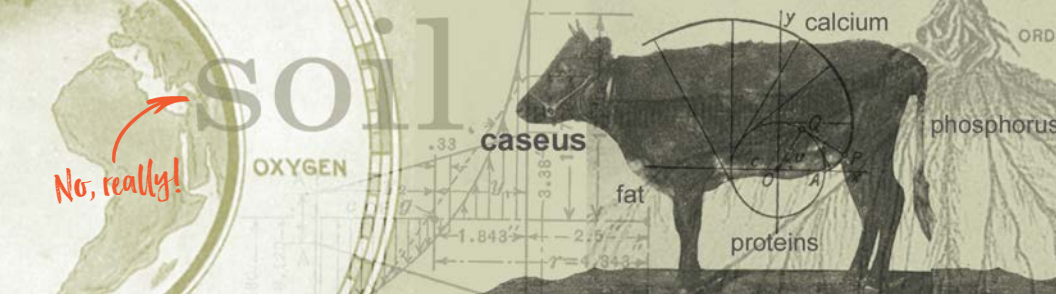

SLOW MONEY

JOURNAL

WINTER 2017/18

It's time for more of us to put our hands into the soil. The actual soil and the metaphorical soil. The soil of a restorative economy—an economy built less on extraction, consumption, and wealth, and more on preservation, restoration, and health.

—Woody Tasch,
SOIL/2017: Notes Towards the Theory and Practice of Nurture Capital

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Slow Money Journal is published once per annum by the Slow Money Institute, a nonprofit dedicated to catalyzing the flow of capital to local food systems, connecting investors to the places where they live, and promoting new principles of fiduciary responsibility that bring money back down to earth. Dozens of Slow Money local networks and investment clubs across the United States, Canada, and France have catalyzed the flow of more than $57 million to over 625 small food enterprises since 2010. The *Journal* aims to capture the voices of this process—local leaders, organic farmers, food entrepreneurs, thought leaders, donors, and investors. For more information, go to www.slowmoney.org or email Michael Bartner at michael@slowmoney.org.

OPENING LETTER

Dear Slow Money Friends:

It wasn't just a cute turn of phrase when Thomas Jefferson said, "Cultivators of the earth are the most valuable of citizens." Or when FDR said, "A nation that destroys its soil, destroys itself." Or when Paul Newman said, "In life, we need to be a little like the farmer, who puts back into the soil what he takes out."

We need to rediscover our roots, our common sense, and all that soil means—both as the foundation of living systems and as a litmus of our cultural health.

We've collected here a number of stories from farmers, food entrepreneurs, and investors who are part of the Slow Money community. We've also pulled together excerpts from the published works of several important thought leaders whose focus on soil inspires so many: Sir Albert Howard, William Bryant Logan, and Courtney White.

We who are involved in this work often talk of bringing our money back down to earth. What could be simpler? Yet we live in an age in which the simple has been made complicated and the complicated has been made simple.

Pushing the power button on your computer, simple. Having an authentic conversation with your neighbor, complicated. Buying a bag of potato chips, simple. Growing potatoes in your front yard, complicated. Owning a diversified portfolio of gold stocks, simple. Making a loan to a farmer down the road, complicated.

We need new, more pragmatic ways to see things as a whole, and to act accordingly.

That's what bunches of us have been working at—in very small ways—since 2009, in tents, barns, theaters, performing arts centers, farmers' markets, restaurants, and other gathering spots in scores of communities around the country (and a few in Canada, France, and Australia), under the loose banner of Slow Money. Yes, we're looking for ways to put a little of our money into local food systems, and more than $57 million has gone to more than 625 small, organic food enterprises. But what is driving us

forward is something more, something that has to do with beauty, hope, health, and peace.

Sincerely,
Woody Tasch

Woody Tasch is founder of the Slow Money Institute. He is the author of SOIL/2017: Notes Towards the Theory and Practice of Nurture Capital *(Slow Money Institute, 2017) and* Inquiries into the Nature of Slow Money: Investing as if Food, Farms, and Fertility Mattered *(Chelsea Green, 2008).*

INTERVIEWS

Daphne Miller, John-Paul Maxfield and Jeff Moyer contribute their voices to a new conversation about food, money and the soil. Daphne, a practicing family physician, presents us with the links between soil health and the health of the people who eat from that soil. John-Paul started off selling organic compost, but now sees an opportunity to leverage new technology to improve alternative food systems. Jeff, with his 30 years of experience at the Rodale Institute, brings a farmer's perspective and approach to issues in organic agriculture.

Daphne Miller

Daphne Miller, MD, (Brown University; Harvard Medical School), is a practicing family physician, author, and associate clinical professor at the University of California San Francisco. For the past 15 years, her leadership, advocacy, and writing have focused on aligning all aspects of food production and agriculture with human health. Daphne is the author of two acclaimed books: The Jungle Effect: The Healthiest Diets from around the World—Why They Work and How to Make Them Work for You *(William Morrow, 2009), and* Farmacology: Total Health from the Ground Up *(William Morrow, 2013). In 2000, Miller founded WholeFamilyMD, the first integrative primary care practice in San Francisco.*

These days I'm focused on the true cost of food. We have the cheapest food in the world. Food purchases make up something like 8% of our GDP. But when you start to factor in all the chronic diseases and environmental impacts—the health footprint of food—then all of a sudden we have the most expensive food in the world. Not 8% but 25% or higher. How is it we have something that is so cheap but so expensive?

Q: How do we tackle this?

It's clear to me that we need to start with the soil. It's a vertical process. The businesses that are putting food on our table must have an

interest in the soil. Their financial return has to be linked back, somehow, to the substrate of the soil. Any consumer goods company that isn't thinking about the ecosystem in which the food is produced isn't going to produce healthier food. We can slightly unprocess this or that, but unless we start thinking about the soil, we're not going to get the shift we need. Farm policy is one shift we need, but the other is to shift the way the food companies do their business. And we need to change our understanding of health.

Q: How does this affect your medical practice?

People are getting so sick because they aren't connected to a healthy food system. Medicine is putting out fires, it gets to people way too late. We need to work upstream, outside the medical model.

Q: When you say this, what's the response of your colleagues in the medical community?

I don't get invited much to medical meetings. I hear more from farmers. Most doctors who pay attention to food focus just on a narrow definition of nutrition, on the broccoli, but not on where the broccoli comes from, how it was grown. They treat food like a drug, a pill, an ingredient. Broader impacts of how food is grown are not sufficiently evidence-based from their perspective. There aren't good studies linking soil DNA to human DNA. To most doctors, soil is a subject for agronomists. But, to my thinking, health starts with the influence of the ecosystem in which we grow our food. Unfortunately, there is more research into the negative effects of toxins—for instance, whether glyphosates are carcinogenic—than there is into the health-promoting effects of ecosystems. An ecosystems approach seems too theoretical to most doctors.

Q: When you put it that way, it does seem a long way from ecological-systems thinking to specific health-care interventions.

What is guiding me is my own experience, not a polemical approach. I'm not trying to draw some grand conclusion. My experience leads me to a systems view of the interconnectedness of all things. I focus on relationships. In an

ecosystem, everything is speaking to everything else. Scientists tend to think in terms of bidirectional arrows and business people in terms of flow charts. Even some of the ideas about ecosystems services, about monetizing the value that ecosystems provide to the economy, slip into linear thinking. The minute you put a monetary value on something in nature you are reducing things to linear calculations of cost effectiveness. You start looking for the most-effective gene deletion, the one organism you are trying to kill, the one drug that will be most effective.

Q: One of our active Slow Money folks—Marco Vangelisti—speaks to the challenges of valuing ecosystem services, giving the example of a living tree that we don't know how to value until we've cut it down and turned it into 2 × 4s.

A farm is growing carrots. You could value it as pounds of beta-carotene per acre. You could determine that *x* amount of beta-carotene delivers *y* amount of nutrients. You could measure the amount of organophosphate-poisoning costs incurred or avoided. Or what about the amount of lung disease in chicken farmers? These are particular impacts that can be measured. But how the heck are you ever going to measure and value the health impacts of a whole, healthy, sustainable farm? That is what I'd like us to wrap our brains around. Nutrient value, invisible influences from the microbial conversations, clean air and water, the economic health of the local community, absence of poisons, biodiversity, and long-term increases in productivity and yield. It's crazy that we don't have a better way to pay for success in farming. Why can't we create good financial returns for investors who support farmers who are farming the right way?

Q: Now you are getting into a whole other field. It's complicated enough linking medicine with ecosystems, and now you want to throw in economics too?

That's where my thinking is going. To the money. We'll pay to have a foot amputated, but we won't pay to maintain hiking trails and get diabetic people walking them. If somehow the cost savings of the foot amputation could be factored in, then everyone would be investing in hiking trails.

Q: Who is "everyone?" Society as a whole? Individual investors who live near the hiking trails? The problem is that investing in prevention is a tough thing to do. Monetizing prevention is challenging. As Wendell Berry and others point out, there's more money to be made treating disease after it occurs than in preventing that disease. It's a kind of corollary to the observation that war is good for the economy.

Why couldn't there be a mutual fund that makes money on preventing diabetes? You'd invest in companies that share in the savings of preventing the disease. You know, you get 20% of the avoided health-care costs from building those hiking trails. Why can't we invest like this?

Q: That gets back to that whole other discussion about economics and finance and markets. They are structured around efficiency and technological innovation and industrialization and globalization. It's not realistic to think you are going to make just as much money farming sustainably and providing services that reduce the incidence of disease as you can make privatizing space travel and accelerating the flow of capital through computer algorithms.

I don't know, but I do want to keep asking these kinds of questions. We need to work on upstream interventions. Just working with individuals who are accessing a medical clinic is not the place for effective interventions. For most . . . health-care professionals, a population is the people who walk in the front door of your clinic. We need to think more in terms of communities, zip codes, and regions. We need to work on the level of communities and systems.

Q: I can't help but ask: Don't you mean "downsoil" instead of "upstream?"

Hah! Of course. That's why I talk so much in my book about soil. It's where everything begins. The carbon, nitrogen, and every mineral and vitamin that is a building block in our own bodies is derived from soil. The nutrient exchange between soil, microbe, and plant is similar to what takes place in our own intestines. Diversity of microbiota is key to health.

Q: This makes me think of the controversy about raw milk. When you first hear critiques of pasteurization and homogenization, they sound wildly heretical and even a bit crazy. But then when you think about it some more, you realize that pasteurization is about killing life in the milk and homogenization is about marketing, not health. I know this is still a very hot issue in many circles, but there is an intuitive level on which ultra-pasteurization of milk seems akin to what I might call *ultra-fiduciarization* of money. You know, we sanitize and commoditize our investments just like we sanitize and commoditize our food.

The raw milk issue is so interesting because there is nothing that horrifies a microbiologist or physician more than someone making even a neutral statement about raw milk. It's on par with sharing a needle with an infected person. So, it was compelling for me to learn about Erika von Mutius's research. She looks at low rates of autoimmune disease among farm kids. She finds that raw milk is one of the factors. She publishes frequently in European journals about this. . . . When it came to . . . publishing . . . in the United States, in the *New England Journal of Medicine*, and reporting the results of her research into lower rates of allergies and asthma of farm kids in Bavaria, she didn't include raw milk in the article. My guess is the *Journal* never would have published Mutius's work if she had included raw milk.

There's a very strong bias against this topic here in the United States. We go on tirades about the evils of raw milk. But so many more people's lives are hurt by diabetes. There are something like 30 million people in United States with diabetes. It's astounding. We know what causes it. No mystery. Most of it is processed sugar. Now, let's Google the number of people sickened by raw milk in the United States every year—1% of milk consumed in the United States is raw—and of course, this isn't an apples-to-apples comparison, because I don't know the number of people who drink raw milk, but still, let's see: 121 outbreaks of illness related to raw milk in the United States from 1993 to 2006. Overall, 1,500 people were sickened and there were two deaths in 13 years . . . versus 10% of our population dealing with diabetes. Way more people become ill or die from ingesting processed sugar. If you go to the Centers for Disease Control website you'll see very strong language saying in no uncertain terms that raw milk is evil, but they don't even have a page about processed sugar. We should be having an open discussion about this.

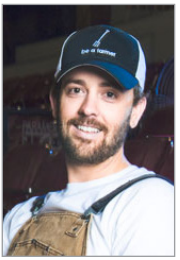
Q: Measuring who gets sick from raw milk is one thing; it's another to consider the health benefits to people and cows and ecosystems. So how do you measure health? Does this have to be a dollar value? A measure of disease incidence and treatment costs? Is there another way to show the value?

Isn't that why some communities create alternative currencies? They are trying to value things in a way money typically doesn't. Some things can be quantified and some can't, even though they are obvious. Community. Less cancer and less suffering. More resilience in the face of disasters. There are folks beginning to measure factors that increase community resilience in times of natural disasters and war.

Q: We've come a long way from the true cost of food, haven't we?

I guess so. But Americans are going to fall into two camps when all is said and done: People who buy cheap goods, regardless of quality, versus people who are willing and able to pay for things that are made with integrity. We are seeing the limits of the "buying cheap crap" approach. Consumer demand is changing to some degree. It's good to see Slow Money working on the investor side of things.

John-Paul Maxfield



John-Paul Maxfield founded Waste Farmers in 2009, with $9,000 and a belief that idealism and capitalism can coexist. Waste Farmers has evolved into an innovator respected by leaders in the global community for developing simple solutions to the complex problems of modern agriculture and food security. In 2007, the Colorado Statesman *selected John-Paul as one of its "Fifty for the Future," and the* Denver Business Journal *in 2011 chose him as one of its "40 under 40." In 2011, Denver Mayor Michael Hancock's administration appointed John-Paul to serve on the Denver Seeds initiative, a strategy to support small businesses, create jobs, and shift food production away from large out-of-state industrial operations toward local growers.*

Q: What made you go into the soil business?

I started with the desire to push toward a more sustainable food system. Soil is the place to start. We saw an opportunity to innovate around products and technology that reconnect people to soil. Long term, we want to be an agricultural innovation company.

Q: Soil seems like a funny place to start with innovation . . . as basic as it can be.

Soil is incredibly complex. Just as with the human microbiome project, there is so much we have yet to discover. If we want to fix climate change, the answer is literally right beneath our feet. Da Vinci had it right when he said we understand the movements of the heavens better than we understand what is happening underfoot. We understand the soil at an intuitive level but not at a practical level.

Q: What do you mean by the "intuitive level"?

It's the place where all life comes from and to which it returns. We all pretty much know this. It's not an accident that kids gravitate toward playing in the dirt.

Q: What do you mean by the "practical level"?

We need greater understanding of how to work with soil to achieve broader goals of feeding people without destroying humanity's ability to continue living on the planet.

Q: So, what was the first thing you did as an entrepreneur?

I was working in private equity, but I was a square peg in a round hole. I'd always admired my grandfather. We'd drive along I-25 to go visit my grandparents in Wyoming, looking at corn fields as we went. My great-grandfather was the largest sheep producer in the country, pre-WWI. He lost everything in the Great Depression. My grandfather had feedlots and corn farms and had one of the largest livestock-sale barns in the country. It was not a mom-and-pop operation. It was vertically integrated. He was a tough old cowboy. My father and brothers sold the operation to their employees back in the '90s. Torrington Livestock is based in Torrington, Wyoming. But I hope that, if he were here now, he'd recognize the need to redesign the food system.

Q: Do you mean he was a smart businessperson for his time, and now a smart businessperson in agriculture would be looking in a very different direction?

Yes. There is a new agricultural story to be told. The idea that, as standards of living rise, people demand more meat. As economies grow, demand for agricultural production increases. So, we've been told a story that food has to be industrialized in mega-farms. But just think about what happened with computers. Someone once said, "There's a market for only five computers." They were imagining roomfuls of computer consoles in the home. Technological advances brought desktops and chips and mobile devices and the Internet. The same thing is going to happen with food. Just as computers became personalized, advances in renewable energy and information will enable more-personalized forms of food production. Personalized systems of food production are going to be integrated into urban living systems in ways we are just beginning to imagine.

Q: What are personalized food systems in the city going to look like?

I'm afraid to say this in a Slow Money discussion, because. . .

Q: Go for it.

Industrial ag is about control. Trying to manipulate the plant so that it operates in certain ways. Controlled environment is not about controlling the plant, but controlling the environment. With advances in technology, management of complexity will improve. So I've got this tension. I want to connect people to the soil, but I also want to change mindsets about what's possible with new technology. We started off selling soil products that help people grow at home. Our products are made from organic sources, inoculated with microorganisms. We sell 1-cubic-foot bags of potting soil and soil conditioner. This is a way of boosting fertility to make entry into home-growing easier. But we want to do more. We want to solve some of the other hurdles to growing at home—knowledge and time.

Q: You started off near Denver in a dense suburb. What did you project?

The food gardening market is a $2 billion market. Seeds, soils, fertilizers, tools. It has grown tremendously. The National Gardening Association reported that the number of households gardening grew 17% from 2008 to 2013. Tens of millions of households. We can see that there is growing enthusiasm, but this enthusiasm can go only so far if it is not matched with know-how. The U.N. [United Nations] says that home gardens can be 10 times more productive, in terms of human nutrition, per unit of land as compared with commercial farms. Twelve crops make up 75% of our diet and they are mostly cereal crops, but there are 80,000 edible varieties of plants. There is opportunity to feed people better by encouraging production at the home level.

Q: Are you talking about vertical farms in the city?

Yes, as a step on the journey, just like we had to go from mainframes to desktops on our way to mobile devices.

Q: So, in that scheme, what is the "home production" equivalent of a mobile device?

Automated systems run through connected gardens, with an operating system that monitors soil conditions, personalized nutrition, light, water, pests. These systems would be a major leap forward for the home grower. There's a whole other issue as well, and that's employment. As jobs are lost to automation, devoting more time to home growing and urban small-scale gardens will make sense for more people. Way down the line, if you really want me to go for it, I'd say that we'll need to re-wild the big industrial farms and sequester the damage they are causing.

Q: But aren't you substituting mechanical complexity for the complexity of a farmer's know-how? But don't even answer this . . . I don't know how to even respond to conjectures that are this bold.

We have a project called Beyond 12, which is exploring different plants that would expand the repertoire for home growers and controlled-environment agriculture.

Q: And to think that I thought of you as a high-functioning Luddite with a good mind for marketing.

I am a Luddite in the sense that I believe that so many of the climate and ag issues we are facing are a result of our perceived human need to continue to innovate. I started the company as an homage to Wendell Berry. This is still where my heart is. Decentralizing our food systems, either by shift of consciousness or technological innovation, is central (Hah!).

Q: There's a lot to discuss about appropriate scale. Wendell Berry once said—in the early days of a start-up called Farmers' Diner, which had a very ambitious rollout strategy for a series of diners that sourced locally and organically—"What will make Farmers' Diner remarkable is knowing when to stop."

Yes, but there is also tremendous urgency. I'm imagining that we, and others like us, have the opportunity to grow into a major company. There is not an ounce of innovation going toward alternative food systems because

the companies that are on top are shifting attention toward creating a slightly better version of what we have now. Like creating more fuel-efficient cars instead of going toward electric vehicles. We need alternative food systems. A whole new kind of ag tech. Not drones and precision agriculture to drive remotely over vast swaths of land, but to grow more diverse things in an urban context.

Maxfield's products

Q: But you are still starting with soil. So, tell me more about your soil.

We began in 2009, collecting and composting food waste in Arvada, Colorado. Next, we started aggregating and mixing feedstock materials and bagging soil products. We thought of it as a "microbe brewery." We sold through local nurseries and hardware stores. Then we got into Whole Foods and Lowe's in the region. We got noticed with a few local awards.

Q: What do you think earned you those awards?

We are telling a story that inspires people. Rebuilding soil is a basic story of hope. It goes back to that intuitive level. At the same time, we found that providing hydroponic solutions to the cannabis industry was profitable.

This is Colorado, after all. I see cannabis as a gateway drug to more farming. I watch cannabis growers getting excited about mycorrhizal fungi. One of the more successful greenhouse tomato growers I know got his start with cannabis. So, we've developed products for the cannabis industry.

Our initial funding was friends and family, then angel investors. Now, we are in this perilous place where our growth requires a larger infusion. We're shooting to grow to tens of millions of dollars in sales over the next five years. At that point, we'll be a national company.

Q: Most of the folks who are involved with Slow Money are not going to have an initially positive reaction to your impulse to go national.

I know. I share that. I feel a strong creative tension between the goal of decentralizing and deindustrializing our food supply, on the one hand, and the urgency of the environmental issues that we have to address, on the other hand. We need to catalyze mass change.

Q: This is like folks telling me we need slow money . . . quickly. But let's get back to the soil. Tell me what's in it.

We mix biochar from pine-beetle kill, coconut husk, alfalfa meal, compost, and other such ingredients. At our original location near Denver, Colorado, we had a 14,000-square-foot yard and warehouse, where we produced our mixes. We were moving thousands of units a year. Now, at our new location in Western Colorado, we are moving hundreds of thousands of units. We've doubled each of the last few years. We're evolving into a company that can create a range of products and systems to significantly expand small-scale, diversified urban food systems. It's gratifying to create an organic starting point for people to bring food production home again.

Jeff Moyer

Jeff Moyer is a world-renowned authority in organic agriculture. His expertise includes organic crop production systems with a focus on weed management, cover crops, crop rotations, equipment modification, and facilities design. Jeff perhaps is 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 (Acres U.S.A, 2011)*, which has become a resource for farmers throughout the world. In 2015, Jeff was appointed as executive director of Rodale Institute after spending the last four decades at the Institute, helping countless farmers make the transition from conventional, chemical-based farming to using organic methods.*

Jeff, before we begin, I want to thank you for the images of the jars of water, one with soil rich in organic matter and one with the dissolved murkiness of soil that is deficient in carbon. Ever since you showed those images during a public talk a decade or so ago, the comparison has stuck with me.

Q: You've been at no-till and organic farming for decades. Do you see attitudes toward the health of the soil changing?

What's exciting is that you can't go to a farmer meeting anywhere around the world today and not find the conversation centered around soil health. Previously, people talked about soil quality. But the problem with the term,

"quality," is it can apply to a watch or a car, but you don't have a *healthy* watch or *healthy* car because they aren't alive. So, once you assign the term health to the soil, you make it clear that it is alive. Now, we can go to work to improve the health of soil. You can impact its dynamic state of being. Farmers are really beginning to embrace this.

Q: Lately, the terms "regenerative agriculture" and "carbon farming" have been gaining traction. Do they affect the way you are talking about things?

These terms represent fundamental shifts. It's no longer about conservation. Robert Rodale coined the term "regenerative agriculture" decades ago. He knew that being organic isn't good enough. You can farm organically and not improve the health of the soil or take care of animal welfare issues or workers' rights. Farming regeneratively means taking into account all of these parts of the larger context.

The national organic standards had difficulty incorporating the concepts of continuous improvement. But this is key—improving the resource while you are using it. If you take care of the soil, it will improve over time while you are farming it.

Q: Is no-till farming key to regenerative agriculture?

The more we reduce tillage, the better it is for the life in the soil. If you are an earthworm, tillage day is not a good day. Unfortunately, many organic farmers till the soil too much. It's one of the tools for managing weeds, but it gets overused.

Q: Any epiphanies along the way?

My constant epiphany is that because soil health is based on biology, improving soil health works and is amazing to watch. Everybody says at first, "It won't work here." But when they try it, it works. . . . Soil health impacts crop yields. As soil regenerates, the way it interacts with water changes. The resilience of crops and soil to climate change is dramatically improved and you see it in yields.

Q: What is next for Rodale?

When we started, everyone said organics was a gardening tool, not a farming tool. Couldn't be done at scale. When we demonstrated that you can farm organically at scale, people said, OK, but it doesn't really address the question of soil health. Then, OK, we can see the impact of soil health, but what about the impact on food and nutrition? So, now we're looking at proteins, amino acids, and all the factors that influence nutrients in food. Soil fungi are more prevalent in organic systems, and this may have demonstrable effects on human nutrition and fighting disease. This is a next frontier: the links between soil health and human health.

