.S.A.: That's fascinating.

CLAPPERTON: That's how this instrument came to be. All the major art museums in the world own TRACERs. They use them to create atomic signatures for their artworks to prevent forgeries, and also in case of theft. Any painting that shows up can be verified as original because it would have the same signature that you would expect for that particular master. The same is true for bronzes. All bronzes are forged unique to that particular bronze artist. So, it's another way to verify bronzes sculptures.

It's been used extensively in archaeology. We now know, for example, with obsidian, which is often used in spear points and arrowheads and knives – we know where all the obsidian mines are in the world, and we've analyzed samples from each of them. The calibration is such that now, if you find an arrowhead and you analyze it on a TRACER, you could actually know what mine it came from. So, you could start to understand the movement of peoples.

And now we've adapted it with the inventor of the Bruker TRACER, Dr. Bruce Kaiser, to agriculture.

ACRES U.S.A.: Is this something that a grower could go out and purchase? Do you sell the calibrations?

CLAPPERTON: I do sell the calibrations, but it's an expensive device. The starting point is $45,000, without any calibration.

ACRES U.S.A.: You can run a lot of plant sap tests and soil tests before you get up to $45,000.

CLAPPERTON: Exactly. So, you'd have to be a co-op or something like that. But I'm working with others to make this more available, or to have other instruments that farmers can use to get after these things. There are a number of optical spectrometers that we think will do molecules – they don't do elements very well, but they do molecules very well – that will probably be able to do this at a much lower price point. We're working on building these instruments, as well as calibrating these instruments, right now.

We believe that growers really need this technology. Not only from the purpose of nutrient density, but also for anti-quality factors. The one thing that we've seen is that spots of rust, or bunts, or smuts, or any of these kinds of things – they have a very different signature than the rest of the leaf. Diagnostics will be available here in the next year or two years that will change the face of agriculture for sure.

ACRES U.S.A.: Could you compare it to a standard soil test that you

got from a different lab? Does it line up that way?

CLAPPERTON: On some things, it does. But it's a total gain. You know how hard it is to get a total phosphorus? There's no such thing. You would use a Bray 1, and then you would use a Bray 2, and then you would hope that the Bray 2 extracted all your phosphorus from your soil. Even the Mehlich and the other ways of extracting phosphorus – they extract it. But XRF gives you a total.

The one objection is that people say, "How do I know it's available?" Well, do a leaf test – your plant is the ultimate authority on what is available in your soil. Your soil test isn't the ultimate authority; your tissue test is. Plants will get what they want. If it's in there, they will get it.

ACRES U.S.A.: Why don't labs use XRF?

CLAPPERTON: Some of them are going to. Even though it's been used in art and archaeology for a very long time, I think what's interesting is the simplicity of some things. Some people think it can't be that good because it's not an automated technology. You don't have an auto sampler, where you can walk away – load the samples in and walk away. I think you could design one easy enough, and I don't think that would be very hard.

But there are some labs that are using them now. They're using them to understand heavy metals primarily. But they're also using them for soil tests. It's a hard thing. Everybody is used to seeing available nutrients, not total elemental analysis. What's available is what the plant sees and what the plant uses. That's what's available in your soil.

I'll give you an example. On a soil test, let's say you get 45 ppm iron, and there will be 60,000 ppm of iron in your soil. Is that really what's available? What is the concentration in your plant? Same with manganese, same with magnesium. Some soils are very rich in magnesium. Is it all available? No. Is some of it available? Yes.

But the plant can leak out acids; it can leak out protons; it can leak out more basic compounds. It can leak out phytates and all sorts of really complicated molecules that will latch onto and chelate things that it needs, and it will keep them in and around the roots so that it can use them.

We're missing out on that. We're saying, "Well, plants aren't very complicated – how would they know?" The truth of the matter is that if you're stuck in one place and you can't move, you've got to be really good at getting what you want. If you can't run away, then you have to defend yourself. So, plants are very good at taking care of themselves. They are way more complicated than a lot of people will give them credit for.

