On Building a Regenerative Economy

by Dorn Cox

Growing up, I had always heard that farming was something to get away from, and so I did. After studying international agriculture and economics at Cornell University, I did not return to my family's diversified organic farm in New Hampshire where I grew up, but worked in technology and finance in New York City, Buenos Aires and Hong Kong. And yet I was not happy. Looking back at a note I wrote myself while on a hydrofoil to Macau, "I deeply miss my farm and my family." It turned out that the farm had never stopped being part of me, and so, 10 years ago, I left the cities, met my wife and returned to the land where four generations of my family now live and work.

New Hampshire is the "live-free-or-die" state, known for the independent spirit of its citizens. At one time in the 1830s, two towns raised more sheep than are raised in all of New England today. Wheat fields stretched for thousands of acres and fed its citizenry and cities. Despite this independent heritage, New Hampshire is now one of the most dependent states in the union, relying on imported food and fuel, and growing only about 5 percent of its needs. More than 60 percent of homes heat with oil, and yet a common complaint in one of the most forested states in the nation is the high cost of oil and the low price for wood. We have abundant rainfall, a climate in which a field reverts to brush in a few years and forest in just decades. New Hampshire has 40 percent of its land area in agricultural soils, yet farms only 10 percent and less than one-third of one percent of the population is engaged in managing the land. It seems to me a cultural paradox: With abundant, fertile land (with a few rocks), plenty of water and capable people, how can we not make an independent, abundant living with the land?

Winter rye being rolled as a weed suppressing mulch before planting no-till sweet corn (without herbicides).

Ten years ago, as I reintroduced myself to the farm I grew up on and began contemplating this question, it was clear that there was greater potential. The land wanted to grow, but conventional agriculture had discarded it as uneconomic. Like so many farmers across the country, our neighbors in New Hampshire joked about selling wholesale, buying retail and paying freight both ways. Although it was always said in jest, it was also a sad indictment of established practices as these farms struggled to survive. I knew that there must be other ways to approach this paradox, and I was sure that, if I was going to be able to make our farm work, this was not a model I wanted to follow. At the time, I was drawn back to the land by a need to be connected to something more real, and a belief that my work with complex systems analysis, finance and project management, and building networked enterprises based on open source software might help in managing our family's land. Although I found my experience helpful, I also found that none of what is called "high tech" comes close to the wonderful complexity of agricultural systems.

My first project was to work on minimizing our farm's inputs, which were, in fact, bought as retail electricity and fuel. I had been interested in pursuing a career in the energy development field after college but became frustrated at the time because energy was just a pseudonym for "petroleum" and "utilities" with very little room for innovation. However, many years later, when I started researching energy options for our farm, I was immediately attracted to the idea of biodiesel because the entire process, from field to fuel tank, could be scaled to a single farm. It could thus enable our operation not just to buy wholesale, but to grow the feedstock on site and bypass the entire global supply chain. In Argentina, I had seen fields of sunflowers growing in a similar climate and thought, "Why not try some varieties here and see how they do?" After a brief discussion with Cooperative Extension at the University of New Hampshire, plots were planted, combines worked on and an oilseed press secured. In the first year, 2002, we grew a sunflower crop that produced 60–80 gallons of oil per acre, and a 30 percent protein meal that was a by-product of pressing the oil on farm. It was very exciting to produce both high quality cooking oil that could then be used for fuel as well as feed for animals. The entire supply chain was within the farm, and we certainly seemed to be making progress away from buying retail.

However, as we explored the larger agricultural system, it soon became clear that biofuel was only a small piece of the puzzle. Because the entire field to food to fuel process was not spread across the globe, I was able to look at all of the energy input costs directly and see that the long term profitability of this fuel in our operation was directly related to the energy that was put into growing the crop, and that was directly related to the health of our soil. Heavy tillage was one of the greatest energy inputs for the whole farm system and the challenges—dragging heavy iron implements through our rocky soil with big horsepower—were clearly not well suited to my goal of having the end products yield more energy than they needed to grow. In my second season of growing oil seeds with conventional tillage, I came across the work of some Pennsylvania farmers who were demonstrating organic no-till techniques by planting directly into rolled cover crop mulches. The potential was to drastically reduce the number of passes over the field, and even to reduce the energy of those fewer passes.