REPORTS FROM THE FIELD

The boundaries between transactions and relationships are rich with possibility. Each person brings money down to earth in their own way. Daniela Ibarra-Howell (Boulder, CO) affords us a glimpse of the progress at the Savory Institute. Esther Park (San Francisco, CA) assesses the state of the impact investing field. Glynn Lloyd (Boston, MA) shares his experience bringing urban farming to Boston. Jesse McDougall (Shaftsbury, VT) reflects on his journey transitioning conventional farmland to organic production. Erika Allen (Chicago, IL) reports on her efforts to divert food waste in Milwaukee and Chicago. Seth Itzkan, Karl Thidemann and Bill McKibben describe how we can use soil to fight climate change.

Scaling Global Solutions Is a Local Proposition

BY DANIELA IBARRA-HOWELL

For many years, agriculture—or the production of food and fiber—has resulted in the massive degradation of billions of acres of land worldwide. Now, the same industry finally has been acknowledged as having the unique ability to sequester carbon through the improvement of soils, representing a viable and *promising* global solution to climate change.

Grasslands occupy 30% of the world's land surface. Their deep soils have the capacity to store substantial amounts of carbon. Grasslands are degrading at an alarming rate, however, and until now they largely have been ignored in the climate agendas. Loss of grasslands leads not only to climate change, but to floods, droughts, famine, and worldwide poverty. The Holistic Management of grasslands and livestock has been proven key to restoring land, boosting soil fertility, mitigating floods, enhancing drought resilience, increasing the nutritional value of food, and restoring

wildlife habitat—and it simultaneously sequesters carbon. Additionally, the one billion people who live on and derive livelihoods from grasslands, as well as livestock, can increase their well-being in the process of saving the planet. All of us—including consumers—can accelerate this shift in agriculture toward a regenerative model via informed purchasing decisions. How can we accomplish this monumental task? Read on.

Local Not Only Matters, It Is the Only One Reality

Can a local leader run a profitable livestock business, heal the land, and change the world for the better? The answer is absolutely "Yes," no doubt. I just returned from White Oak Pastures (WOP) in Bluffton, Georgia. My mentor, friend, and leader—holistic farmer Will Harris—owns and runs WOP. Will is well-known in the regenerative ag space.

What differentiates WOP is that not only is the land regenerating under Will's management, but a whole town has been revived. Will's farm also is solidly profitable. What is most important to his enduring success? According to Will it is resilience. He has succeeded at combining land and livestock management, has achieved business success, and has created social wealth in a model that has integrity and should be replicated. Will has moved from the

Will Harris

extractive model of industrial agriculture that has defined the "success" and profitability of farmers for the past 50-plus years (with incredibly negative, unintended consequences via the liquidation of ecological and social capital), and now practices Holistic Management. He is rebuilding ecological and socio-cultural wealth while remaining profitable—a lot more profitable and more resilient than ever before. Committing to a regenerative model provides virtually endless opportunities for profitability.

Cattle, goats, and sheep move strategically around the farm under holistic planned grazing; chickens, geese, turkeys, and ducks follow grazers and peck at grubs and insects, thus managing pest cycles; hogs and rabbits do their part and add more complexity and resilience to the whole livestock mix. The farm produces pastured eggs and grows numerous types of heritage vegetables. At WOP, no species is confined, no hormones are used, and animals do not endure long rides in trucks—animals are always in pastures, and are slaughtered and processed in the farm's USDA-inspected plant, which is powered by solar panels. Everything from the farm is used or goes back into the land—waste is nearly zero.

The whole family is happily involved in various aspects of running this complex business. Employees—more than 100 of them—come from diverse backgrounds and all see their jobs as both incredibly important and of high quality. Clearly, WOP represents a socially, ecologically, and financially regenerative model.

"We believe that the local movement is about the decentralization, de-industrialization, and de-commoditization of the food (and fiber) industries. We believe that it is grown by a group of passionate people who are bound by family core values, rather than by faceless corporations that are bound by quarterly earnings reports." *—Will Harris, White Oak Pastures*

White Oak Pastures also is a demonstration and training site for other local farmers; some of them work with and supply animals to WOP. Will Harris is the leader of the Georgia Savory Hub. The Savory Hub is dedicated to demonstrating the holistic framework and practices, training and supporting other farmers in the region in all aspects of Holistic Management, incubating and disseminating holistically sound solutions, and serving as a research site for relevant science focusing on livestock management and the health of soil and grasslands.

White Oak Pastures

Now We Go Global

This incredible story is replicable, not as a formula for all farmers but as a model of what happens when we start paying attention to all aspects of a successful agriculture—soil, plants, animals, people, and finances. The integrated return on investment is mind-blowing.

In each regional and local context; on each farm, ranch, or landscape; and within each human group, answers will differ and creativity will dictate and unveil different possibilities, but the fundamental principles of building resilience and fostering regeneration remain the guiding stars.

This is exactly what the Savory Hub network is designed to do. Just as WOP serves as a Savory Hub of holistically regenerative solutions in Georgia, a burgeoning global network of 30-plus Hubs on six continents is doing the same. From Turkey to the United Kingdom to Spain, from southern Africa to Patagonia, from Australia to Canada, the "WOPs" of the world are at work to make regenerative livestock agriculture a reality.

The key to scaling the Savory strategy is to embrace, incentivize, and support the beauty and uniqueness of what is local; safeguard the integrity of processes; and promote contextualized replication through local leadership and long-term investment. Not one big top-down initiative,

but rather countless smaller grassroots gems activating the models for agriculture we need in a regenerative, circular, edge economy as offered by Hunter Lovins, John Fullerton, and others.

A Strategy Is Born

Backtrack seven years, to when I took on the leadership of the Savory Institute. We set out to take Allan Savory's lifework to a whole new level, to a visible and coordinated realization of Holistic Management across multiple social actors in all socio-political, ecological, and economic contexts worldwide. It had to become a tangible reality. Land is desertifying at an alarming rate. Grasslands until very recently were ignored in both agriculture and climate agendas.

Our pledge: That all our initiatives would have an underlying self-sustaining or—even better—regenerative business model supporting them.

Year after year, ideas were vetted, business plans were put in place, tools and programs were developed, partnerships formed and were nurtured, and an increasingly strong network of close and allied partners began forming the entrepreneurial infrastructure through which knowledge, tools, and assets are distributed, and our common mission is realized.

The hero in our story continues to be the holistic farmer, rancher, pastoralist—working day in and day out, sunup to sundown, to produce our food and fiber in ways that heal the land, sequester carbon in our soils, steward the habitat of many species, and recharge our water tables.

Now these heroes would be united in a local tribe, coordinated and orchestrated by a local entrepreneur. A solutionary. An advocate. A businessperson. A marketer. A facilitator. A trainer. A philosophically aligned organization. This local figure would create, lead, and help replicate a self-sustaining initiative—just as Will and his family and team are doing at WOP—with deep understanding of the context in which it is operating. These are the Savory Hubs, our scaling infrastructure, our distribution and deployment mechanism.

With all its growing pains; learning curves; and constant monitoring, adjusting, and re-planning—which is the core of Holistic Management—this burgeoning network of Savory Hubs is growing strong and is collaborating in novel and unexpected ways. The integrity of the local context is protected, respected, and (in many cases) restored. The soundness of the processes and practices promoted evolves and strengthens through

Paul and Phyllis Van Amburgh are Holistic Management–accredited professional educators who co-manage Dharma Lea grass-fed dairy and beef farm (Sharon Springs, New York), which is one of the Savory Institute's Hubs.

peer-to-peer modeling and support, skillful implementation, ongoing learning, and relevant scientific research. Soil microbes are being fed, nutrients are cycling into better and richer food, human health and animal health are being positively impacted, plants are drawing carbon into the soil making it richer and more productive, water is being soaked up by soils and supporting life, community passion is reigniting, younger generations are engaging, and money and resources are reinvested, strengthening the circular economy. If we zoom out to examine the large network, the sum of these local initiatives clearly is addressing the global food, water, climate, and economic crises.

The Power of All of Us through the Marketplace

The network is now positioned to accelerate our joint impact, as world and business leaders look for actionable strategies to meet their corporate social responsibility, sustainability, and climate commitments, and as all of us consumers of food and fiber become increasingly astute, educated, curious, and demanding when it comes to understanding the impact, quality, and authenticity of the products we buy and the brands we support.

Grassroots and collaborative programs need to facilitate an interactive market and production network for food and fiber products that regenerate

the land. One such program is being prototyped with a handful of Hubs, their producer networks, and select market partners. The intelligence inside the program is unquestionable: the measurement of key indicators of ecological health of the land, such as soil carbon and microbiology. This program, deployed by the Hub network, will facilitate the sourcing of regenerative raw materials to ecologically and socially conscientious brands with a deep commitment to incentivize regenerative models. It will enable consumers to buy food and goods derived from livestock that is properly managed through practices verified to enhance water availability, soil health, carbon sequestration, and wildlife habitats. Producers learn, improve their management practices and outcomes, and gain differentiation. Brands gain access to regenerative producer networks, volumes, and data-based transparency. Hubs engage as problem solvers and service providers for livestock producers, verifying outcomes and coordinating market opportunities in their own well-known, specific socio-cultural, political, economic, and ecological contexts.

The sky is the limit in how wide, far, and fast this movement can go in contributing to the global solutions required in our challenging times. A few innovators spread across the globe are willing to lead and minimize risk for livestock producers around the world, and to model what progressive brands, conscientious retailers, educated consumers, and slow money can do to foster a regenerative agriculture movement that is transparent, meaningful, profitable, and resilient, and builds from the ground up to achieve global impact.

A native Argentinean, Daniela Ibarra-Howell is an agronomist by profession and specializes in natural resource management and economics. More than 25 years of international experience in the field of regenerative resource management and policy, coupled with her hands-on land-management experience in a variety of ecological and cultural environments, led Daniela to cofound the Savory Institute with Allan Savory and other colleagues in 2009. She became its CEO in 2011. Since then, Daniela has led the design and implementation of a revolutionary entrepreneurial, grassroots, network-based strategy to reverse desertification and tackle systemic food, water, and climate-change issues. She has served as advisor to sustainability initiatives including UN Global Compact, UN Rio+20, Solidaridad Farmers Support Program, Global Roundtable for Sustainable Beef, Sustainable Agriculture Network, HRH Prince of Wales Campaign for Wool, 4 per 1000 French initiative, and The Nature Conservancy's sustainable-grazing initiative.

The Alt-Investor and "Fake" Market Returns

BY ESTHER PARK

The notions of "alt-right," "alt–National Park Service," and other similar concepts, along with the idea of "fake" news, recently got me thinking about my own work, and about how there's something edgy, subversive, and radical about investing in soil. As the field of impact investing grows by the day and the dollar—becoming nearly mainstream—I find myself feeling increasingly separated from this practice. Ostensibly, we at Cienega Capital call ourselves regenerative investors specifically to make this point. It's not about doing things in the same way just a little less poorly, but rather it's about turning the concept on its head with the hope of achieving systems change. To do that, we must reexamine some of the assumptions in that system, such as the inalienable right of investors to make as much money as they can, and the use of "market returns" as a benchmark for successful investment.

To give you a sense of how I got here, rewind to 1996. I first started getting interested in how money worked when I was living abroad in central Asia. I lived and worked near the Aral Sea (or at least where it used to be)—one of the worst "ecological catastrophes," as the locals put it. It's an interesting story if you ever want to look it up. In a nutshell, the sea has shrunk by about 70% due to poor water-management practices occurring during the Soviet era. After the Union of Soviet Socialist Republics dissolved, an influx of multilateral and foreign aid came from Europe and the United States. Enormous amounts of grant money flowed into Uzbekistan, a country that previously never had known philanthropy or a nonprofit sector. This had a corrupting influence on the people and their society. I wanted to believe there were better ways to use capital to solve these environmental, social, and human problems, so I set off to find out what those were.

Fast-forward to 2006, when I began working with social enterprises as the director of lending at RSF Social Finance (RSF). As a lender, the company was only one part of the capital stack for these enterprises, but the other layers impacted it—particularly when company performance was less than stellar. I was surprised to find that RSF often had to mediate between

The Aral Sea in 1989 (L) and 2008 (R) | Images courtesy of NASA

the financial stakeholders. Investor behavior in many situations revealed conflicting objectives among parties and, in my view, called for capital that had more realistic and flexible returns. I found that the damage being done—the demoralization of people and the necessary sacrifices made to achieve mission objectives, all for the sake of growth—was not worth the financial return.

In 2014, I started working on direct investing with Sallie Calhoun, who opened my eyes to the essential role of soil in our ecology and particularly in the carbon cycle. Having worked with many packaged-food and beverage companies, I found that it was very different to work with farmers, ranchers, and closely related enterprises. Their connection to this sense of balance among the financial, ecological, and human was instinctual and profound. When I described my investment philosophy to them, they got it immediately. Then I knew I was working with the right group of people.

The necessary balance of financial, ecological, and social returns is most evident and critical to success when working with nature and the land.

Esther Park discussing sheep, grass, and soil with Paicines Ranch (Paicines, California) manager Kelly Mulville.

If something is out of whack, you notice it almost immediately. In many other industries, such imbalances are externalized and anonymized to the point that they no longer are noticed. We're starting to wake up to this as climate change is reaching the point of no return, but we still don't always make the connection to the way we do business.

I know there are different camps in the investing world. Some investors say that you don't have to sacrifice returns for mission—and, in fact, you even can achieve outsized returns. Others say that returns must be sacrificed to achieve impacts. In my mind, this debate is garbage, and only reveals that the impact investing industry still elevates financial returns over everything else. Ecological and social returns are sidelined as "impacts." We instead should be talking about holistic returns, in which all aspects are balanced. Having achieved "market returns" by degrading environmental resources and stripping wages and wealth from people, we might need to experience a period of negative financial return to restore the ecological and human aspects of our system. I'm not saying that all investments should have a negative return, but perhaps some of our portfolios must net a negative return to achieve balance.

How does this look for us on a micro level? Some of the entrepreneurs in our portfolio do very well because they foster a healthy and balanced

context, and the financial return also is healthy, although it perhaps still could be considered "below market." In other areas, a lot of innovation is still needed, which means that we take an R&D approach—we spread investment across a number of models knowing that some (most?) of them will not succeed. The models that do succeed have the potential to bring significant change to their industries.

Cienega Capital's philosophy is to bring the right type of capital to companies and organizations that understand the land stewardship practices needed to create healthy soil. This can range from a grant for a farmer-assistance program to a program-related investment for a permaculture-based social-justice organization, an equipment loan for a sheep farmer, or an equity investment in a grass-fed beef company. This approach muddles returns, and some people will say it's not an institutional investment approach and will never scale. But that's the idea. We don't need to scale some huge investment vehicle—we need a thousand people (or more!) to invest this way. We call this method of investing, and the call for more investors to do it, the "No Regrets Initiative."

Ultimately, our goal is to be able to look at our portfolio and be able to say that it's a "beautiful portfolio." That definition might be different for everyone, but we'd like it to indicate that we're moving toward a healthy picture of agricultural soils across North America.

Esther is the CEO of Cienega Capital, a regenerative investment firm utilizing an integrated capital approach to systemic change in the areas of soil health, regenerative agriculture, and local food systems. She serves as a board member at New Resource Bank, Nutiva, City Fresh Foods, Custom Food Solutions, and Carman Ranch Provisions, and is an advisor to Kitchen Table Advisors. Esther also founded Commons Stock, an impact-focused due diligence consulting firm. She also has served as the vice president for Strategy and Business Development at RSF Social Finance, was a senior consultant for ShoreBank Advisory Services, has conducted program evaluation work for the United Nations, and has trained lenders internationally in small business lending practices. Esther received her MPP from University of Chicago and BA in Social Welfare from the University of California Berkeley. She lives in Berkeley, California, with her husband, Greg, and their two children, Evangeline and Bryce.

The Future of Urban Farming

BY GLYNN LLOYD

Some sights in the neighborhood were so common that I had stopped noticing them; but then one day they came into view. While driving down Harold Street on the way to my cousin's house, I noticed a vacant lot on my left and then, just a block down, I saw two large vacant lots on my right. At the end of Harold Street—right before Howland Street—stood a huge half-acre vacant lot. This area had been labeled the "H-block." It was a tough neighborhood in Boston, Massachusetts, known for the significant number of shootings that occurred—which primarily were gang related. It also was a neighborhood with beautiful housing stock, long-term residents, and strong community leadership. Later that week, intrigued at the amount of vacant space, I walked the streets and tallied approximately 1.5 acres of land sitting vacant among the homes and apartment buildings.

Not long after that day, in the commissary kitchen of my company—City Fresh—the staff was preparing meals for one of the summer camps in session. The team members were cutting heads of lettuce that had been shipped in from across the country, and a question occurred to me: Why couldn't we be growing this lettuce closer to home?

In answer to that question, I—along with a small group of community residents—founded City Growers. It was the spring of 2007. We set out to convert vacant lots—primarily located in the Roxbury, Dorchester, and Mattapan neighborhoods—into intensive micro farms: to put our community idle hands to work and supply fresh, local, organic produce to the growing and insatiable market for local and sustainably grown food. We desired to apply the idea that human-scale production that is less reliant on large equipment and fossil fuels is a more-efficient production method. We weren't alone.

Decades prior, I had devoured Eliot Coleman books. I marveled at the amount of high-quality vegetables his Maine farm was producing on just a couple of acres and well into the cold season. I intently listened to Will Allen and the production he proselytized from Growing Power's greenhouse vertical systems. I was inspired by his emphasis on using practical and functional technologies and his obsession for making amazing soil.

A vacant lot in Dorchester being converted into a microfarm.

Closer to home and a few years back, Greg Maslowe revealed to me how much revenue he could produce on one acre on his Newton Community Farm; the figure he quoted was $135,000. These people—in their different ways—have proven the ability and efficacy of intense small-scale production.

In 2008, City Growers squatted on land behind Sportsmen's tennis club in Dorchester. This would prove to be the catalyzing act that changed the zoning laws of Boston. Prior to our land grab, the Tommy's Rock community in Roxbury had been eying local vacant lots with the idea of converting them into agricultural use. Community members had been stumbling along a complicated and unclear path in trying to work with the city to achieve their goals. Bette Toney, an active resident, had heard about City Growers, and a mutual friend introduced us. The community vision was clear, so we took it directly to Mayor Thomas Menino. In our meeting, he clearly was not happy with the idea of setting aside taxable, buildable vacant lots, but he also wanted to get out in front of this new demand for urban farming land. After we were dismissed from his office, Mayor Menino's administration quickly moved to form an urban agricultural zoning committee. Over the next year, there were dozens of meetings. Once a month there was a public meeting at city hall. Consistently, at 8:45 a.m. on the day of the meetings, dozens of community members—

including agricultural activists, farmers, beekeepers, rooftop growers, and compost specialists—gathered in the overflow section. The community, together with city officials, negotiated the language of what would become Article 89, a citywide zoning article that allows for commercial urban agriculture in Boston.

Just a couple of years after the passage of Article 89, City Growers recruited and trained a group of new urban farmers who sold $45,000 of produce grown on slightly less than one-half acre. The revenue per square foot was encouraging. Most of the produce was sold directly to restaurants, and roughly 20% was sold back to the community at farmers' markets. Making a go commercially at small-scale farming is not easy work, however, and I came to realize that it is for the extreme few dedicated farmers. Urban farming also has broader potential—as evidenced by its impact in Boston over the past 10 years.

Thousands of volunteers have put their hands in the dirt on urban farms. Thousands of farmers' market and restaurant customers have been buying and eating hyper-locally-produced fruits and vegetables from urban farms. The City of Boston and the Massachusetts Department of Agricultural Resources have invested hundreds of thousands of dollars and significant resources into urban farming. Over the last five years, thousands of attendees have filled sold-out Massachusetts Urban Farming conferences, and dozens of local food events and workshops have become regular staples of the growing local food movement in Boston and other cities. In 2014, newly elected Mayor Marty Walsh cut the ribbon on the city's first urban farm: Garrison-Trotter Urban Farm at 227 Harold Street. This was the first vacant lot that came into view during my travels in 2007, and now the land for the farm is being shifted into a newly formed urban farm land trust, thus ensuring its longevity.

Great start, but what's next? I am convinced that the real challenge and opportunity of the urban farming movement is persuading, encouraging, enticing, and facilitating more urban dwellers to grow their own food. Period.

It gradually is becoming common knowledge that all of us are participants in a dysfunctional and dangerously fragile food system. Our current food system has a design problem. Most of our food comes from large monocrop agribusiness systems that rely on cheap labor and fast-depleting fossil fuels. Fresh water and soil are the two most critical natural resources relied upon by our species, and the rate of depletion of these

Mayor Walsh announcing Boston Urban Agriculture Day at the Garrison-Trotter Urban Farm grand-opening celebration.

resources is the most serious threat to the ability of our next generation to comfortably survive. I would argue that it is no longer sustainable or practical to have less than 2% of the U.S. population directly involved in its own food production. Urban and suburban readers: Picture each household on your block growing market-size gardens and fruit trees, and maybe even a few of your neighbors farming chickens or rabbits. Now envision all the in-between spaces—sidewalk medians, vacant lots, and unused parts of parks—overflowing with food production. We need to get there, but how? How do we create and transition to a more practical and resilient food system while we still are dependent on the existing system?

Now, more than ever, I believe this is a bottom-up spiritual and cultural undertaking. The leaders in this movement play important roles as catalysts. This is where organizations such as the Urban Farming Institute (UFI)—with community credibility, farming knowledge, and social and political capital—can fully step in and start creating the new system. In 2011, The Urban Farming Institute was formed as the founders of City Growers realized that relying on pure market forces to obtain land, develop farms, and train community farmers wasn't going to work. In 2015, City Growers

merged with UFI. This allowed government and philanthropic dollars to blend with market sales as revenue sources to support all the components of not only attempting to develop urban farms but also attempting to create a new industry. Public and private vacant-land conversion has been a slow process but recently has picked up steam. Currently, six parcels totaling approximately two acres are under cultivation or are in the process of being converted.

Urban community residents lead UFI, from the board to the staff. Executive Director Pat Spence is a beloved longtime Mattapan resident. Bobby and Nataka, a husband-and-wife team who were born and raised in Roxbury, are spiritual leaders of the urban farming movement and have both street credibility and industry mastery. Together they are a taste of the secret sauce that positions UFI to shift community behavior. As communities of color that historically and economically have been dispossessed, we must be more self-reliant regarding food—this is a crucial step toward making us more resilient to the unstable future.

How do we make it happen? How do we become more self-reliant? Start with the community influencers and provide them with the necessary education and tools. The UFI is positioned to "train the trainer"—partner-

From left, Nataka Crayton-Walker, Greg Bodine, and Bobby Walker at a City Growers microfarm in Dorchester. | Photo by Leise Jones/City Growers

ing with individuals and organizations to provide education on the mechanics of small-scale food production, and to provide the tools—including land, soil, and water. The goal is to enroll families and to find champions within each family to start getting their hands dirty—one seed at a time. From a spiritual and cultural place, the next chapter in the movement is to make the act of growing food both a family and a community practice. Additionally, there is a health and economic argument: Densely nutritious and less-toxic diets, dollars saved from self-production and, potentially, dollars earned by selling excess food all are practical benefits.

Access to land is key. For many residents of our urban and peri-urban communities, the good news is that land ownership or access is an asset that we already have on the books. Be it your front porch, windowsill, or backyard, many urban dwellers have access to land and its power to grow. This underutilized resource is sitting right under our noses.

The UFI has been working with national and local land-trust experts, including the Dudley Neighbors Inc., and is in the process of creating a land trust for urban farms. Simultaneously, UFI is working with the City of Boston—a willing partner that is ready to shift appropriate vacant lots into this urban farm land trust. This provides secure long-term land tenure for the larger spaces within the community. An important milestone of this relationship is the construction of the new UFI urban farming center at the old Fowler Clark Epstein Farm on which the oldest buildings in Mattapan sit—the original farmhouse and barn are being repurposed as the hub of the activities described here.