There's often, too, this argument about phosphorus. "How much phosphorus is there in my soil? I have to keep adding it." Do you? How much really is there in your soil? I have seen soils where there's hardly any – where you definitely need to add phosphorus. But I've also seen soils that are in the 6,000-ppm range, where I wouldn't touch phosphorus again for a very long time.

ACRES U.S.A.: So much more of it is the ability of the soil microbes to make that available to the plant.

CLAPPERTON: The microbes are going to make it available to the plant, but the plant drives it all. The root exudates are what attract the microbial community to that root. Just as I talked about with art – that there are these unique chemical signatures – every different plant has a unique carbon signature that is leaked from its roots.

The signature changes a little bit, depending on how the plant's feeling. But that signature is there to attract what the plant needs. The plant will say, "Oh man, something is grazing on my roots right now." So it's going to send different signals down. It's going to move different molecules down. It's going to move other molecules up. That's going to change the whole microbial community, and they might just have to hold the course for a while because they're not going to get fed very much until this whole situation goes away. The plant is also going to send down some really complicated molecules, like flavonoids, and maybe some terpenes, and maybe some isoflavonoids, to try to attract some insect-eating nematodes – to come and parasitize these insect larvae that are grazing on the roots.

The plant might realize, "I've got a disease. Okay, I'll send out signals, because I need some other things. I need to build up my soil Bacillus thuringiensis population because I need some more bacteria in the area to kill root feeders." Plants are sending out signals all the time that modify what they can take up – that modify the microbial and faunal communities around them. But it's always for the same purpose: to exclude the competition and to make a beneficial rhizosphere.

ACRES U.S.A.: That rhizosphere will be different if a plant is surrounded by different plants, correct?

CLAPPERTON: Yes, it will be,

because now, I (the plant) may not like the competition too much. Maybe I don't like my neighbor very much. So maybe now I'm going to send out some signals that say, "Bug off." And I'm going to interfere with your root system a little bit. I might even interfere with you a little bit and make you all stressed. Weeds are very good at doing that – especially weeds that are living in very hard climates – they're very good at excluding the competition.

ACRES U.S.A.: So, they're allelopathic in their own sense.

CLAPPERTON: Yes, but that also means that they need different minerals and nutrients. So, if I have to be super allelopathic, then I'm going to be taking up a whole bunch of trace elements. I'm going to be making out of my root exudates a whole bunch of compounds that will chelate metals and will put them into an organic form so they don't leach away – and also so I can transport them into the roots.

ACRES U.S.A.: So then, in terms of the spectrum of what a farmer should do – should he or she focus more on feeding the soil, feeding the microbes, or feeding the plant?

CLAPPERTON: All of the above. I would say that the plant is going to also drive your microbial and soil biome. The most active microbial area in the soil is in the rooting zone – the rhizosphere. The plant doesn't exist without a rhizosphere of some kind. The better the soil – the more organic the soil, the more organic matter it has, the more diverse the community is – it's going to have more services, and that plant's going to be able to tap into those services. The rhizosphere is a partner. The root, the soil, the soil organisms – they're all connected.

It's the plant that's driving the changes in either one because plants can change soil structure, if they want. Some plants create really soft soil structure; some plants create really hard soil structure. Depending on the conditions, that same plant that you think creates bigger clods may create a very fine soil structure because it's stressed and it needs access to more things. By the same token, when it changes that soil structure, that means that different microbes have access to organic carbon, to nutrients, and to the roots.

It all works together. There's no separating them. They're all feeding off each other. If the microbes have to change – let's say something happens and you get too much water, and the pH changes, and you get inundation, and then the microbial community changes – that's going to affect the plant roots. That's going to change what leaks out of the plant roots. It's going to change how the plant grows, which is going to affect the soil structure. We have to think of the system.