In studying the no-till literature, it was clear that the benefits were not just energy savings but also enhanced soil health. While traditional plowing provides a quick flash of nutrients to the plants that growing season, it also releases carbon to the atmosphere and reduces the future capacity of the soil. I had not previously been focused on the energy value of the carbon stored in our soil, and it soon became clear to me that, if I were going to have our farm achieve the goal of being truly profitable in a biological sense, we could not do it at the expense of the topsoil. Because the process doesn't depend on loosening soil, the added benefit of working with cover crops that are mulched and not tilled is that the rockiness or depth of the soil isn't so important. Rocks and old weed seeds are buried rather than brought up to the surface.

I had now identified that everything that we were growing on the surface was actually peripheral to our farm's more central role of preserving and building healthy soil in order to remain viable into the next century and beyond. A new, soil-centric approach to farming emerged: Take care of the soil and deposit more carbon than you take out so the soil will be more resilient and provide a more regular return, no matter the crop.

As I started growing more oil seeds, including canola, mustards and sunflowers, all required at least a three-year rotation in order to break pathogen cycles and maintain yield. Grain crops were the logical rotation to introduce before going back into forages and oilseeds. This was daunting, however, given that grain had not been grown in our area since the Civil War when it was

harvested by hand. As much as adding grain made sense, my farm operation was also getting more complicated. There was clearly too much trial and error for one farm to bear, and it therefore became important to find other farmers willing to share the risk in developing new growing techniques, skills and infrastructure that would reduce production costs while also producing new high value products that could be sold locally at retail prices.


Sweet corn.

Several farmers stepped up to take on pieces of the puzzle, and, with the help of USDA/NRCS, we were able to improve cover cropping for nitrogen and weed suppression and begin building experience with no-till and low-till planting in New Hampshire. The group of farmers, loosely organized as the Great Bay Grain Cooperative, also exchanged knowledge and added farm-built infrastructure from cleaning grain and providing storage to finding more combines, oilseed presses and gristmills. As a group, we continue to build the skills that will allow us to grow more of our own inputs (rather than buy retail) and sell at retail prices. Since most transactions are on-farm or local, shipping costs are also dramatically reduced.

But the quest is far from over, and the complexity and importance of this approach continues to expand as we attempt to close biological loops and localize technology. It will not happen overnight, but we are gradually able to replace products otherwise produced by multibillion-dollar, global supply chains—from processed grain and animal feeds, to biodiesel catalyst, to nitrogen fertilizer, to the fuel that powers our tractors. As we learn more about how our agricultural systems work, the importance of the relationships with other farmers and the wider community is also exposed. The project of localizing and understanding these systems is beyond any one individual: Only by collaborating and sharing knowledge, tools, designs and seeds have we made progress.

As we delve deeper into what makes our soil and farm work, we are exposing an economics that is greater than the agricultural economics or even the ecological economics I studied at Cornell. I feel that, for the first time, our family farm is on the edge of a regenerative economy, which links us to our customers, to other farmers and to the land. On our farm I can see living economic growth express itself when grazing patterns match the growth cycles of the forage, when grain prospers following a legume cover crop and when earthworms in the soil are abundant. I believe that this is the true economy that each and every one of us can feel as we struggle to reconcile stock market reports or futures prices with the reality we experience. Each individual life—from soil fungi, to cow, to grains, to humans—will not survive individually in this larger economy, yet cumulatively this living economy has already grown and transformed a hot environment of methane and rock to a cooler one of oxygen, nitrogen, carbon, water and deposits of topsoil—a living skin—which we have the privilege of contemplating and improving.