Access to good soil also is critical for making the shift. Half of what urban residents put on the street corner for trash pickup can and should be turned into compost. We have the potential to create thousands of pounds of black gold. Vacant lots, raised beds, and backyards are waiting to receive it. We also have the unique opportunity for an intergenerational knowledge transfer—many of our elders have experience and knowledge of growing—and it is our responsibility to reconnect our kids to the sources of their food. Seeds can be part of that educational medium, being able to save, share, and plant community seeds is a critical part of true self-sufficiency and resilience. This is the reason that a seed library will be part of the new center.

An important benefit of this shift is that it offers an alternative to today's material-accumulation-focused and screen-obsessed culture. Parents can point themselves and their kids toward activities that teach practical skills

Every year, hundreds of volunteers—primarily youths—are reconnected to the land by touring and volunteering at UFI farms, such as the Glenway Street farm pictured here.

and produce something worthwhile. It enables us to reconnect to the natural cycles and all the richness of natural sciences (such as plant biology) that come with the growing of food.

Sustainable and long-term change includes ongoing education. It also requires a strong mindset, one that not only asks and answers important questions, such as, "How did we get here?" and "Where are we going?" but also envisions a new path and future of what is possible. What would it mean if nearly 100% of your home waste was turned into soil that grew most of your food? And what if this became true for you and for more than half your neighbors? I am humbly optimistic that this is what is next for urban farming.

Glynn Lloyd has been an innovator in the field of transformative urban economic development for more than 25 years. He is the president and founder of City Fresh Foods, a company that brings ethnic meals to homebound elders and provides healthy meals to school-aged children. Glynn catalyzed Article 89, a citywide zoning article that allows for commercial urban agriculture in Boston. He then founded the Urban Farming Institute, a community-led nonprofit that supports the development of the new urban farming industry in Massachusetts.

Conventional Farming Ruined the Soil on Our Farm—Here's How We Saved It

BY JESSE MCDOUGALL

Reprinted with permission from Rodale's Organic Life

Jesse McDougall (R)

On a cold spring day in 2013, I walked into one of the hayfields on our farm in Vermont and began to panic. For three generations, my wife's family had tended 50 acres of luxurious, green hayfields. But now, one season after my wife and I took over, all I saw was gravel, moss, slime, and washouts.

Seventy-seven years earlier, my wife's great-grandparents, Thomas and Candace Stevenson, bought the hilltop farm in Shaftsbury in the wake of the Great Depression. For 40 years, my wife's aunt Edie—the Stevensons' granddaughter—had tended the land. She managed the hay-production operation using tillage and chemicals to clear the fields of weeds so they could produce the clean, uniform grass bales that packed the barn every summer.

In 2011, Edie was diagnosed with a glioblastoma, an aggressive form of brain cancer. The next year, at age 56, she passed away. My wife, Cally, and I suddenly inherited a farm, but there was one problem: We weren't farmers. I was a semi-ecoliterate web developer. Cally had spent summers on the farm growing up but had never given much thought to soil or agriculture.

Standing on the edge of the field at the level where the ground used to be. Eighteen inches of topsoil had washed away over the decades.

The first decision we made—suspicious of the toxic chemicals used on the land—was to stop spraying pesticides, herbicides, and synthetic fertilizers. We did this naively assuming that once we stopped spraying, nature would flourish and the lush, green fields would remain lush and green.

The following spring, we found dirt patches under the snow. By June, we could walk across a field without stepping on grass. We spread composted manure to little effect. We cast seed with no results. In fall and the following spring, we saw more gravel, moss, and slime, and deeper washouts. We entered winter 2013 tormented by the idea that we would fail the farm.

I called organic farmers and organizations for help. I called conventional farmers. I asked the same question: How can we manage 50 acres of hayfield without chemicals? I was told, "If you figure it out, let us know."

I turned to books, videos, and Google. I spent many bleary-eyed nights that winter combing the Internet for clues. One evening, I found a TED Talk by Allan Savory, a biologist working to reverse desertification in Africa's grasslands. Savory listed eerily familiar symptoms: gravel, moss, slime, deep washouts. The culprit? The soil was devoid of carbon.

For the first time, we understood that our fields had been depleted of microbes, organic matter, and carbon—a molecular building block of all life forms. Suddenly, our farming imperative shifted from pulling crops from the ground to pushing carbon into it. We started soil triage.

In our research, we learned there are two ways to kill soil: chemicals and tillage. Our farmland had been subjected to both for decades. Tilling the soil exposed any buried carbon—as rotting organic matter—to the elements. The exposed carbon bonded with oxygen and floated away as CO_2 (carbon dioxide)—starving the soil's microbes of food. Pesticides then killed the surviving microbes.

The degraded land I found in 2013 wasn't the result of our decision to stop using chemicals but rather was the true state of our soil. Grass grew only because, after seeding, the farmers on this land applied water-soluble pellets containing nitrogen, phosphorus, and potassium (NPK)—the bare-minimum macronutrients needed for growth. The soil itself was dead.

The question was: What could we do about it? Savory explained that he was able to return carbon to the soil by returning animals to the land and managing them in a way that mimicked a herd's natural "bunch, munch, and move" behavior. Savory had recreated a system of animal management that had kept grassland soil fertile for millennia.

By doing this, Savory had restarted the ecosystem's process for carbon sequestration: Grass draws in carbon as CO_2 and converts it into plant matter; animals eat the plants and dump carbon as manure; the animals

then trample it into the soil—where it improves soil structure and feeds the soil microbes. The plants grow back stronger, which attracts more animals, and so on.

Farming in a way that restores ecosystems is known as carbon farming, or regenerative agriculture. Ray Archuleta, a soil-health specialist at the USDA's Natural Resources Conservation Service, confirmed its effectiveness. "Farming," he said, "should promote biology—life."

We were nervous about raising livestock, but we now knew that grass needs grazers as much as grazers need grass, so we took the plunge. We started slowly, in spring 2014, by putting 50 chickens in a mobile coop in our hayfield. We moved the coop along every 12 hours, and the chickens scratched, pecked, and fertilized. On the patches of ground where the chickens had done their work appeared tall, lush, green grass. The anxiety that had gripped me for nearly two years faded.

In the years that followed, we raised more chickens and added turkeys, sheep, and pigs. After three years—by focusing on restoring the farm's ecosystems—the grass has rebounded across our 50 acres of hayfield. The bugs, worms, deer, and birds have returned, too—adding balance and resilience to the land.

Mobile coop

Corn in 2012 (L); grass so deep that it hides sheep in 2016 (R).

We're also producing chicken, turkey, lamb, pork, and hay on acres that used to produce only hay. We've replaced the expense and degradation of chemicals and tillage with the revenue and regeneration of the animals. Our farming models are now regenerative: The more we produce, the more we can produce. Our farm is growing more profitable every day—economically and ecologically.

Globally, we face a climate crisis not because there's more carbon in the world than there was before (there isn't), but because we've broken the carbon and water cycles by breaking our ecosystems. We send too much carbon into the atmosphere and prevent ecosystems from returning it back down by building parking lots, bulldozing forests, and sending carbon into the air through tillage.

Pioneering farmers around the globe—on small plots and across millions of acres—are experimenting with managed livestock grazing, no-till vegetable and grain production, perennial fruit- and nut-tree production, restorative ocean farming, and other methods to produce food while sequestering carbon and restoring ecosystems.

The section on the left was grazed by the animals in the rotation, and the section on the right wasn't.

Be a pioneer in your community: Support carbon farmers, ask your grocer for regenerative food, and talk to your legislators about regenerative agriculture. Be a part of the cycle. Learn more at RegenerationInternational.org.

Jesse McDougall and his wife, Caroline, own and operate Studio Hill—a pasture-based regenerative farm—on their family's fourth-generation farm in southern Vermont. In 2012, Jesse and Caroline began transitioning their farm away from conventional practices to regenerative, organic practices—mainly mob grazing with sheep and poultry, no-till annual vegetables, fruit orchards, and beekeeping. In 2017, the team at Studio Hill began developing a 4.5-acre perennial food forest on land that was formerly clear-cut for timber. In 2015 and 2016, Jesse helped to write and introduce legislation that would promote regenerative agricultural practices within Vermont.

Building Economic Equity through Fertility, Food, and Energy

BY ERIKA ALLEN

First, a clarification: Compost is not mulch—it is energy. Compost is the product of decomposed organic materials, carbon- and nitrogen-based plant waste, food scraps, and landscape refuse. These materials—when properly broken down in static piles (anaerobic) or in active, turned piles (aerobic)—provide the energy needed to grow nutritionally dense food that doesn't rely on external sources of fertilizer (which often are petroleum based). Compost is a rich source of fertility that provides the foundation for community-controlled food production.

Depending upon external sources of energy and fertility means that self-sufficiency always is at risk. A transition from low-tech to high-tech composting helps not only by providing increased soils to grow in, but also by promoting wealth building that creates a bridge for equity.

Additionally, many community-based compost projects began as an extension of environmental justice and economic development work. Now, simply by diverting waste to compost, people can grow food efficiently and intensively—even in the city. This creates more food access and less food scarcity, and fosters a healthier, more-sustainable local food system.

In the United States, we have an opportunity to scale up and build a carbon-neutral future for food and energy. What makes this possible? Partly the tremendous amount of waste sent to landfills. The United States alone throws away 68 billion pounds of food every year. This wasted food comprises nearly 14% of the total municipal solid-waste stream—it is the single largest component of the municipal solid waste that reaches landfills. Notably, less than 3% of food waste created is recovered or recycled, and 97% ends up in landfills.

The landfill "method of disposal" is expensive and has the potential to pollute the air, water, and soil. Additionally, landfilling does not yield any beneficial products (such as energy and fertilizer). Importantly, local neighborhoods desperately need more organic fertilizer to support community gardens, urban farmers, and green space—and diverting landfill-bound components could alleviate some of that need.

Food waste

Growing Power operates community-composting operations in Milwaukee, Wisconsin, and Chicago, Illinois. The waste is picked up from wholesalers, food retailers, and restaurant partners; several microbreweries also participate. The community is directly engaged and is invited to deposit organic waste into the community food centers' compost bins. This closed-loop approach to food production and composting in neighborhoods creates the nexus of sustainability needed to spur a local food system. The ability to create a perpetual loop of fertility is essential to successfully growing food in the depleted soils typically available for use as community gardens, and for using raised furrows of compost to grow food on top of contaminated areas.

The processes range from large-scale in-vessel composting in high tunnels, and windrow, mechanized turning in Wisconsin. Both Growing Power strategies are site-specific and are highly replicable by any community seeking economic development and increased food access and security. There also is an opportunity for edible food rescue—especially with wholesale partners. The corresponding policy work was necessary at the state and city level to allow for ordinances and licensing, and now also is in place in Chicago, Illinois.

Growing Power—Milwaukee

Growing Power–Chicago recently expanded its current composting operation to serve more than 25 local businesses. Its goal is to divert eight million pounds (4,000 tons) of food waste from local landfills and instead use it for compost. After waste material is broken down it is fed into a series of worm bins, where thousands of red-wiggler worms process it into the balanced, natural, nutrient-dense casings valued by farmers and gardeners.

One of the Chicago farm projects—the Altgeld Sawyer Corner Farm—is a dynamic urban farm with more than three acres of growing space. The site has eight hoop houses; each of the 90-foot hoop houses is filled with 100 yards of compost and is used to grow vegetables throughout the year. It is essential that community farms have consistent compost supplies to build growing beds and to replenish the beds after each harvest. This is possible when using a closed-loop composting approach.

Growing Power–Chicago is the community partner of a startup for-profit company, Green Era Sustainability. Together they will launch an anaerobic digester that composts organic food scraps and food-manufacturing waste to produce compressed natural gas (biogas) and compost blends for food production. This is a transformative project for Chicago that can help

solve waste-handling challenges, stimulate economic development, reduce greenhouse-gas emissions and other pollution, eliminate food deserts, and create jobs.

As noted, anaerobic digestion—a natural process that uses microorganisms to break down organic waste—transforms food waste into a renewable energy source and compost. This can support the emerging urban-agriculture industry and boost overall local food production. The market for locally grown food is rapidly expanding, but there is a lack of clean, healthy soil in urban areas. To meet the demand for locally grown food in urban areas, Green Era is developing the digester on a vacant brownfield site on Chicago's South Side.

The project is a unique and replicable model that "closes the loop" between organic waste, renewable energy, and local food production. It will have a profound social and environmental impact, create jobs, drive economic development in an underserved community, and provide a profitable rate of return.

The project site is in Auburn Gresham, which, along with other South Side Chicago communities, is extremely underserved. Minorities comprise

Will Allen, founder and CEO of Growing Power, teaches a small group about good compost.

99.5% of the community, and 30% of the population lives below the poverty level. This is more than twice the national average, and 98% of those households living in poverty include children. Chicago has the highest African-American unemployment rate among the nation's five most populous cities, and the Auburn Gresham neighborhood is a "food desert." The proposed investment will directly benefit this impoverished minority population.

Green Era anticipates the digester project will create more than 100 new jobs and entrepreneurial opportunities, and Growing Power's "Farmers for Chicago" initiative continues to build new farms. This is the future of the food system: creating food and energy at the community level that is not based on exploiting petroleum or the workforce. The integration of technology and community-equity practices provides the opportunity to keep natural resources and wealth in the community.

Erika Allen is the Chicago and National Projects Director for Growing Power. Daughter of Growing Power founder, Will Allen, Erika has a small-farm agricultural background and experience. Erika received her BFA from the School of the Art Institute of Chicago and her MA in art therapy from the University of Illinois at Chicago. Erika is a Post Carbon Institute Fellow; has served on the Illinois Local Food, Farms and Jobs Act Council appointed by Illinois Governor Pat Quinn; and most recently served on the Energy, Environment and Public Space Committee Chicago for Mayor Rahm Emanuel's transition team. Erika was appointed as a board commissioner for the Chicago Park District in September 2012, and was named "Green Entrepreneur of the Year" by the Chicago Urban League in 2015.

Using Soil to Fight Climate Change

BY SETH ITZKAN, KARL THIDEMANN, AND BILL MCKIBBEN

Lake Champlain—the crown jewel of New England—is sick. Every time rain falls in the area, fertilizer runs off farms, flowing downstream to pollute our cherished rivers and lakes.

Lake Champlain

Two bills under consideration by the Vermont Legislature, S.43 and H.430, promise to address this problem—and to fight global warming. These bills promote practices that enhance soil's natural ability to retain water, nutrients, and carbon. According to the Natural Resources Defense Council, a 1% increase in soil organic matter enables each acre to retain an additional 20,000 gallons of rainfall. More water absorbed into soil means that less irrigation is needed, and less pollution of water bodies occurs.

At the 2015 Paris climate talks, France's Minister of Agriculture Stéphane Le Foll introduced the international "4 per 1,000" climate and food-security initiative, calling on nations and regional authorities to boost the carbon content of their soil by 0.4% per year. In conjunction with deep cuts in fossil-fuel emissions, this seemingly modest improvement to soil

would draw down enough carbon to halt the increase of the carbon dioxide (CO_2) concentration in the atmosphere. That's the good news. The bad news is that the CO_2 level already is dangerously high.

As spelled out in climate guru James Hansen's latest paper, "Young People's Burden," negative emissions are now needed. In addition to keeping fossil fuels in the ground, we must remove excess CO_2 from the air. Anything less is a prescription for disaster.

Fortunately, a number of Vermont farmers already have adopted farming practices that pull carbon from the air and return it to soil—including no-till techniques. The goal is to disturb the soil as little as possible, plant cover crops instead of leaving fields fallow, and use compost to shade soil and keep it moist. Some farmers have begun bunching and frequently moving their cows and sheep (a practice sometimes referred to as "bunch and munch") to achieve the same beneficial grazing impact of ruminants in the wild.

Agriculture—with its unique ability to sequester carbon on, as Carl Sagan might say, billions and billions of acres—is the only industry poised to reverse global warming. Improved management of cropping and grazing heals land, boosts soil fertility, prevents flooding, enhances drought resilience, increases the nutritional content of food, and restores wildlife habitat as it concurrently sequesters carbon.

Reforestation also plays a key role in the biological solution for clean water and climate change. Trees are an integral part of the water cycle and lock up carbon that otherwise would be warming the planet; they also provide habitat to birds and mammals.

For too long, we've been diminishing the quality of our land, waterways, and atmosphere through agricultural practices that degrade soil. Fortunately, alternatives are available. The growing scientific and policy consensus is that improving soil to retain rainfall and capture carbon makes sense. Vermont's leadership in this agricultural revolution—capitalizing on the environmental and market opportunities it provides—makes both ecological and fiscal sense.

Seth Itzkan and Karl Thidemann are cofounders of Soil4Climate, a Vermont-based nonprofit that advocates for soil restoration to reverse global warming. Bill McKibben is the Schumann Distinguished Scholar at Middlebury College and founder of the anti-climate-change campaign group 350.org.

INVESTMENT TRACKING

The Slow Money Institute (Boulder, Colorado) tracks dollar flows through the Slow Money network. Each small food enterprise is a test plot for efforts to fix the economy from the ground up. Below are a few samples of recent Slow Money investments.

SLO Natural Foods Co-op *SAN LUIS OBISPO, CALIFORNIA*

$87,000 | 9 Investors

After more than 30 years in business, the SLO Natural Foods Co-op in San Luis Obispo, California, probably would not have continued to survive without the help of Slow Money SLO. Inspired by a desire to save the community's beloved store, a group of investors started Slow Money SLO and in 2013 made $87,000 in peer-to-peer loans to help the co-op move from a tiny, rustic space to a much larger building nearby. Some of the lenders also assisted with the tenant improvements and even joined the board!

With the help of Jeff Wade—Slow Money SLO founder and executive director—that move is proving to be beneficial not just for co-op members/owners and other customers, but also for many local food and farm businesses, the health of the soil, the local food system, and the local economy. Farm and food products from 85 local suppliers now grace the co-op shelves, quadruple the number before the move, and co-op membership has grown from 450 to 1,150 over the past 4 years.

"It's a win-win for everybody!" says the co-op's general manager, Gwen Schmidt. The mission of the member-owned store includes providing the community with "real food," and buying from local farmers and suppliers. With 30% of the store's fresh produce now coming from local family farms, SLO Natural Foods has a competitive edge over nearby healthy food chain stores. "We love working with our local farmers," Schmidt says. "Their

products are beautiful, they're so colorful and fresh, and we can get more variety—sometimes including things we've never heard of!"

In the welcoming produce department at SLO Natural Foods, large photo banners of local family farmers hang from the ceiling. On the beautifully arranged rows of amazingly fresh organically and sustainably grown vegetables and fruits, shoppers see an abundance of brightly hued "local" stickers on the labels, alongside the name of the farm where the crops grew. A blackboard proclaims: "We (heart) farmers." Produce buyer/manager Tifney Melton says, "It's so nice to call the local farmers and get their produce delivered the next day. Some farmers will deliver every day, some a few times a week, so everything is always gorgeous and fresh." In the months since Tifney started buying more produce from local farmers rather than from an out-of-town distributor, fruit and vegetable sales at the co-op have doubled. Local family farmers—and the healthy soil where they grow their crops—also are reaping the benefits.

Across town in the fields farmed by one of the co-op's local suppliers—Javier Magaña of Red Barn Farms—a wide variety of vegetable crops flourishes in the springtime warmth of a recent morning. Javier and his helper Domingo spread composted chicken manure from his abundant flock on the soil between rows of young lettuce plants. They've just picked

SLO Natural Foods Co-op general manager Gwen Schmidt and produce manager/buyer Tifney Melton show off the fresh, local vegetables offered in the store.

Javier Magaña and his helper Domingo spread chicken manure at the San Luis Obispo City Farm.

cases of fresh spring vegetables for delivery to SLO Natural Foods Co-op: golden beets, English peas, red chard, green garlic, Russian kale. "With the extra money I get from the co-op, I can pay for a worker," Javier says. He also was able to lease more farmland from the City of San Luis Obispo, which owns the SLO City Farm where Javier's vegetable crops grow. It's prime agricultural soil that developers were required to provide to the city in exchange for permission to build a shopping center. Javier's sustainably grown vegetables from the SLO City Farm also are sought by farmers'-market customers, local gourmet restaurants, a local farm-fresh produce box delivery service called SLO Veg, and Javier's wife's cold-pressed juice and vegan café business, Julia's Juices.

Down the road at 195-acre Kandarian Organic Farms in Los Osos, enthusiastic farmer Larry Kandarian grows more than 200 varieties of ancient grains, beans, peas, seeds, and herbs, alongside native plants produced for revegetation projects around the state. The SLO Natural Foods Co-op was his first customer, buying a variety of certified-organic dried beans, grains, seeds, and herbs after the move to a bigger store. "The co-op helped me expand my retail sales," Kandarian says. "Now we're getting so popular! I used to say, 'Where will we sell all this?' Now I say, 'Where will we grow all this?' " Kandarian Organic Farms' ancient grains—including

Larry Kandarian of Kandarian Organic Farms in Los Osos examines the ripeness of his einkorn grain.

Ethiopian blue tinge farro, Peruvian purple corn, and einkorn—have earned a cult following among sourdough bread bakers around the world, Larry attests. He's also excited that his emmer farro was featured in a delicious Mediterranean salad dish recently served in the local middle school's cafeteria. "We trained four school chefs," he says. "It's the first time in the nation that emmer farro has been served in a school cafeteria!"

Another farm that supplies the SLO Co-op—Templeton Valley Farms—has increased its vegetable production thanks to its sales to the co-op. On five acres, farming couple Trina Baumsteiger and Edwin Rambuski grow various certified-organic vegetables, berries, fruits, and flowers, and have a flock of 70 chickens. The farm uses its own compost and high-quality organic fertilizer. The 30 or 40 families who come to the farm to pick up their weekly CSA farm boxes are treated to about 15 different food items. On a sunny spring afternoon, as customers arrive for their boxes, Trina makes colorful flower bouquets and Edwin runs the tractor to mound soil around rows of young potato plants. "I have a lot of vegetables, and I really want to share! I just call Tifney at the co-op, tell her what I have, and make deliveries once or twice a week. We work really well together," Trina says.

Quite a few other local food businesses—including Mama Ganache Artisan Chocolates and Vert Foods catering and meal preparation—buy many of their ingredients at SLO Natural Foods Co-op, in some cases making products that are then sold at the co-op. Virginia Marum of Vert Foods, for example, says that she supports her belief in sustainable economics by purchasing local foods to provide nutrient-dense meals for local families.

SLO Natural Foods and Slow Money SLO continue to be great partners in promoting local food, and have collaborated with Niner Wine Estates in Paso Robles, California, to promote the importance of local food consumption. Niner Wine Estates has twice invited SLO Natural Foods

Trina Baumsteiger of Templeton Valley Farms checks out her thriving broccoli plants.

Co-op and Slow Money SLO to participate in its popular farm-to-table dinners. Niner avidly supports local farms, and even has its own on-site garden. *Food and Wine* magazine named Niner as one of the Best Winery Restaurants in America for 2017. "Slow Money SLO is a super-important link in the local food chain," says Andy Niner.

The success of the co-op and the expansion that the Slow Money SLO loan enabled are creating positive repercussions throughout the community—an impact that Larry Kandarian calls "dendritic." The loans were fully paid back more than a year ago, and today the local co-op has enough sales volume and revenue to qualify for membership in the National Co-op Grocers, a "co-op of co-ops" that offers the buying power of 200 stores. The resulting reduced prices are helping the San Luis Obispo store compete against bigger chains.

As the co-op's produce manager Tifney says, "Our family farmers and food producers work so hard for us to eat this well, it's important to support them."

Reported by SLO Natural Foods Co-op member Kathy Johnston.