ACRES U.S.A.: Can you speak a bit about oxidation and reduction – redox – in the soil? What does that mean, and why is a reduced environment better than an oxidized one?

CLAPPERTON: Let me explain it more in terms of human health. Oxidation often means that we are having issues – inflammation. It often is associated with inflammation, and not the best metabolism – if we're having too much oxidation. Reduction is a much better situation. We don't have peroxidase.

Plants are the same. Plants that don't have high inflammation are probably working better. When plants have diseases, just like in our own bodies, we tend to see a lot more oxidation.

If we look at the ratio between oxidation and reduction, we can look at the amount of inflammation in the plant, just as we can look at the amount of inflammation in ourselves and in our animals.

That's the key point in all of this. What we're always trying to do is to reduce the amount of inflammation, which means we're trying to reduce the amount of oxidation. Think about rust. What is rust? Oxidation.

ACRES U.S.A.: How do we do that?

CLAPPERTON: Partly by creating diverse plant communities instead of always going to monocultures. We still need to grow food, and we need to have money to do the things that we do – so we need cash crops. But that doesn't mean we can't have companion plants with our cash crops. It doesn't mean we can't grow living mulches with our cash crops. If we can keep the soil covered more, we will have a more reduced environment.

We will also have more pollinators, and we have more beneficial things happening, which means that everything is going to be in a more reduced state and less inflamed.

Now, I'm sure – and this is not my expertise – that there are ways to feed plants that would assist with that. I have more expertise in human supplements than I do with plants. I've always found that with plants, as long as I am putting them into a soil that is on its way up – more organic matter, more diversity of roots – things grow well.

This is where fertilizer comes in – using fertilizers that are in a more organic state. That's why people are using humic acids and finding that the roots respond to that better, as well as mixing a lot of trace elements in. You don't want your iron oxidized; you want it chelated – attached to an organic compound that can be broken off. Then your iron goes into a chemical compound, which can be taken up by the plant.

So, it's all about having things attached to an organic form so that we can recycle them. Think about your soil like a digester, because that's what it's doing – decomposing, digesting. You're getting more organic compounds. Organic compounds are held; they don't leach. Not to the same extent that our more inorganic compounds leach. We don't want things to leach. We want to hold them in the soil so that the plant has access to them when it needs them, and so does the soil microbiome.

ACRES U.S.A.: Changing gears, how do you think changes in our crop insurance program would affect soil health?

CLAPPERTON: That's a loaded question. I have to say that I think crop insurance has been very behind the times.

I understand they are insurance agents, so it's actuarial. They like to have 20 years of data in order to make changes. Well, if we waited for 20 years every time to make a change, of course you'd always be behind the times, because things are changing so fast. We need changes. Well, we've seen that things have changed – like cover crops, for example.

There are a lot of rules with respect to crop insurance that have changed with cover crops. Now we have to change again for companion crops. But we have to understand that those insurance companies and the banks have a risk too. In my opinion, I would like to see them change a little bit and actually start understanding agriculture in a better way.

In other words, if I have an organic soil, my organic matter is higher and my water holding capacity is higher. My cation exchange capacity is higher. I'm a lower risk for failure from drought. I'm a lower risk for failure from flooding. Why don't I get a better rate?

ACRES U.S.A.: And what if there wasn't this safety net, period – how would that affect our growing practices?

CLAPPERTON: I think that, well, some people would fail more. There's no question about it. But some people would thrive, because there's a lot of farmers – especially younger farmers – that are paying off their land, that have bank loans, and the banks simply will not allow them to not have insurance.

This means that they can no longer be creative and innovative. They might be able to experiment on maybe ten acres, which I would recommend they do – to prove out those practices so that they feel comfortable in going ahead without insurance. Or going ahead when they can.

I'd like to see the insurance companies evaluate practices more and have insurance for other practices. What about polyculture or intercropping? You intercrop and you walk away from insurance – but why? Your crop is at less risk. The cash crop is at less risk, and you're intercropping, so if one crop happened to have a real problem, the

other one probably will survive, and you're more than likely to be profitable.