We are starting to see that we can create abundant yields while adding soil, a process that reveals a truly empowering role for the agrarian. It is through our understanding and actions that we can cause the natural economy to function at a higher rate. I see the surplus from the abundance we intentionally grow as the basis for a "regenerative economy." Without the agrarian, pH would not be adjusted, geological compacted layers alleviated or phosphorus freed from the

soil with cover crops. With the same industriousness that has reduced diversity and resilience in our landscapes, so, too, can we on our farms introduce diversity, resilience, health and the abundance of true biological profitability.

This is by no means a new idea, but, as Samuel Johnson said in 1750, "mankind more often needs to be reminded than informed." As I started to explore the relationship between the productivity of the soils on our farm, the amount of fuel that we could produce from the woods and oilseeds and how the nutrients cycled, I came across the writings of François Quesnay, a prominent pre-French Revolution economist and physician, who recognized that blood in the body circulates rather than is consumed by the organs as was previously thought; this led to his insight that agricultural commodities might circulate through an economy like blood through a body. This first study of economics, later called physiocracy—loosely translated to "Government of Nature"—was the basis of Adam Smith's better-known work, The Wealth of Nations. These 18th century economists were describing a regenerative economy when they wrote that all wealth originated with the land, making farming the only truly productive enterprise; all other work was seen as extraction or transformation of the original value created by the farmer. Discovering this writing once again shifted how I thought about the land we manage and how I thought of myself in relation to all other professions. This revelation also carried with it responsibility for the stewardship and improvement of the primary resource responsible for creating growth and abundance in a regenerative economy.

This hairy vetch will provide the nitrogen needs for the 2012 corn crop. It was drilled directly into hay sod and established without herbicides.

We create the regenerative economy to produce biological abundance

Beyond just words on a page, I could finally see the accumulation of topsoil, coal and oil as a biologically produced carbon bank, proof of past growth of the living economy; it represents the accumulated surplus of life on earth and on our own farm. Each plant and animal in its life and as a species has played a role with an absolute profit and loss expression. If it prospers, it grows, thrives and reproduces as it collects, retains and exchanges nutrients from the environment; but all succumb to entropy in the end. The magic of the living economy is that where there was just one life, through seeds and eggs, there is the potential for many. Where there was just some carbon deposited in the soil as a surplus from the last life, there is a little more.

It is this simple accounting process of changing the soil that is observable in just a single season, and, unlike my electronic deposits in the bank, the deposits of surplus organic material into the carbon bank show a natural form of compound interest, and a natural and real return on investment. I can clearly see that as I Invest one seed I get one hundred back, and that as I return the residue, nutrients are circulated like blood through a body and soil responds like a muscle being used. When one seed is invested the following season, and one hundred twenty seeds are returned, I can observe true compound interest based on the universal asset of life: carbon. And, like any farmer, I can also feel the sense of satisfaction in knowing that the increase in return and the surplus added back to the soil has been truly earned, and has not simply extracted from the millions of lives before us.

I was so taken by these revelations and the potential for returning carbon to the soil that I did some simple calculations. If the degradation and loss of soil carbon since 1750 in the form of organic matter, coal and oil transformed into 246 billion tons of carbon in the atmosphere were instead transformed into new soil, it would create 10 percent organic matter six inches deep across the 2.3 billion acre Sahara, or about 46 percent organic matter soil 8 feet deep across the 32 million acres of active cropland in the United States.

No-till planter seeding directly into mulched hairy vetch.

More knowledge spread across more people is critical to the growth of the regenerative economy

I left my last corporate job partly because I believed that our software would be more successful if we were to share the source and then develop the business around our own expertise. With networked communications technology we are in a better position to share knowledge than in any other period in the history of our planet. I feel lucky and privileged to live in a time when we can share, store and exchange complex ideas just as effectively as a saved seed documents the millions of years leading to its successful development. In my quest to develop our farm's first biodiesel processor and through my professional technology work, I became exposed to collaborative, open source documentation methods used to share the small "appleseed" biodiesel processors. Since then, the complexity of my farming operation and diversity of technology would be unmanageable without the free flowing exchange of information with farmers and engineers in online communities. I believe that open source knowledge sharing will revolutionize agriculture just as Wikipedia has revolutionized the encyclopedia. The beginnings of this exchange can be seen in the growing resource of do-it-yourself instructions posted on sites like *Instructables.com*; images of tools being fixed and used on YouTube; and in the documentation of mass customization and repurposing technology in publications like *Make* or *Farm Show* magazines.