Full Sun Company *MIDDLEBURY, VERMONT*

Netaka White and David McManus | $204,000 | 3 Investors

Full Sun Company is a Vermont-based regional enterprise that produces cold-pressed, extra-virgin seed oils for culinary markets. Full Sun sells its oils primarily through distributors to food services, restaurants, colleges, and a growing number of grocery retailers. These oils also serve as inputs to value-added producers that use them in specialty products.

Additionally, the co-product of the oil production process often is sold directly to farms for use as feed for livestock or as a soil amendment. The meal that remains after oil extraction is a high-quality animal feed ingredient and a nitrogen-rich organic fertilizer. The non-GMO meal contains 27% to 32% protein, and has a high-quality, plant-based fat content that doesn't cause the digestion challenges for animals that soymeal products can. As a soil-building staple, the N-P-K content ranges from 5-3-1 to 6-2-1 and offers a buffered nutrient release for planting and side dressing. Full Sun's products currently are available in 300 stores in New England, New York, and Pennsylvania. The company's canola and sunflower seed oils are differentiated from chemically refined, expeller-pressed oils and are particularly unique.

Founded in 2014 by Netaka White and David McManus, Full Sun presented at the June 2016 Slow Money Vermont Entrepreneur Showcase, and attended a prior Vermont Food Investors Network (VFIN) mixer (VFIN is a project of Slow Money Vermont). Through relationships cultivated in the Slow Money Vermont network, Full Sun has raised diverse types of capital from an array of capital providers—ranging from the White River Investment Club (WRIC) to the Vermont Community Loan Fund (a Community Development Financial Institution [CDFI]) and Clean Yield Asset Management. According to Netaka, "Slow Money Vermont has been at the nexus of raising money and building awareness of what Full Sun is doing. The network

Full Sun cold-pressed oils

Cofounders David McManus (L) and Netaka White (R).

feels inclusive. Slow Money Vermont seems to be a main touch point for what's going on or where opportunities are for entrepreneurs and investors." Part of the secret of SM Vermont's network impact is that SM Vermont is a project of the Vermont Farm to Plate Network and leverages shared commitment to Vermont's Farm to Plate goal to increase investments and financial partnerships in food-system enterprises.

A key question at the outset of the business was how to source seeds. The founders committed to bringing in more local and regional acres, even though relying on outside sourcing would have been easier. Netaka and David started the business with a goal of sourcing regionally, but knew that supply initially would be limited. Full Sun makes multiyear agreements with producers that provide non-GMO oil seeds, and Full Sun's acquisition of raw materials positively effects the local economy. The company's specifications for production practices are geared toward soil health and continue to evolve.

Before the term "slow money" was coined, people often spoke in terms of "patient capital." Full Sun noted that it raised capital that would be in the company seven years prior to redemption. Additionally, the debt financing received from the Vermont Community Loan Fund (VCLF) was provided

through VCLF's innovative SPROUT Deferred Payment Loan Program, which is designed to meet the financing needs of working lands entrepreneurs who might not otherwise be eligible for a VCLF loan. SPROUT received start-up support from the public-sector Vermont Working Lands Enterprise Initiative, whose R&D work on capital gaps and solutions had unearthed the need for favorably termed capital for early-stage enterprises, paired with technical assistance. According to Will Belongia, executive director of the Vermont Community Loan Fund:

> *For 30 years, VCLF has been providing financing to start-up and emerging businesses in Vermont that haven't had access to traditional loan capital. And with SPROUT, we've added even greater depth to our small-business lending program.*
>
> *Vermont's small food and agricultural businesses are central to our state's economy and identity. SPROUT, as a deferred payment program, offers eligible borrowers from these important, core categories a viable opportunity to address critical early-stage business needs. Full Sun is an ideal candidate for SPROUT, and we're thrilled to help support this very promising new enterprise.*

Slow Money Vermont's Janice St. Onge, president of the Flexible Capital Fund, is fond of saying, "It's not just the money, but what comes with the money." Another example of an investor who also facilitated business assistance for Full Sun was the Fair Food Fund. Alex Linkow, director of the Fair Food Fund, explained:

> *We understand that good food entrepreneurs need more than just financial capital. That's why we offer business assistance in addition to financing. As part of our investment in Full Sun Company, we sent the cofounders, David and Netaka, to the three-day Natural Products Consulting seminar to enhance their sales and marketing skills and then supported their full-day workshop with the Lyric Group to take that learning to the next level. We believe that pairing financing with this type of business assistance is critical to building entrepreneurial capacity, developing successful enterprises, and ultimately growing vibrant local food systems that benefit families, farmers, and local economies.*

These values resonate with the factors that the White River Investment Club considers when making an investment decision, such as its $10,000 equity investment in Full Sun.

White River Investment Club participated in a broader capital-raising plan that Full Sun had under way. The WRIC has about 25 members, each of whom has invested at least the minimum of $1,000 in the Club; there is no upper limit. The Club is run democratically by its members—with a "one-member, one-vote" approach; investment decisions require a two-thirds majority. There currently is approximately $160,000 in total capital under management, and WRIC's policy is to maintain 20% of that total as a reserve. Jerry Ward, WRIC president, sheds light on the Club's rationale for pursuing the Full Sun opportunity.

> *As a small, locally oriented investment club, we were attracted to this opportunity for an equity offering. This complemented nicely our mostly loan portfolio. It met all of our investment criteria, being an investment that strengthens the local economy and promotes sustainable growth. In particular, we have been pleased to note Full Sun's openness to modifying [its] business plan, such as the trend toward more regional sourcing of [its] seed stock.*

In considering its convertible preferred stock in Full Sun, Clean Yield Asset Management saw value in attributes such as Full Sun being a zero-waste producer. The sustainable practices and regional-economy-building designed into Full Sun's approach resonated with Clean Yield's screening and priorities. Karin Chamberlain, an impact and community investment analyst at Clean Yield, pointed out that:

> *David and Netaka first visited Clean Yield's offices in 2013, before they had produced a drop of oil. We got to know Full Sun over the next few years and determined [that] the company's measured approach to growth and sound business fundamentals, combined with its key role in the local food infrastructure, made this high-risk but high-impact investment worthwhile for our clients where appropriate.*

Full Sun has focused on sales and marketing, while also incrementally scaling production. The company sees itself as building the business

through a series of steps. Region by region, it has an evolving sense of itself as being a national player. During its technical assistance, some of the input Full Sun received included, "If you don't think of yourselves as a national brand, you may have a hard time reaching your goals." Full Sun sees its investment of time in the nearby region as a fit for its market and values. Meanwhile, it caught the attention of a national distributor when a multistore natural foods grocer in Texas became interested in Full Sun's products.

One of the key lessons that Netaka said the company has learned is "learning to be patient with a Slow Money vision, while rapidly building a Slow Money business. Being committed to a Slow Money vision takes real patience on the part of the entrepreneur (not just the investor)."

Reported by Eric DeLuca, chair of Slow Money Vermont and principal of Leverage Point Consulting. Disclosures: Eric is a member of the White River Investment Club and is vice chair of the Vermont Working Lands Enterprise Board.

Maui Breadfruit Company *KAHULUI, HAWAII*

John Cadman | $10,000 | 5 Investors

We all have them—you know, those things we call defining moments in our lives. I've had several, but the one that stands out most for me occurred in the fall of 2012. I was asked to give a cooking demo at the local chapter of the Farmers Union on Maui. I said, "Sure, what would you like me to focus on?" The Farmers Union said, "How about breadfruit?" I thought, "OK, I know a little bit about that—heck, I had even eaten and cooked with breadfruit a few times." Just so it sounded like I knew what I was talking about, however, I figured I better do a little research and experimentation.

I can't really explain it, but for some reason the light just came on for me. I quickly realized what an amazing food breadfruit is. You see, it is one of the original canoe plants that the ancient Polynesian voyagers brought to Hawaii. It has been grown throughout Polynesia as a staple food crop for many centuries. The tree itself has many uses, but the fruit is what is so amazing. When immature it is firm, very much like a potato. As it ripens it becomes soft, sweet, and deliciously aromatic. The trees are amazingly easy to grow, extremely high yielding, and are very tolerant of many types of growing conditions. Sadly, it has become a neglected food here in Hawaii, but I was determined to change this. I am convinced that breadfruit has more potential to address food security than does any other crop in Hawaii,

Breadfruit (L) and John's business partner Maile (R).

where we import about 90% of what we eat. Developing our local small-chain food supply is truly essential in overcoming this staggering figure.

John Cadman with a slice of Pono pie. Photo by Sue Hudelson Photography

So, with my newfound passion for this forgotten fruit, I began experimenting and making all kinds of delicious things using breadfruit in both its starchy and sweet stages. Fast-forward about a year, and I had come up with a dessert that was nothing short of amazing—or so I was told. Naturally, the next step was to quit my secure and high-paying job and go into selling breadfruit pies. That was four years ago, and now Pono pies are sold on all four of the major Hawaiian Islands, at health food stores, and in some excellent restaurants. In Hawaiian, "Pono" means correct, beneficial, and done in the right way. I have tried to adhere to this principle in my business. One way is to source my ingredients locally. My breadfruit, sweet potatoes, bananas, honey, macadamia nuts, coconut, and coffee are all grown in Hawaii.

One of the greatest unintended consequences of bootstrapping my business is that I can help other aspiring food entrepreneurs by renting out kitchen time at my factory. This is a win-win situation for everyone involved. Currently, there are no truly affordable options available to anyone who wants to develop a value-added product here on Maui. Presently, five fledgling companies use my kitchen space. Although I have watched at least that many companies start up only to shut down when the harsh realities of small-company food production became all too real, at least they didn't have to make significant investments in building or leasing an entire kitchen to find this out. For my company, the additional income really helped in the early growth stages when cash flow is so crucial.

You see, I started the company with very little money. I believe that growing a company with as little debt as possible is the best way; but sometimes it is just not possible to expand without some financial assistance. That's where Slow Money Hawaii came in. Previously, I had my labels printed locally in small batches at a cost of $0.31 per label. My printer told me that if I could order in bulk it could get the cost down to $0.06 per

label, but that would require ordering at least 100,000 labels. Slow Money Hawaii connected me with some very supportive and enthusiastic community members who believe in breadfruit as much as I do. The very generous loan terms provided by Slow Money enable me to make the monthly payments and still increase my profit. I really hope that someday I will be able to return the favor and help other aspiring food entrepreneurs as a Slow Money lender.

Reported by John Cadman, founder of Maui Breadfruit Company.

Grow a Farmer Fund *MINNESOTA*

$97,400

My grandparents were berry farmers in western Pennsylvania. Visiting their farm was a highlight of my childhood and is part of the reason that I do the work I do. I want a future for my kids (and their kids . . . and everyone's kids) that includes shelling and eating peas, husking and roasting fresh corn, and picking plump berries. I want there to be family farms and farms that people can visit with their children. I love good, fresh food. I also love the cultural richness tied to food—such as making fresh strawberry pies with my Aunt Ruth or stuffed zucchini with my Greek YiaYia [grandmother].

In Minnesota, those of us who work with farmers see the challenges and risks they face in growing fruits and vegetables; raising grass-fed livestock; and producing honey, maple syrup, and other "specialty crops." Farmers often have difficulty accessing traditional sources of capital. We know that many young farm families and new immigrant farm families are eager to grow healthy local food, but they need access to smart financing to grow their businesses.

It is these issues—and a desire to give "good food citizens" a way to invest in the types of farms that they want to see spread and grow in Minnesota—that led us to form the Slow Money Minnesota network and link up with the FEAST Local Foods Network to launch the Grow a Farmer Fund.

Katie Wiste of the Capra Nera Creamery said, "To keep up with the demand for my farmstead goat cheese, I need to build a bigger aging cave. A low-interest Grow a Farmer Fund loan would be a huge help!"

The Grow a Farmer Fund is a pilot project launched in May 2016. Since its launch, it has raised $100,000 from community members, established policies and procedures for the fund itself, received applications from small-scale sustainable farmers, provided low-interest loans, and given technical assistance to help farmers improve operations and to increase a farm's bottom line.

Initially, the plan seemed reasonable. In reality, however, raising $100,000 was a challenge for a group of folks that was more experienced at writing grants than it was at asking for donations. Nevertheless, we pooled our experience and put together a plan that has been successful.

Katie Wiste, Capra Nera Creamery

Highlights to date include:

- Receiving an initial $25,000 contribution from the Southern Minnesota Initiative Foundation to seed the fund.
- Launching and introducing the fund at the second annual Slow Money Minnesota event. (We invited people to contribute to the fund at the $500 level and raised more than $6,000 from 10 people.)

The wonderful St. Paul, Minnesota, food co-op—Mississippi Market—selected Grow a Farmer as its Positive Change award recipient for August 2016. Asking customers to "round up" their purchases resulted in the co-op raising nearly $10,000 for the fund.

In September 2016, the Grow a Farmer fund launched a Barnraiser campaign to raise the next $25,000. A Barnraiser is similar to a Kickstarter, but it also supports projects that align with these values:

- Food should be good for you.
- Products should respect the environment.
- People make things special.
- Every bite counts to change how we eat and live.

People said this type of campaign was a lot of work—and it was. For our team, it meant that each team member had to step outside of his or her comfort zone, and we each had to ask our families, friends, colleagues, and networks to contribute to the fund.

Before the campaign kicked off, the Grow a Farmer Fund got great news: An anonymous family foundation offered to match all donations made during the campaign's first 10 days, up to a maximum of $10,000. Then—to draw much-needed attention to the campaign—a group of chefs, farmers, city officials, and nonprofit staff members participated in a Mud Bucket Challenge.

The Grow a Farmer Fund reached its goal a few hours before the deadline, which was crucial because this was an all-or-nothing campaign. After the Barnraiser campaign, the team was completely astounded to learn that *another* anonymous family foundation had stepped forward and doubled the Barnraiser achievement—and had made a $25,000 donation through the Minneapolis Foundation Anonymous Grants Fund.

Then, in October 2016, more than 50 people attended a fundraising house party in Minneapolis and—after meeting local farmers, eating delicious farm-fresh food, and sipping local craft brews and wines—the guests pitched in another $5,000 for the fund.

As of August 2017, the Grow a Farmer Fund team has raised $97,400 and is working to secure the final $3,100 needed for the fund to be opened to farmers by the end of 2017.

The Mud Bucket Challenge

The organization still is working out some of the specifics, but has settled on the following items.

- The Southern Minnesota Initiative Foundation (SMIF)—a well-respected community foundation that serves the 20 counties of southeast and south-central Minnesota—will manage the fund, with Slow Money Minnesota and the FEAST Local Foods Network providing input.
- The first loans will be made in SMIF's region in amounts of up to $15,000.
- Interest rates will be low, and repayment terms will be determined on a case-by-case basis.
- The process will be straightforward and transparent.

"Fruit and nut trees are a long-term investment in farm resilience. A low-interest loan from the Grow a Farmer Fund would make that investment possible." *—Nick and Kathy Zeman, Simple Harvest Farm*

Nick and Kathy Zeman, Simple Harvest Farm

The Grow a Farmer Fund provides support to small farmers right away, and helps investors better understand the needs and challenges both for farmers and for those managing this type of fund. The fund serves as "proof of concept" for broader Slow Money Minnesota initiatives, and investors believe this donation-based fund will create more pathways for good-food citizens to support the kinds of farms and food businesses that all entities involved want to see flourish.

Reported by Jan Joannides, cofounder of Slow Money Minnesota, and executive director and cofounder of Renewing the Countryside.

Colorado Soil Systems *ROARING FORK VALLEY, COLORADO*

Jim Dula | $15,000 | 2Forks Club

In 2009, when I first heard Woody Tasch speak at a Slow Money Institute book signing, I had little idea that seven years later the Slow Money movement and ethos would enable me to chase my dream right into the soil. Our local Slow Money group—the 2Forks Club—is a nonprofit investment club that is reshaping the landscape of capital and local food businesses. The critical mass of minds at each club meeting is a hopeful and energizing harbinger of the future of our local food system.

Founded in 2012, Colorado Soil Systems is a landscape-management company serving the Roaring Fork Valley and the surrounding area. Its mission is to act as a resource for information, education, and assistance in organic landscape-management practices and soil-building processes to grow the local food economy, increase environmental health, and increase the community's ability to resist disturbances and disruptions in food production. Colorado Soil Systems provides an organic compost tea service and soil-health consulting services.

Compost tea is a liquid solution of beneficial bacteria, fungi, and protozoa that restores health to soils in need. To brew compost tea, we begin with a variety of high-quality composts each containing a diversity of bacteria, fungi, and protozoa. We then use a composite tea brewer to extract the microorganisms from the compost. The compost material next is placed into a "tea bag," and air is pumped in to provide enough energy to knock the microorganisms off the compost and extract them. After extraction, we feed the microorganisms molasses, kelp, and liquid fish to encourage the microbes to multiply. Once the brew is ready, it can be applied as a soil drench, foliar spray, and deep-root application.

Compost tea brewing.

In 2016, Colorado Soil Systems received a $15,000 zero-percent loan from the 2Forks Club. This loan allowed us to establish a fruit-tree rootstock nursery to preserve

Marketing and sales director Martin Suthren spraying compost tea.

indigenous trees that grow in the valley; purchase irrigation supplies, fencing, and soil amendments; and embark on a vegetable- and flower-production operation. In 2017, Colorado Soil Systems, in partnership with Erin's Acres Farm, is set to grow food for 40 CSA shares, two farmers' markets, and several restaurants located throughout the valley.

The 2Forks Club is unlike any other lender found in the sphere of agriculture. Previously, the banks that Colorado Soil Systems approached for funding would not lend money for things such as purchasing electric fencing or ordering $1,200 of compost for a start-up farmer. Farming and the local community work hand in hand—farmers connect the local community to the earth, and now the missing link of this chain has been found; the people of the farmers' community close the loop. Relationship-based lending is the future of agriculture.

As the founder of Colorado Soil Systems, I presented my ideas, plans, and pursuits to the 2Forks Club in a room filled with my peers, mentors, and investors—and it was one of the healthiest experiences I've had as an entrepreneur. With Slow Money and the 2Forks Club, the lending criterion was based on my preparation, knowledge, character, and vision, and not just a credit score and adjusted gross income.

I am incredibly grateful for what the Slow Money movement has brought into my life and what it is doing for farmers around the county. As local farms and food artisans continue to grow through Slow Money investments, consumers will continue to reconnect with their producers and undoubtedly drive the resurgence of the local food community.

Reported by Jim Dula, founder of Colorado Soil Systems.

Bou'Sol *FRANCE*

Benjamin Borel and Samuel Mougin | $133,000 | 17 Investors

Starting Slow Money Francophone in 2014—first in France, and then in Switzerland and Belgium—was challenging, particularly because many of the financing solutions designed for local food production already were working successfully. Crowdfunding campaigns, state subsidies (for amounts of up to $50,000), and community savings used for buying land ("Terre de Liens") already were in place. Preferred loans from banks, state-agency guarantees, private equity funds, and an entrepreneurship platform also were available.

In my opinion, the ability of private investors to make direct loans to small companies—in amounts ranging from $100,000 to $500,000—is what was missing. Indeed, such sums are too great for community loans and crowdfunding, and too little for private equity funds. In France, making direct loans also is challenging from a legal perspective, because they cannot be made unless the lender is regulated as a private investor. These were the difficulties to be overcome when I came across Bou'Sol.

Created in 2013, Bou'Sol is a French holding. Its mission is to construct, develop, and structure long-lasting relationships with local and organic wheat growers and flour producers through a socially minded bakery network that is engaged in a collaborative and inclusive dynamic to produce organic and locally sourced bread. The production of the different bread varieties utilizes semi-industrial units and a "homemade" long-fermentation method which conciliates quality and meaningful purpose. Although Bou'Sol products cost more than those of its competitors, they offer a better value.

Bou'Sol began selling its products to institutional catering companies and canteens (eating establishments in places such as colleges, factories, and hospitals, which serve a simple menu and where the cost of food is less than that in a cafeteria and often is subsidized). For 10 years, Bou'Sol was a nonprofit association, and then two members decided to leave and to develop a network based on their experience.

The investment required to open a local Bou'Sol is $500,000. State subsidies and foundations provide half the money, and the other half comes from banks. It takes time to acquire the funding, however, because each supporter requests a financial plan from the Bou'Sol before providing a

Bou'Sol employees preparing dough for the oven.

grant or a loan. Therefore, as SM Francophone was determining the right support to provide Bou'Sol, we sought a pragmatic solution. We met with farmers, entrepreneurs, and investors, and learned that the key points are flexibility and having a complementary offer.

A short delay (even just three months) in garnering an investment of about $130,000 can make it very difficult to attract local workers and customers. Slow Money Francophone therefore decided to involve "general" private investors in the local community to secure investments that have an option for complementary financing. We found investors who were open to impact investing and gave them opportunities to invest in several local companies that provide healthy and environmentally conscious food. This type of partnership is a win-win solution, because it gives entrepreneurs confidence in the success of the fundraising.

Bou'Sol's solution is the "Pain et Partage" (which roughly translates to "Sharing Bread") network it created across France. The network is based on brand licensing and mutualized services, and enables a fully integrated social and environmental model to expand. Pain et Partage buys local and organic flour and wheat, produces bread using local workers, and distributes the bread to collective restaurant customers.

Freshly baked bread from Pain et Partage in Lyon.

Bou'Sol received $133,000 for four years. The loan helped the initial financing of a new "Pain et Partage" in Lyon and was complemented by other loans received from banks. The initial SM Francophone loan was fundamental to acquiring additional financing.

The Bou'Sol holding company advises and invests in each subsidiary. It also co-manages and assists the franchises, negotiates sales, searches for financing, structures supplies, and works toward concerted communication. Each bakery generates approximately $575,000 in revenue and provides bread to an average of 40 clients or 10,000 consumers. Annually, Bou'Sol receives 15% of its subsidiaries' gross margin (about $30,000). In 2016, Bou'Sol's 5 franchises generated about $1,900,000 in revenue and created 35 full-time jobs.

Bou'Sol also has impacted both social and environmental arenas by:

- Supporting organic farming (each bakery uses 65 to 75 hectares of local wheat—which comes from four or five different suppliers).
- Bringing consumers closer to the people that grow and produce their food.
- Generating jobs.

It has been gratifying to work with Bou'Sol, and we look forward to future opportunities to bring together investors who want to build a new economic paradigm from the bottom up and entrepreneurs who are developing solutions for producing healthy, local food.

Reported by Aymeric Jung, cofounder of Slow Money Francophone.

SOIL/2017

This fall, the Slow Money Institute is publishing Woody Tasch's new book, *SOIL/2017: Notes Towards the Theory and Practice of Nurture Capital*. The following excerpt is the beginning of its chapter called "*Return*."

I Whereabouts

II Return

III Nurture

IV Hereabouts

Salmon return. Boomerangs return. Hindus return. When things work out, investments return. Letters with insufficient postage return. So do infections, mosquitos, prodigal sons, wandering eyes, sideways glances, the hands of a clock, circular reasons, not-quite-infinite seasons, pendulums, memories, criminals to the scenes of their crimes, and stories to where they left off. Prior to the advent of Colony Collapse Disorder, bees returned. Heroes, real and mythic, return: Odysseus, Columbus, General Douglas MacArthur. Too many winks, verdicts, and tennis serves have been returned over the course of human history to be counted. The same goes for sweaters after Christmas. And, as long as there have been neighbors, economists, democratic entanglements, and governments, there have been many happy returns, diminishing returns, election returns, and tax returns.

Through it all, however, through all these physical, spiritual, emotional, postal, historical, mythical, electoral, recreational, and commercial goings and comings, there is one thing, in our infinite, industrial wisdom and pioneering spirit, that we haven't returned.

Carbon.

Lulled into frenzied complacency by internal combustion and industrialization, we've taken carbon from the earth and put it into the atmosphere, treating an elegant, billions-of-years-in-the-making system of solar energy, cellular biology, photosynthesis, and carbon cycling as if it were a one-way street. The end result? An economy of tailpipes, smokestacks, superstores, turbo-charged financial markets, and petro-chemical doused industrial agriculture.

And the Mother of All End Results, climate change.