We should support success instead of supporting failure. It's a mindset.

ACRES U.S.A.: Are you optimistic that a lot of these practices are going to be taken up more and more?

CLAPPERTON: I see them being taken up more and more. I remember even ten years ago – you talk about cover crops and people go, "What? What is that? Oh, it'll never work." And now it's like, "So how do I do this cover cropping thing?"

You see the success of some of the cover crop seed companies. And now we're talking about intercropping, and more and more farmers are trying intercropping. Who would have thought that in the last five years?

ACRES U.S.A.: Or 60-inch rows for corn, with something in between.

CLAPPERTON: Exactly! Sunflowers with fava beans and crimson clover in-between them, and the whole ground being completely covered.

ACRES U.S.A.: Right – which is going to do wonders for your soil microbiome.

CLAPPERTON: Think about the farmers that are still using chemical fertilizers. Think about the price of nitrogen right now. You need to grow fava beans. You need to grow legumes in-between your rows, because next year you may not be able to afford nitrogen. Maybe the prices will be high enough that you'll be able to, but then – at how much profit? You're glad that the prices are up, but you're still not going to see that margin because you're going to spend all of it on fertilizer.

This is the time to be really starting to understand intercropping and companion cropping and getting legumes into your system.

ACRES U.S.A.: A farmer who is beginning to transition toward a more regenerative approach – what would be a first step that you would recommend?

CLAPPERTON: Cover crop. Make sure you get a cover crop in. And make sure that you have at least three species. If you really feel that three species is too much, then do two. But never, ever, just grow one.

ACRES U.S.A.: Even in these no-till systems – where you're trying to roll down a rye or a vetch, and you really want to be able to do it without the herbicides?

CLAPPERTON: Even in no-till systems – and everybody knows that I'm a no-till advocate – there's no excuse. We need diversity. I would much rather that, if you're going to roll down, you roll down ryegrass and vetch. Why are you just rolling down ryegrass? Why are you just rolling down vetch? They should be together, and you should be rolling them down together.

And why do you only have ryegrass and vetch? Why don't you have a brassica? Why don't you have an oilseed? Why don't you have something else? Why are you

limiting yourself to two? There's no reason; you just roll down those others.

ACRES U.S.A.: The timing of it would make it challenging, right – to make sure that they're able to die at the same time?

CLAPPERTON: Yes, but do we need them to die? There's some beautiful new technology from Dawn Equipment – they have a between-row mower and a between-row roller. Some of that corn growing with alfalfa? It's fabulous. You roll down or you mow your alfalfa, the corn comes up, and then it shades out the alfalfa and you have this complete cover of alfalfa.

You harvest your corn, then you have the alfalfa crop. And you're getting free nitrogen the whole time. Corn and alfalfa love each other. We have the technology now. People have done the innovation. There's no reason for us to stand down. We need to keep going.

Maybe I'm overly optimistic, but I believe that there's a lot of really creative and innovative people in the world that are trying really hard to make a difference.

ACRES U.S.A.: What research are you working on, and where's the gap? What needs to be done in the future?

CLAPPERTON: I think farmers need to be supported, and they need to be recognized for their creativity and innovation. Too often, I think, as a researcher and a scientist, we dismiss the results on farms.

We know the results are not replicated. Yes, they are kind of anecdotal. But why wouldn't you investigate that and see if there's any merit to it? And then, try and take it further. Farmers don't have time to look into the crystal ball 20 years down the road and say, "I've done this, this is really great. I know I need to take the next steps, but now I need to make more money, so I can be innovative for tomorrow." It should be the researcher's job to take the innovations that the farmers are talking about and take them to the next level. This allows more people who don't want to be innovative and who don't want to take the risk to adopt those practices without the risk.

ACRES U.S.A.: So, the scientific system – the university system – is hampering this.