As with so many operations, the tools on our farm must be increasingly flexible and responsive to rapid changes on the ground as we push and refine the boundaries of agricultural knowledge. Often what is needed is not commercially available. This past season I found The National Young Farmers Coalition's Farm Hack project (*www.farmhack.net*) and our farm hosted one of the very first on-farm hacking (problem solving) workshops, bringing together farmers and engineers to brainstorm, document and publish designs. I now post many of my own projects, including the mobile biodiesel processor and an oat dehuller. Other posts include greenhouse temperature, water level and electric fence monitoring systems that text a cell phone when they need attention. Each of these was an innovation generated by a farmer who was sharing his or her explorations and knowledge.

Accelerating the accumulation and exchange of knowledge

As the diversity and complexity of cropping systems have increased on our farm, monitoring and feedback systems have increased in value. While we must still rely on our own eyes and other senses, we are no longer limited to what we can humanly see, feel and remember. With low cost technology, we can now measure quickly

and inexpensively levels of soil respiration, photosynthetic activity, aggregate stability, water capacity and mineralizable nitrogen.

I regularly use Cornell's soil health test (*http://soilhealth.cals.cornell.edu*), and this spring I expanded the ability to monitor biological activity on my farm by collaborating with Farm Hack and PublicLaboratory (*http://publiclaboratory.org*). Public Labs is an open source community which develops and shares appropriate ultra low cost observation technology, and I had interesting results after using these sites. I noticed in some fields that locally produced wood ash greatly improved no-till vetch drilled into a living hay sod, and thought the results would be more clearly visible from overhead. This was a very exciting trial because the use of wood ash could provide a year's nitrogen needs from the atmosphere while adding tons of carbon to the soil with very little input. A 10-minute flight with Public Labs' open-source, $100-balloon- mounted camera and associated post processing yielded data that would otherwise have taken weeks of labor to collect. Just a few weeks later we were able to document more fields using a camera mounted in a remotely-controlled aircraft that cost only $200.

I believe that our farm's interaction with communities like Farm Hack and Public Labs, along with participation in traditional cooperative extension events and collaborative research projects with other farms in our region, is as important as walking the fields each day. The number of new ideas that I can now assess and try has increased, and the risk of trying them is reduced. These communities provide a greater context in which to place my own observations, to document and share experiences, and to obtain feedback, which in turn spurs new ideas and approaches.

New agrarians and the heartbeat of the landscape

The revelation of this living economy has transformed the way I see myself as an agrarian. I no longer see an environment of scarce resources to be controlled and protected, but an environment of abundant resources with all the building blocks of life, a surplus of carbon and an abundance of nitrogen available in our atmosphere. By artfully managing the same biological systems that create a productive patch of soil from a sand lot, we can change the way we think about our most basic of natural assets. Agriculture should not be limited by statistics of current arable land, but by the question of where land can be created and improved from eroded and depleted expanses that stretch across the horizon. Seeing the limiting factor as knowledge rather than resources means that more people engaged within these systems can create a path to healthy landscapes, people and society. Reversing the negative language of limited resource consumption into the positive framework of human impacted growth and abundance creates hope, purpose, and direction: The regenerative economy has yet to be built, but it is within our capacity.

At the most basic level, building a regenerative economy is learning to make a life with land I love, sharing that experience with friends and neighbors, and recruiting new agrarians in the endeavor to build a biologically profitable economy by investing carbon in the soil and expanding natural abundance.

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