And the Sisters of All End Results, distrust and befuddlement.

Paul Newman, Sir Albert Howard, and armies of soil critters to the rescue.

Even in the era of venture capital Moonshots and billion-dollar Mars-shots, returning is as important as venturing forth. Coming back down to earth. Returning to "the ignorance which our growth requires." Returning to humility and civility.

It wasn't just a cute turn of phrase when Thomas Jefferson said, "Cultivators of the earth are the most valuable citizens." Or when FDR said,

"A nation that destroys its soil, destroys itself." Or when Paul Newman said, "In life, we should be a little like the farmer, who puts back into the soil what he takes out." Or when the founder of the Earthworm School of Fiduciary Responsibility and Peaceable Finance conjures up the Thoreauvian Fiduciary Activist.

But, not to worry, you won't find the words Thoreauvian, fiduciary, or activism on a bottle of Newman's Own salad dressing. Or in any Presidential proclamations. Or in an investment prospectus. For that matter, you may never see them again in a discussion of Slow Money or something called SOIL—Slow Opportunities for Investing Locally. Because they are awfully complicated terms for something as simple as making 0% loans to local farmers and food entrepreneurs.

We live in a world in which the complicated has been made simple and the simple has been made complicated.

Pushing the power button on your computer, simple. Having an authentic conversation with your neighbor, complicated. Buying a bag of potato chips, simple. Growing potatoes in your front yard, complicated. Owning a diversified portfolio of gold stocks, simple. Making a loan to a farmer down the road, complicated.

So, forget about matters of the Thoreauvian or fiduciary kind and think about the farmer down the road. And about Newman's Own.

How beautifully simple. Giving away all the profits:

> *Our "100% of Profits to Charity" commitment is one of two founding values upon which Newman's Own is built (the other being "Quality Will Always Trump the Bottom Line"). It's a very important part of our story, it's in our DNA, it's why we exist, it motivates all of us, and it's the true heart of Newman's Own. We are proud of this commitment, and, especially in these times of so many promotional programs tying business sales to social purpose, want to be clear and unambiguous about what we mean when we say "100% of Profits to Charity." It's not something we just thought up to boost sales, it's not a play on words, and one shouldn't need an accounting degree to understand it. We have*

> *been doing it for close to 35 years, and as of May 2017, have donated over $495 million to thousands of deserving organizations around the world. (Newman's Own website)*

How beautifully worth repeating, Paul Newman's words, "In life, we should be a little like the farmer, who puts back into the soil what he takes out."

How beautifully fundamental, rejiggering the ethos of business, splicing altruism into entrepreneurship and consumerism in ways no one had ever imagined.

What made Newman's Own possible, was, of course, Newman. Which is not to say that you have to be an impossibly charismatic celebrity to be altruistic. Only, that you have to be an authentic individual. You need to muster the gumption to tune out the experts, the professional permission givers and takers, the intermediaries and the naysayers, and find ways to act authentically.

For some, authenticity means competing for market share. For others, authenticity means terroir.[1] For some, authenticity means protesting. For others, it means leaving a field fallow. For some, it means paying taxes. For others, avoiding them. For some, belonging to a church. For others, belonging to a CSA. For some, hot dogs. For others, organic apple pie. For some, ethanol. For others, earthworms. For some, conscientious objecting. For some, conscientious investing. For some, giving away 1% of revenue. For others, giving away all the profits.

Sir Albert Howard's Law of Return is, it seems to me, as authentic as it gets.

Howard wrote *An Agricultural Testament* and *The Soil and Health* in the mid-20th century, based on his observation of soil-building practices in India, where he was a government scientist. His concepts of farming in concert with nature show the way, still, for many of the *AHA!* persuasion.

Here is a little of Sir Albert Howard's vision, as digested by poet farmer Wendell Berry:

> *The balance between growth and decay is the sole principle of stability in nature and in agriculture. And this balance is never static, never fully achieved, for it is dependent upon a cycle, which in nature, and within*

1 The soil and climate that give a food its particular taste.

the limits of nature, is self-sustaining, but which in agriculture must be made continuous by purpose and by correct methods. "This cycle," Howard wrote, "is constituted of the successive and repeated processes of birth, growth, maturity, death, and decay."

The interaction, the interdependence, of life and death, which in nature is the source of an inexhaustible fecundity, is the basis of a set of analogies, to which agriculture and the rest of the human economy must conform in order to endure, and which is ultimately religious, as Howard knew: "An eastern religion calls this cycle the Wheel of Life [. . .] Death supersedes life and life rises again from what is dead and decayed."

The maintenance of this cycle is the practical basis of good farming and its moral basis as well:

> *The correct relation between the processes of growth and the processes of decay is the first principle of successful farming. Agriculture must always be balanced. If we speed up growth we must accelerate decay. If, on the other hand, the soil's reserves are squandered, crop production ceases to be good farming; it becomes something very different. The farmer is transformed into a bandit.*[2]

What Howard called banditry is referred to by many of today's proponents of healthy agriculture as *mining*. We are mining soil fertility. In order to maximize efficiency, we apply industrial practices to farming, turning farms into factories and focusing on productivity, rather than fertility. Over time, life in the soil is degraded. And, it turns out, so is the health of communities and the health of democracy.

In recent years, the degradation of community and the dysfunction of democratic institutions have become impossible to ignore; what is far easier to overlook, but no less important, and integral to many related processes of cultural and ecological decline, is the degradation of the soil.

Based on competing worldviews and the related interpretation of data, it may be possible for two equally patriotic individuals to disagree about

2 *The Soil and Health*, Sir Albert Howard, Introduction by Wendell Berry (University Press of Kentucky, 2006), p. xvii

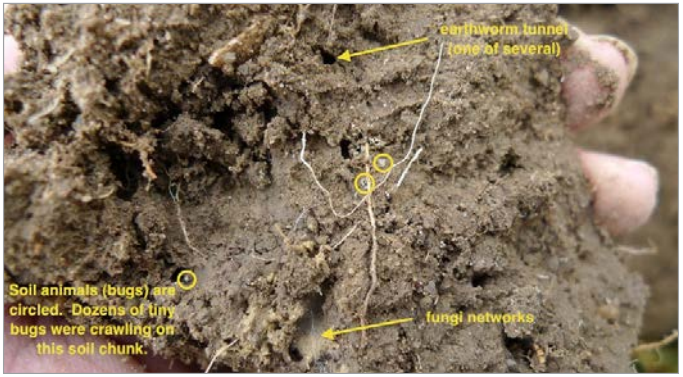
the meaning of the decline of the family farm and the consolidation of the agricultural sector in large, industrial farms. Or about the significance of the decline during the 20th century in the number of plant varieties in commercial cultivation. Or about the tillage of hundreds of millions of acres and the application of hundreds of millions of tons of synthetic fertilizer, herbicides, and pesticides. Or about the vulnerability of increasingly long and complex supply chains in the food system. Or about the role of ruminants and manure. Or about the safety of GMOs and raw milk.

The room for disagreement between these same two individuals is far smaller, I'd like to imagine, when it comes to the following proposition:

Soil Teeming with Life, Good; Lifeless Soil, Bad.

Just how good the good is and how bad the bad is . . . well, that, as Shakespeare sort of put it, is the question.

While searching for images of life in the soil, I came upon the following on Sweet Bay Farm's website:



On Sweet Bay Farm, they are working to restore soils depleted by decades of monoculture—the continual cultivation of a single crop, in this case tobacco—so this picture of several earthworm tunnels in a clod does not yet suggest anything *teeming*. Charles Darwin's observation, in his last manuscript, is instructive with respect to the magnitude of earthworm populations in general:

> *Hensen, who has published so full and interesting an account of the habits of worms, calculates, from the number which he found in a measured space, that there must exist 133,000 living worms in a hectare of land, or 53,767 in an acre. This latter number of worms would weigh 356 pounds, taking Hensen's standard of the weight of a single worm, namely three grams. It should, however, be noted that this calculation is founded on the numbers found in a garden, and Hensen believes that worms are here twice as numerous as in cornfields. The above results, astonishing though they be, seem to me credible, judging from the number of worms which I have sometimes seen.*[3]

But Darwin's numbers were only the beginning. In 1951 (the year this author joined the ranks of the Baby Boomers), observers of pastureland in Scotland estimated the number of earthworms per acre to be 100,000 to 200,000. Today, the United States Department of Agriculture's Natural Resources Conservation Service (NRCS) reports that the number of earthworms per acre of cropland can exceed a million, if the land is "highly organic."[4]

The NRCS cites the following beneficial soil fertility services performed by earthworms:

Stimulate microbial activity. Although earthworms derive their nutrition from microorganisms, many more microorganisms are present in their feces or casts than in the organic matter that they consume. As organic matter passes through their intestines, it is fragmented and inoculated with microorganisms. Increased microbial activity facilitates the cycling of nutrients from organic matter and their conversion into forms readily taken up by plants.

Mix and aggregate soil. As they consume organic matter and mineral particles, earthworms excrete wastes in the form of casts, a type of soil aggregate. Charles Darwin calculated that earthworms can move large

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3 *The Formation of Vegetable Mould Through the Action of Worms, With Observations on Their Habits*, Charles Darwin (John Murray, 1881).

4 See a dramatic comparison of earthworm populations in organic versus conventional farmland in Boone County, Iowa, in the National Research Council's *Toward Sustainable Agricultural Systems in the 21st Century* (The National Academies Press, 2010), p. 382.

amounts of soil from the lower strata to the surface and also carry organic matter down into deeper soil layers. A large proportion of soil passes through the guts of earthworms, and they can turn over the top 6 inches (15 cm) of soil in 10 to 20 years.

Increase infiltration. Earthworms enhance porosity as they move through the soil. Some species make permanent burrows deep into the soil. These burrows can persist long after the inhabitant has died, and can be a major conduit for soil drainage, particularly under heavy rainfall. At the same time, the burrows minimize surface water erosion. The horizontal burrowing of other species in the top several inches of soil increases overall porosity and drainage.

Improve water-holding capacity. By fragmenting organic matter, and increasing soil porosity and aggregation, earthworms can significantly increase the water-holding capacity of soils.

Provide channels for root growth. The channels made by deep-burrowing earthworms are lined with readily available nutrients and make it easier for roots to penetrate deep into the soil.

Bury and shred plant residue. Plant and crop residue are gradually buried by cast material deposited on the surface and as earthworms pull surface residue into their burrows.

Earthworms are joined in the soil by many other invertebrates, including millipedes, centipedes, springtails, grubs, beetles, and snails. But the first point in the above list of earthworm functions, referring to the stimulation of microbial activity, is our conceptual wormhole to a whole other realm—the realm of myriad soil creatures that we cannot see with the naked eye.[5] This is, truly, the realm of *teeming*. Bacteria, fungi, protozoa, nematodes,

5 According to *Popular Science*, "A wormhole is [. . .] deformed space that has warped in such a way as to connect two different points in space-time. The result is a tunnel-like structure that could be straight or curved, linking two areas of the Universe that are incredibly far apart. Einsteinian mathematical models predict that wormholes exist, but none have ever been found."

mites, microarthropods—there can be 10,000 to 50,000 species in less than a teaspoon of soil. That's *species*. In terms of individuals, there are more microbes in a teaspoon of soil than there are humans on earth. Bacteria, actinomycetes, and fungi in an acre of soil can weigh thousands of pounds. Some estimates suggest that microbes account for half the weight of all life on earth.[6]

David Suzuki's *The Sacred Balance* (Greystone, 2007) offers the following:

Relative Number of Soil Flora and Fauna in Surface Soil

Organisms	Number/Metre^2	Number/Gram
Microflora		
Bacteria	10^{13}–10^{14}	10^{8}–10^{9}
Actinomycetes	10^{12}–10^{13}	10^{7}–10^{8}
Fungi	10^{10}–10^{11}	10^{5}–10^{6}
Algae	10^{9}–10^{10}	10^{4}–10^{5}
Microfauna		
Protozoa	10^{9}–10^{10}	10^{4}–10^{5}
Nematoda	10^{6}–10^{7}	10–10^{2}
Other Fauna	10^{3}–10^{5}	

Microorganisms also live in the guts of earthworms—500,000 or so per worm.[7] They are found in more astonishing numbers in the guts of humans. Recent studies indicate that 1,000 species and tens of trillions of microbes live in the human digestive tract, with as many as 100 trillion in total occupying each human body. Multiply this by the global human population of 7 billion or so and you arrive at an astounding 700,000,000,000,000,000,000,000,000, if I have the zeroes right, which I may not.

6 David Montgomery and Ann Biklé, *The Hidden Half of Nature: The Microbial Roots of Life and Health* (W.W. Norton & Co., 2016), p. 25. Also see the work of David Zuberer at Texas A&M University.

7 Edwards and Lofty, *Biology of Earthworms* (Chapman and Hall, London, 1972), p. 156. While Denis Hayes was organizing the first Earth Day in 1970, C.A. Edwards and J.R. Lofty (the latter an intriguing name for one focused on matters of the subterranean kind) were gathering data for their book, still one of the definitive texts on this subject.

Is that 700 septillion? Such a name seems far too reductionist for the enormity it denotes.

The names of big numbers don't do justice to our understanding of the underlying nature of things. Take trillions, for example. We talk of wars costing trillions of dollars and the U.S. gross domestic product of $18 trillion and world economic output of $75 trillion and $250 trillion of total global financial assets and trillions of dollars a day flowing through currency markets. But do we really know what the number 1 trillion *means*? Do we have any frame of reference that can give this number a context to which we can relate?

I know I didn't until my encounter with Jerome McGeorge, friend and financial advisor to George Siemon and Theresa Marquez, leaders of CROPP, the $1 billion farmer-owned co-operative behind Organic Valley, a leading organic food brand.

"I want to see what Jerome thinks of Slow Money," George said to me, as we drove up to a rustic home outside La Farge, Wisconsin.

Here's how one journalist describes Jerome:

> *Jerome McGeorge, a 70-year-old man with long white hair and a wispy beard, is the wizard I'm looking for. He was a founding member of Coulee Region Organic Produce Pool (CROPP), the cooperative that owns the Organic Valley brand, and an old hippy straight out of the Summer of Love. One moment he is describing the revolutionary spirit of late 1960s San Francisco, the next he's on to peak food, the price of organic milk in Europe, mission versus profit motivated enterprises, and the long, slow death of the family farm during his lifetime.*[8]

I've long forgotten what I said to Jerome during that visit, perhaps because I was taken aback by his soothsayerly demeanor. Was I to take him seriously? Was he to take me seriously? Would he dismiss my explanations of fast money and slow money as mumbo jumbo? His reception proved far too warm for any such anxiety to linger.

8 Sascha Matuszak, in an article titled "The Driftless Manifesto."

"Here's something that you need to know," Jerome said to me, "I'm going to start you off with a fact, and then ask you two questions. The fact is: A million seconds equals 12 days. The first question is, How long is a billion seconds?"

I don't remember if I came up with the correct answer: 12,000 days, otherwise known as 32.9 years.

"Now, here's the second question," Jerome continued, "how long is a trillion seconds?"

Again, I don't remember if I came up with the correct answer: 32,900 years.

A million seconds equals 12 days and a trillion seconds equals 32,900 years. That's how much bigger a trillion is than a million.

Expressing the quantity one trillion as *time* instead of as an imaginary stack of dollar bills makes it somewhat more comprehensible. For instance, a stack of 1 trillion dollar bills would be 67,866 miles high, reaching a quarter of the way to the moon. This is remarkable, to be sure, but it doesn't quite tickle my imagination the way this does: If someone had lent Jesus $1 trillion at zero percent interest on the day he was born, and it was to be paid back by him and those who came after at the rate of $1 million *per day*, payments would still have more than 500 years to go.

I'd worked in a small venture capital fund in New York City in the 1980s and as treasurer of a $60 million foundation in the 1990s and with a national network of sustainability-minded angel investors for another decade, reviewing who knows how many business plans with financial projections showing hundreds of millions of dollars or more of sales within five years, but until that day in Jerome's living room decades later, I didn't have an authentic feel, a wizard-enhanced feel, for the implications of billions and trillions.

In terms of money and the flow of capital through complex securities, millisecond computer trades and financial institutions that are Too Big To Fail, trillions means *mind-numbing*.

In terms of microbes and life in the soil, trillions means *teeming*.

ESSAYS

William Bryant Logan examines the all-encompassing role that the dirt plays in shaping our lives. Sir Albert Howard argues that we must respect and restore the health of the soil for the benefit of future generations. Elaine Ingham explores the relationship between human health and the soil. Courtney White explains why essential nutrients have decreased in our food and how we can get them back.

Excerpts from *Dirt: The Ecstatic Skin of the Earth*

BY WILLIAM BRYANT LOGAN

Reprinted with permission.

Fire and Ice

When I was about four, I used to love to watch oatmeal boil. Inevitably, my mother would throw it on the stove and rush off to make bag lunches. I sat on the red step stool, waiting for the moment when the bubbles first appeared.

A watched pot may never boil, but a watched oatmeal pot positively roils. After a stray bubble or two, the stuff would begin to well up in the middle, sending out ripples that reached the pot edge, then dived under the surface again. Suddenly, a whole new mass of light tan bubbles would appear.

They hissed as they multiplied, climbing quickly to the edge of the pot and boiling over. Inevitably, my mother would come running, and I would clap my hands in delight. When the Earth was still new, the surface was a liquid

mass, boiling like oatmeal in a pot; the liquid rose to the surface, then moved across it and folded under again. The silica in the melt was lighter than the other elements, so more silica-rich mass would push up and remain. As the silicon cooled, it formed the expanding nipple of a proto-continent.

The silica was a float or a bubble, in whose matrix also came the elements that would make life possible, especially calcium, magnesium, phosphorus, and potassium. At the beginning, this was an ordering process, where liquid matter rose in order to become a resting, structured solid. Once the crust of the Earth was formed, however, the ordermaking convection currents suddenly became intruders. Where they welled up, they no longer had free access. Instead, they had to punch through crust, spewing their half-melted magma over an existing landscape.

This is how volcanoes have behaved to this day. Ultimately, all minerals on the surface of the Earth were derived from this process, and fully two-thirds of the current crust was thrown up by volcanoes in the last two hundred million years. When the magma is richer in basalt and the other heavier minerals, it may extrude quietly, building a mounded shield volcano, or simply flooding out of the ocean-bottom cracks where tectonic plates diverge. The magma richer in silica is more light and viscous; it bubbles up underground, sometimes forming great batholiths that, when eroded, become mountain ranges like the Sierra Nevada and the Andes. In fact, the name given a volcano made from this sort of magma is called an "andesitic" volcano.

The andesitic volcanoes—many of them located along the Pacific "ring of fire," the system of tectonic plate boundaries that encircles the North Pacific—produce spectacular destruction. Almost exactly a century before the Mount St. Helens eruption, Krakatoa Island in the South Pacific exploded. Its four eruptions created explosions that were heard in Australia, more than two thousand miles away. The volcano literally blew the island to pieces, making a three-hundred-foot-deep trench where a six-hundred-foot elevation had been. The ash thrown into the stratosphere circled the Earth for years, bringing fresh minerals to soils around the globe.

The lava, ash, and dust renew the surface of the Earth with the necessary mineral elements that over eons are carried down to the sea.

Mount Vesuvius erupted in A.D. 79, killing twenty thousand people in Pompeii and Herculaneum, among them Pliny the Elder, the great natural historian. He died with what must have been the most spectacular

observation of his long life, considerably less believable than, for example, his thesis that buzzards were impregnated by the wind. The land was black, abandoned. But more than a millennium and a half later, in A.D. 1611, a traveler observed the following scene at Vesuvius:

> *The throat of the volcano at the bottom of the crater is almost choked with broken rocks and trees that are fallen thereon. Next to this, the matter thrown up is ruddy, light and soft; more removed, blacke and ponderous; the uttermost brow that declineth like the seats in a theatre flourishing with trees, and excellent pasturage. The midst of the hill is shaded with chestnut trees and others, bearing sundry fruits.*
>
> *Vesuvius was blooming.*

Not all magmas are equally fertile. Those that come from andesitic volcanoes generally yield granites and other acid igneous rocks. Those from basaltic volcanoes yield basic igneous rocks. The former, shiny with insoluble quartz and light in color, tend to make sandier and thinner soils. The dark minerals in granites, the potassium feldspars in particular, give these soils their fertility. The basic igneous rocks, on the other hand, are rich in black biotite, hornblende, and augite, and the greenish olivine. In the salt-and-pepper of a chunk of basalt, there is a good deal more pepper than salt, and these dark minerals are rich in the bases that make a fertile soil.

So much for fire. What about ice?

The soils of the early Earth were cut by gradual weathering, not by ice. Only our recent soils are ice-made, but perhaps without them, the human expansion over the Earth would not have been possible. In the time of dinosaurs, the weathering of the igneous rocks coupled with the decay of organic life and the biosynthesis and laying down of limestones by diatoms, corals, and other creatures would have been quite sufficient to make fertile soils. In fact, the lush fern and cycad forests that the dinosaurs inhabited might never have seen an Ice Age. Though it is possible that the ice has come before—it probably did come around two hundred million years ago—the Ice Age that cut the cloth for most of our present soils was an anomaly.

The fertile soils of the prairies, not only in North America but also in Russia and China and wherever they occur—the black mollisols and

chernozems—have fueled the industrial civilizations of the modern age. They are very, very young, the most recent advance of glacial ice having turned back only fifteen thousand years ago. As the ice retreated, it left glacier-ground dust in the outwash plains. The rising winds lifted and spun these dusts out over vast areas of the flattish stable platforms of the world. This fertile dust, lying in deposits up to a thousand feet deep, is really no more than a stirring in the ashes of the earth. From it has sprung the flame that we refer to as civilization.

The Continental glaciers never extended over the entire present-day black-soil belts. Indeed, the soils are richer where the glaciers did not quite reach, because the fertile silt falling there did not fall atop the grittier matter, the rough tills and drifts of dropped boulders, rocks, and pebbles.

A glacier becomes a tool for cutting and polishing first by picking up stone from the bedrock. The part of the frozen surface in contact with the ground sends water into cracks in the bedrock, which on freezing breaks out hunks of stone. These become grit of the glacier's sandpaper, adhering to the bottom of the ice and scraping along carving grooves and grinding smaller or weaker rocks into powder. The powder advances with the glacier front or flows slowly out suspended in outwash streams. Thousands of years later, as the glacier recedes, the wind lifts the powder and fills the gentle bowl of the craton with the dust.

The fertility of the dust is partly owed to its particle size. Crushed small, it has many more surfaces for chemical reaction than would a large chunk. When a cook cuts up a stick of butter in the saucepan, so that it will melt quicker, the same effect occurs. The fertility is also owed to the nutrients released in the dust—potassium, magnesium, calcium, and others—and to the great deep matrix of silica upon which plants can stand firm and secure.

It is strange to think that indeed this grinding, this plowing in solid rock, is responsible for our existence. A cornbelt soil in the United States is an extraordinary machine, even after half a century of rapine at the hands of industrial agriculture. The soil as a body is continually doing work. An acre of good natural Iowa soil burns carbon at the rate of 1.6 pounds of soft coal per hour. It breathes out twenty-five times as much CO_2 in a day as does a man. Every acre puts out a horsepower's worth of energy every day. Without a soil this productive, we would still be hunting and gathering in small bands.

These soils are not eternal. Far from it. They are young. They will grow old and die. For many years Hans Jenny studied an unglaciated soil at the

pygmy forest on the Mendocino Coast; no dust or incoming erosive matter has renewed this soil, and it can support nothing at all but stunted trees and shrubs—plants that grow nowhere else—as well as lichens. Because they are porous and because water carries away their nutrients, soils eventually deteriorate.

But we can make them run longer. One motive for protecting the soil is the certainty that it is fragile. It does not have the same unchanging character as a mountain or a river; it is a recent and ephemeral product. We owe it our lives and our energy, and the bodies we give back to it are not payment enough.