CLAPPERTON: A lot of times, they're saying, "We don't see that in our research, so it can't be right."

Well, if you have ten farmers showing up and they're all doing the same thing, and they're all doing a whole lot better than everybody else, why are you telling them that the results they have are rubbish? Instead, the answer should be, "Wow, that's amazing! Can we come see? Show us how you're doing that. Come and look at our trials. We must be doing something wrong, because we don't see those things."

A lot of times, researchers are using plot tools, because they have to – they don't have the land to do some of these things farmers are doing. And they're doing replicated trials. And they're doing things in singles, because they have to – because the scientific community dictates that, in a certain way.

I come from a different background. I come more from ecology. And in ecology, there's no such thing as a true rep. I mean, I go into the prairie and where is the true rep? There are no true reps in the prairie. If I set out a transactor, if I set out plots in

the prairie, they are all going to be different.

I have to use a different set of statistics. I am probably less worried about that than somebody who comes from a pure agricultural background in plant breeding and other specialties. They're gonna be like, "What? You didn't do 12 reps? You don't have the power in that task. How can that be right?"

But for me, that's the wrong way to look at it. I don't believe that I'm the authority. I'm learning from farmers every day. And I hope that we are sharing in our learning.

And just as I'm trying not to be close-minded, and they're trying not to be close-minded, we need everybody to try and not be close-minded. To be open to new things. Maybe it does challenge our understanding. I could say, "You know, that's not what I see. This is what I see. But hey, you see this. Let me come and look at that." Just because I don't see the same thing that somebody else does, doesn't mean it's not real. It just means that I haven't seen the same thing.

I will give you a perfect example of that. I worked on earthworms for a very long time in Canada. We had a national project, where everybody on the same day went out and was using a mustard extraction to get earthworms out. We all followed the same recipe. We even used distilled water so that we didn't have any differences in water. We used the same watering can. Everybody used the same thing.

So, everybody in eastern Canada mustard-extracted all the earthworms. We sat there. There was nothing. Here's the film crew, taking pictures of all the people in Lethbridge, Alberta, standing around going, "Wow – did all the earthworms go away today? What is going on? How is this not working?" We were all scratching our heads and going, "Hmm. This is not working very well."

My students thought it was a big failure, and they wanted to change the experiment. I said, "Wait. Stop and think for a minute. How do we figure out what's going on here? Oh, we should dig. Yeah, we should see if they're there."

They were all there. The mustard just didn't bother them. Nothing felt the need to crawl out. They were all fine. And they were all there. There were lots of earthworms. They were just totally unaffected by the mustard. Probably something in our soils was de-activating the compound that caused them to be irritated and come out. Soap worked fine. We had no problem with dish soap or hand soap. But when it came to mustard, it didn't work at all. Maybe it's because we've put all our mustards on all those soils and the earthworms have adapted to it. I don't know.

But when we reported the paper, there were a lot of scientific reviewers who said that that was not possible. It had to have worked. It works everywhere else in the world. You didn't do enough reps. You didn't do it right. You did something wrong.

Actually, no – we all did it exactly the same, and in these soils, it doesn't work. Why should one size fit everyone? It doesn't.

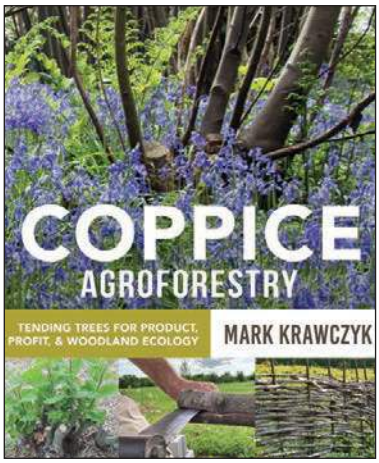
So, that's what I'm saying – researchers can oftentimes, like everybody else, be really close-minded. They should be saying, "That's not my experience, but it's yours. How about I come and have a look at that and just see what it looks like? Maybe you can come and look at my experiments and talk to me about what we're doing?"

In the end, everybody now starts collaborating and getting a lot further along. This is about sharing. We need to share and collaborate.

Interview by Paul Meyer, editor of Acres U.S.A.

Call the Coppice

REVIEW BY PAUL MEYER



Coppice Agroforestry

Tending Trees for Product, Profit, and Woodland Ecology

By Mark Krawczyk

It's easy to take for granted all the things trees provide us. Consider just a few from the list Mark Krawczyk compiles in his introduction to *Coppice Agroforestry: building materials, shade, fuel, food, erosion control, climate stabilization, water cycling, wildlife habitat, medicine, air filtration.* Not to mention beauty and inspiration.

Coppicing is the practice of growing a tree – which begins life with a single trunk – and then, several years later, cutting it at its base while the tree is dormant and allowing it to sprout a number of new poles. Some years later these poles are harvested, again at the stump, during the winter, and the stump is allowed to again put out sprouts – the process continuing in a decades- or centuries-long cycle. Researchers have shown that coppicing can actually increase the lifespan of a tree by a factor of three or more.

The significance of coppicing is that it is basically a self-maintaining system – producing wood for many of the above-mentioned purposes over and over. The only human requirement, besides harvesting, is patience. And human interaction is beneficial for the tree as well.

Krawczyk goes into great detail on the science behind coppicing – how, after disturbance, trees are able to produce new sprouts from preventitious (dormant) buds that are embedded beneath their bark. The book also discusses the related phenomenon of suckering (the practice of trees like cherry and locust to produce new shoots from their roots) and the associated technique of pollarding (like coppicing, but the cuts are further up the trunk of the tree instead of near the ground, in order to keep the new sprouts out of reach of livestock).

Yet apart from its incidental practice when roadcrews try in vain to keep trees from invading the sides of highways, coppicing is rarely practiced in the U.S. today. In fact, it is a practice that European settlers never established here in the New World. In the Old World, where resources were much more scarce and costly, a practice like coppicing made sense. It required relatively little effort and was a local, renewable resource for building homes, constructing fences, providing heat, making tools and much more.

▲Pollarded willow trees in the Netherlands. *Stock photo by Canva.*

But here in America there were plenty of existing resources. Then, once coal and oil began to be used, the need for wood naturally declined.

Krawczyk makes the case for a renewal of coppicing, although he rightly recognizes that it's not the right tool for all of our problems. There are healthy and productive forests that would be poor candidates for coppice conversion. Pine, which makes up much of our managed forests, generally does not coppice (although there are some forms of resprouting that could be used to manage coniferous plantations). And steel and plastic have of course become preferred materials for many modern buildings, vehicles and other products.

There surely is a place for coppicing, though. Rot-resistant locust and other species can be coppiced for the production of fence posts. Coppicing can be an important way to produce biomass for industrial use. It can be a used to grow material for furniture making and other crafts. And on the community/homestead scale, in otherwise unproductive or low-grade forests, it can be a very useful technique for wood production.

This book is a project that took author Mark Krawczyk over a decade of his life to write. It is thorough – encompassing nearly 550 pages – and while it may be a bit too much information (and too pricy) for the casual reader, for anyone interested in developing a sustainable community-level agroforestry system it will certainly be an invaluable resource. •••

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After harvest, we want to keep our lands covered. Yet, cover cropping takes an understanding just like any other cash crop, so we share expertise on ground cover in this issue.
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Equipment for soil health systems depend on minimal disturbance and a dependence on equipment to plant seeds, harvest crops and spread fertilizer in smart ways.
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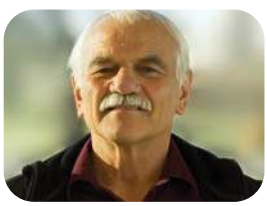

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PICTURES FROM THE 2021 ON-FARM INTENSIVE