Dirt

"Dirt" is a good word. It goes straight back to the Anglo-Saxon and the Old Norse. Like "love," "fuck," "house," "hearth," "earth," "sky," "wrath," and "word," it is short, strong, and leaves a taste in the mouth. Therefore, even before you know what it means, you want to get ahold of it and chew it.

Many people would rather use the word "soil." I met an ecologist in a parking lot one day, getting out of his car. He asked me what my book was about. "Dirt," I said. The man scowled. "Soil, you mean," he corrected.

"No, no. I mean dirt," I insisted. "The stuff kids play in, the kind of road that begins where the pavement ends. Dirt."

An Englishwoman said, "But dirt, well 'dirt' among us English is the word for . . . excrement. You know, as in "dog dirt." If you are not going to use "soil" then for goodness' sake, use "earth." It's more spiritual."

"When I say dirt, I mean dirt," I replied. "Earth" can be confusing, because to me it means the whole ball of wax. "Soil" sometimes strikes my ear as sexless and ugly. It makes the mouth taste of sour old nurses who complain, "Mr. A. has soiled himself again!"

It takes dirt to grow an oak from an acorn. It takes the rot and the shit that is the root meaning of "dirt"—dritten means "shit" in Old Norse. It takes the hot and the wet to awaken the cool order of the mineral world.

Turds no less than rocks and roses are repositories for the energy of the sun. Dirt is where those three meet and meld, to transform the surface of the world and the air that we breathe.

Even into this century, when a country girl was going to be married in France, they fixed the amount of her dowry according to the weight of the manure produced on her father's farm. And until quite recently, if you sold

a farm, you always got a credit for the amount of compost that you'd saved. That is what I mean by dirt, the stuff of husbandry.

I mean the stuff that my father used to crumble in his hands and say softly, "That's good black dirt, that is."

The Theory and Practice of Manuring

Muck is the mother of the mealbag.

—Traditional Irish Saying

A great deal of the world's wisdom is contained in manure. Not only the grain in the mealbag but the full-blown rose are, in one sense, the gift of turds.

To be accurate, manure isn't just shit. It is both the dung and urine of an animal, the latter often contained in soaked straw or other bedding. It's important to grasp this dual nature of muck, because while the solid feces are comparatively rich in phosphorus, they contain only about one-third of the manure's nitrogen and one-fifth of its potash. The greater proportion of these two important nutrients is contained in the urine.

A whole web of organisms in the soil eats manure, cleaving the organic molecules into simpler ones, using some of the results to feed itself, pushing some back into the soil where something else munches it. Then the flatworms and the mites and the beetles and the springtails chase the fattened bacteria, fungi, and earthworms, devouring them, building their own cell walls, excreting the rest. At the death of insects, the chitin-digesting actinomycetes go to work on their exoskeletons, cleaving the tough shells into food and releasing that unmistakable odor that Pliny called "divine," sweeter than any perfume and the only criterion by which to judge healthy soil.

Viewed from this perspective, the process of manure making is slightly comical, yet undeniably attractive in its variety and efficiency. From closer up, it is messy. The cow, horse, chicken, sheep, dog leaves its pie, manure, dung, droppings, dirt, to the tune of roughly two billion tons each year, enough for a three-foot layer over all the home gardens in America.

Who wants to pick it up? Less than a quarter of the manure (including both feces and urine) that these animals drop is usefully returned to the soil. Take the case of New York City. "Sanitation takes it away,"' says [police officer] Oliver of the New York City Mounted Unit. "It's piled out back there,"' says Bob of the Wichita Zoo. "We pay a guy to cart it off," says the

owner of a horse stable not three city blocks away from a community garden that is starving for rich soil. And all over America, urban people wrap their dog's doo fastidiously in old newspaper and chuck it in the trash.

If it's any consolation, modernity and the flush toilet are not entirely to blame. Though among the colonists who destroyed New England's already thin soils in less than a century were some few who had the sense to follow the first-century Roman writer Columella's recommendations and return the manure to the cultivated soil—in some towns, William Cronon reports in "Changes in the Land," there was a weekly lottery for the right to have the town sheep spend the night on one's land—the majority let their stock roam free, diluting the benefit of their droppings over acres of pasture and forest.

I propose a new national symbol: not Smoky the Bear or an eagle but a colonist planting an apple tree over the old outhouse hole.

John Adams's Manure Piles

John Adams was second president of the United States, the great friend of Thomas Jefferson, and the proudest manure man in colonial America. He was so sanguine about his own compost heaps that his grandson and editor, Charles Francis Adams, excised many of the manure-related entries from John's journals. This was wrong because he, among all the gentlemen of his time, understood the ground he walked upon. Here is some of what was excised.

July 1763, from the Draft of the "Essay on Agriculture"

In making experiments, upon the variety of soils, and Manures, Grains and Grasses, Trees, and Bushes, and in your Enquiries in the Course and operation of Nature in the Production of these, you will find as much Employment for your Ingenuity, and as high a Gratification to a good Taste, as in any Business of Amusement you can chuse to pursue. The finest productions of the Poet or the Painter, the statuary or the Architect, when they stand in Competition with the great and beautiful operations of Nature, in the Animal and Vegetable World, must be pronounced mean and despicable baubles.

Braintree, Massachusetts. 25 June 1771, "Recipe to Make Manure"

Take the Soil and Mud, which you cutt up and throw out when you dig Ditches in a Salt Marsh, and put 20 Loads of it in a heap. Then take

20 Loads of common Soil or mould of Upland, and Add to the other. Then to the whole add 20 Loads of Dung, and lay the whole in a Heap, and let it lay 3 months, then take your Spades And begin at one End of the Heap, and dig it up and throw it into another Heap, there let it lie, till the Winter when the Ground is frozen, and then cart it on, to your English Grass Land. Ten or 20 Loads to an Acre, as you choose.

Braintree, Massachusetts. 8 August 1771

Have loitered at home most of the past week, gazing at my Workmen. I set 'em upon one Exploit, that pleases me much. I proposed ploughing up the Ground in the Street along my Stone Wall opposite to Mr. Jos. Fields, and carting the Mould into my Cow Yard. A few Scruples, and Difficulties were started but these were got over and Plough, Cart, Boards, Shovells, Hoes, &c were collected. We found it easyly ploughed by one Yoke of Oxen, very easy to shovel into the Cart, and very easily spread in the Yard. It was broke entire to Pieces, and crumbled like dry Snow or indian meal in the Cow Yard. It is a Mixture of Sand, of Clay, and of the Dung of Horses, neat Cattle, Sheep, Hogs, Geese &c washed down the whole length of Pens bill by the Rains. It has been a Century a Washing down, and is probably deep. We carted in 8 Loads in a Part of an Afternoon with 3 Hands, besides ploughing it up, and 8 Loads more the next forenoon, with 2 Hands. I must plough up a long ditch the whole length of my Wall from N Belchers to my House, and cart in the Contents. I must plough up the whole Balle from my Gate to Mr. Fields Corner, and cart in the Sward. I must enlarge my Yard and plough up what I take in, and lay on that Sward; I must dig a Ditch in my fresh Meadow from N Belchers Wall down to my Pond, and Cart the Contents into my Yard. I must open and enlarge four Ditches from the Street down to Deacon Belchers Meadow, and cart in the Contents. I must also bring in 20 Loads of Sea Weed, i.e., Eel Grass, and 20 Loads of Marsh Mud, and what dead ashes I can get from the Potash Works and what Dung I can get from Boston, and what Rock Weed from Nat. Belcher or else where. All this together with what will be made in the Barn and Yard, by my Horses, Oxen, Cows, Hogs, &c, and by the Weeds, that will be carried in from the Gardens, and the Wash and Trash from the House, in the Course of a Year would make a great Quantity of Choice manure.

London. 8 July 1786

In one of my common Walks, along the Edgeware Road, there are fine Meadows belonging to a noted Cow keeper. These Plotts are plentifully manured. There are on the Side of the Way, several heaps of Manure, an hundred Loads perhaps in each heap. I have carefully examined them and find them composed of Straw, and dung from the Stables and Streets of London, mud, Clay, or Marl, dug out of the Ditch, along the Hedge, and Tutj, Sward cutt up, with Spades, hoes, and shovels in the Road. . . . This may be good manure, but it is not equal to mine. . . .

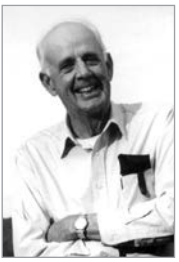
William Bryant Logan is a certified arborist and president of Urban Arborists, Inc., a Brooklyn-based tree company. William has won numerous Quill and Trowel Awards from the Garden Writers of America, and won a 2012 Senior Scholar Award from the New York State chapter of the International Society of Arboriculture. He also won an NEH grant to translate Calderón de la Barca. William is a faculty member at the New York Botanical Garden, and is the author of Oak *and* Dirt*—the latter of which was made into an award-winning documentary. The same filmmakers currently are planning to make a documentary from another of his books,* Air. *William lives in New York City.*

The Soil and Health

BY SIR ALBERT HOWARD
with a new introduction by Wendell Berry

Note to reader: *The following introduction and excerpt are reprinted with permission from* The Soil and Health: A Study of Organic Agriculture.

New Introduction



In 1964 my wife, Tanya, and I bought a rough and neglected little farm on which we intended to grow as much of our own food as we could. My editor at the time was Dan Wickenden, who was an organic gardener and whose father, Leonard Wickenden, had written a practical and inspiring book, *Gardening with Nature*, which I bought and read. Tanya and I wanted to raise our own food because we liked the idea of being independent to that extent, and because we did not like the toxicity, expensiveness, and wastefulness of "modern" food production. *Gardening with Nature* was written for people like us, and it helped us to see that what we wanted to do was possible. I asked Dan where his father's ideas had come from, and he gave me the name of Sir Albert Howard. My reading of Howard, which began at that time, has never stopped, for I have returned again and again to his work and his thought. I have been aware of his influence in virtually everything I have done, and I don't expect to graduate from it. That is because his way of dealing with the subject of agriculture is also a way of dealing with the subject of life in this world. His thought is systematic, coherent, and inexhaustible.

Sir Albert Howard was born in 1873 to a family in Shropshire, and he died in 1947. He published several books and also many articles in agricultural journals. His best-known books, *An Agricultural Testament* (1940) and *The Soil and Health* (1947), were addressed both to general readers and to his fellow scientists.

An Agricultural Testament and *The Soil and Health* are products of Howard's many years as a government scientist in India, during which he conceived, and set upon sound scientific footing, the kind of agriculture to which his followers have applied the term "organic." But by 1940, when the first of these books was published, the industrialization of agriculture

had already begun. By 1947, when *The Soil and Health* was published, World War II had proved the effectiveness of the mechanical and chemical technology that in the coming decades would radically alter both the practice of agriculture and its underlying assumptions.

This "revolution" marginalized Howard's work and the kind of agriculture he advocated. So-called organic agriculture survived only on the margin. It was practiced by some farmers of admirable independence and good sense and also by some authentic nuts. In the hands of the better practitioners, it was proven to be a healthful, productive, and economical way of farming. But while millions of their clients spent themselves into bankruptcy on industrial supplies, the evangelists of industrial agriculture in government and the universities ignored the example of the successful organic farmers, just as they ignored the equally successful example of Amish farming.

Meanwhile, Howard's thought, as manifested by the "organic movement," was seriously oversimplified. As it was understood and prescribed, organic agriculture improved the health of crops by building humus in the soil, and it abstained from the use of toxic chemicals. There is nothing objectionable about this kind of agriculture, so far as it goes, but it does not go far enough. It does not conceive of farms in terms of their biological and economic structure, because it does not connect farming with its ecological and social contexts. Under the current and now official definition of organic farming, it is possible to have a huge "organic" farm that grows only one or two crops, has no animals or pastures, is entirely dependent on industrial technology and economics, and imports all its fertility and energy. It was precisely this sort of specialization and oversimplification that Sir Albert Howard worked and wrote against all his life.

At present this movement (if we can still apply that term to an effort that is many-branched, multicentered, and always in flux) in at least some of its manifestations appears to be working decisively against such oversimplification and the industrial gigantism that oversimplification allows. Some food companies as well as some consumers now understand that only the smaller family farms, such as those of the Amish, permit the diversity and the careful attention that Howard's standards require.

Howard's fundamental assumption was that the processes of agriculture, if they are to endure, have to be analogous to the processes of nature. If one is farming in a place previously forested, then the farm must be a

systematic analogue of the forest, and the farmer must be a student of the forest. Howard stated his premise as an allegory:

> *The main characteristic of Nature's farming can . . . be summed up in a few words. Mother earth never attempts to farm without live stock; she always raises mixed crops; great pains are taken to preserve the soil and to prevent erosion; the mixed vegetable and animal wastes are converted into humus; there is no waste; the processes of growth and the processes of decay balance one another; ample provision is made to maintain large reserves of fertility; the greatest care is taken to store the rainfall; both plants and animals are left to protect themselves against disease.*

Nature is the ultimate value of the practical or economic world. We cannot escape either it or our dependence on it. It is, so to speak, its own context, whereas the context of agriculture is, first, nature and then the human economy. Harmony between agriculture and its natural and human contexts would be health, and health was the invariable standard of Howard's work. His aim always was to treat "the whole problem of health in soil, plant, animal, and man as one great subject." And Louise Howard spells this out in *Sir Albert Howard in India*:

> *A fertile soil, that is, a soil teeming with healthy life in the shape of abundant microflora and microfauna, will bear healthy plants, and these, when consumed by animals and man, will confer health on animals and man. But an infertile soil, that is, one lacking sufficient microbial, fungous, and other life, will pass on some form of deficiency to the plant, and such plant, in turn, will pass on some form of deficiency to animal and man.*

This was Howard's "master idea," and he understood that it implied a long-term research agenda, calling for "a boldly revised point of view and entirely fresh investigations."

His premise, then, was that the human economy, which is inescapably a land-using economy, must be constructed as an analogue of the organic world, which is inescapably its practical context. And so he was fundamentally at odds with the industrial economy, which sees creatures, including humans, as machines, and agriculture, like ultimately the entire human economy, as an analogue of an industrial system. This was, and is,

the inevitable and characteristic product of the dead-end materialism that is the premise of both industrialism and the science that supports it.

Howard understood that such reductionism could not work for agriculture:

> *But the growing of crops and the raising of live stock belong to biology, a domain where everything is alive and which is poles asunder from chemistry and physics. Many of the things that matter on the land, such as soil fertility, tilth, soil management, the quality of produce, the bloom and health of animals, the general management of live stock, the working relations between master and man, the esprit de corps of the farm as a whole, cannot be weighed or measured. Nevertheless their presence is everything: their absence spells failure.*

This understanding has a scientific basis, as it should have, for Howard was an able and conscientious scientist. But I think it comes also from intuition, and probably could not have come otherwise. Howard's intuition was that of a man who was a farmer by birth and heritage and who was a sympathetic as well as a scientific observer of the lives of plants, animals, and farmers.

If the farm is to last—if it is to be "sustainable," as we now say—then it must waste nothing. It must obey in all its processes what Howard called "the law of return." Under this law, agriculture produces no waste; what is taken from the soil is returned to it. Growth must be balanced by decay: "In this breaking down of organic matter we see in operation the reverse of the building-up process which takes place in the leaf."

The balance between growth and decay is the sole principle of stability in nature and in agriculture. And this balance is never static, never finally achieved, for it is dependent upon a cycle, which in nature, and within the limits of nature, is self-sustaining, but which in agriculture must be made continuous by purpose and by correct methods. "This cycle," Howard wrote, "is constituted of the successive and repeated processes of birth, growth, maturity, death, and decay."

The interaction, the interdependence, of life and death, which in nature is the source of an inexhaustible fecundity, is the basis of a set of analogies, to which agriculture and the rest of the human economy must conform in order to endure, and which is ultimately religious, as Howard knew: "An

eastern religion calls this cycle the Wheel of Life . . . Death supersedes life and life rises again from what is dead and decayed."

The maintenance of this cycle is the practical basis of good farming and its moral basis as well:

> *[T]he correct relation between the processes of growth and the processes of decay is the first principle of successful farming. Agriculture must always be balanced. If we speed up growth we must accelerate decay. If, on the other hand, the soil's reserves are squandered, crop production ceases to be good farming: it becomes something very different. The farmer is transformed into a bandit.*

It seems to me that Howard's originating force, innate in his character and refined in his work, was his sense of context. This made him eminent and effective in his own day, and it makes his work urgently relevant to our own. He lacked completely the specialist impulse, so prominent among the scientists and intellectuals of the present-day university, to see things in isolation.

He himself began as a specialist, a mycologist, but he soon saw that this made him "a laboratory hermit," and he felt that this was fundamentally wrong:

> *I was an investigator of plant diseases, but I had myself no crops on which I could try out the remedies I advocated: I could not take my own advice before offering it to other people. It was borne in on me that there was a wide chasm between science in the laboratory and practice in the field, and I began to suspect that unless this gap could be bridged no real progress could be made in the control of plant diseases: research and practice would remain apart: mycological work threatened to degenerate into little more than a convenient agency by which—provided I issued a sufficient supply of learned reports fortified by a judicious mixture of scientific jargon—practical difficulties could be side-tracked.*

The theme of his life's work was his effort to bridge this gap. The way to do it was simply to refuse to see anything in isolation. Everything, as he saw it, existed within a context, outside of which it was unintelligible. Moreover, every problem existed within a context, outside of which it was unsolvable. Agriculture, thus, cannot be understood or its problems solved without

respect to context. The same applied even to an individual plant or crop. And this respect for context properly set the standard and determined the methodology of agricultural science:

> *The basis of research was obviously to be investigation directed to the whole existence of a selected crop, namely, "the plant itself in relation to the soil in which it grows, to the conditions of village agriculture under which it is cultivated, and with reference to the economic uses of the product"; in other words research was to be integral, never fragmented.*

If nothing exists in isolation, then all problems are circumstantial; no problem resides, or can be solved, in anybody's department. A disease was, thus, a symptom of a larger disorder. The following passage shows as well as any the way his mind worked:

> *I found when I took up land in India and learned what the people of the country know, that the diseases of plants and animals were very useful agents for keeping me in order, and for teaching me agriculture. I have learnt more from the diseases of plants and animals than I have from all the professors of Cambridge, Rothamsted, and other places, who gave me my preliminary training. I argued the matter in this way. If diseases attacked my crops, it was because I was doing something wrong. I therefore used diseases to teach me. In this way I really learnt agriculture—from my father and from my relatives and from the professors I only obtained a mass of preliminary information. Diseases taught me to understand agriculture. I think if we used diseases more instead of running to sprays and killing off pests, and if we let diseases rip and then found out what is wrong and then tried to put it right, we should get much deeper into agricultural problems than we shall do by calling in all these artificial aids. After all, the destruction of a pest is the evasion of, rather than the solution of, all agricultural problems.*

The implied approach to the problem of disease is illustrated by the way Howard and his first wife, Gabrielle, dealt with the problem of indigo wilt:

> *In fifteen years £54,207 had been spent on research, at that time a large sum. Yet the Imperial Entomologist could find no insect, the Imperial*

Mycologist no fungus, and the Imperial Bacteriologist no virus to account for the plague.

The Howards proceeded differently. Their start was to grow the crop on a field scale and in the best possible way, taking note of local methods. Their observation was directed to the whole plant, above and below ground; they followed the crop throughout its life history; they looked at all the surrounding circumstances, soil, moisture, temperature. But they looked for no virus, no fungus, and no insect.

And it was the Howards who solved the problem. The plants were wilting, they found, primarily because the soils were becoming water-logged during the monsoon, killing the roots; the plants were wilting and dying from starvation. It was a problem of management, and it was solved by changes in management. But it could not have been solved except by studying the whole plant in its whole context.

Because he refused to accept the academic fragmentation that had become conventional by his time, Howard, of course, was "accused of invading fields not his own," and this he had done intentionally and in accordance with "the guiding principle of the closest contact between research and those to be served."

Agriculture is practiced inescapably in a context, and its context must not be specialized or simplified. Its context, first of all, is the nature of the place in which it is practiced, but it is also the society and the economy of those who practice it. And just as there are penalties for ignoring the natural context, so there are penalties for ignoring the human one. As Howard saw it, the agricultural industrialists' apparent belief that food production could be harmlessly divorced from the economic interest of farmers needlessly repeats a historical failure:

Judged by the ordinary standards of achievement the agricultural history of the Roman Empire ended in failure due to inability to realize the fundamental principle that the maintenance of soil fertility coupled with the legitimate claims of the agricultural population should never have been allowed to come in conflict with the operations of the capitalist. The most important possession of a country is its population. If this is maintained in health and vigour everything else will follow; if this is allowed to decline nothing, not even great riches, can save the country from eventual ruin.

The obligation of a country's agriculture, then, is to maintain its people in health, and this applies equally to the people who eat and to the people who produce the food.

Howard accepted this obligation unconditionally as the obligation also of his own work. He realized, moreover, that this obligation imposed strict limits both upon the work of farmers and upon his work as a scientist: First, neither farming nor experimentation should usurp the tolerances or violate the nature of the place where the work is done; and second, the work must respect and preserve the livelihoods of the local community. Before going to work, agricultural scientists are obliged to know both the place where their work is to be done and the people for whom they are working. It is remarkable that Howard came quietly, by thought and work, to these realizations a half century and more before they were forced upon us by the ecological and economic failures of industrial agriculture.

In India he used his training as a scientist and his ability to observe and think for himself, just as he would have been expected to do. But he also learned from the peasant farmers of the country, whom he respected as his "professors." He valued them for their knowledge of the land, for their industry, and for their "accuracy of eye." He accepted also the economic and technological circumstances of those farmers as the limit within which he himself should do his work. He saw that it would be possible to ruin his clients by thoughtless or careless innovation:

> *Often improvements are possible but they are not economic. ... In India the cultivators are mostly in debt and the holdings are small. Any capital required for developments has to be borrowed. A large number of possible improvements are barred by the fact that the extra return is not large enough to pay the high interest on the capital involved and also to yield a profit to the cultivator.*

The reader may wish to contrast this way of thinking with that of the Green Revolution or with that of the headlong industrialization of American agriculture since World War II, in both of which the only recognized limit was technological, and in neither of which was there any concern for the ability of farmers or their communities to bear the costs.

Howard's solution to the problem was simply to do his work within the technological limits of the local farmers:

> *The existing system could not be radically changed, but it might be developed in useful ways. This must never exceed what the cultivator could afford, and, in a way, also what he was used to. This principle Sir Albert kept in mind to the very end … his standard seems to have been the possession of a yoke of oxen; when more power was needed, the presumption was that the second yoke could be borrowed from a neighbor. Thus the maximum draught contemplated was four animals.*

By the observance of such limits, Howard was enfolded consciously and conscientiously within the natural and human communities that he endeavored to serve.

No university that I have heard of, land-grant or other, has yet attempted to establish its curriculum and its intellectual structure on Sir Albert Howard's "one great subject," or on his determination to serve respectfully and humbly the local population. But a university most certainly could do so, and in doing so it could bring to bear all its disciplines and departments. In doing so, that is to say, it could become in truth a university.

At present our universities are not simply growing and expanding, according to the principle of "growth" universal in industrial societies, but they are at the same time disintegrating. They are a hodge-podge of unrelated parts. There is no unifying aim and no common critical standard that can serve equally well all the diverse parts or departments.

The fashion now is to think of universities as industries or businesses. University presidents, evidently thinking of themselves as CEOs, talk of "business plans" and "return on investment," as if the industrial economy could provide an aim and a critical standard appropriate either to education or to research.

But this is not possible. No economy, industrial or otherwise, can supply an appropriate aim or standard. Any economy must be either true or false to the world and to our life in it. If it is to be true, then it must be made true, according to a standard that is not economic.

To regard the economy as an end or as the measure of success is merely to reduce students, teachers, researchers, and all they know or learn to merchandise. It reduces knowledge to "property" and education to training for the "job market."

If, on the contrary, Howard was right in his belief that health is the "one great subject," then a unifying aim and a common critical standard are

clearly implied. Health is at once quantitative and qualitative; it requires both sufficiency and goodness. It is comprehensive (it is synonymous with "wholeness"), for it must leave nothing out. And it is uncompromisingly local and particular; it has to do with the sustenance of particular places, creatures, human bodies, and human minds.

If a university began to assume responsibility for the health of its place and its local constituents, then all of its departments would have a common aim, and they would have to judge their place and themselves and one another by a common standard. They would need one another's knowledge. They would have to communicate with one another; the diversity of specialists would have to speak to one another in a common language. And here again Howard is exemplary, for he wrote, and presumably spoke, a plain, vigorous, forthright English—no jargon, no condescension, no ostentation, no fooling around.

—Wendell Berry
Port Royal, Kentucky

The Operations of Nature

The Introduction to this book describes an adventure in agricultural research and records the conclusions reached. If the somewhat unorthodox views set out are sound, they will not stand alone but will be supported and confirmed in a number of directions—by the farming experience of the past and above all by the way Nature, the supreme farmer, manages her kingdom. In this chapter the manner in which she conducts her various agricultural operations will be briefly reviewed. In surveying the significant characteristics of the life—vegetable and animal—met with in Nature, particular attention will be paid to the importance of fertility in the soil and to the occurrence and elimination of disease-ill plants and animals.

What is the character of life on this planet? What are its great qualities? The answer is simple: The outstanding characteristics of Nature are variety and stability.

The variety of the natural life around us is such as to strike even the child's imagination, who sees in the fields and copses near his home, in the ponds and streams and seaside pools round which he plays, or, if being city-born he be deprived of these delightful playgrounds, even in his poor

back-garden or in the neighbouring park, an infinite choice of different flowers and plants and trees, coupled with an animal world full of rich changes and surprises, in fact, a plenitude of the forms of living things constituting the first and probably the most powerful introduction he will ever receive into the nature of the universe of which he is himself a part.

The infinite variety of forms visible to the naked eye is carried much farther by the microscope. When, for example, the green slime in stagnant water is examined, a new world is disclosed—a multitude of simple flowerless plants—the blue-green and the green algae, always accompanied by the lower forms of animal life. We shall see in a later chapter that on the operations of these green algae the well-being of the rice crop, which nourishes countless millions of the human race, depends. If a fragment of mouldy bread is suitably magnified, members of still another group of flowerless plants, made up of fine, transparent threads entirely devoid of green colouring matter, come into view. These belong to the fungi, a large section of the vegetable kingdom, which are of supreme importance in farming and gardening.

It needs a more refined perception to recognize throughout this stupendous wealth of varying shapes and forms the principle of stability. Yet this principle dominates. It dominates by means of an ever-recurring cycle, a cycle which, repeating itself silently and ceaselessly, ensures the continuation of living matter. This cycle is constituted of the successive and repeated processes of birth, growth, maturity, death, and decay.

An eastern religion calls this cycle the Wheel of Life and no better name could be given to it. The revolutions of this Wheel never falter and are perfect. Death supersedes life and life rises again from what is dead and decayed.

Because we are ourselves alive we are much more conscious of the processes of growth than we are of the processes involved in death and decay. This is perfectly natural and justifiable. Indeed, it is a very powerful instinct in us and a healthy one. Yet, if we are fully grown human beings, our education should have developed in our minds so much of knowledge and reflection as to enable us to grasp intelligently the vast role played in the universe by the processes making up the other or more hidden half of the Wheel. In this respect, however, our general education in the past has been gravely defective partly because science itself has so sadly misled us. Those branches of knowledge dealing with the vegetable and animal kingdoms—botany and zoology—have confined themselves almost entirely

to a study of *living* things and have given little or no attention to what happens to these units of the universe when they die and to the way in which their waste products and remains affect the general environment on which both the plant and animal world depend. When science itself is unbalanced, how can we blame education for omitting in her teaching one of the things that really matter?

For though the phases which are preparatory to life are, as a rule, less obvious than the phases associated with the moment of birth and the periods of growth, they are not less important. If once we can grasp this and think in terms of ever-repeated advance and recession, recession and advance, we have a truer view of the universe than if we define death merely as an ending of what has been alive.

Nature herself is never satisfied except by an even balancing of her processes—growth and decay. It is precisely this even balancing which gives her unchallengeable stability. That stability is rock-like. Indeed, this figure of speech is a poor one, for the stability of Nature is far more permanent than anything we can call a rock—rocks being creations which themselves are subject to the great stream of dissolution and rebirth, seeing that they suffer from weathering and are formed again, that they can be changed into other substances and caught up in the grand process of living: They too, as we shall see, are part of the Wheel of Life. However, we may at a first glance omit the changes which affect the inert masses of this planet, petrological and mineralogical—though very soon we shall realize how intimate is the connection even between these and what is, in the common parlance, alive. There is a direct bridge between things inorganic and things organic and this too is part of the Wheel.

But before we start on our examination of that part of the great process which now concerns us—namely, plant and animal life and the use man makes of them—there is one further idea which we must master. It is this: The stability of Nature is secured not only by means of a very even balancing of her Wheel, by a perfect timing, so to say, of her mechanisms, but also rests on a basis of enormous reserves. Nature is never a hand-to-mouth practitioner. She is often called lavish and wasteful, and at first sight one can be bewildered and astonished at the apparent waste and extravagance which accompany the carrying on of vegetable and animal existence. Yet a more exact examination shows her working with an assured background of accumulated reserves, which are stupendous and also

essential. The least depletion in these reserves induces vast changes and not until she has built them up again does she resume the particular process on which she was engaged. A realization of this principle of reserves is thus a further necessary item in a wide view of natural law. Anyone who has recovered from a serious illness, during which the human body lives partly on its own reserves, will realize how Nature afterwards deals with such situations. During the period of convalescence the patient appears to make little progress till suddenly he resumes his old-time activities. During this waiting period the reserves used up during illness are being replenished.

The Life of the Plant

A survey of the Wheel of Nature will best start from that rather rapid series of processes which cause what we commonly call living matter to come into active existence; that is, in fact, from the point where life most obviously, to our eyes, begins. The section of the Wheel embracing these processes is studied in physiology from the Greek word *φύόις*, the root *φύω* meaning to bring to life, to grow.

But how does life begin on this planet? We can only say this: that the prime agency in carrying it on is sunlight, because it is the source of energy, and that the instrument for intercepting this energy and turning it to account is the green leaf.

This wonderful little example of Nature's invention is a battery of intricate mechanisms. Each cell in the interior of a green leaf contains minute specks of a substance called chlorophyll and it is this chlorophyll which enables the plant to grow. Growth implies a continuous supply of nourishment. Now plants do not merely collect their food: They manufacture it before they can feed. In this they differ from animals and man, who search for what they can pass through their stomachs and alimentary systems, but cannot do more; if they are unable to find what is suitable to their natures and ready for them, they perish. A plant is, in a way, a more wonderful instrument. It is an actual food factory, making what it requires before it begins the processes of feeding and digestion. The chlorophyll in the green leaf, with its capacity for intercepting the energy of the sun, is the power unit that, so to say, runs the machine. The green leaf enables the plant to draw simple raw materials from diverse sources and to work them up into complex combinations.

Thus from the air it absorbs carbon-dioxide (a compound of two parts of oxygen to one of carbon), which is combined with more oxygen from the

atmosphere and with other substances, both living and inert, drawn from the soil and from the water which permeates the soil. All these raw materials are then assimilated in the plant and made into food. They become organic compounds, i.e. compounds of carbon, classified conveniently into groups known as carbohydrates, proteins, and fats; together with an enormous volume of water (often over 90 percent of the whole plant) and interspersed with small quantities of chemical salts which have not yet been converted into the organic phase. They make up the whole structure of the plant—root, stem, leaf, flower and seed. This structure includes a big food reserve. The life principle, the nature of which evades us and in all probability always will, resides in the proteins looked at in the mass. These proteins carry on their work in a cellulose framework made up of cells protected by an outer integument and supported by a set of structures known as the vascular bundles, which also conduct the sap from the roots to the leaves and distribute the food manufactured there to the various centres of growth. The whole of the plant structures are kept turgid by means of water.

The green leaf, with its chlorophyll battery, is therefore a perfectly adapted agency for continuing life. It is, speaking plainly, the only agency that can do this and is unique. Its efficiency is of supreme importance. Because animals, including man, feed eventually on green vegetation, either directly or through the bodies of other animals, it is our sole final source of nutriment. There is no alternative supply. Without sunlight and the capacity of the earth's green carpet to intercept its energy for us, our industries, our trade, and our possessions would soon be useless. It follows therefore that everything on this planet must depend on the way mankind makes use of this green carpet, in other words on its efficiency.

The green leaf does not, however, work by itself. It is only a part of the plant. It is curious how easy it is to forget that normally we see only one-half of each flowering plant, shrub, or tree: The rest is buried in the ground. Yet the dying down of the visible growth of many plants in the winter, their quick reappearance in the spring, should teach us how essential and important a portion of all vegetation lives out of our sight; it is evident that the root system, buried in the ground, also holds the life of the plant in its grasp. It is therefore not surprising to find that leaves and roots work together, forming a partnership which must be put into fresh working order each season if the plant is to live and grow.

If the function of the green leaf armed with its chlorophyll is to manufacture the food the plant needs, the purpose of the roots is to obtain the water and most of the raw materials required—the sap of the plant being the medium by which these raw materials (collected from the soil by the roots) are moved to the leaf. The work of the leaf we found to be intricate: that of the roots is not less so. What is surprising is to come upon two quite distinct ways in which the roots set about collecting the materials which it is their business to supply to the leaf; these two methods are carried on simultaneously. We can make a very shrewd guess at the master principle which has put the second method alongside the first: It is again the principle of providing a reserve—this time of the vital proteins.

None of the materials that reach the green leaf by whatever method is food: It is only the raw stuff from which food can be manufactured. By the first method, which is the most obvious one, the root hairs search out and pass into the transpiration current of the plant dissolved substances which they find in the thin films of water spread between and around each particle of earth; this film is known as the soil solution. The substances dissolved in it include gases (mainly carbon dioxide and oxygen) and a series of other substances known as chemical salts, like nitrates, compounds of potassium and phosphorus, and so forth, all obtained by the breaking down of organic matter or from the destruction of the mineral portions of the soil. In this breaking down of organic matter we see in operation the reverse of the building-up process which takes place in the leaf. Organic matter is continuously reverting to the inorganic state: It becomes mineralized—nitrates are one form of the outcome. It is the business of the root hairs to absorb these substances from the soil solution and to pass them into the sap, so that the new life-building process can start up again. In a soil in good heart the soil solution will be well supplied with these salts. Incidentally we may note that it has been the proved existence of these mineral chemical constituents in the soil which, since the time of Liebig, has focused attention on soil chemistry and has emphasized the passage of chemical food materials from soil to plant to the neglect of other considerations.

But the earth's green carpet is not confined to its remarkable power of transforming the inert nitrates and mineral contents of the soil into an active organic phase: It is utilized by Nature to establish for itself, in addition, a direct connection, a kind of living bridge, between its own life

and the living portion of the soil. This is the second method by which plants feed themselves. The importance of this process, physiological in nature and not merely chemical, cannot be over-emphasized and some description of it will now be attempted.

The Living Soil

The soil is, as a matter of fact, full of live organisms. It is essential to conceive of it as something pulsating with life, not as a dead or inert mass. There could be no greater misconception than to regard the earth as dead: A handful of soil is teeming with life. The living fungi, bacteria, and protozoa, invisibly present in the soil complex, are known as the soil population. This population of millions and millions of minute existences, quite invisible to our eyes of course, pursue their own lives. They come into being, grow, work, and die: They sometimes fight each other, win victories, or perish; for they are divided into groups and families fitted to exist under all sorts of conditions. The state of a soil will change with the victories won or the losses sustained; and in one or other soil, or at one or other moment, different groups will predominate.

This lively and exciting life of the soil is the first thing that sets in motion the great Wheel of Life. Not without truth have poets and priests paid worship to "Mother Earth," the source of our being. What poetry or religion have vaguely celebrated, science has minutely examined, and very complete descriptions now exist of the character and nature of the soil population, the various species of which have been classified, labelled, and carefully observed. It is this life which is continually being passed into the plant.

The process can actually be followed under the microscope. Some of the individuals belonging to one of the most important groups in this mixed population—the soil fungi—can be seen functioning. If we arrange a vertical darkened glass window on the side of a deep pit in an orchard, it is not difficult to see with the help of a good lens or a low-power horizontal microscope (arranged to travel up and down a vertical fixed rod) some of these soil fungi at work. They are visible in the interstices of the soil as glistening white branching threads, reminiscent of cobwebs. In Dr. Rogers's interesting experiments on the root systems of fruit trees at East Malling Research Station, where this method of observing them was initiated and demonstrated to me, these fungous threads could be seen approaching the young apple roots in the absorbing region (just behind the advancing root

tips) on which the root hairs are to be found. Dr. Rogers very kindly presented me with two excellent photographs—one showing the general arrangement of his observation chamber (Plate I), the other, taken on 6th July 1933, of a root tip (magnified by about twelve) of *Lane's Prince Albert* (grafted on root stock XVI) at sixteen inches below the surface, showing abundant fungous strands running in the soil and coming into direct contact with the growing root (Plate II).

But this is only the beginning of the story. When a suitable section of one of these young apple roots, growing in fertile soil and bearing active root hairs, is examined, it will be found that these fine fungous threads actually invade the cells of the root, where they can easily be observed passing from one cell to another. But they do not remain there very long. After a time the apple roots absorb these threads. All stages of the actual digestion can be seen.

The significance of this process needs no argument. Here we have a simple arrangement on the part of Nature by which the soil material on which these fungi feed can be joined up, as it were, with the sap of the tree. These fungous threads are very rich in protein and may contain as much as 10 per cent of organic nitrogen; this protein is easily digested by the ferments (enzymes) in the cells of the root; the resulting nitrogen

Plate 1. Observation chamber for root studies at East Malling (L). Plate 2: The beginnings of mycorrhizal association in the apple (R).

complexes, which are readily soluble, are then passed into the sap current and so into the green leaf. An easy passage, as it were, has been provided for food material to move from soil to plant in the form of proteins and their digestion products, which latter in due course reach the green leaf. The marriage of a fertile soil and the tree it nourishes is thus arranged. Science calls these fungous threads *mycelium* (again from a Greek word, *μύκης*, and as the Greek for root is *ρίζα (rhiza,* d. rhizome); the whole process is known as the *mycorrhizal association*. This partnership is universal in the forest and is general throughout the vegetable kingdom. A few exceptions, however, exist which will be referred to in the next paragraph.[1]

Among the plants in which this mycorrhizal association has hitherto not been observed are the tomato and certain cultivated members of the cabbage family, many of which possess a very diffuse root system and exceptionally elongated root hairs. Nevertheless, all these examples respond very markedly to the condition of the soil in which they are grown and if fed with dressings of humus will prosper. The question naturally arises: Exactly how does this take place? What is the alternative mechanism that replaces the absent mycorrhizal association?

A simple explanation would appear to be this. Fertile soils invariably contain a greatly enhanced bacterial population whose dead remains must be profusely scattered in the water films which bathe the compound soil particles and the root hairs of the crops themselves; these specks of dead organic matter, rich in protein, are finally mineralized into simple salts like nitrates. We have already mentioned this breaking down process of the soil population. What is here to be noted is that it is no sudden transformation, but takes place in stages. May not, therefore, some at least of the first-formed nitrogen complexes, which result from this breaking down, be absorbed by the root hairs and so added to the sap current? That is to say that the non-mycorrhiza-forming plants, not drawing on the soil fungi,

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1 The reader who wishes to delve into the technical details relating to the mycorrhizal association and its bearing on forestry and agriculture should consult the following works:—

1. Rayner, M. C. and Neilson-Jones, W.—*Problems in Tree Nutrition*, Faber & Faber, London, 1944.
2. Balfour, Lady Eve—*The Living Soil*, Faber & Faber, London, 1944.
3. Howard, Sir Albert—*An Agricultural Testament*, Oxford University Press, 1940.
4. Rodale, J. I.—*Pay Dirt*, The Devin-Adair Company, New York, 1945.

do compensate themselves by absorbing organic nitrogen in this form—they catch the bacterial soil population, as it were, before it has been reduced to an entirely inert phase and so have their link also with the biological life of the soil. That there must be some such passage of matter on a biological basis is suggested by the fact that only in fertile soil, i.e. in soils teeming with bacteria, do these non-mycorrhiza formers reveal resistance to disease and high quality in the produce, which means that only in these soils are they really properly fed.

This would be a third method used by plants for feeding themselves, a sort of half-way method between the absorption powers exercised by the root hairs and the direct digestive capacity of the roots: as the mechanism used in this method is presumably the root hairs, the diffuseness of the root system of plants of the cabbage family would be explained. It is possible that even mycorrhiza formers use this alternative passage for organic nitrogen. There seems no reason at all why this should not be so.

But how do the various agencies concerned in these intricate operations manage to carry on their work, buried as they are away from the light and thus unable to derive anything from the source of energy, the sun? How do they do their initial work at all until they can hand over to the green leaf? They derive their energy by oxidising (i.e. burning up) the stores of organic matter in the soil. As in an ordinary fire, this process of oxidation releases energy. The oxygen needed for this slow combustion is drawn from the air, in part washed down by the rain, which dissolves it from the atmosphere in its descent. Incidentally this explains why rain is so superior as a moistening agency for plants to any form of watering from a can: incidentally, again, we can understand the need for cultivating the soil and keeping it open, so that the drawing in of oxygen, or the respiration of the soil, can proceed and the excess carbon dioxide can be expelled into the atmosphere.

Humus is the Latin word for soil or earth. But as used by the husbandman humus nowadays does not mean just earth in general, but indicates that undecayed residue of vegetable and animal waste lying on the surface, combined with the dead bodies of these bacteria and fungi themselves when they have done their work, the whole being a highly complex and somewhat varying substance which is, so to say, the mine or store or bank from which the organisms of the soil and then, in direct succession, the plant, the tree, and thereafter the animal, draw what they need for their existence. This store is all important.

The Significance of Humus

Humus is the most significant of all Nature's reserves and as such deserves a detailed examination.

A very perfect example of the methods by which Nature makes humus and thus initiates the turning of her Wheel is afforded by the floor of the forest. Dig down idly with a stick under any forest tree: First there will be a rich, loose accumulation of litter made up of dead leaves, flowers, twigs, fragments of bark, bits of decaying wood, and so forth, passing gradually as the material becomes more tightly packed into rich, moist, sweet-smelling earth, which continues downwards for some inches and which, when disturbed, reveals many forms of tiny insect and animal life. We have been given here a glimpse of the way Nature makes humus—the source from which the trunk of the tree has drawn its resisting strength, its leaves their glittering beauty.

Throughout the year, endlessly and continuously, though faster at some seasons than at others, the wastes of the forest thus accumulate and at once undergo transformation. These wastes are of many kinds and mix as they fall; for leaf mingles with twig and stem, flower with moss, and bark with seed-coats. Moreover, vegetable mingles with animal. Let us beware of the false idea that the forest is a part of the vegetable kingdom only. Millions of animal existences are housed in it; mammals and birds are everywhere and can be seen with the naked eye. The lower forms of animal life—the invertebrates—are even more numerous. Insects, earthworms, and so forth are obvious: The microscope reveals new worlds of animal life down to simple protozoa. The excreta of these animals while living and their dead bodies constitute an important component of what lies on the forest floor; even the bodies of insects form in the mass a constituent element not without importance. so that in the end the two sources of waste are completely represented and are, above all, completely mingled. But the volume of the vegetable wastes is several times greater than that of the animal residues.

These wastes lie gently, only disturbed by wind or by the foot of a passing animal. The top layer is thus very loose; ample air circulates for several inches downwards: The conditions for the fermentation by the moulds and microbes (which feed on the litter) are, as the scientist would say, *aerobic*. But partly by pressure from above and partly as the result of fermentation the lower layers are forced to pack more closely and the final

manufacture of humus goes on without much air—the conditions are now *anaerobic*. This is a succession of two modes of manufacture which we shall do well to remember, as in our practical work it has to be imitated.

This mass of accumulated wastes is acted on by the sunlight and the rain; both are dispersed and fragmented by the leaf canopy of the trees and undergrowth. The sunlight warms the litter; the rain keeps it moist. The rain does not reach the litter as a driving sheet, but is split up into small drops, the impetus of whose fall is well broken. Nor does the sunlight burn without shade; it is tempered. Finally, though air circulates freely, there is perfect protection from the cooling and drying effects of strong wind.

With abundant air, warmth, and water at their disposal, the fungi and bacteria, with which, as we have already noted, the soil is teeming, do their work. The fallen mixed wastes are broken up; some passes through the bodies of earthworms and insects: All is imperceptibly crumbled and changed until it decomposes into that rich mass of dark colour and earthy smell which is so characteristic of the forest floor and which holds such a wealth of potential plant nourishment.

The process that takes place in a prairie, a meadow, or a steppe is similar; perhaps slower, and the richness of the layer of humus will depend on a good many factors. One, in particular, has an obvious effect, namely, the supply of air. If, for some reason, this is cut off, the formation of humus is greatly impeded. Areas, therefore, that are partly or completely waterlogged will not form humus as the forest does: The upper portion of the soil will not have access to sufficient free oxygen nor will there be much oxygen in the standing water. In the first case a moor will result; in the second a bog or morass will be formed. In both these the conditions are anaerobic: The organisms derive their oxygen not from the air but from the vegetable and animal residues including the proteins. In this fermentation, nitrogen is always lost and the resulting low-quality humus is known as peat.

But the forest, the prairie, the moor, and the bog are not the only areas where humus formation is in progress. It is constantly going on in the most unlikely places—on exposed rock surfaces, on old walls, on the trunks and branches of trees, and indeed wherever the lower forms of plant life—algae, lichens, mosses, and liverworts—can live and then slowly build up a small store of humus.

Nature, in fact, conforming to that principle of reserves, does not attempt to create the higher forms of plant life until she has secured a good

store of humus. Watch how the small bits of decayed vegetation fall into some crack in the rock and decompose: Here is the little fern, the tiny flower, secure of its supply of food and well able to look after itself, as it thrusts its roots down into the rich pocket of nourishment. Nature adapts her flora very carefully to her varying supplies of humus. The plant above is the indicator of what the soil below is like, and a trained observer, sweeping his eye over the countryside, will be able to read it like the pages of a book and to tell without troubling to cross a valley exactly where the ground is waterlogged, where it is accumulating humus, where it is being eroded. He looks at the kind and type of plant, and infers from their species and condition the nature of the soil which they at once cover and reveal.

But we are not at the end of the mechanisms employed by Nature to get her great Wheel to revolve with smooth efficiency. The humus that lies on the surface must be distributed and made accessible to the roots of plants and especially to the absorbing portions of the roots and their tiny prolongations known as root hairs—for it is these which do the delicate work of absorption. How can this be done? Nature has, perforce, laid her accumulation on the surface of the soil. But she has no fork or spade: She cannot dig a trench and lay the food materials at the bottom where the plant root can strike down and get them. It seems an impasse, but the solution is again curiously simple and complete. Nature has her own labour force—ants, termites, and above all, earthworms. These carry the humus down to the required deeper levels where the thrusting roots can have access to it. This distribution process goes on continually, varying in intensity with night and day, with wetness or dryness, heat or cold, which alternately brings the worms to the surface for fresh supplies or sends them down many feet. It is interesting to note how a little heap of leaves in the garden disappears in the course of a night or two when the earthworms are actively at work. The mechanism of humus distribution is a give and take, for where a root has died the earthworm or the termite will often follow the minute channel thus created a long way.

Actually the earthworm eats of the humus and of the soil and passes them through its body, leaving behind the casts which are really enriched earth—perfectly conditioned for the use of plants. Analyses of these casts show that they are some 40 [percent] richer in humus than the surface soil, but very much richer in such essential food materials as combined nitrogen, phosphate, and potash. Recent results obtained by Lunt and Jacobson of the

Connecticut Experiment Station show that the casts of earthworms are five times richer in combined nitrogen, seven times richer in available phosphate, and eleven times richer in potash than the upper six inches of soil.