SOIL HEALTH EVENTS

IN-PERSON

Weed Control Strategies in Organic Corn and Soybeans. August 2. Harlan, IA. Organic weed control strategies using Buffalo Ridge-Tillage cultivators and planters. *practicalfarmers.org*

4th Annual Healthy Soil Summit. August 2-3. Sacramento, CA. The annual Healthy Soil Summit gathers growers and experts around education of sustainable soil health management systems. *soil.acresusa.com*

On-Farm Intensive with Zimmer Ag. August 22-23. Lone Rock, WI. Join Gary Zimmer and Leilani Zimmer-Durand for an educational journey on the famous Otter Creek Organic Farm. *onfarm.acresusa.com*

Midwest Mechanical Weed Control Field Day. September 14. Benton Harbor, MI. A field day featuring the latest in weed control equipment and techniques for organic farms. *thelandconnection.org*

Agroforestry Field Day. September 14. Maxwell, IA. Learn about Bruce Carney's agroforestry system and about a new calculator to help determine profitability factoring in permanent conservation tax incentives. *silt.org*

2022 Common Ground Country Fair. September 23-25. Unity, ME. The Common Ground Fair is an annual celebration of rural living, held the third weekend after Labor Day. *mofga.org/the-fair*

Regenerative Healthcare Conference. October 16-19. Kutztown, PA. This conference is the first of its kind in the world and aims to connect soil health with human health. *rodaleinstitute.org/regenerative-healthcare-conference*

Southeast Organic Center Field Day. October 26. Chattahoochee Hills, GA. Tour the Southeast Organic Center farm and research facilities, meet our regional farm consultants, and hear from guest speakers and panelists about all things organic. *rodaleinstitute.org/events/southeast-organic-center-field-day-2022*

11th Annual Soil & Nutrition Conference. Dec. 3-4. By the Bionutrient Food Association. *bionutrient.org*

Eco-Ag Conference & Trade Show. Dec. 6-9. Covington, KY. Celebrate 51 years of *Acres U.S.A.* by joining hundreds of farmers, ranchers and industry professionals who are actively improving their operations with a 360-degree approach. *ecoag.acresusa.com*

VIRTUAL

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"Paddock grazing and cover crops have put me in intimate contact with my soil." — Curt Sayles

Meet an Eco-Farmer

CSF Farm • Seibert, Colorado

Why did you begin farming?
After a stint working in the oil industry post college, I got a chance to return to the family farm. I did not like living in the city and longed for country life. I also realized that to achieve the financial independence I wanted, I'd have to be my "own boss." Farming provided that opportunity.

What do you most enjoy about farming?
Our move to regenerative agriculture has made farming fun again. I enjoy the financial freedom provided by moving away from commercial chemicals and fertilizer. Paddock grazing and cover crops have put me in intimate contact with my soil. It's fun to ask, "What life are we going stimulate today?" instead of, "What are we going to kill?"

What is your biggest current challenge?
Our biggest challenge is an arid climate and erratic precipitation. Moisture makes regenerative principle easier to achieve.

What is the best piece of advice you ever received about farming?
My father-in-law, who was a dairyman, once commented how the monthly milk check had allowed him to address debt and increase his success. This made us seriously reconsider fallow in our rotation (a common practice in our area). Shortly after that we went to continuous-crop no-till. It's still a rare model in our part of the world. Every acre works for us every year. This reduces risk and normalizes our cashflow.

Farm Profile

Farm name: *CSF Farms*
Farm location: *Seibert, Colorado*
Names of farmers: *Curt and Kerry Sayles, Patrick and Morgan Einspahr, Audrey Sayles*
Farm size: *5,000 acres*
Year established: *1987*
Products: *Grains (all dryland): cereal rye, corn, sunflower, millets, safflower, oats, chickpeas, buckwheat, field peas and flax; livestock: grass-fed beef, fed pigs grazed on cover crops*
Farm contact: *csffarms.com*

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