It is estimated that on each acre of fertile land, no less than twenty-five tons of fresh worm casts are deposited each year. Besides this the dead bodies of the earthworms must make an appreciable contribution to the supply of manure. In these ways Nature in her farming has arranged that the earth itself shall be her manure factory.

As the humus is continually being created, so it is continually being used up. Not more than a certain depth accumulates on the surface, normally anything from a few inches to two or three feet. For after a time the process ceases to be additive and becomes simply continuous: The growing plants use up the product at a rate equalling the rate of manufacture—the even turning of the Wheel of Life—the perfect example of balanced manuring. A reserve, however, is at all times present, and on virgin and undisturbed land it may be very great indeed. This is an important asset in man's husbandry; we shall later see how important.

The Importance of Minerals

Is the humus the only source from which the plant draws its nourishment? That is not so. The subsoil, i.e. that part of the soil derived from the decay of rocks, which lies below the layer of humus, also has its part to play. The subsoil is, as it were, a depository of raw material. It may be of many types, clay, sand, etc.; the geological formation will vary widely. It always includes a mineral content—potash, phosphates, and many rarer elements.

Now these minerals play an important part in the life of living things. They have to be conveyed to us in our food in an organic form, and it is from the plant, which transforms them into an organic phase and holds them thus, that we and the other animals derive them for our wellbeing.

How does the plant obtain them? We have seen that there is a power in the roots of all plants, even the tiniest, of absorbing them from the soil solution. But how is the soil solution itself impregnated with these substances? Mainly through the dissolving power of the soil water, which contains carbon dioxide in solution and so acts as a weak solvent. It would appear that the roots of trees, which thrust down into the subsoil, draw on the dissolved mineral wealth there stored and absorb this wealth into their structure. In tapping the lower levels of water present in the subsoil—for

trees are like great pumps drawing at a deep well—they also tap the minerals dissolved therein. These minerals are then passed into all parts of the tree, including the foliage. When in the autumn the foliage decays and falls, the stored minerals, now in an organic phase, are dropped too and become available on the top layers of the soil: They become incorporated in the humus. This explains the importance of the leaf-fall in preserving the land in good heart and incidentally is one reason why gardeners love to accumulate leaf-mould. By this means they feed their vegetables, fruit, and flowers with the minerals they need.

The tree has acted as a great circulatory system, and its importance in this direction is to be stressed. The destruction of trees and forests is therefore most injurious to the land, for not only are the physical effects harmful—the anchoring roots and the sheltering leaf canopy being alike removed—but the necessary circulation of minerals is put out of action. It is at least possible that the present mineral poverty of certain tracts of the earth's surface, e.g. on the South African veldt, is due to the destruction over wide areas and for long periods of all forest growth, both by the wasteful practices of indigenous tribes and latterly sometimes by exploiting Western interests.

Summary

Before we turn to consider the ways in which man has delved and dug into all these riches and disturbed them for his own benefit, let us sum up with one final glance at the operations of Nature. Perhaps one fact will strike us as symptomatic of what we have been reviewing, namely, the enormous care bestowed by Nature on the processes both of destruction and of storage. She is as minute and careful, as generous in her intentions, and as lavish in breaking down what she has created as she was originally in building it up. The subsoil is called upon for some of its water and minerals, the leaf has to decay and fall, the twig is snapped by the wind, the very stem of the tree must break, lie, and gradually be eaten away by minute vegetable or animal agents; these in turn die, their bodies are acted on by quite invisible fungi and bacteria; these also die, they are added to all the other wastes, and the earthworm or ant begins to carry this accumulated reserve of all earthly decay away. This accumulated reserve—humus—is the very beginning of vegetable life and therefore of animal life and of our own being. Such care, such intricate arrangements, are surely worth studying, as they are the basis of all Nature's farming and can be summed up in a phrase—the Law of Return.

We have thus seen that one of the outstanding features of Nature's farming is the care devoted to the manufacture of humus and to the building up of a reserve. What does she do to control such things as insect, fungous, and virus diseases in plants and the various afflictions of her animal kingdom? What provision is to be found for plant protection or for checking the diseases of animals? How is the work of mycologists, entomologists, and veterinarians done by Mother Earth? Is there any special method of dealing with diseased material such as destruction by fire? For many years I have diligently searched for some answer to these questions, or for some light on these matters. My quest has produced only negative evidence. There appears to be no special natural provision for controlling pests, for the destruction of diseased material, or for protecting plants and animals against infection. All manner of pests and diseases can be found here and there in any wood or forest; the disease-infected wastes find their way into the litter and are duly converted into humus. Methods designed for the protection of plants and animals against infection do not appear to have been provided. It would seem that the provision of humus is all that Nature needs to protect her vegetation; and, nourished by the food thus grown, in due course the animals look after themselves.

In their survey of world agriculture—past and present—the various schools of agricultural science might be expected to include these operations of Nature in their teaching. But when we examine the syllabuses of these schools, we find hardly any references to this subject and nothing whatever about the great Law of Return. The great principle underlying Nature's farming has been ignored. Nay more, it has been flouted and the cheapest method of transferring the reserves of humus (left by the prairie and the forest) to the profit and loss account of Homo sapiens has been stressed instead. Surely there must be something wrong somewhere with our agricultural education.

Sir Albert Howard (1873–1947) often is referred to as the father of modern organic agriculture. He noted the relationship between the rise and fall of civilizations and their agricultural practices. In 1905, with his wife Gabrielle, he began work as an agricultural advisor in Indore, India. There he observed the local farmers' methods of cultivation. It was in India that he learned and began promoting composting methods that returned nutrients to the soil. Howard went on to document and develop organic farming techniques, and he spread his knowledge through the United Kingdom–based Soil Association and the Rodale Institute in the United States. His 1940 book An Agricultural Testament is a classic organic farming text. His work influenced and inspired many farmers and agricultural scientists who furthered the organic movement, including Lady Eve Balfour and J. I. Rodale.

You Are What You Eat: Human Health and Soil Life

BY ELAINE INGHAM

Facts:

1. A complex web of life exists on *all* plant surfaces, both below and above ground.
2. Soil is not soil if beneficial organisms are missing.
3. Microbial foods (otherwise known as organic matter) must be present at high levels to feed and keep those beneficial organisms active and functioning.
4. When people touch or eat plants, beneficial organisms should be present on that food to help replenish the organisms needed for normal human digestion and uptake of nutrients.

Beneficial soil organisms promote plant growth through a number of functions, such as:

1. Reducing pests and diseases (so pesticides aren't needed).
2. Making nutrients available to the plant right around the roots (so inorganic fertilizers aren't needed).
3. Building soil structure so the plants' roots can go deep into the soil instead of being forced to go sideways.
4. Preventing leaching of soil nutrients and organic matter.
5. Remediating toxic materials in the soil that might harm desired plants.

Soil is a living entity. All sorts of organisms—each doing highly specific things for plants—are present in soil. These organisms are required to keep plants healthy.

Any disturbance of the soil impacts the organisms in that soil, and many will be killed. Any time soil is mixed, moved, or amended with something toxic, or when temperatures fluctuate outside the normal, that is a disturbance.

Are all disturbances bad? It depends . . . from a weed's point of view, a disturbance that kills microbes that prevent weed seeds from being able to germinate or grow would be a good thing. But from a farmer's point of view

that disturbance would be a bad thing, because suddenly there are a million weeds competing with the crop. On the other hand, a disturbance—such as tillage or plowing that breaks up compaction—could be a good thing if the increase in oxygen moving into the dirt results in the beneficial microbes being able to grow and outcompete the "bad guys." But tillage will also slice, dice, and crush beneficial organisms, leading to compaction deeper in the soil, and ultimately a loss of oxygen in the soil. Thus, disturbance can result in exactly what we want, or disturbance can wipe out the improvements we were trying to achieve.

Soil that is constantly and continually disturbed loses all the beneficial organisms needed to promote healthy plant production. Loss of life converts soil into dirt. Weeds adore dirt; diseases adore dirt; many pests require dirt in order to flourish.

How do we turn dirt back into soil? Because of the years of abuse, step one must be replenishing the proper organisms and soil life so that the processes required to convert dirt back into soil can be carried out. Problem organisms (diseases, pests, parasites) are rapidly outcompeted, consumed, and inhibited by the conditions that promote beneficial organisms.

What are these organisms, and how can the conditions that promote beneficial organisms be made? The organisms needed are not just one or two species of bacteria, fungi, protozoa, nematodes, microarthropods, earthworms, enchytraeids, spiders, and macroarthropods, but rather hundreds to thousands of species of each group. For readers who want to delve into these organisms and learn more about how to promote them and which ones are needed for which jobs, please check our websites—soilfoodweb.com and environmentcelebration.com—or a host of other sites you can search just by typing in "soil fungi," for example, or "beneficial soil nematodes."

But now let's move on to how these beneficial soil organisms affect human health.

Facts:

1. A complex web of life exists on *all* human surfaces, including exterior (e.g., skin, hair, lips) and interior surfaces (e.g., the digestive system containing the gut microbiome).
2. Each habitat on and in the human body requires different communities of organisms to work with the human body to result in healthy individuals.

3. Humans cannot be healthy if beneficial organisms are lacking on their surfaces.
4. Exudates, or food for microorganisms, are released from all the surfaces of the human body, just as exudates are released from all surfaces of plants. These foods select for the growth of beneficial microorganisms on all these surfaces, if the beneficial organisms are present.
5. People need to eat foods that have beneficial organisms present on their surfaces to constantly replenish these needed microbes on all body surfaces.
6. Historically, both agronomic and medical practices have negatively impacted, if not completely destroyed, the microbes critical to the healthy function of soil and humans. Both plant and human health have been severely compromised as a result.
7. Instead of sterilizing soil and food, the conditions that select for beneficial organisms and against disease organisms both in soil and on food surfaces need to be recognized.

The human microbiome operates just like soil. Both root exudates and gut exudates select for the different organisms that perform the functions the root or gut require. Each part of the digestive system requires different organisms, that is, different bacteria, fungi, protozoa, and even nematodes, each doing highly specific things in each different habitat, just as we find in soil. The point of all of this is to keep people, and plants, healthy.

Any disturbance will impact the organisms present in that system. For example, when a person consumes something toxic to the organisms in the digestive system, such as an antibiotic, a large dose of alcohol, food laced with heavy metals, or water with high levels of human pathogens, the gut biology will be affected.

Are all disturbances bad? Again, it depends. Alteration in gut microflora can result in highly unpleasant symptoms, including vomiting, severe cramps or upset stomach, to much less severe symptoms, such as a bout of diarrhea. To return gut function to normal will require replenishment of the right biology.

If returning to balanced, normal function requires replenishing the gut microbiome, from where, exactly, do we obtain that set of organisms? Which food should be eaten to replenish the organisms that were lost?

As a result of chemical agriculture, most of the foods people eat are essentially sterile, due to the use of preservatives, antibiotics, antimicrobial pesticides, herbicides, and use of storage conditions that microbes cannot survive (nitrous oxide atmosphere in the lettuce bag for example, or irradiation with UV light). And given that most food is no longer raised in soil, the nutrition in our chemically raised food is sadly out of balance and inadequate to maintain human health.

How can we predict if the food eaten will negatively or positively affect digestive system function? There is much yet to be discovered in this nascent science of understanding the interaction between the human digestive system and the organisms present in the system. If certain beneficial organisms are not present in the digestive system for some reason, then what foods, raised in which type of soil, with which microorganisms, need to be consumed?

Take-home message? We must learn to work with nature. Nature needs to be understood, not beaten down, not conquered. And to understand human health, we must understand soil.

Dr. Elaine Ingham currently is founder, president, and director of research for Soil Foodweb Inc., a business that grew out of her Oregon State University research program. Elaine holds a BA in biology and chemistry, an MS in microbiology from Texas A&M University, and a PhD in microbiology from Colorado State University. She has worked as managing scientist at Environment Celebration Institute, and chief scientist for the Rodale Institute, and was a faculty member at Oregon State University. She and her husband, Russ (who also holds a doctorate in zoology from Colorado State University) live in Corvallis, Oregon.

Essential Minerals: Cover Crop Workshop, Emporia, Kansas

BY COURTNEY WHITE

It must have looked silly. Twelve of us were hunched over in a corn field under a blazing July sun, a few miles north of Emporia, Kansas, swishing butterfly nets among the corn stalks like deranged collectors chasing a rare breed of insect—deranged because it was a record-breaking 105 degrees! The federal government announced two days before I arrived that the Midwest was in the grip of the worst drought since 1956. Legions of farmers had begun plowing under or chopping up their stunted corn and soybean crops, already writing off the year as a complete failure. There we were, however, swishing our nets back and forth fifty times in a good-looking corn field owned and farmed by Gail Fuller, with nothing between us and the blazing sun except our determination to follow instructions and find spiders.

We found lots of spiders.

Back under the shade of a large oak tree, we handed our nets to our instructor, an affable entomologist with the U.S. Department of Agriculture, who searched through them enthusiastically, pulling out spider after spider with his bare fingers (most spiders are poisonous, he told us, but very few can pierce human skin). Peering over his shoulder, I was amazed not only by the quantity of spiders in my net but by their diversity. I never knew so many odd-looking spiders existed! And who would have expected it from a corn field, in a record drought, during midday heat . . . which was exactly the point of the exercise, of course.

In a conventionally managed, monocropped Midwestern corn field, planted with genetically modified (GM) seeds, fertilized with industrially produced nitrogen, and sprayed with synthetic chemicals, there would be no spiders, the entomologist told us—drought or no drought. There wouldn't be much of anything living, in fact, except the destructive pests that could withstand the chemicals. The corn field we had just swept, however, was different, and I knew why. Fuller's field was no-tilled, it had a cover crop

(and moisture in the soil as a result), it didn't use GM seeds, its corn coexisted with a diversity of other plants, and livestock were used to clean up after the harvest—all the things I had learned in my travels so far.

All in one field, all under a broiling sun.

Seeing them together, however, wasn't the reason I had driven across humid Kansas in mid-July. I came to hear Jill Clapperton—an independent soil scientist and cover-crop specialist—and to ask her a question: What happened to the nutrition in our food? And a second one: How can we get it back?

These questions first formed in my mind two years earlier, when I heard pioneering Australian soil scientist Christine Jones say at a conference that it was possible to buy an orange today that contained *zero* vitamin C. As in zilch. It got worse. In Australia, she continued, the vitamin A content of carrots had dropped 99 percent between 1948 and 1991, according to a government analysis, and apples had lost 80 percent of their vitamin C. She went on to say that according to research in England, the mineral content of nearly all vegetables in the United Kingdom had dropped significantly between 1940 and 1990. Copper had been reduced by 76 percent, calcium by 46 percent, iron by 27 percent, magnesium by 24 percent, and potassium by 16 percent. Furthermore, the mineral content of U.K. meat had dropped significantly over the same period as well—iron by 54 percent, copper by 24 percent, calcium by 41 percent, and so on.

This is important because all living creatures, humans included, need these vitamins and minerals to stay strong and healthy. Iron, for example, is required for a host of processes vital to human health, including the production of red blood cells (hemoglobin), the transportation of oxygen through our bodies, the conversion of blood sugar to energy, and the efficient functioning of our muscles. Copper is essential for the maintenance of our organs, for a healthy immune system, and to neutralize damaging "free radicals" in our blood. Calcium, of course, is essential for bone health. And every single cell in our body requires magnesium to function properly. Vitamins are organic compounds, by the way, composed of various chemicals and minerals, including carbon.

A deficiency or imbalance of these minerals (necessary to us only in small amounts) can cause serious damage to our health, as most people understand. That's why taking vitamin pills has become such a big deal—

and big business—today, especially where young children are concerned. But few people stop to think about why we need vitamin pills in the first place. It's not simply because we don't eat our veggies, or because we drink too much soda, but because *the veggies themselves* don't have the amount of essential nutrients that they once did. As Jones quipped, for Aussies today to gain a comparable amount of vitamin A from carrots that their grandparents could, they'd have to eat themselves sick.

How did this happen? Well, the quick answer is that industrial agriculture happened. The hybridization of crops over the decades for production values—yield, appearance, taste, and ease of transport—has drained fruits and vegetables of nutrients. But the main culprit is what we've done to the soil. As a consequence of repeated plowing, fertilizing, and spraying, the top few feet of farmland soil has been (1) leached of its original minerals and (2) stripped of the biological life that facilitates nutrient uptake in plants. Some farms, especially organic ones, resupply their soils with mineral additives, but many farms do not, preferring to rely on the Big Three—nitrogen, potassium, and phosphorus (NPK)—to keep the plants growing. According to the industrial mind-set, as long as crops are harvestable, presentable, digestible, and profitable, it doesn't matter if their nutrition is up to par. If there's a deficiency, well, that's what the vitamin pills are for!

However, it was the next thing that Jones said that spun my wheels. There was another way to remineralize our bodies without having to rely on pills or their corporate manufacturers: restore essential elements the old-fashioned way—with plant roots. With carbon, specifically. Building humus by increasing the amount of carbon in the soil via no-till agriculture, planned rotational grazing, and other practices that stimulate mycorrhizal fungi/root activity and the production of glomalin, she said, would (1) increase the availability of potassium, calcium, phosphorus, sulfur, copper, zinc, iron, magnesium, and boron to plant roots (which are good for plants); (2) reduce availability of sodium and aluminum (which are bad for plants); and (3) increase the pH in the soil (from acidic to neutral—good for everything).

Access to these essential minerals in combination with carbon means vitamins and other types of nutrients, including acids, carbohydrates, fats, and proteins, can be produced within a plant.

One key to building soil carbon on farms is cover crops—plants that keep the land covered with something green and growing at all times, even in winter. I went to Kansas to find out more.

Clapperton, who hails originally from Canada but lives today on a Montana ranch, told the workshop audience that the key to rebuilding soil health is to start a "conversation among plants." Cool-season grasses (such as barley, wheat, and oats) and cool-season broadleaf plants (such as canola, pea, turnip, lentil, radish, and mustard), she said, need to dialogue constructively with warm-season grasses (including millet, corn, and sorghum) and warm broadleafs (such as buckwheat, sunflower, and sugar beet). Who gets along with whom? Who grows when? Who helps whom? If you can get these plants engaged in a robust conversation in one field, she said, you'll be creating "a feast for the soil." That's because increased plant diversity, as well as year-round biological activity, absorbs more CO_2, which in turn increases the amount of carbon available to roots, which feeds the microbes, which builds soil, round and round.

This is exactly what happened on Fuller's farm. When he took over the operation from his father they were growing just three cash crops: corn, wheat, and soybeans. Today, Fuller plants as many as fifty-three different kinds of plants on the farm, mostly as cover crops, creating what Clapperton called a "cocktail" of legumes, grasses, and broadleaf plants. He doesn't apply any herbicides, pesticides, or fertilizers either, despite the recommendations of his no-till neighbors and chemical manufacturers who advise them. That's because Fuller considers "weeds" to be a part of the dynamic conversation as well. Besides, chemicals kill life, Clapperton reminded us, including spiders, dung beetles, and even grasshoppers.

As a result of this big, robust conversation, Clapperton said, the carbon content of the soil on the Fuller farm has doubled from 2 percent in 1993 (when they switched to no-till) to 4 percent today. That's *huge*. But what about the mineral content of Fuller's crops?

That's risen dramatically too, she said, and it's done so for two reasons: First, no-herbicide/no-pesticide no-till means the microbial universe in the soil remains intact and alive, and if the soil dwellers have enough carbon (as an energy source) they will facilitate the cycling of minerals in the soil, especially earthworms, who are nature's great composters. Second, a vigorous and diverse cover of crops will put down deeper roots, enabling plants to access fresh minerals, which then become available to everything up the food chain, including us. And by covering the soil surface with green plants, or litter from the dead parts, Clapperton said, a farmer like Fuller traps moisture underground, where it becomes available for plants and

animals (of the micro variety), enabling roots to tap resources and growing abundant life.

"Aboveground diversity is reflected in belowground diversity," she said. "However, soil organisms are competitive with plants for carbon, so there must be enough for everybody." Predator-prey relationships are also important to nutrient cycling, she said. Without hungry predators, such as protozoa and nematodes, the bacteria and fungi would consume all the nutrients in the soil and plants would starve. Predators aboveground play a positive role too, including spiders and especially the number one predator, ants!

So exactly how do minerals get into plants? There are two principle paths: First, minerals can dissolve in water, and when the water is pulled into the plant through its roots, the minerals are absorbed into the cells of plant tissue. Whichever minerals the plant doesn't need (or doesn't want) will remain stored in the cells. Second, mineral nutrients can enter a plant directly by being absorbed through the cell walls of root hairs. Some minerals, such as phosphorus, can also "hitch a ride" with mycorrhizal fungi, which then "barter" them for carbon molecules from the plant roots. Of course, if there aren't any minerals in the vicinity, no uptake into plants is possible!

It all begins with a dynamic conversation at a cocktail party for plants—where everyone is gossiping about carbon!

Standing under the oak tree at the end of the workshop, after we had oohed and aahed over a giant wolf spider someone discovered under a shrub, Clapperton reminded us why using nature as a role model—for cover crops in this case—was so important: We need to recycle nutrients, encourage natural predators to manage pests, and increase plant densities to block weeds, which in a natural system are all integrated and interconnected strategies.

This reminded me of something the great conservationist Aldo Leopold once wrote:

> *The black prairie was built by the prairie plants, a hundred distinctive species of grasses, herbs, and shrubs; by the prairie fungi, insects,*

and bacteria; by the prairie mammals and birds, all interlocked in one humming community of cooperations and competitions, one biota. This biota, through ten thousand years of living and dying, burning and growing, preying and fleeing, freezing and thawing, built that dark and bloody ground we call prairie.

One biota. With carbon at its core.

Courtney White, a former archaeologist and Sierra Club activist, dropped out of the "conflict industry" in 1997 to cofound the Quivira Coalition, a nonprofit dedicated to building bridges between ranchers, conservationists, and others around practices that improve economic and ecological resilience in western working landscapes. He is the author of Revolution on the Range, The Age of Consequences, and The Indelible West, a collection of black-and-white photographs with a foreword by Wallace Stegner. He lives in Santa Fe, New Mexico, with his family and a backyard full of chickens.

BUILD SOIL

an excerpt

By Robert Frost

. . . Plant, breed, produce,
But what you raise or grow, why feed it out,
Eat it or plow it under where it stands
To build the soil. For what is more accursed
Than an impoverished soil pale and metallic?
What cries more to our kind for sympathy?

From A Further Range (1936)

SLOW MONEY PRINCIPLES

1. We must bring money back down to earth.

2. There is such a thing as money that is too fast, companies that are too big, finance that is too complex. Therefore, we must slow our money down—not all of it, of course, but enough to matter.

3. The 20th century was the era of Buy Low/Sell High and Wealth Now/Philanthropy Later—what one venture capitalist called "the largest legal accumulation of wealth in history." The 21st century will be the era of nurture capital, built around principles of carrying capacity, care of the commons, sense of place, diversity, and nonviolence.

4. We must learn to invest as if food, farms, and fertility mattered. We must connect investors to the places where they live, creating healthy relationships and new sources of capital for small food enterprises.

5. Let us celebrate the new generation of entrepreneurs, consumers, and investors who are showing the way from Making a Killing to Making a Living.

6. Paul Newman said, "I just happen to think that in life we need to be a little like the farmer, who puts back into the soil what he takes out." Recognizing the wisdom of these words, let us begin rebuilding our economy from the ground up, asking:

   What would the world be like if we invested 50 percent of our assets within 50 miles of where we live?

   What if there were a new generation of companies that gave away 50 percent of their profits?

   What if there were 50 percent more organic matter in our soil 50 years from now?

These principles have been signed by tens of thousands of individuals as part of a new public conversation and an accompanying process of local investing. To learn more, go to slowmoney.org.

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